UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

19 FEB 2014

REPLY TO THE ATTENTION OF:

Mr. Roger Eberhardt
Acting Deputy Director, Office of the Great Lakes
Michigan Department of Environmental Quality
525 West Allegan
P.O. Box 30473
Lansing, Michigan 48909-7773

Dear Roger:

Thank you for your February 4, 2014, request to remove the "Restrictions on Fish and Wildlife Consumption" Beneficial Use Impairment (BUI) from the Deer Lake Area of Concern (AOC) in Michigan. As you know, we share your desire to restore all of the Great Lakes AOCs and to formally delist them.

Based upon a review of your submittal and the supporting data, the U.S. Environmental Protection Agency hereby approves your BUI removal request for the Deer Lake AOC. In addition, EPA will notify the International Joint Commission of this significant positive environmental change at this AOC.

We congratulate you and your staff, as well as the many federal, state, and local partners who have worked so hard and been instrumental in achieving this important environmental improvement. Removal of this BUI will benefit not only the people who live and work in the Deer Lake AOC, but all the residents of Michigan and the Great Lakes basin as well.

We look forward to the continuation of this important and productive relationship with your agency and the local coordinating committee as we work together to fully restore all of Michigan's AOCs. If you have any further questions, please contact me at (312) 353-4891, or your staff may contact John Perrecone, at (312) 353-1149.

Sincerely,

Chris Korleski, Director
Great Lakes National Program Office

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cc: Dan Wyant, Director, MDEQ
Jon W. Allan, MDEQ, Office of Great Lakes
Rick Hobrla, MDEQ, Office of Great Lakes
Stephanie Swart, MDEQ, Office of Great Lakes
Stephen Locke, IJC
Wendy Carney, EPA, GLNPO
John Perrecone, EPA, GLNPO
Mark Loomis, EPA, GLNPO

STATE OF MICHIGAN
OFFICE OF THE GREAT LAKES
LANSING

RICK SNYDER
GOVERNOR

JON W. ALLAN
DIRECTOR

February 4, 2014

Mr. Chris Korleski, Director
Great Lakes National Program Office
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard (G-17J)
Chicago, Illinois 60604-3507

Dear Mr. Korleski:

The purpose of this letter is to request the United States Environmental Protection Agency (USEPA), Great Lakes National Program Office's (GLNPO) concurrence with the removal of the Restrictions on Fish and Wildlife Consumption Beneficial Use Impairment (BUI) for the Deer Lake Area of Concern (AOC). The Michigan Department of Environmental Quality (MDEQ) has assessed the status of this BUI in accordance with the state's *Guidance for Delisting Michigan's Great Lakes Areas of Concern* and recommends that this final BUI be removed from the list of impairments in the Deer Lake AOC.

We have made minor changes to the document since the original submittal in November 2013. The edits are located on page 8 of the enclosed Removal Recommendation. All other documentation necessary for removal of the Restrictions on Fish and Wildlife Consumption BUI for the Deer Lake AOC has also been enclosed.

We value our partnership and look forward to working with the GLNPO on delisting this AOC. If you need further information concerning this request for the Deer Lake AOC, please contact Ms. Stephanie Swart, Office of the Great Lakes at 517-284-5046, or at swarts@michigan.gov, or you may contact me.

Sincerely,

Roger Eberhardt
Acting Deputy Director
517-284-5035

Enclosures
cc: Mr. Jon W. Allan, MDEQ
Mr. Richard Hobrla, MDEQ
Ms. Stephanie Swart, MDEQ
cc/enc: Mr. Marc Tuchman, USEPA
Mr. John Perrecone, USEPA

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

INTEROFFICE COMMUNICATION

TO: Lynelle Marolf, Deputy Director, Office of the Great Lakes

FROM: Rick Hobrla, Chief, Great Lakes Management Unit

DATE: November 15, 2013

SUBJECT: Removal of the Restrictions on Fish and Wildlife Consumption Beneficial Use Impairment for the Deer Lake Area of Concern

The Department of Environmental Quality, Great Lakes Management Unit, Areas of Concern (AOC) Program staff request concurrence with the recommendation to remove the Restrictions on the Fish and Wildlife Consumption Beneficial Use Impairment (BUI) in the Deer Lake AOC. This request is made in accordance with the process outlined in the *Guidance for Delisting Michigan's Great Lakes Areas of Concern*.

Attached is a Removal Recommendation documenting restoration and justifying removal of this BUI. Also attached is a draft letter to Mr. Chris Korleski, Director, Great Lakes National Program Office, United States Environmental Protection Agency, requesting removal of the BUI. The re-designation was discussed by the Deer Lake Public Advisory Council and the community at a meeting on November 5, 2013. As part of their continued support for this BUI removal recommendation, the Deer Lake Public Advisory Council submitted a letter on November 5, 2013.

Attachments
cc: Stephanie Swart, Office of the Great Lakes

Removal Recommendation
Restrictions on Fish and Wildlife Consumption Beneficial Use Impairment
Deer Lake Area of Concern

Issue

The Michigan Department of Environmental Quality (MDEQ), Office of the Great Lakes, Areas of Concern (AOC) program recommends removal of the Restrictions on Fish and Wildlife Consumption Beneficial Use Impairment (BUI) in the Deer Lake AOC. This recommendation is made with the support of staff from the MDEQ Water Resources Division, the Michigan Department of Community Health (MDCH), and the Deer Lake Public Advisory Council (PAC). This recommendation is made in accordance with the process and criteria set forth in the *Guidance for Delisting Michigan's Great Lakes Areas of Concern* (Guidance) (MDEQ, 2008).

Background

Deer Lake is a 1,010-acre impoundment located in central Marquette County near the center of Michigan's Upper Peninsula. The Deer Lake AOC includes a portion of Carp Creek, Deer Lake, and the Carp River. Carp Creek flows into Deer Lake at the middle of the South Basin. Deer Lake flows into the Carp River via the dam at the North Basin impoundment. The AOC terminates as the Carp River flows into Lake Superior near the city of Marquette, Michigan (Figure 1).

Historic mining practices resulted in mercury contamination to the Deer Lake basin from Ropes Creek and Carp Creek. According to the 1987 Remedial Action Plan (RAP), mercury contamination led to a fish consumption advisory in 1981 by MDCH for all species in the Carp River, Carp Creek, and Deer Lake Michigan Department of Natural Resources (MDNR).

Two BUIs -- Eutrophication or Undesirable Algae as well as Bird or Animal Deformities or Reproduction Problems -- have been assessed and removed (Swart, 2011a; Swart, 2011b). One BUI remains for the Deer Lake AOC: Restrictions on Fish and Wildlife Consumption. Additional historical information can be found in Attachment B and a timeline of activities in the AOC can be found in Attachment C.

Removal Criteria

The *Guidance* has three tiers which serve as removal criteria for the Restrictions on the Fish and Wildlife Consumption BUI, the third of which applies to the Deer Lake AOC. This BUI is considered restored when:

1. The fish consumption advisories in the AOC are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associated Great Lake or control site:

2. A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC, compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

3. Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

The attached excerpt from the *Guidance* (pages 14-18) includes the rationale for the delisting criteria (Attachment A).

Tier 3 of the *Guidance* is applicable to Deer Lake, as the fish advisory for the lake is more stringent than that of Lake Superior and there is not a suitable comparison site with similar characteristics. The BUI was evaluated based on an analysis of trend data for fish with consumption advisories as compared to other appropriate Great Lakes trend sites. The research supporting the recommendation to remove the Restrictions on Fish Consumption BUI demonstrates that there is a strong decreasing trend in fish tissue concentrations of mercury over the last 20 years as a result of elimination of primary sources of mercury to the lake.

It is expected that fish consumption advisories will remain in place for Deer Lake for the foreseeable future, as they do for all inland lakes in Michigan due to mercury contamination of fish tissue. The specific MDCH fish consumption advisories for Deer Lake are in Attachments G and H. Please refer to the MDCH *Eat Safe Fish Guide* for any fish consumption restrictions at www.michigan.gov/eatsafefish.

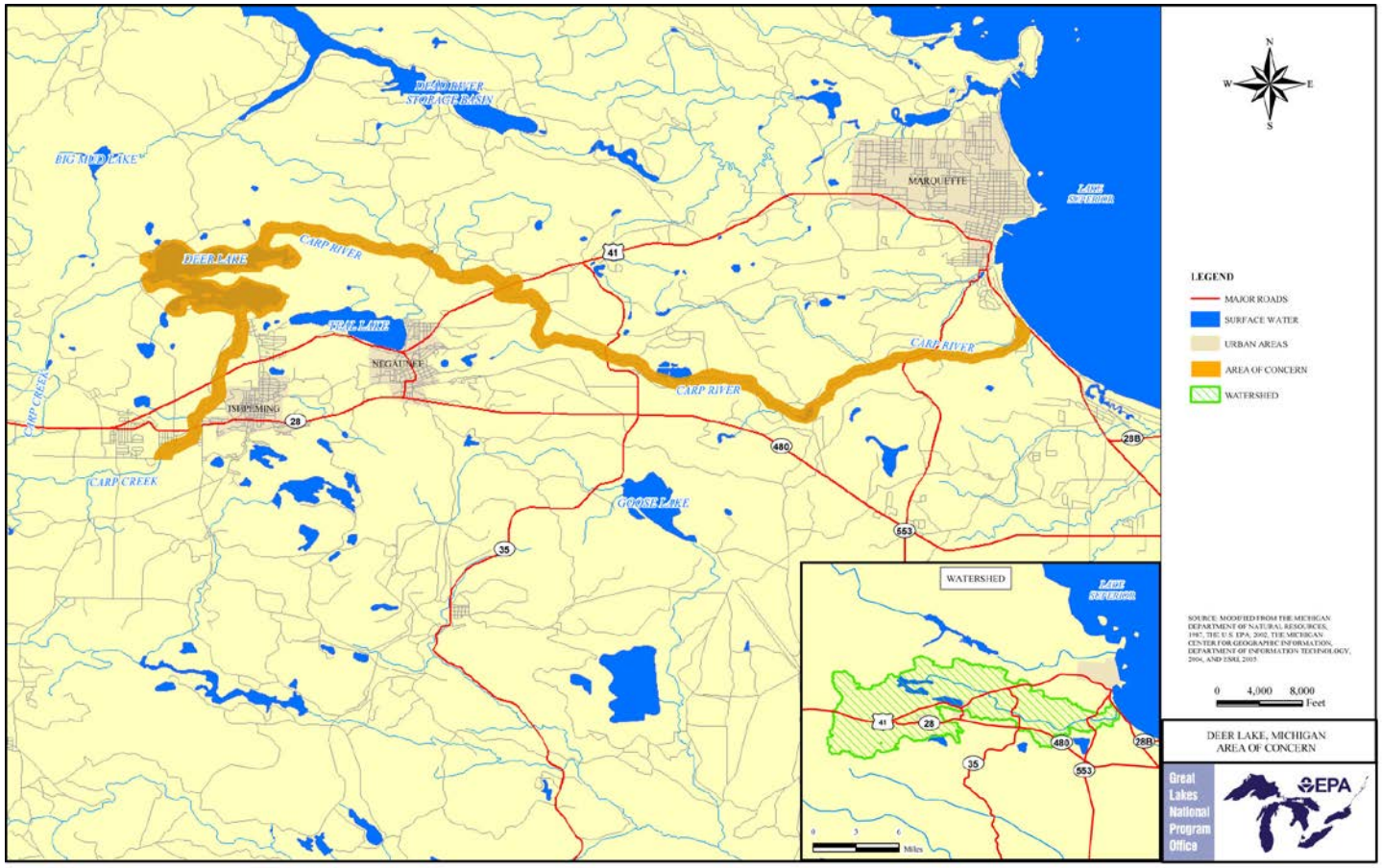

Figure 1. Deer Lake AOC Boundary

Analysis

Mercury inputs to the Deer Lake AOC primarily came from mining activities in the surrounding area. The Ropes Gold Mine, located northwest of Deer Lake, used a mercury amalgamation process to concentrate gold (MDNR, 1987). The tailings from this process remained in the watershed. The Cleveland-Cliffs Iron Company (now Cliffs Natural Resources [CNR]) disposed

of mercury reagents down drains that led to the city of Ishpeming's wastewater treatment plant, and Carp Creek. In 1970, the city of Ishpeming, in order to cope with wet weather events, diverted Partridge Creek from their storm water system into Cliffs Shaft Mine tunnels beneath the city. The diverted water picked up mercury, some of which came from used blasting caps, and transported it into Carp Creek. Ropes Gold Mine is no longer operational and other mining practices no longer take place. The controllable legacy mercury in the system has been remediated through source control and lake management activities.

The last controllable source of mercury to the lake, Partridge Creek, has been diverted from the Cliffs Shaft Mine into the city's storm water system. A 2006 Amendment to Consent Judgment commits CNR to maintaining Deer Lake at a minimum of 1,385 feet above sea level. This water depth has been determined to be the most effective long-term remedial approach for Deer Lake. At this depth methylmercury production is curtailed in sediments and thereby a bioavailable source of mercury to fish is minimized (ACJ, 2006).

An interoffice memo by the MDEQ estimated the total mercury load to Deer Lake via Carp Creek to be 241 grams per year (g/yr) and the estimated total from the surrounding watershed to be 314 g/yr (Staron, 2004). Approximately 46 percent of the load is the result of direct and indirect atmospheric deposition, while approximately 54 percent is from local sources.

The city of Ishpeming and the city of Negaunee's wastewater treatment plants each have a 12-month rolling average mercury limit of 10 nanograms per liter for discharge to Carp Creek. The largest remaining point source of mercury to the Deer Lake AOC was Partridge Creek, with an estimated 22.7 percent of the annual mercury load (Staron, 2004).

The MDCH and MDEQ have monitored mercury in fish in the Deer Lake AOC since 1984 (Bohr, 2013a). The evaluation of the Deer Lake AOC also informs the Fish Contaminant Monitoring Program for the MDEQ in conjunction with MDCH. The assessments were designed to focus specifically on Tier 3 of the Guidance described on page 1, analysis of trend data. The full scope and methods can be found in Attachment E.

Fish Tissue Assessment

Fish tissue concentrations of mercury have declined over the last 20 years in Deer Lake fish for which data is available. This includes northern pike, walleye, white sucker and yellow perch. The tissue concentrations are never expected to be zero given the atmospheric deposition of mercury to all inland lakes. Therefore, the assessment data below strongly support this BUI removal recommendation based on the established criteria (Attachment A).

Northern Pike

Mercury concentrations in northern pike declined between 1984 and 2011 at an average annual rate of 6.9 percent based on multiple regression results (Attachment E). In a standard sized 24-inch northern pike, estimated mercury concentrations declined from 2.3 parts per million (ppm) in 1988 to 0.9 ppm in 2011 (Attachment E). The estimated mercury concentration in a standard size northern pike has been stable since 2001.

Changes in mercury concentrations were also measured in northern pike collected in the Carp River Basin, downstream from Deer Lake. A t-test comparing similar sized northern pike showed that the mercury concentration in the 2011 samples (mean = 0.42 ppm) were significantly less than the concentrations measured in the 1999 samples (mean = 0.64 ppm) (Attachment E).

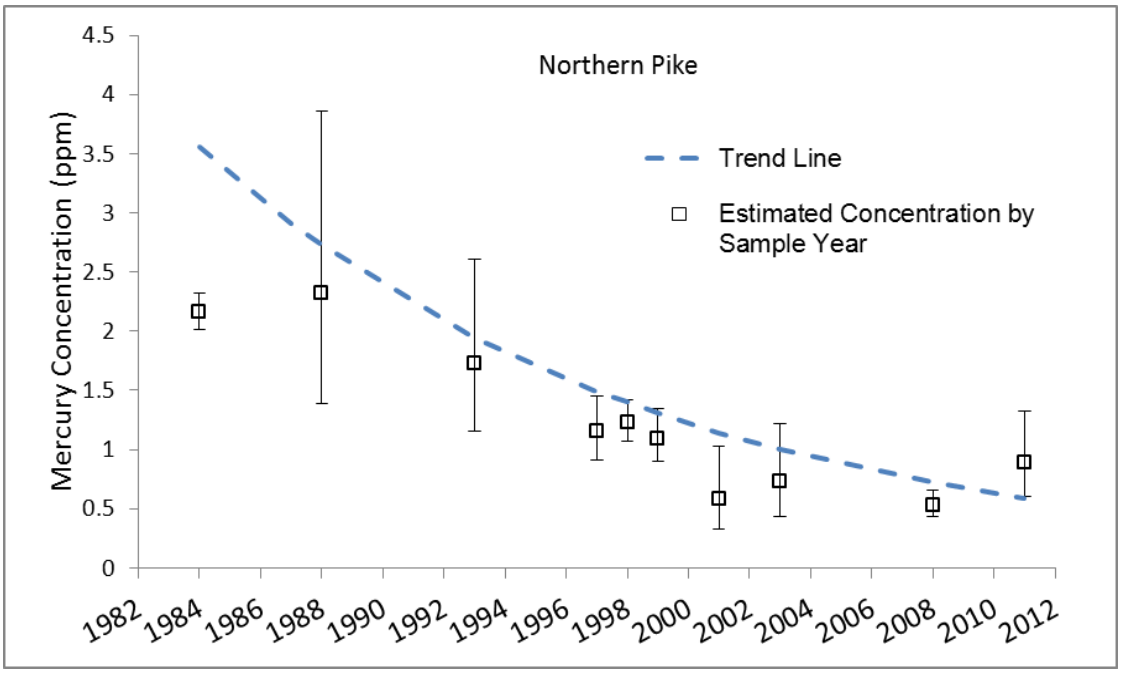

Figure 2. Temporal trend and estimated mercury concentrations in standard sized northern pike collected from Deer Lake, Marquette County, Michigan, from 1984 through 2011. Error bars represent 95 percent confidence intervals (Bohr, 2013a).

Walleye

Walleye mercury concentrations have declined between 1990 and 2011 at an average annual rate of 3.8 percent based on multiple regression results (Attachment E). The estimated mercury concentration in a standard sized 18-inch walleye declined from a peak of 1.12 ppm in 1997 to 0.99 ppm in 2011. Although it appears that concentrations may have increased slightly from 1990 to 1997, there was no significant trend. In fact, this period was followed by a decline of 2.7 percent per year from 1997 to 2011 (Attachment E).

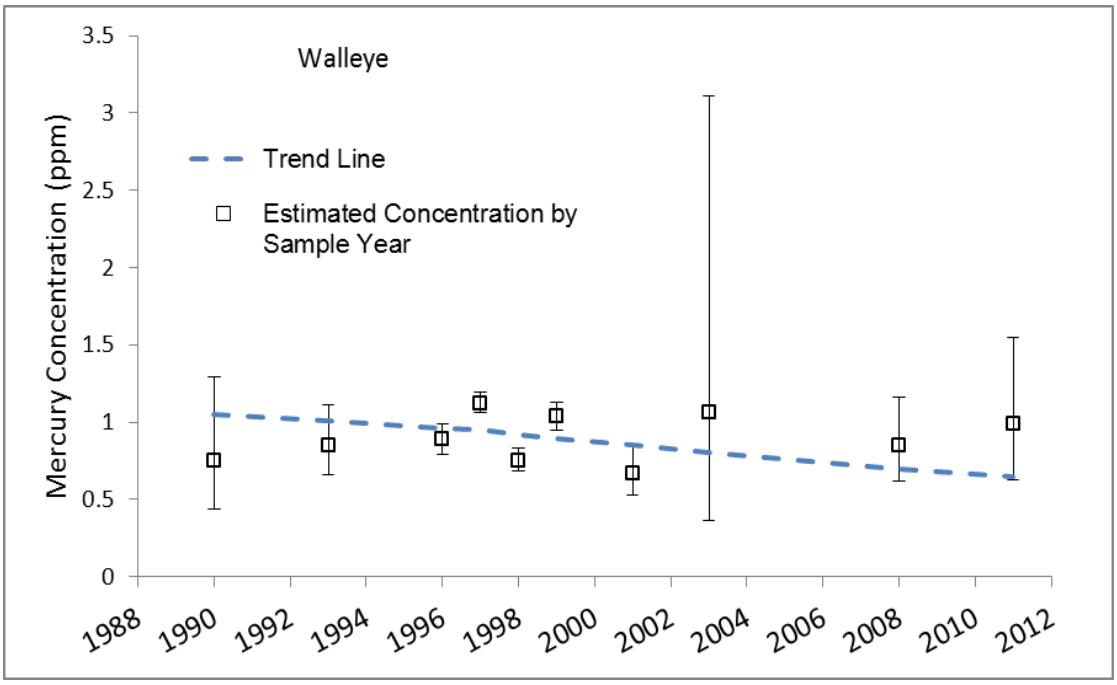

Figure 3. Temporal trend and estimated mercury concentrations in a standard sized walleye collected from Deer Lake, Marquette County, Michigan, from 1990 through 2011. Error bars represent 95 percent confidence intervals (Bohr, 2013a).

White Sucker

Mercury concentrations in white sucker collected from Carp Creek and Deer Lake declined at an average annual rate of 2.5 percent (Attachment E). The estimated mercury concentration in standard sized 15-inch white suckers declined from 0.41 ppm in 1984 to 0.15 ppm in 2011 (Attachment E).

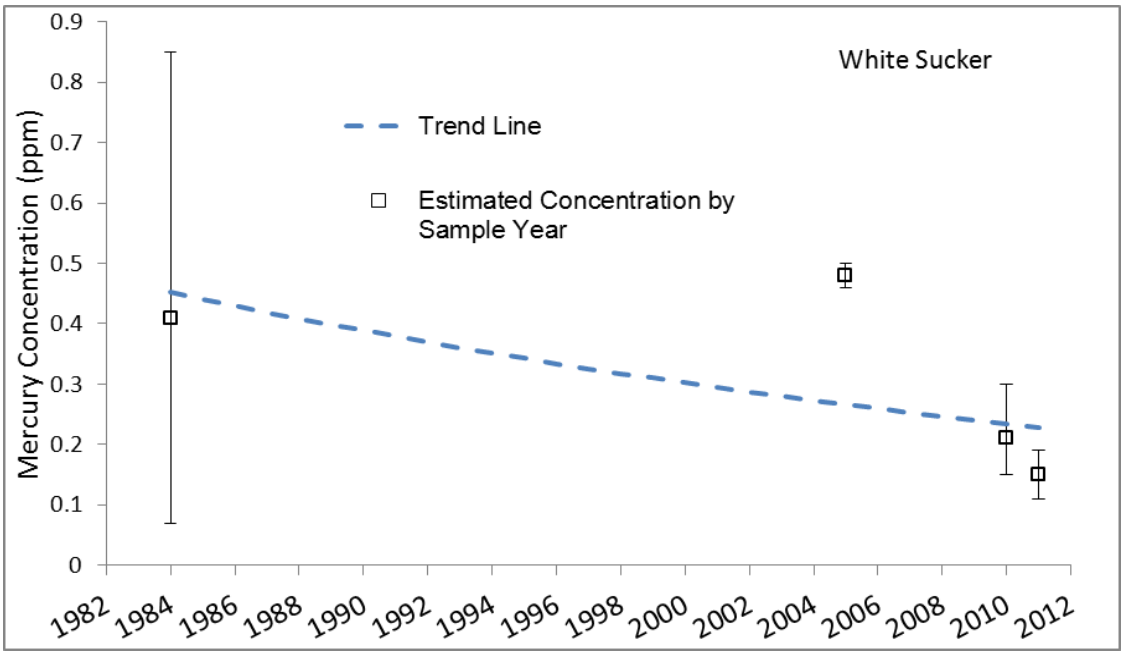

Figure 4. Temporal trend and estimated mercury concentrations in 15-inch white sucker collected from Carp Creek and Deer Lake, Marquette County, Michigan, from 1984 through 2011. Error bars represent 95 percent confidence intervals (Bohr, 2013a).

Yellow Perch

Yellow perch mercury concentrations declined between 1984 and 2011 at an average annual rate of 6.7 percent (Attachment E). The estimated mercury concentration in a standard-sized 10-inch yellow perch declined from a peak of 1.65 ppm in 1984 to 0.34 ppm in 2011 (Attachment E).

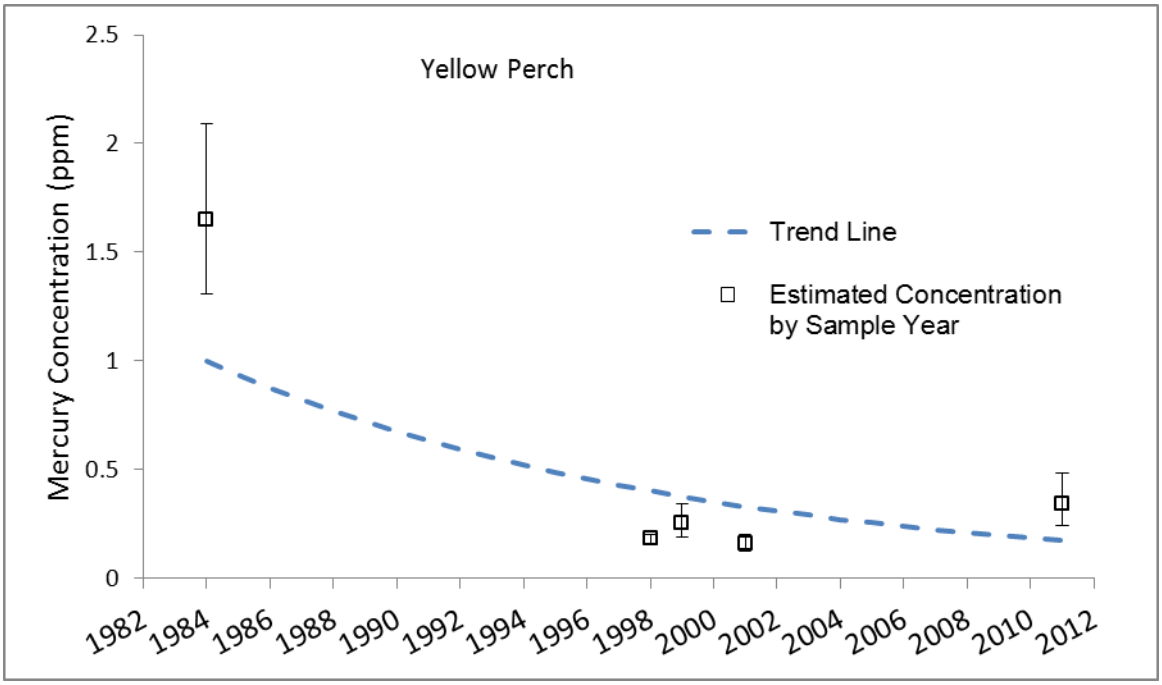

Figure 5. Temporal trend and estimated mercury concentrations in standard sized yellow perch collected from Deer Lake, Marquette County, Michigan, from 1984 through 2011. Error bars represent 95 percent confidence intervals (Bohr, 2013a).

Concentrations of mercury decreased in northern pike by 61 percent, in walleye by 12 percent, in white sucker by 63 percent, and in yellow perch by 79 percent from 1984 to 2011 (Attachment E). Concentrations of mercury in fish with consumption advisories appear to have stabilized since 2000 (Attachment E).

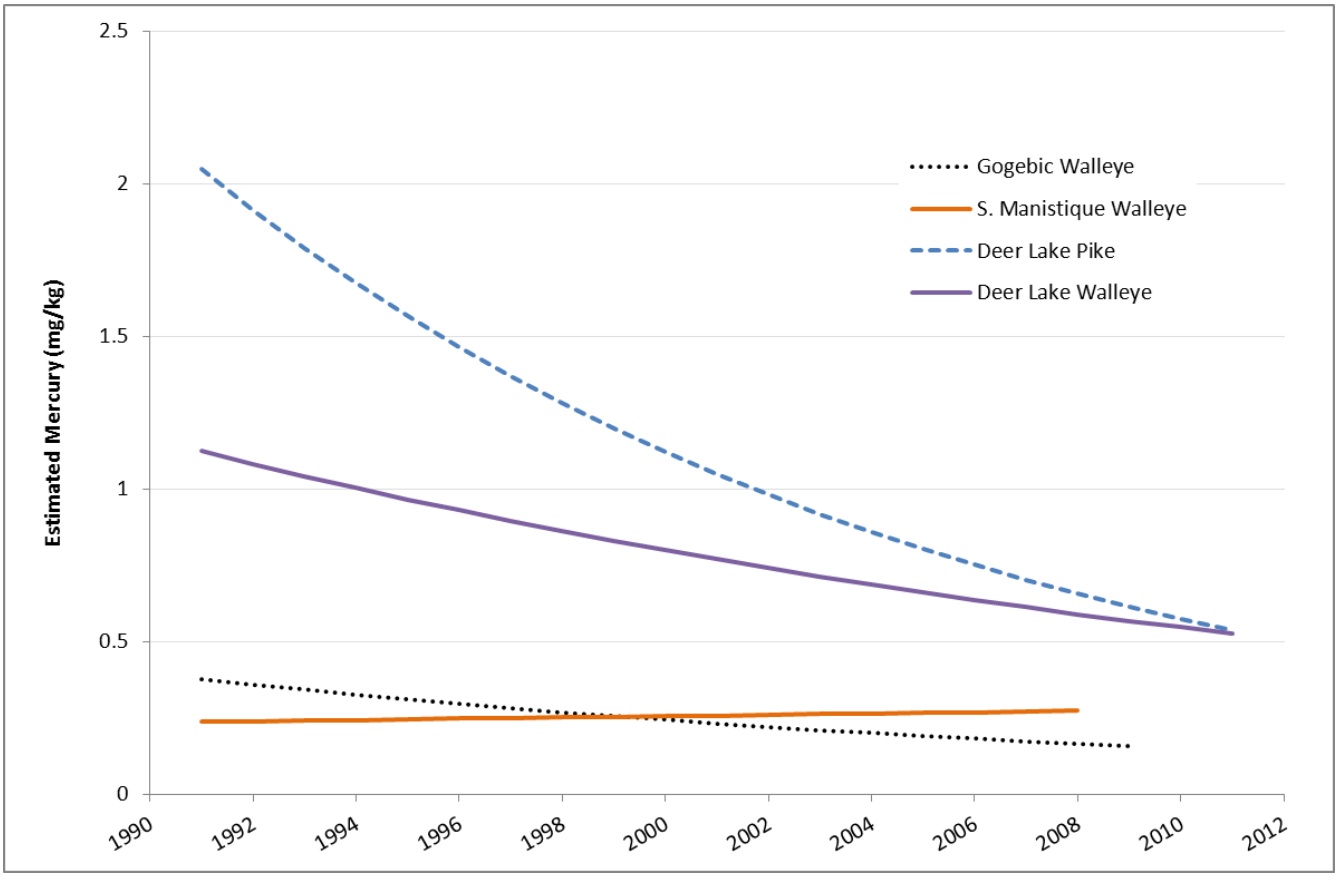

Figure 6. Comparison of Deer Lake pike and walleye trends to the same for Lake Gogebic walleye and Manistique walleye (Bohr, 2013b).

Trends in walleye for Deer Lake are similar to walleye from the Great Lakes trend sites of Lake Gogebic and South Manistique Lake (Figure 6) (Bohr, 2013b; Attachment F). The lakes were selected as they are the only inland lake trend sites in the Upper Peninsula and they have trend data for walleye. In addition, they are relatively close to the AOC and are more likely to have atmospheric inputs and other regional influencing factors similar to Deer Lake. The Deer Lake walleye slope is similar to Lake Gogebic and both are improving more so than Manistique, with the note that there is no significant trend for Manistique at this time. Since there is a significant decrease in mercury in pike, a comparison to another Great Lakes trend site is not warranted.

Conclusions

Mercury concentrations declined in northern pike and walleye from 1984 to 2011, with northern pike showing the most dramatic decline. Both northern pike and walleye were collected regularly over the period and the size of the data sets provides confidence in the conclusions. Yellow perch and white sucker were not sampled regularly; although the results for those species suggest declines in mercury concentrations the data sets are too small to be a basis for the BUI recommendation. The results for yellow perch and white sucker have been included for reference and because they are included in the fish consumption advisory. In comparison to other Great Lakes trend sites, mercury concentrations in the Deer Lake AOC have declined at a rate comparable to Lake Gogebic and at a higher rate than South Manistique Lake (Attachment E). There are no longer significant point sources of mercury to the Deer Lake AOC. Management of the dam and water levels will continue to limit mercury from becoming bioavailable.

Mercury concentrations in Deer Lake fish with consumption advisories from 1984 to 2011 had declined at rate similar to or higher than other Great Lakes trend sites. Therefore, this BUI meets the criteria for removal, according to the *Guidance* criteria outlined on page 1 of this report.

Recommendation

Based upon review of the data and technical input from the MDCH, MDEQ's Water Resources Division staff, and USEPA staff, the MDEQ AOC program staff recommends removal of the Restrictions on Fish and Wildlife Consumption BUI in the Deer Lake AOC. The data and this Removal Recommendation were shared and discussed with the Deer Lake PAC, which provided a letter of support (Attachment D).

Prepared by: Stephanie Swart, AOC Coordinator
Great Lakes Management Unit
Office of the Great Lakes
Michigan Department of Environmental Quality
September 26, 2013

Attachments

A – Restrictions on Fish and Wildlife Consumption; pages 14-18 of the *Guidance for Delisting Michigan's Great Lakes Areas of Concern*
B – Deer Lake AOC Historical Background
C – Deer Lake – A History of mining and the Deer Lake AOC
D – Deer Lake PAC letter supporting BUI removal, November 5, 2013
E – Temporal Trends in Deer Lake Fish Tissue Mercury Concentrations 1984-2011, J. Bohr
F – A Summary of Contaminant Trends in Fish from Michigan Waters, draft April 4, 2013, J. Bohr
G – MDCH Eat Safe Fish in AOCs Fact Sheet
H – MDCH letter supporting BUI removal, July 30, 2013

References

Amendment to Consent Judgment. 2006. State of Michigan in the Circuit Court for the County of Marquette, Case Number 82-14767. Honorable John R. Weber, Circuit Court Judge. Signed November 7, 2006.

Bohr, J. 2013a. Temporal Trends in Deer Lake Fish Tissue Mercury Concentrations 1984-2011. Water Resources Division, MDEQ, Lansing, Michigan.

Bohr, J. 2013b. A Summary of Contaminant Trends in Fish from Michigan Waters. April 4, 2013 draft. Water Resources Division, MDEQ, Lansing, Michigan.

ELM Consulting, LLC. 2002. Mercury Source Characterization for Deer Lake, Marquette County, Michigan. Prepared for Cleveland-Cliffs Iron Company.

International Joint Commission. 2012. Protocol Amending the Agreement between the United States of America and Canada on Great Lakes Water Quality 1978, as amended on October 16, 1983 and November 18, 1987.

MDEQ. 2011. Stage 2 Remedial Action Plan for the Deer Lake Area of Concern. Office of the Great Lakes, MDEQ, Lansing, Michigan.

MDEQ. 2008. *Guidance for Delisting Michigan's Great Lakes Areas of Concern,* revised. MI/DEQ/WB-06-001.

MDNR. 1987. Remedial Action Plan for the Deer Lake River Area of Concern. Great Lakes and Environmental Assessment Section, Surface Water Quality Division, MDNR, Lansing, Michigan.

Staron, M. 2004. Interoffice Memo. Annual Mercury Loading Estimates to Deer Lake via Carp Creek Watershed. Surface Water Assessment Section, Water Bureau, MDEQ, Lansing, Michigan. September 17, 2004.

Swart, S. and S. Baker. 2011a. Briefing Paper Removal Recommendation Bird or Animal Deformities or Reproduction Problems Beneficial Use Impairment Deer Lake Area of Concern.

Swart, S. and S. Baker. 2011b. Briefing Paper Removal Recommendation Eutrophication or Undesirable Algae Beneficial Use Impairment Deer Lake Area of Concern.

Attachment A

2008 Guidance for Delisting
Michigan's Great Lakes Areas of Concern

Restrictions on Fish and Wildlife Consumption

Significance in Michigan's Areas of Concern

Fish and wildlife consumption advisories in Michigan are determined by the Michigan Department of Community Health (MDCH), based on levels of contaminant concentrations in fish or wildlife tissue. Currently, all of Michigan's 14 AOCs have consumption advisories for specific contaminants in certain species of fish. No AOCs have advisories for wildlife consumption. Fish consumption advisories range from no human consumption to restrictions on consumption for specific amounts of fish for certain human populations.

Almost all fish consumption advisories are based on levels of polychlorinated biphenyls (PCBs) or mercury which exceed MDCH guidelines. Excessive levels of dioxin result in fish consumption advisories in the Saginaw River/Bay/River AOC and in the Detroit River AOC. Excessive chlordane is causing fish consumption advisories in the White Lake AOC. Other non-AOC locations in Michigan also have various consumption advisories for these contaminants. There is a statewide consumption advisory for certain fish in all inland lakes due to mercury contamination.

Michigan Restoration Criteria and Assessment

The restoration criteria for this BUI uses a tiered approach for evaluating restoration success. This BUI will be considered restored when:

1. The fish consumption advisories in the AOC are the same or less restrictive than the associated Great Lake or appropriate control site.

OR, if the advisory in the AOC is more stringent than the associate Great Lake or control site:

2. A comparison study of fish tissue contaminant levels demonstrates that there is no statistically significant difference in fish tissue concentrations of contaminants causing fish consumption advisories in the AOC compared to a control site.

OR, if a comparison study is not feasible because of the lack of a suitable control site:

3. Analysis of trend data (if available) for fish with consumption advisories shows similar trends to other appropriate Great Lakes trend sites.

When comparison studies (per #2 above) are used to demonstrate restoration of a BUI, the studies will:

- Be designed to control variables known to influence contaminant concentrations such as species, size, age, sample type, lipids and other relevant variables from the examples in the MDEQ's Fish Contaminant Monitoring Program (FCMP).

- Include a control site which is agreed to by the MDEQ, in consultation with the PAC. It will be chosen based on physical, chemical, and biological similarity to the AOC, and the 2 sites must be within the same U.S. EPA Level III Ecoregions for the Conterminous U.S. (see references). When a single control site cannot be found, sites may be pooled for comparisons. Where mercury concentrations in fish tissue cause waterbody specific advisories in lakes, the comparison may be made to the concentrations causing the general inland lake advisory.

- Use fish samples collected from the AOC and control site within the same time frame (ideally 1 year).

- Evaluate contaminant levels in the same species of fish from the AOC and the control site to avoid problems with cross-species comparisons. In addition, fish used for comparison studies should be the same species as the consumption advisory.

If there is no statistically significant difference (alpha = 0.05) in fish tissue concentrations of contaminants causing advisories in the AOC compared to a control site, then the BUI has been restored. If there is a significant difference between the AOC and the control site in the comparison study, then an impairment still exists.

If a comparison study is not practical for the AOC due to the lack of an appropriate control site, then trend monitoring data (if available) can be used to determine restoration success (as per approach #3 above). This is likely to be the approach used to evaluate this BUI in the connecting channel AOCs, where there are not appropriate control sites for a comparison study, and where MDEQ has substantial trend monitoring data. If MDEQ trend analysis of fish with consumption advisories shows similar trends to other appropriate, MDEQ-approved Great Lakes trend sites, this BUI will be considered restored. If trend analysis does not show similarity to other appropriate Great Lakes trends sites, then an impairment exists.

No AOCs have advisories for wildlife consumption. However, if a wildlife restriction is issued at a later time within an AOC with the Fish and Wildlife Consumption BUI, the process for assessing restoration of the wildlife restriction will be similar to the process outlined above for fish consumption.

Rationale

Practical Application in Michigan

Restoration of the fish consumption advisory BUI is based on comparison of fish consumption advisories and tissue concentrations in the AOC with the associated Great Lake or other appropriate control site, not whether or not fish advisories exist in the AOCs or control site.

Comparison of advisories or tissue concentrations to a control site is used because some fish consumption advisories are issued statewide or are due to sources outside an AOC. Because the existence of an advisory may not be due to contaminant sources in an AOC, it should not preclude removal of this BUI. A more stringent advisory in the AOC than the associated Great Lake is an indication that there may be an ongoing contaminant issue within the AOC. In this case, additional source assessment may be conducted to determine whether there are sources of contamination within the AOC (e.g., caged fish studies).

The MDEQ will consider restoration of this BUI on a case by case basis for AOCs with circumstances that do not fit exactly into the evaluation steps outlined above.

1991 IJC General Delisting Guideline

When contaminant levels in fish and wildlife populations do not exceed current standards, objectives, or guidelines, and no public health advisories are in effect for human consumption of fish or wildlife. Contaminant levels in fish and wildlife must not be due to contaminant input from the watershed.

The IJC general delisting guideline for the BUI is presented here for reference. The Practical Application in Michigan subsection above takes the general guideline and applies specific criteria for restoration based on existing Michigan programs and authorities.

State of Michigan Programs/Authorities for Evaluating Restoration

Michigan assesses water bodies throughout the state on a 5-year basin rotation plan according to the MDEQ's "Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (MDEQ, 1997) and the "Michigan Water Quality Strategy Update" (MDEQ, 2005). Each year, a set of targeted watersheds are sampled at selected sites defined by the National Pollutant Discharge Elimination System (NPDES) permitting program for conventional and toxic pollutants, and biological and physical habitat/morphology indicators. The set of watersheds sampled rotates each year, with each major watershed in the state revisited every 5 years (see Appendix 1 for basin rotation maps). One element of the State's monitoring strategy is the enhanced and improved FCMP.

The specific objectives of the FCMP are to:

1. Determine whether fish from the waters of the state are safe for human consumption.

2. Measure whole fish contaminant concentrations in the waters of the state.

3. Assess whether contaminant levels in fish are changing with time.

4. Assist in the identification of waters that may exceed standards and target additional monitoring activities.

5. Evaluate the overall effectiveness of MDEQ programs in reducing contaminant levels in fish.

6. Identify waters of the state that are high quality.

7. Determine if new chemicals are bio-accumulating in fish from Michigan waters.

The FCMP element consists of several components that, in combination, provide data necessary to achieve these objectives. These include:

- Edible fish portion monitoring to support the establishment or delisting of fish consumption advisories;
- Native whole fish trend monitoring;
- Periodic evaluations to expand and improve the State's fish trend monitoring network; and
- Caged fish monitoring for source/problem identification.

Fish contaminant data are used to determine whether fish from waters of the state are safe for human and wildlife consumption, and as a surrogate measure of bioaccumulative contaminants in surface water. Fish tissues are analyzed for bioaccumulative contaminants of concern. These include mercury, PCBs, chlorinated pesticides (e.g., DDT/DDE/DDD), dioxins, and furans. More recently, some fish tissues have been analyzed for polybrominated biphenyl ethers (PBDEs) and perfluorooctane sulfonate (PFOS). Data are reviewed each year to determine whether there are additional new parameters of concern for which the fish should be analyzed.

Fish contaminant studies needed for the assessment of this BUI restoration will be arranged by MDEQ as part of the Michigan FCMP. Timing and study design will be determined by the MDEQ based on available resources.

Some local AOC communities also have programs for monitoring water quality and related parameters which may be applicable to this BUI. If an AOC chooses to use local monitoring data for the assessment of BUI restoration, the data can be submitted to the MDEQ for review. If the MDEQ determines that the data appropriately addresses the restoration criteria and meets quality assurance and control requirements, they may be used to demonstrate restoration success.

Attachment B

Deer Lake AOC Historical Background

Historic mining practices resulted in mercury contamination to Deer Lake basin from Ropes Creek and Carp Creek. The “Ropes” Goldmine operated at various times from 1882 through 1991 along Ropes Creek. Gold recovery in the Ropes Mine from 1882-1897 used a mercury amalgamation process to concentrate the gold mined there. Gold processed from the Ropes Mine from 1900-1901 used a cyanide leaching process and additional gold was recovered from scraps of mercury amalgam recovered throughout the Ropes Mill buildings. Mining activity resumed from 1983-1991, but the ore was trucked off-site and out of the basin to the Humboldt Iron Mine for extraction. Throughout the earlier activities, the gold mine tailings from the Ropes Mine were deposited into Ropes Creek watershed. The mine closed in 1979. During the course of investigations by Ecological Research Services, Inc. for the Callahan Mining Company pursuant to the reopening of the Ropes Gold Mine in 1983, high levels of mercury were discovered in fish tissue, sediments, and the water column in Deer Lake (MDNR, 1987).

Investigations by the Michigan Department of Natural Resources (MDNR) determined that Cleveland-Cliffs Iron Company, now Cliffs Natural Resources (Cliffs) assay labs practiced disposal, down the lab drains, of mercury reagent laden wastewater. These wastewaters drained through the Ishpeming Wastewater Treatment Plant (WWTP) to Carp Creek. Cliffs immediately stopped the practice in 1981 when it was determined that their labs were the major continuing mercury source. The 1984 Consent Judgment (CJ) committed both the State of Michigan and Cliffs to a restoration plan which included drawing down the level of the Deer Lake Reservoir, eliminating the contaminated fish, slowly refilling the reservoir, and monitored recovery. The 1984 CJ is Appendix B of in the *1987 Remedial Action Plan for Deer Lake Area of Concern* (MDNR, 1987). The 2006 amendments to the 1984 CJ are intended to facilitate the long term maintenance of the completed remedial measures, provide funding for any additional remedial measures, and minimize discharges from Cliffs Shaft Mine to Carp Creek.

The natural Deer Lake basin covered approximately 90 acres. The original impoundment was formed in 1887 to provide a steady source of water for the Ropes Goldmine operations and did little to change the size of the lake. The second higher dam was built in 1912 by the Cliffs Electric Services Company (CESC) as a hydropower storage reservoir, increasing the reservoir to approximately 602 acres to provide energy and to augment winter water flows to the Cliffs iron ore processing operations in Marquette. A third higher dam was built just below the second in 1942 by the CESC, inundating the second dam, creating the current reservoir to enhance the reservoir’s operational capacity. This dam remains in place and is the operating outlet for the Deer Lake reservoir. A large butterfly valve was installed for water flow control at the base of this dam. This valve now helps to control anoxic conditions in the north basin by operating as a bottom draw on the dam. Opening the valve as the lake begins to thermally stratify allows anoxic waters in the north basin to flow out the lake bottom keeping dissolved oxygen levels in the hypolimnion higher, instead of allowing all of the flow to exit through the notch at the top of the dam. The notch at the top of the dam is set to maintain the water level in the lake at 1,385 feet above sea level. The water level was agreed to between the state and the Cliffs in the 2006 amendments to the CJ. This level was agreed to be the optimal level needed to minimize the mercury methylation from the contaminated sediments remaining within the lake.

AOC Designation

In 1985, the Great Lakes Water Quality Board recommended an AOC designation for Deer Lake to the International Joint Commission. This recommendation was based on the fish consumption advisory issued by the Michigan Department of Community Health (MDCM) in 1981 for the Deer Lake reservoir that was expanded in 1982 to include Carp Creek and the Carp River. The fish consumption advisory was driven by high levels of mercury in fish tissues, water, and sediment as described in the 1987 Deer Lake RAP (MDNR, 1987).

Elevated levels of mercury in fish were discovered by Ecological Research Services, Inc. through work for the Callahan Mining Company as part of the investigation into the feasibility of reopening of the Ropes Gold Mine. The elevated levels of mercury in the fish were believed to have been primarily caused by discharges of mercury originating from the Cliffs assay labs. These labs discharged wastewater through the old Ishpeming WWTP (MDNR, 1987). Mercury discharges were curtailed in 1981 when the problem was identified (MDNR, 1987).

Attachment C

Deer Lake – A history of mining and the Deer Lake AOC

Version 2
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Iron Mining:

1844 – William Burt surveys area by Teal Lake, identifies potential iron deposits with compass Magnets.

1846 – Jackson Mining Company files mining claims for iron ore near Teal Lake after talking with Chippewa chief (Marji-Gesick).

1847 – Cleveland Iron Company is formed on signing of Articles of Association on November 9, 1847.

1848 – Cleveland Iron Company opens Little Mountain Mine. Cliffs shaft mine began as number of smaller mines to the west of Teal Lake, developed by people attracted to area by Jackson Company's activities.

1855 – Locks at Sault Ste Marie open. Railroads connect Ishpeming and Negaunee mines to harbor in Marquette, Michigan – ore moved through locks to Detroit, Toledo, and Cleveland (then to Pittsburgh).

1865 – Iron Cliffs Company formed by S. Tilden.

1868 – Cliffs company is 1st mine in the region to use dynamite
Iron Cliffs Company based in Cleveland opens Barnum Mine, an open pit on the same ore body as the Little Mountain. The two companies (Cleveland Iron Company and Iron Cliffs Company) open a number of other open pits (Cleveland, Incline, Sawmill, New York).

1877 – The "New Barnum" mine started when Iron Cliffs Company drills hole "A" – March 15, 1877.

1877 – June, Iron Cliffs drills hole "B", ore discovered ~400 feet below surface.

1879 – Iron Cliffs company uses diamond drilling to determine ore body continued west under the city of Ishpeming.

1880 - 1882 Alternatively proposed date of sinking shafts north of Barnum mine. The Cliffs Shaft mine was sited entirely by diamond drill testing; there was no outcrop of the ore body as was the case in most Marquette range mines.

1891 – Cleveland-Cliffs Iron Company is formed on May 7, 1891 with the merger of Iron Cliffs Company and the Cleveland Iron mining Company.
As the new mine workings went deeper, the earlier mines were connected underground and their ore hoisted through the A and B shafts of the opposite ends of the Cliffs Shaft Site.
The earlier open pit mines to the east of the city are now being mined from below and provided natural ventilation for the mine, with fresh air entering through their workings and rising through A and B shafts.

1897 – Barnum Pit mine closes.

1919 – Egyptian revival designed concrete shafts are constructed at A and B to replace the aging wooden structures. Cleveland-Cliffs president William G. Mather recommended that the new shafts incorporate architectural beauty because of the mine's proximity to Ishpeming. George W. Maher (consulting architect from Chicago) designed shafts. Concrete was colored by the high iron content of the local gravel and originally had a light brown and pink variegated color. They became the only concrete structures, for an iron mine, to be used as shaft houses, in the U.S.

Sometime after 1926, Cleveland-Cliffs needed to expand to keep the company working because the Republic Mine was inactive. Cliffs shaft is a geological puzzle of faults and cross faults. Drilling discovers the Bancroft vein just north of Euclid street and under Lake Bancroft. They also open the south-east vein. A lease was taken out by the Oliver Mining Company, formerly the Lake Superior Iron Company for holdings just south of Division Street. More ore was also discovered to the Cooper Lake Road area to the west.

1955 – 174 feet "C" shaft Koepe lift is installed. A and B shafts are retired from active mining. This was the first Koepe friction hoist installed in the western hemisphere, using German and Swedish technology. The mine was now 1250 feet below the surface with very extensive drifts running for miles in all directions.

1967 – Cliffs Shaft Mine "Barnum Mine" ends production. This was the largest and longest operating underground, direct-shipping, hard ore mine in the Lake Superior Region and the U.S., producing 28.9 million tons of ore from 1848-1967 (contested 1868-1972).

Gold Mining:

1845 – D. Houghton identifies gold and copper deposits, also shows probability of iron deposits is high.

1877 – Julius Ropes of Ishpeming finds serpentine group with gold-bearing quartz 15 miles west of Ishpeming.

1880 – Ropes discovers promising quartz vein.

1881 – Ropes finds quartz vein "leaders" that are the base of the Ropes Gold Mine. – spring 1881.

July – The Ropes Gold and Silver Mining Company starts active mining.

1881

1883 – The Curry Mine shaft begins.

1884 – 25-stamp mill is erected in November.

1888 – 50-stamp mill starts. Ropes mine is ~500 feet deep and $125,000 in gold/silver concentrates have been taken out. Average yield of rock is ~$4/ton, erected in November.

1888 – NY Times article reports "no great rush of miners to Ishpeming." This is a shaft mine and only a dozen or so men can work at a time. There are no placer mines here; quartz mining requires miners, supplies, and months of pre-production investment. Also, land is owned by companies and private holders so there is no squatter claim potential like in the west.

1897 – Ropes Gold Mine closes - The Ropes Mine ran for 14 years and produced $645,792 in gold and silver, but was never able to pay a dividend to its stockholders. Fifteen levels had been developed to 813 feet. The gold was shipped and extracted by the mercury amalgamation process and gravity separation.

1900 – Corrigan, McKinney and Co. purchased the mine property and, using the newly-developed cyanide leaching process, reclaimed nearly $200,000 in gold from the tailings during **1900-1901**. Additional gold was gleaned from scraps of mercury amalgam recovered throughout the mill buildings.

1970s–Callahan Mining Co. purchases the mine property. The mine changed hands numerous times without further production until the inflation of the 1970s drove up gold prices enough to prompt Callahan Mining Co. to purchase the property and invest in exploration and rehabilitation of the mine.

Improved metallurgical methods and higher gold prices in the 1970's and 1980's attracted a $20 million redevelopment project to the Ropes Mine, which again began producing gold in the fall of 1985. The reopened mine produced until 1989, when a combination of low gold prices, poor ore grade, and a collapse of rock in the production shaft prompted its shutdown.

1983 – Callahan Mining resumed mining with the sinking of a truck decline to 900 feet depth.
1984 – A new shaft was sunk, with workings reaching 1548 feet depth. Ore rock was trucked to the ore dressing plant of the retired Humboldt Iron Mine for gold extraction. Operations continued despite the collapse of the uppermost levels in 1987.
1985 – Callahan Mining Co. begins producing gold
1989/1990 – Ropes Gold Mine closed due to declining ore values and a cave-in that resulted in extensive underground damage. This prompted the closing of the only profitable gold mine in Michigan history.

The AOC:
1877 –Iron Cliffs company used diamond drilling to determine ore body and continued west under the city of Ishpeming. Shafts "A" and "B" are started. This begins the use of dynamite in the mine under the city. Mercury from the dynamite blasting caps accumulates in mine workings. Mercury is still in the now submerged mine shafts and is the main source of contamination for Partridge Creek.
1882 – 1897 Liquid (elemental) mercury was used to recover gold from ore at the Ropes Gold Mine (located on Deer Lake, west of the north basin). Mercury amalgam was also recycled for gold.
Early–1880's The Carp River is impounded to form Deer Lake. The water is taken from the reservoir and used for mining operations. Over the years the location of the dam has shifted as mining operation needs changed. Deer Lake has been in place since this time, resulting in the accumulation of mercury contaminated sediments.
1891 – The surface mine pit east of the city is connected to underground mine workings associated with shafts "A" and "B." This created the direct hydrologic connection between surface waters (future Partridge Creek) and contaminated groundwater (groundwater infiltrated the underground mines after closure in the 1960s).
1897 – Ropes Gold mine closes. W.H. Rood erected several large vats and attempted to reclaim the gold in tailings using a cyanide process. This work only lasted a few years.
1929 – 1981 Mercury salts were used in iron ore assays in laboratories of the Cleveland Cliffs Iron Company. Mercury-containing wastewater from the lab was discharged to the wastewater treatment system (which was inadequate). This discharge ended up in Carp Creek and then Deer Lake.
1929 – 1963 All wastewater generated in the city of Ishpeming and Ishpeming Township is discharged without treatment through combined sanitary and storm sewers (CSOs) into Carp Creek. This had direct impact on the Eutrophication BUI.
1967 – Following closure, the Cliffs Shaft mine (underneath the city of Ishpeming) fills with groundwater. Because of the low oxygen conditions, mercury methylates into a more bioavailable form.
1970 – Prior to this time, Partridge Creek flowed westerly into the east-side of the City. It was then directed through the City's storm sewer and re-emerged on the west-side of the city. In 1970, due to flooding and overflow concerns, the City was allowed to divert Partridge Creek into a mine pit on the east side of town. The water then flowed through the now flooded historic mine workings where it accumulated mercury and became contaminated. Then on the west-side of the City, two 24" wells were installed to help re-create Partridge Creek with the mercury contaminated mine water.
1986 – An Enhanced Secondary Wastewater Treatment Plant replaced the three primary treatment plants in April 1986. This construction significantly reduced nutrient loading (a major factor in the AOC's Eutrophication BUI) by 86%.
1987 – Deer Lake AOC Remedial Action Plan is developed. Natural attenuation is selected as remedy for Deer Lake. Over time, mercury contaminated sediments have accumulated in Deer Lake. Studies showed that the mercury in these sediments was not bioavailable so long as the bottom of the reservoir had high oxygen levels. The high oxygen levels keep the mercury from methylating, thereby reducing its bioavailability. Therefore, the solution

to control mercury was to maintain a bottom draw dam, which forces oxygen rich water at the surface down to the bottom of the reservoir. Additionally, natural sediments will attenuate or build up to cover the mercury contaminated sediments.

2004 – A study by the MDEQ shows that over 67.4 grams of mercury per year enters the AOC from Partridge Creek. This is over 21% of the total mercury load to the AOC.

2010 – City of Ishpeming receives FY2010 Great Lakes Restoration Initiative grant to conduct Phase 1 of the Partridge Creek diversion.

September – 2011 The MDEQ, in conjunction with EPA GLNPO and the local public advisory Council, recommends removal of two BUIs: 1) Eutrophication or Undesirable Algae and 2) Bird and Animal Deformities or Reproductive Issues.

2012 – City of Ishpeming receives FY2012 GLRI grant to conduct a portion of Phase 2 of the Partridge Creek diversion. Because of cost constraints, the project was divided into two portions, the open channel areas and the closed culvert/sewer areas.

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