

REMEDIAL ACTION PLAN UPDATE

for the

LOWER GREEN BAY AND FOX RIVER AREA OF CONCERN

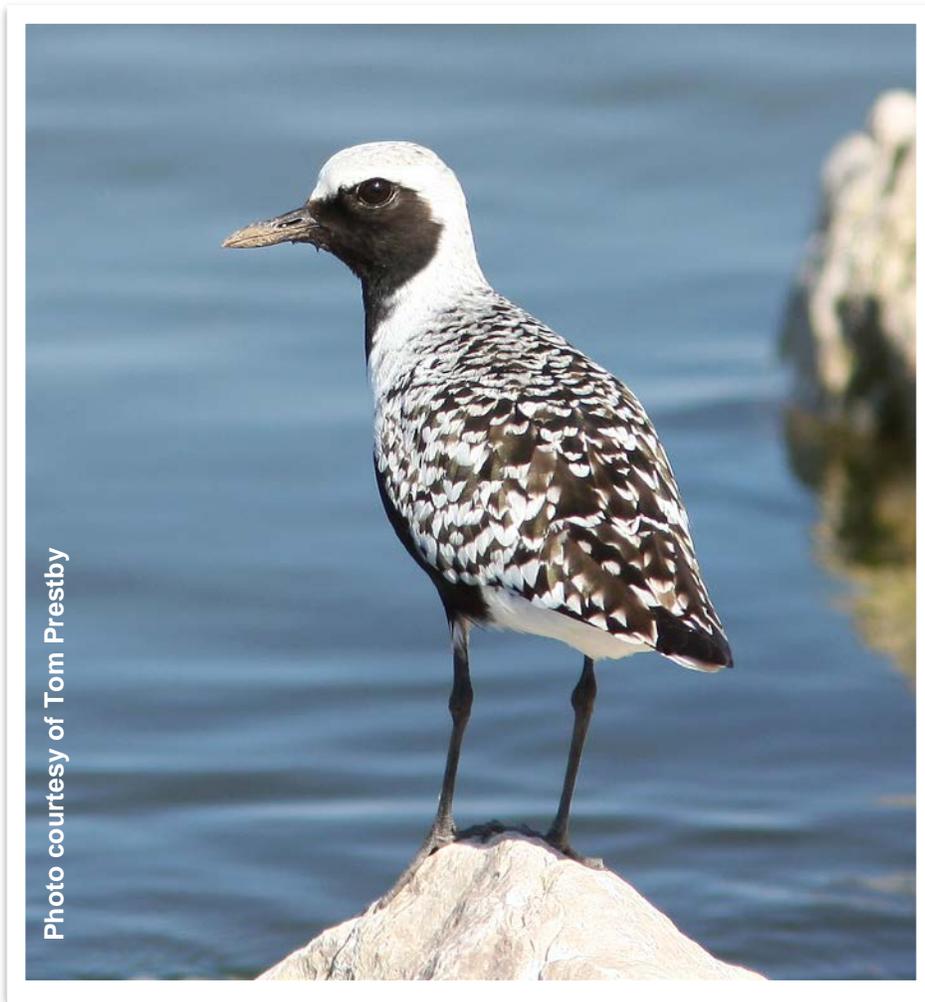


Photo courtesy of Tom Prestby

Black-bellied plover at Cat Island

**Remedial Action Plan Update
for the
Lower Green Bay and Fox River Area of Concern
December 2015**

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Disclaimer

The Great Lakes Water Quality Agreement is a non-regulatory agreement between the U.S. and Canada, and criteria developed under its auspices are non-regulatory. The actions identified in this document as needed to meet beneficial use impairment (BUI) delisting targets are not subject to enforcement or regulatory actions.

The actions identified in this Remedial Action Plan Update do not constitute a list of preapproved projects, nor is it a list of projects simply related to BUIs or generally to improve the environment. Actions identified in this document are directly related to removing a BUI and are needed to delist the Area of Concern.

EXECUTIVE SUMMARY

The Area of Concern program has evolved over the last 25 years. Over the past five years, the Great Lakes Restoration Initiative (GLRI) has provided Areas of Concern (AOCs) with many of the necessary resources to carry out assessments for listed beneficial use impairments (BUIs), and has funded needed management actions to facilitate the removal of these impairments with the ultimate goal of delisting remaining AOCs. This initiative has been vital in moving the Area of Concern program forward.

Locally, in 2009, the final phase of the Lower Fox River polychlorinated biphenyl (PCB) cleanup project began. In this document, for the purposes of planning with regard to the AOC, the Wisconsin Department of Natural Resources (WDNR) cites that in-river remedial action work is expected to conclude by 2018 for the PCB cleanup project. If the project stays on schedule, however, it is currently scheduled to be complete by the end of 2017. While cleanup completion is a significant step for removal of several BUIs, BUI removal also depends on being able to meet BUI-specific criteria, or targets. The most current version of those targets can be found in this document. Over the next couple of years, WDNR will be working with technical stakeholders on refining some of these targets to better defined endpoints so that once these endpoints are met, BUI removal can occur. WDNR will also continue collaboration with partners to ensure that funding opportunities can be leveraged so that the local ecosystem can continue to improve.

Changes from the 2014 Remedial Action Plan (RAP) Update to this document are summarized below, in order to assist the reader in better understanding what occurred between 2014 and 2015.

Summary of Changes for Restrictions on Fish and Wildlife Consumption

- The waterfowl consumption advisory re-assessment was originally scheduled to be completed in 2015. Because of some difficulties with obtaining tissues samples for analysis, we anticipate needing to continue sample collection through 2016.
- In 2015, approximately 515,000 cubic yards of material were removed from the Lower Fox River as part of the PCB cleanup. The in-river remedial action work is expected to conclude by 2018.

Summary of Changes for Tainting of Fish and Wildlife Flavor

- WDNR reviewed data from a fish flavor and odor assessment that was conducted in 2013 and 2014. There were no reports of poor flavor or odor in any of the completed surveys.
- WDNR is determining next steps for engaging anglers who frequently consume fish from the AOC.

Summary of Changes for Degradation of Fish and Wildlife Populations

- A University of Wisconsin-Green Bay team has been working on the fish and wildlife assessment throughout 2015. They conducted bird and amphibian surveys in the project area and have started the process of inventorying past fish and wildlife projects and identifying priority AOC target species for restoration. They have also mapped habitat types throughout the AOC.
- WDNR fisheries completed a survey following large river monitoring protocols for fish indices of biotic integrity (IBIs). The mean IBI score was 29, which corresponds to the “poor” category.
- Further collaboration among partners who manage fish populations in the AOC is necessary; additional fish population assessments in 2016 are needed in order to determine where the most cost-effective opportunities exist to improve fish habitat in the AOC.

Summary of Changes for Fish Tumors or Other Deformities

- A draft target has been developed for this BUI and is included in this document (see p. 13). This draft target is similar to that for other Wisconsin AOCs that have this impairment listed.
- WDNR is planning to conduct a fish tumor assessment beginning in 2018, dependent upon completion of the in-river remedial action work for the Lower Fox River PCB Cleanup.
- A final cleanup schedule is pending for the Wisconsin Public Service (WPS) Green Bay Former Manufactured Gas Plant Superfund Alternative Site. Note that We Energies acquired Integrys, the parent company of WPS this year.

Summary of Changes for Bird or Animal Deformities or Reproduction Problems

- In 2015, additional tree swallow monitoring data was analyzed from past years, and three new tree swallows monitoring arrays were established in the AOC.
- In 2016, WDNR will continue working on this impairment to determine which kinds of monitoring data are needed to assess the impairment.

Summary of Changes for Degradation of Benthos

- U.S. Geological Survey (USGS) sampled the AOC for benthos and plankton in 2012 and again in 2014. They have provided preliminary findings for the studies and are engaged in a peer review process before releasing the final reports.
- In 2015, approximately 515,000 cubic yards of material were removed from the Lower Fox River as part of the PCB cleanup. The in-river remedial action work is expected to conclude by 2018.
- A final cleanup schedule is pending for the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site.

Summary of Changes for Restrictions on Dredging

- In 2015, approximately 515,000 cubic yards of material were removed from the Lower Fox River as part of the PCB cleanup, and 145 acres of sediment were capped and covered (note that these are not cumulative totals, just what was done in 2015). The in-river remedial action work is expected to conclude by 2018.
- A final cleanup schedule is pending for the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site.

Summary of Changes for Eutrophication or Undesirable Algae

- In 2015, WDNR engaged stakeholders in discussions about a possible target revision that would clarify the geographic bounds of AOC efforts for this BUI and establish AOC-specific measurable endpoints (i.e., endpoints that can be achieved through management actions within the defined geographic bounds established for this BUI).
- A draft revised target is included in this document; additional changes are likely to be made as WDNR, U.S. Environmental Protection Agency's Great Lakes National Program Office, and stakeholders continue discussing the draft. WDNR anticipates a formal target change for this BUI in 2016.

Summary of Changes for Restrictions on Drinking Water Consumption, or Taste and Odor Problems

- No change reported for 2015; however, a more extensive data set for cyanobacteria and cyanotoxins is needed within the AOC to determine the current state of this BUI.

Summary of Changes for Beach Closings

- In 2015, WDNR monitored *E. coli* at Bay Beach. WDNR collected weekly samples during the swimming season, and three post-rainfall event samples were also collected. *E. coli* levels at the beach were typically below the standard used for issuing a beach advisory. The raw data is available on www.wibeaches.us.
- The City of Green Bay is in the beginning stages of planning for a beach restoration project at Bay Beach.
- Bay-Lake Regional Planning Commission issued a report of their findings for monitoring conducted at Bay Beach from 2012-2014. That report is available from <http://www.baylakerpc.org/about/publications>.
- A more extensive data set for cyanobacteria and cyanotoxins is needed within the AOC to determine the current status of this BUI.

Summary of Changes for Degraded Aesthetics

- In early 2015, WDNR consulted with stakeholders regarding its 2015 revision of the volunteer monitoring program. The revision allowed WDNR to incorporate lessons learned from previous years and enhance consistency between the two AOCs that are implementing the program. The program helps to determine whether there are other aesthetic factors, besides algae, that need to be addressed in the AOC.
- In 2015, volunteers continued aesthetics monitoring.
- A priority outreach need in 2016 is continued aesthetics monitoring, including retaining existing volunteer monitors and recruiting new volunteer monitors.

Summary of Changes for Degraded Phytoplankton and Zooplankton Populations

- USGS sampled the AOC for benthos and plankton in 2012 and again in 2014. They have provided preliminary findings for the studies and are engaged in a peer review process before releasing the final reports.

Summary of Changes for Loss of Fish and Wildlife Habitat

- A UW – Green Bay team has been working on the fish and wildlife assessment throughout 2015. They have started the process of inventorying past fish and wildlife projects, identifying priority AOC target species for restoration, and have conducted bird and amphibian surveys in the project area. They have also mapped habitat types throughout the AOC.
- WDNR is engaging stakeholders in a habitat planning process for the Cat Island chain. Cat Island has been identified as an early priority for habitat restoration in the AOC. We expect that there will be habitat projects that will be ready to compete for AOC-specific habitat funding opportunities.

Next Steps

For 2016, the Lower Fox River AOC Coordinator will continue collaboratively developing BUI-focused assessment strategies for the AOC. The main priorities for 2016 will be the Degradation of Aesthetics, Bird and Animal Deformities and Reproduction Problems, Loss of Fish and Wildlife Habitat, Degraded Fish and Wildlife Populations, and Eutrophication/Undesirable Algae BUIs.

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List of Acronyms

AOC	Area of Concern
BUI	Beneficial Use Impairment
GLRI	Great Lakes Restoration Initiative
IBI	Index of biotic integrity
µg/L	Micrograms per liter
mg/L	Milligrams per liter
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
ppm	Part per million
RAP	Remedial Action Plan
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
UWGB	University of Wisconsin – Green Bay
WDNR	Wisconsin Department of Natural Resources
WPS	Wisconsin Public Service

DEFINITIONS

Area of Concern (AOC)

Defined by Annex 2 of the 1987 Protocol to the U.S.-Canada Great Lakes Water Quality Agreement as “geographic areas that fail to meet the general or specific objectives of the Agreement where such failure has caused or is likely to cause impairment of beneficial use of the area’s ability to support aquatic life.” These areas are the “most contaminated” areas of the Great Lakes, and the goal of the AOC program is to bring these areas to a point at which they are not environmentally degraded more than other comparable areas of the Great Lakes. When that point has been reached, the AOC can be removed from the list of AOCs, or “delisted.”

Beneficial Use Impairment (BUI)

A “beneficial use” is any way that a water body can improve the quality of life for humans or for fish and wildlife (for example, providing fish that are safe to eat). If the beneficial use is unavailable due to environmental problems (for example if it is unsafe to eat the fish because of contamination) then that use is impaired. The International Joint Commission provided a list of 14 possible beneficial use impairments in the 1987 Great Lakes Water Quality Agreement amendment.

Delisting Target

Specific goals and objectives established for beneficial use impairments, with measurable indicators to track progress and determine when BUI removal can occur.

Escherichia coli (E. coli)

A bacterium commonly found in natural bodies of water that serves as an indicator of the possible presence of other health risks in the water, such as bacteria, viruses, and other organisms.

Microcystins

A class of toxins produced by freshwater cyanobacteria (also known as “blue-green algae”). These chemicals include microcystin-LR, which is the most toxic type. Microcystins can be produced in large quantities during algal blooms, and can cause adverse reactions in humans and animals that come in contact with the toxin.

Remedial Action Plan (RAP)

According to the 1987 Protocol to the U.S.-Canada Great Lakes Water Quality Agreement, a RAP is a document that provides “a systematic and comprehensive ecosystem approach to restoring and protecting beneficial uses in Areas of Concern...” RAPs were required by the 1987 Protocol to be submitted to the International Joint Commission at three stages:

- Stage 1: Problem definition
- Stage 2: When remedial and regulatory measures are selected
- Stage 3: When monitoring indicates that identified beneficial uses have been restored

Note that a renegotiated Great Lakes Water Quality Agreement was signed in 2012 by the U.S. and Canada which removed the “stage” terminology from the AOC Annex, and simply requires Remedial Action Plans to be “developed, periodically updated, and implemented for each AOC.”

Total Maximum Daily Load (TMDL)

A TMDL is the amount of a pollutant a waterbody can receive and still meet water quality standards. It can be thought of as a pollution “budget” for a water body or watershed that establishes the pollutant reduction needed from each pollutant source to meet water quality goals.

PURPOSE STATEMENT

The purpose of this document is to serve as a Remedial Action Plan update. Remedial Action Plans are required by Annex 1 of the Great Lakes Water Quality Protocol of 2012 (which replaced the 1987 Protocol amending the Revised Great Lakes Water Quality Agreement of 1978). The 2012 Protocol indicates that Remedial Action Plans must include the following elements:

1. Identification of beneficial use impairments and causes;
2. Criteria for the restoration of beneficial uses that take into account local conditions and established in consultation with the local community;
3. Remedial measures to be taken, including identification of entities responsible for implementing these measures;
4. A summary of the implementation of remedial measures taken and the status of the beneficial use; and
5. A description of surveillance and monitoring processes to track the effectiveness of remedial measures and confirm restoration of beneficial uses.

This Remedial Action Plan Update was prepared by the Wisconsin Department of Natural Resources in consultation with its partners and is intended to be a concise summary of beneficial use impairment status and specific actions that will be important for reaching the delisting targets. "Actions" may include on-the-ground restoration projects, monitoring and assessment projects, and stakeholder engagement processes. It is also a tool for documenting and communicating progress to agency partners and technical stakeholders. The Remedial Action Plan is typically updated annually to incorporate new information that becomes available over the course of the year.

INTRODUCTION

Areas of Concern (AOCs) are severely degraded geographic areas within the Great Lakes. The areas – 43 within the Great Lakes region – were designated as AOCs primarily due to contamination of river and harbor sediments by toxic pollutants (sometimes referred to as “legacy” pollutants due to the historical industrial development that often was the source of the pollution). Cleaning up these severely degraded areas is a first step toward restoring the chemical, physical, and biological integrity of the lakes as required by the Great Lakes Water Quality Agreement. When the areas have been cleaned up to the point where they are not more degraded than other, comparable non-AOC areas, they are “delisted” as AOCs; they are then considered to be part of the Lakewide Action and Management Plan (LAMP) program, a “whole lake” program that is also set forth in the Agreement. The Agreement provides the framework for the U.S. and Canada to work together to restore the chemical, physical, and biological integrity of the lakes.

The Lower Green Bay and Fox River AOC is one of five AOCs in Wisconsin. This AOC spans seven miles of the Lower Fox River (downstream from the De Pere Dam to the mouth) and 22 square miles of southern Green Bay (from the Fox River mouth to a line drawn between Long Tail Point and Point au Sable, Figure 1). The relatively small geographic area officially recognized as the AOC is the location where cumulative impacts from the much larger Fox-Wolf watershed are manifested and the environment is most severely impaired.

The Lower Green Bay Remedial Action Plan (RAP; WDNR, 1988) and RAP Update (WDNR, 1993) provide extensive descriptions of the historical and environmental setting of the AOC, the original environmental problems that led to designation of this area as an AOC, and the sources of those problems as they were characterized at the time. These plans also include goals, objectives, and strategies to address these problems and restore the Lower Bay and Fox River. These plans are available on the Wisconsin Department of Natural Resources’ (WDNR’s) website: <http://dnr.wi.gov/topic/greatlakes/greenbay.html>.

At the time of the first RAP, the major environmental problems in the Lower Bay and Fox River that led to AOC designation were caused by sources that can be divided into four broad categories:

- Toxic Substances: Polychlorinated biphenyls (PCBs), historically discharged by mills during the manufacture and recycling of carbonless copy paper, were of primary concern although the RAP mentions several chemicals including 20 that were on the U.S. Environmental Protection Agency’s (USEPA’s) priority pollutant list at that time.
- Point Source and Runoff Pollution: Phosphorus and sediment discharges from municipalities and industries lining the Fox River corridor and nonpoint sources in the Lower Fox Watershed.
- Physical Habitat Alterations: including wetland filling and draining, shoreline erosion and filling.
- Other: water level fluctuations and non-native invasive species.

More complete descriptions of these causes can be found in the 2013 RAP Update.

These sources of impairment led to designation of eleven of the possible fourteen beneficial use impairments (BUIs) as applicable to this AOC. Additionally, two of the fourteen beneficial use impairments were listed as “suspected,” meaning that they were likely to be a problem but data were lacking or inconclusive.

The original RAP (WDNR, 1988) and RAP Update (WDNR, 1993) contained goals and objectives for restoring beneficial uses in the AOC. In the twenty-five years since these were first developed, local, state, and federal partners made significant progress toward addressing the causes of impairments. However, no beneficial use impairments have been removed and the Lower Green Bay and Fox River still remain an Area of Concern. In an effort to recognize progress towards meeting RAP goals, USEPA requested that states generate “Delisting Targets” for each BUI. The targets clearly define when impairments are to be considered sufficiently addressed so that they can be removed from the AOC. The Wisconsin Department of Natural Resources (WDNR) worked with local stakeholders in early 2009 to develop the targets for the Lower Green Bay and Fox River AOC (WDNR, 2009). In some cases, those targets have been modified or updated as needed in subsequent RAP Updates. The annual RAP Updates provide the most current version of the target, summarize the current status of the BUIs, and identify actions needed to reach the delisting targets. Public participation is part of the AOC process and is discussed in the overview below.

Stakeholder Engagement

WDNR has been primarily focused on efforts to engage technical stakeholders as discussions about beneficial use impairments evolve. However, all interested stakeholders, including those affiliated with the independent Clean Bay Backers organization, are encouraged to participate in these discussions, as their interest dictates. As in 2015, WDNR’s primary focus for 2016 will be to work with technical stakeholders to develop or refine BUI-specific assessment strategies. The impairments WDNR will intensively focus on for 2016 will be Degradation of Aesthetics, Loss of Fish and Wildlife Habitat, and Degraded Fish and Wildlife Populations.

For 2016, the key priority for outreach is engaging additional volunteers for the aesthetics monitoring program.

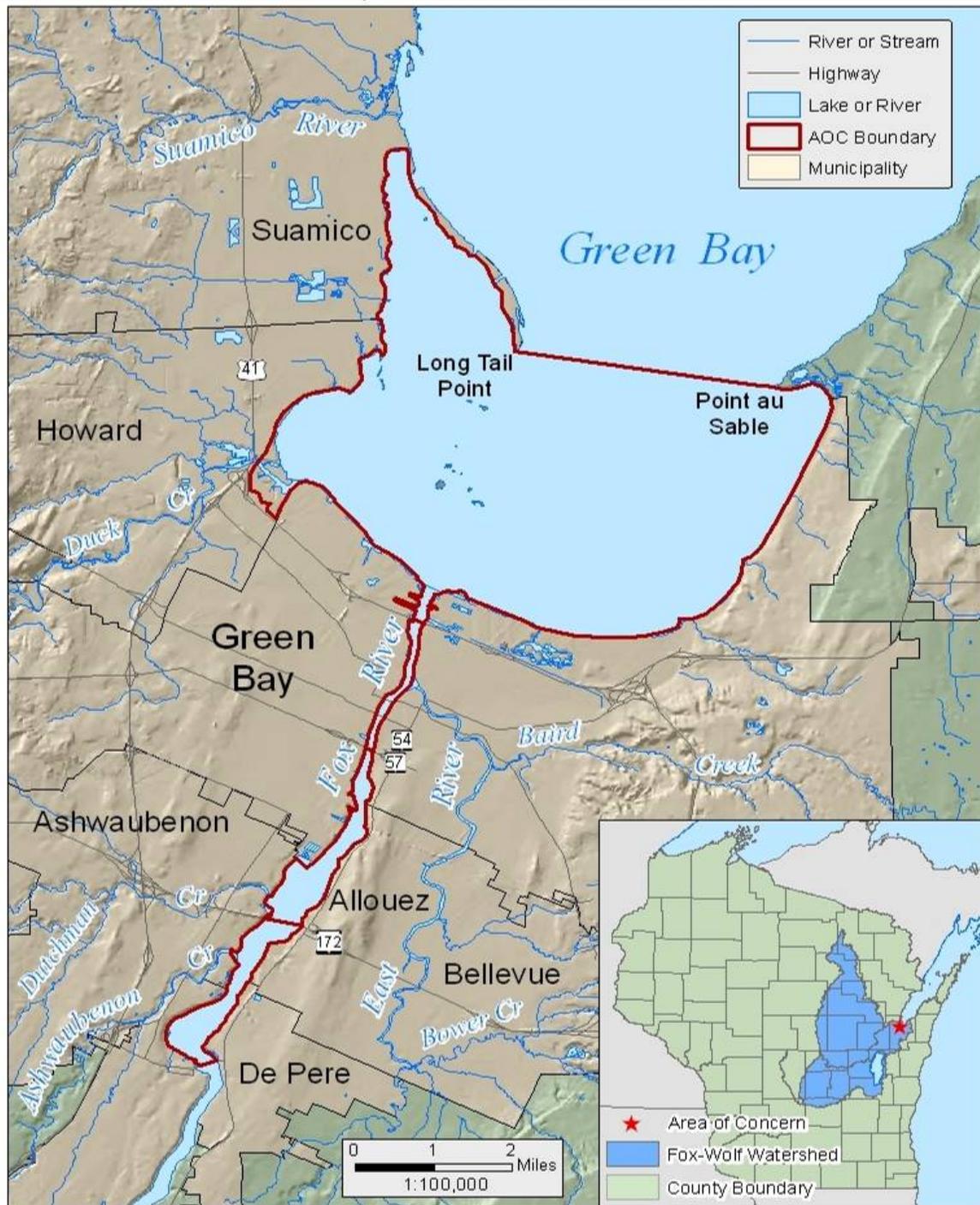


Figure 1. The boundaries of the Lower Green Bay and Fox River Area of Concern.

Table 1. Current Status of Beneficial Use Impairments in the Lower Green Bay and Fox River AOC (Refer to Appendix A for more detail).

Beneficial Use Impairment	Beneficial Use Remains Impaired	Summary Status
Restrictions on fish and wildlife consumption	Yes	Wildlife consumption assessment is in progress. Sampling is scheduled to occur 2013-2016. Fish consumption advisories for PCBs specific to the AOC will be addressed by the Lower Fox River PCB Cleanup project.
Tainting of fish and wildlife flavor	Suspected	WDNR conducted an angler survey in 2013-2014 to help inform the status of this BUI. Additional information is being sought from ethnic minority communities to help ensure diverse perspectives are represented in the survey. The assessment strategy will be further developed in 2017 for this BUI.
Degradation of fish and wildlife populations	Yes	WDNR secured GLRI funding for 2015-2016 to assess habitat and populations in the AOC. Pending those results, a list of necessary projects to address habitat and population deficiencies will be developed. Also currently depends on completion of on-going Lower Fox River PCB Cleanup and TMDL implementation.
Fish tumors or other deformities	Suspected	BUI will be assessed following WDNR criteria after in-river remedial action work for the Lower Fox River PCB Cleanup is complete (currently scheduled for 2018).
Bird or animal deformities or reproductive problems	Yes	BUI removal depends on completion of contaminated sediment remediation. Tree swallow monitoring stations were added in 2015. The next step will be to develop an assessment strategy in 2016.
Degradation of benthos	Yes	Results from the USGS-led 2012 and 2014 studies are pending.
Restrictions on dredging activities	Yes	This use will remain impaired until the on-going Lower Fox River PCB Cleanup project has been completed and the Institutional Control Implementation and Assurance Plan (ICIAP) is in place and fully implemented. The WPS Green Bay Former Manufactured Gas Plant Superfund Alternative site must also be cleaned up before this BUI can be removed.
Eutrophication or undesirable algae	Yes	WDNR is working with partners on a revised target and strategy for this BUI. The intention is to enable the AOC program to have a discrete role in addressing this complex issue.
Restrictions on drinking water consumption, or taste and odor problems	Yes	Supplemental data for cyanobacteria and cyanotoxins within the AOC is required to assess the current status of this impairment.
Beach closings	Yes	Beach program monitoring at locations used by the public for recreation indicate <i>E. coli</i> levels are good overall. However, supplemental data for cyanobacteria and cyanotoxins within the AOC is required to assess the current status of this impairment.
Degradation of aesthetics	Yes	Assessment, in the form of the volunteer monitoring program, is in progress.
Degradation of phytoplankton and zooplankton populations	Yes	Results from the USGS-led 2012 and 2014 studies are pending.
Loss of fish and wildlife habitat	Yes	Key projects that address this impairment include Cat Island Chain and Point au Sable habitat restoration projects. Additional projects will be identified in the next two years through the AOC habitat and populations assessment.

BENEFICIAL USE IMPAIRMENT UPDATES

The following pages summarize the current status of each Beneficial Use Impairment using the format below. An explanation of each section is provided after the heading. In 2014, WDNR added a section called “target rationale” to the Beneficial Use Impairment Updates for each impairment. This section will supplant the “notes” section that was in the previous years’ updates.

Target	Status
The most recent version of the Lower Green Bay and Fox River AOC delisting targets based on the delisting targets produced in 2009 (WDNR, 2009), or with subsequent modifications made during previous RAP Updates are listed here as separate target components on each row to clearly show status of each part of the target.	May be: - “Complete” - “In progress” - “Action needed” - “Unknown” - “Assessment in progress” (data collection occurring in years listed in parentheses) - “TBD” (to be determined)

Target rationale

This section may address or provide one or more of the following:

- Relevant background and explanation related to the target and any applicable modifications.
- If applicable, an explanation of why the updates or clarifications were necessary for the 2009 target updates.
- Potential concerns WDNR has about the target, particularly if the target is not specific enough to define a measurable endpoint for the BUI.

Please note that the original 2009 delisting targets can be found in the document *Lower Green Bay and Fox River Area of Concern Beneficial Use Impairment Delisting Targets* (WDNR, 2009).

Rationale for listing

The section briefly summarizes the reason the BUI was known or suspected at the time of listing. If sources contributing to the impairment have been identified since listing, those are included in this section as well.

Summary of key remedial actions since the 2014 RAP Update and current status

“Key remedial actions” are those that directly contributed to the current status of the BUI. A table may be included as an appendix to capture a detailed list of past projects. The narrative here explains and leads to the “Next action needed”.

Next action(s) needed

1. This section is a narrative listing of assessments, and on-the-ground projects, that are clearly delineated and directly address the specific BUI.
2. Plans for verifying achievement of delisting targets are listed here if known.

Issues (challenges, risks) affecting progress on this BUI

This section lists project contingencies (i.e., one thing has to happen before another can occur), funding obstacles, and any other considerations that could affect the timeline for removal.

RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION

Target	Status
The Fox River Contaminated Sediment Remediation has been completed and meets the target established in the plan (Surface Area Weighted Concentration of 0.25 ppm or that determined acceptable by the agencies for completion of the PCB remedial action)	In progress
Fish and wildlife consumption advisories are the same or lower than those in the associated Great Lake or appropriate control site.	Assessment in progress

Target rationale

Contaminated sediments are the primary contributor of PCBs to fish and wildlife within the AOC. An effective source control and remediation program is therefore necessary in order to meet delisting goals. Post-remedial actions and taking appropriate source control measures and evaluation monitoring must be conducted to determine the state of recovery for this impairment. Please note that for this impairment, PCBs are the contaminant of concern; there are no additional fish consumption advisories in the AOC for mercury or other chemical contaminants (i.e., beyond the state-wide fish consumption advice that applies for mercury). Please refer to WDNR's *Choose wisely: A health guide for eating fish in Wisconsin* (WDNR, 2015a) document for more information about current fish consumption advisories.

A waterfowl consumption advisory has also been in effect in the AOC since 1987. The most current information can be found on page 26 of the *2015 Wisconsin migratory bird regulations* (WDNR, 2015b).

Rationale for listing

This impairment was originally identified because of the presence of persistent, bioaccumulative, and toxic substances, primarily PCBs, in sediments that resulted in consumption advisories for certain species of fish and waterfowl specifically in AOC waters. At the time the RAP was developed concerns were also noted about the presence of more than 100 chemicals including 20 then listed on USEPA's priority list of pollutants that pose a risk to the environment and human health (Allen et al., 1987).

Summary of key remedial actions since the 2014 RAP Update and current status

Sources of PCB discharges to the river have been largely eliminated and completion of the on-going Lower Fox River PCB Cleanup will address PCBs remaining in sediments along with mercury and other potentially toxic chemicals. The long-term goal of the cleanup project is to protect human health by removing fish consumption advisories as quickly as possible, although it may take years before this occurs.

In 2015, the Lower Fox River PCB Cleanup project continued. At the end of the 2015 dredging season, project milestones were:

- 515,000 cubic yards of material removed
- 337,740 tons of material were sent to the landfill
- 113 acres were sand covered
- 32 acres were rock capped

The WDNR received funding to reassess the waterfowl consumption advisory for the AOC to determine if the existing advisory is still warranted. Sampling began in spring of 2013 and will continue through at least 2016 (WDNR encountered some difficulties with obtaining a sufficient number of samples, so the project timeline has been adjusted accordingly). A final report with update consumption advice is now

scheduled for 2017. In conjunction with this project, a new method for determining waterfowl consumption advice was developed in Wisconsin. This new advice methodology will shift advisories from being species-specific to those based on feeding niche (Sean Strom, 2014, personal communication).

Next action(s) needed

1. Waterfowl Consumption Advisory Update: Complete 3-year waterfowl consumption advisory evaluation to determine if the existing advisory is still warranted (final report expected 2017).
2. Complete the Lower Fox River PCB Cleanup project (in-river Remedial Action is expected to be complete by 2018).
3. Complete fish tissue monitoring as required by Lower Fox River PCB Cleanup project long term monitoring plan.
4. Complete fish consumption advisory analysis as required by WDNR and Wis. Dept. of Health Services (WDHS) procedures. Data from the sediment remediation project can be used for this process, but additional monitoring may be necessary for updating the consumption advisory.

Issues (challenges, risks) affecting progress on this BUI

- Removal of this impairment depends on completion of the Lower Fox River PCB Cleanup project. Any delay in the sediment remediation will also delay removal of this impairment.
- Time may be needed for the fish and wildlife contaminant levels to decline after completion of the PCB cleanup.

TAINTING OF FISH AND WILDLIFE FLAVOR

Target	Status
No target was developed in 2009, as this is a suspected impairment.	Target in development

Target rationale

Not applicable at this time.

Rationale for listing

This impairment was briefly mentioned in the 1993 RAP Update as suspected based on 1) occasional angler reports of problems with fish taste and odor and 2) the potential for components in industrial and municipal effluents (resin acids, chlorophenols) to cause off-flavors in fish (WDNR, 1993).

Summary of remedial actions since the 2014 RAP Update and current status

The current status is unknown as WDNR does not routinely collect reports about problems with fish taste.

In order to inform whether this impairment may exist in the AOC, WDNR conducted an angler survey in 2013. The majority of the surveys were distributed in conjunction with WDNR's annual creel survey, which is conducted to estimate fishing effort, catch, and harvest rates using angler counts and interviews. The creel clerk handed out survey forms with pre-addressed, postage-paid envelopes to anglers she encountered during her regular creel surveys. In addition, a few surveys were distributed by other means, such as via the Green Bay Area Great Lakes Sport Fishermen, during the Green Bay Tall Ship Festival, and to the Hmong Center of Green Bay. The AOC angler survey asked anglers a variety of questions about fishing in the AOC, including whether they ate fish from the AOC; whether they noticed a difference in the taste and odor of fish caught in the AOC versus other locations; and if they didn't eat fish from the AOC, why they did not. The survey also asked some questions related to the fish consumption advisory and the aesthetics/beauty of the area.

For the 2013 angler survey, of the 55 completed surveys that WDNR received from survey participants, 29 consumed their catch. Of those 29, there were no reports among anglers who ate fish in the AOC of poor fish flavor or smell.

Next action(s) needed

WDNR will work with stakeholders to develop a target for this BUI. Further actions can be determined once a target exists.

Issues (challenges, risks) affecting progress on this BUI

Because of the fish consumption advisories, many people do not eat fish caught in the area. The fish consumption advice is more likely to influence whether people consume fish caught from the AOC compared to potential concerns with poor fish flavor.

DEGRADATION OF FISH & WILDLIFE POPULATIONS

Target	Status
The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native fish species (including walleye, northern pike, yellow perch, lake sturgeon, Great Lakes spotted muskellunge, and centrarchids) in abundances sufficient to provide ecological function in the fish community	Action needed
Populations of traditionally harvested fish species are capable of supporting some level of exploitation	Partially complete (walleye); more assessment needed
The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native furbearers (including mink, muskrats, and otter), amphibians (including spring peepers, leopard frogs, American toads, eastern gray tree frogs, green frogs, bullfrogs, and salamanders), reptiles (including snapping and painted turtles), terns (common and Forster's), migratory diving ducks, dabbling ducks, marsh nesting birds and island-dependent colonial nesting birds in abundances sufficient to provide ecological function	Assessment in progress
Populations of traditionally harvested wildlife species are capable of supporting some level of exploitation	Assessment in progress
Invasive species (lamprey, carp, gobies, white perch, and others) expansion is minimized and controlled as needed to protect native species within the AOC and upstream	In progress
Contaminant levels in forage fish populations do not impair the reproductive success of fish-eating birds and wildlife (including predatory fish) and meet the criteria established in Annex 1 of the 1978 Great Lakes Water Quality Agreement as amended by Protocol in 1987, specifically "the concentration of total polychlorinated biphenyls in fish tissues (whole fish, calculated on a wet weight basis), should not exceed 0.1 micrograms per gram for the protection of birds and animals which consume fish"	Assessment in progress
The AOC supports fish and wildlife populations at levels consistent with extant fish and wildlife management plan objectives. Specifically, the following objectives should be met unless extant management plans have updated criteria (specific objectives identified in past RAP documents are listed in Appendix B)	Partially complete; more assessment needed

Target rationale

In Green Bay, there is a strong desire among stakeholders to use an ecosystem approach. At the time that targets were developed, narrative goals were crafted with the intention of allowing experts to use their best judgment to determine when the targets had been met. A rather lengthy list of objectives for fish and wildlife were developed as part of this process (see Appendix B).

WDNR intends to revisit these objectives in the upcoming year or two and work with technical stakeholders to create final delisting targets whose objectives can be achieved as part of the remedial goals of the Area of Concern program.

Rationale for listing

The major causes of degraded fish and wildlife populations in the AOC listed in the original Remedial Action Plan (WDNR, 1988) and Update (WDNR, 1993) include the following:

- Changes in habitat due to wetland filling, hardened shorelines, and development associated with urban and industrial areas

- Impact from exotic species of fish (alewife, sea lamprey, rainbow smelt, gobies, white perch, and carp) and vegetative invasive species
- Toxic chemicals – suspected impacts of toxics on wildlife (mink, bald eagle, osprey, otter, terns nesting in unsuitable locations such as Renard Island)
- Fewer fish species and numbers of top predator fish, and an overabundance of rough fish
- Waterfowl – lack of preferred foods (invertebrates, submerged aquatic plants)
- Periods of low dissolved oxygen caused by hypereutrophication
- Loss of habitat, including reduced submerged aquatic vegetation due to poor light transmissivity through turbid waters and reduced hydrologic connections between the Bay and coastal wetlands.

Summary of remedial actions since the 2014 RAP Update and current status

In 2015, the Lower Fox River PCB Cleanup project continued. 2015 project milestones were:

- 515,000 cubic yards of material removed
- 337,740 tons of material were sent to the landfill
- 113 acres were sand covered
- 32 acres were rock capped

In 2014, WDNR funded a trapper survey for the AOC. Results from this survey were mixed, and the recommendations from the final report included obtaining baseline abundance data and conducting habitat assessments in the AOC for mink, otter, and muskrats (Dhuey et al., 2014). In late fall 2015, an aerial muskrat survey is planned to determine whether they are as abundant in the AOC compared to adjacent areas that aren't within the AOC.

In 2015, a fish assemblage survey was conducted in the riverine portion of the AOC following the Wisconsin large river index of biotic integrity (IBI) monitoring protocols. Ten reaches were surveyed, making that stretch of the river one of the most densely sampled in the state using this particular monitoring protocol. The benefit of such indices is that they provide overall quantitative empirical models for rating the health of an ecosystem. The mean score of the ten sites was 29, with the scores ranging from 25 to 35 (out of 100). The score of 40 forms the lower threshold for the "fair" category. Figure 2 is a histogram of the scores. Note that the score for both the median and mode was 30.

The assessment for fish and wildlife populations and habitat in the AOC began this year, and will continue through next. Preliminary results from that effort will be shared as they become available.

Next action(s) needed

1. Work with technical stakeholders to create final delisting targets whose objectives can be achieved as part of the Area of Concern program.
2. Complete the Lower Fox River PCB Cleanup (currently expected to be complete by 2018).

Issues (challenges, risks) affecting progress on this BUI

Working through the assessments and developing AOC-specific plans will take a couple of years, but by that point, we will have an informed way to determine which specific management actions are needed.

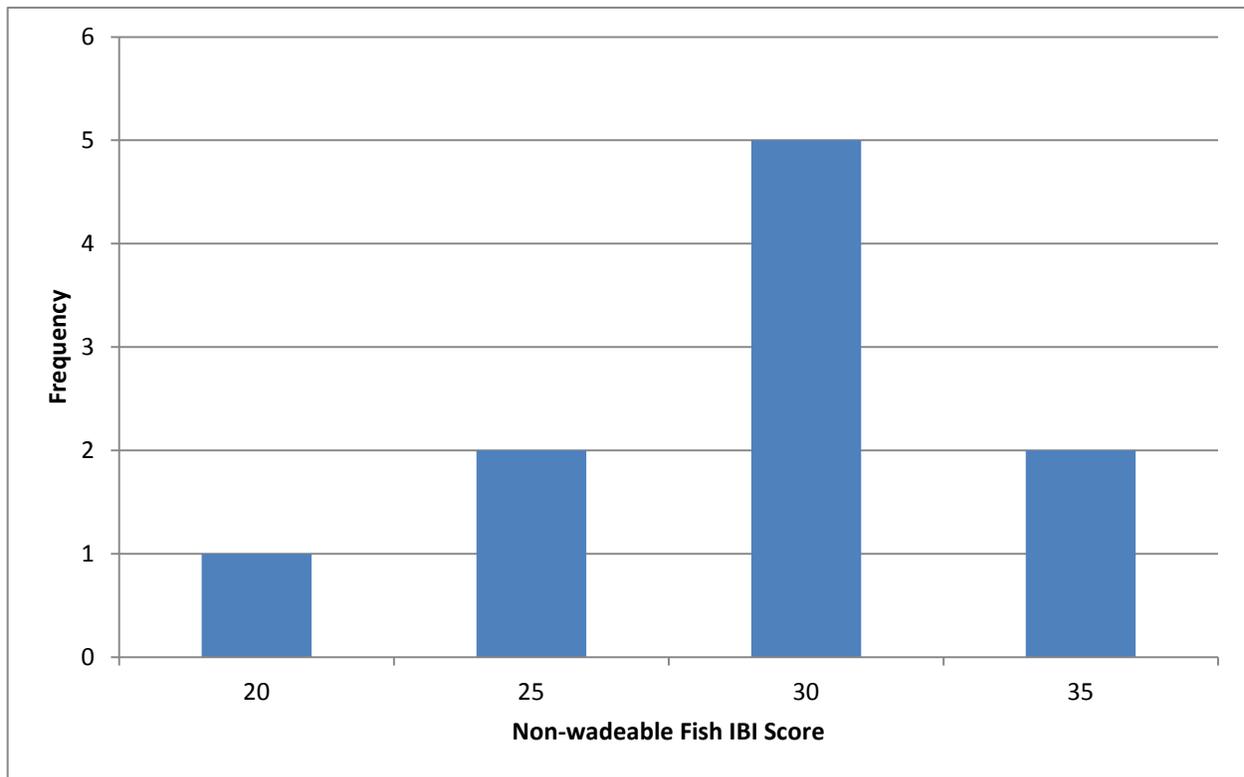


Figure 2. Distribution of Lower Fox River non-wadeable fish indices of biotic integrity scores from 2015 sampling following Lyons et al. 2001 protocols. Note that n=10, and that IBI scores range from 0-100.

FISH TUMORS OR OTHER DEFORMITIES

2015 Draft Target	Status
Removal may occur if: <ul style="list-style-type: none"> All known major sources of PAHs and chlorinated organic compounds within the AOC and tributary watershed have been controlled or eliminated A fish health survey of resident benthic fish species, such as white suckers, finds incidences of tumors or other deformities at a statistically similar incidence rate of minimally impacted reference sites. 	Action needed
OR, in cases where tumors have been reported: <ul style="list-style-type: none"> A comparison study of resident benthic fish such as white suckers of comparable age and maturity, or of fish species found with tumors in previous fish health surveys in the AOC, with fish at minimally impacted reference sites indicate that there is no statistically significant difference (with 95% confidence) in the incidence of liver tumors or deformities. 	TBD

Draft target rationale

At a September technical stakeholders' meeting, WDNR shared some information about how other AOCs have approached developing a target for this BUI. Stakeholders at the meeting indicated that it would be appropriate for WDNR to develop a draft target and include it in the RAP Update draft for stakeholder review. Of the comments WDNR received, all indicated that they preferred an approach where contaminated sediments would be addressed and where a sufficiently large sample of fish were collected in order to determine the fish tumor incidence rate. Wisconsin has developed a fairly robust sampling procedure for this assessment, and we would propose using the same type of procedure here. Typically, at least 200 fish are collected from an AOC. Considerations are made for residency of the fish, as the preferred species has typically been brown bullheads, which are not often found in sufficient abundance along Western Lake Michigan tributaries. In instances where another fish species must be used in order to address considerations related to statistical power, isotopic analysis may be used to help determine how much time fish are spending in different portions of the AOC system.

Rationale for listing

This BUI was listed as suspected due to the presence of persistent, bioaccumulative, and toxic substances, primarily PCBs, in Lower Fox River sediments thought to induce external and liver tumors in fish. At the time the original RAP (WDNR, 1988) and the first RAP Update (WDNR, 1993) were developed there was not enough evidence of tumors or other deformities in fish collected from the AOC to definitively list this BUI. Baumann et al. (1991) only identified one hepatocellular neoplasm in 40 walleye and no liver neoplasms in brown and black bullheads collected from the Fox River. It was then recognized that only a small number of fish (10 per location) were taken at random for histopathology and that "a larger study would be required to determine a frequency of neoplasms or cellular alteration with confidence" (Baumann et al., 1991).

Summary of remedial actions since the 2014 RAP Update and current status

Although the Lower Fox River PCB Cleanup project is important to the AOC overall, the current understanding is that contaminant-related liver tumors of interest for this BUI (defined more specifically by the International Joint Commission's listing criteria as neoplastic or preneoplastic liver tumors in bullhead or suckers) are associated with polycyclic aromatic hydrocarbon (PAH) exposure, typically not PCB exposure (Rafferty et al., 2009).

Because these tumors are more closely associated with PAH exposure, cleaning up any sites in the AOC that contain elevated concentrations of PAHs is necessary to removing this impairment. There is a known PAH-contaminated site in the AOC, the Wisconsin Public Service (WPS) Green Bay Former Manufactured Gas Plant Superfund Alternative Site. In August of 2014, the Integrys Group completed contaminated sediment sampling at the site that will be used to inform remedial actions. A cleanup schedule is pending.

Next action(s) needed

1. Completion of the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site cleanup.
2. BUI Assessment following WDNR criteria after the Lower Fox River PCB Cleanup is complete. The earliest that a BUI assessment could be initiated is 2018 based upon the anticipated completion date of the in-river remedial action work.

Issues (challenges, risks) affecting progress on this BUI

The assessment will be conducted once the PCB cleanup project is completed. Funding will need to be secured to complete the assessment.

BIRD OR ANIMAL DEFORMITIES OR REPRODUCTIVE PROBLEMS

Target	Status
<p>PCB remedial actions have been implemented and the AOC is in recovery</p>	<p>In progress</p>
<p>Studies indicating the incidence rates of deformities (e.g., crossbill syndrome) or reproductive problems (e.g., eggshell thinning) in sentinel wildlife species (avian, amphibian, mammalian, predatory fish, and reptilian) do not exceed background levels of reference populations from unimpacted sites of comparable physical and chemical characteristics.</p> <p>A stepwise approach will be used to conduct <u>both</u> of the following evaluations in the AOC to determine when the BUI can be delisted:</p> <ol style="list-style-type: none"> 1. If fish tissue or other food sources (e.g., insects and amphibians) concentrations of contaminants of concern identified in the AOC are: <ol style="list-style-type: none"> a. at or lower than the Lowest Observable Effect Level (LOEL) known to cause reproductive or developmental problems in fish, fish-eating birds, and mammals, the BUI can be delisted, or b. not statistically different than Lake Michigan (at 95% confidence interval), then the BUI can be delisted. <p>Fish and other food sources (e.g., insects and amphibians) should be of a size and species considered prey for the species under consideration;</p> 2. Field studies including observational data and direct measures of birds and other wildlife (including predatory fish) exhibit deformities or reproductive problems are verified through an: <ul style="list-style-type: none"> – Evaluation of observational data of bird and other animal deformities for a minimum of two successive monitoring cycles in indicator species identified in the initial studies as exhibiting deformities or reproductive problems. If deformity or reproductive problem rates are not statistically different than those at minimally impacted reference sites (at a 95% confidence interval), or no reproductive or deformity problems are identified during the two successive monitoring cycles, then the BUI can be delisted. If the rates are statistically different than the reference site it may indicate a source from either within or outside the AOC. Therefore, if the rates are statistically different or the data are insufficient for analysis, then: – Evaluation of tissue contaminant levels in egg, young and/or adult wildlife. If contaminant levels are lower than the Lowest Observable Effect Level (LOEL) for that species for a particular contaminant that are not statistically different than those at minimally impacted reference sites (at a 95% confidence interval), then the BUI can be delisted. 	<p>Assessment needed</p>

Target rationale

The current target calls for extensive studies of food sources and birds and/or wildlife. This target will be revisited because of recent work that has been done using indicators that are suitable for this impairment (i.e., taking advantage of existing efforts and reducing the need for additional studies).

Rationale for listing

This BUI was originally listed because of the impact of contaminants on bird reproduction and suspected impacts on mammals (WDNR, 1993). Strong evidence of adverse impacts on reproductive success and/or embryonic deformations linked to PCB exposure were documented in fish-eating birds, including

Forster's, Common, and Caspian terns and less conclusively in double-crested cormorants and bald eagles (Stratus Consulting, 1999). Only circumstantial evidence, primarily the lack of their presence in potential habitat, existed to suggest mink and river otter were impacted by contaminants in the AOC (Allen et al., 1987).

Summary of remedial actions since the 2014 RAP Update and current status

In 2015, the Lower Fox River PCB Cleanup project continued. Project milestones were:

- 515,000 cubic yards of material removed
- 337,740 tons of material were sent to the landfill
- 113 acres were sand covered
- 32 acres were rock capped

In 2015, three additional tree swallow monitoring arrays (Lambeau Cottage, East River, and Dead Horse Bay) were added within the AOC. Analytical data are pending and are not yet available at this time. Figure 3 is a map of where tree swallow monitoring has occurred within the last five years.

Next action(s) needed

1. Develop an assessment strategy for this BUI: WDNR will work with stakeholders and experts to identify appropriate species, metrics, sampling methods, timing, locations, and a lead entity to collect sufficient data to demonstrate whether or not this BUI is still impaired.
2. Completion of the Lower Fox River PCB Cleanup (in-river remedial action work is expected to conclude by 2018).

Issues (challenges, risks) affecting progress on this BUI

The Lower Fox Contaminated Sediment Remediation project long term monitoring plan does not include bird or wildlife monitoring.

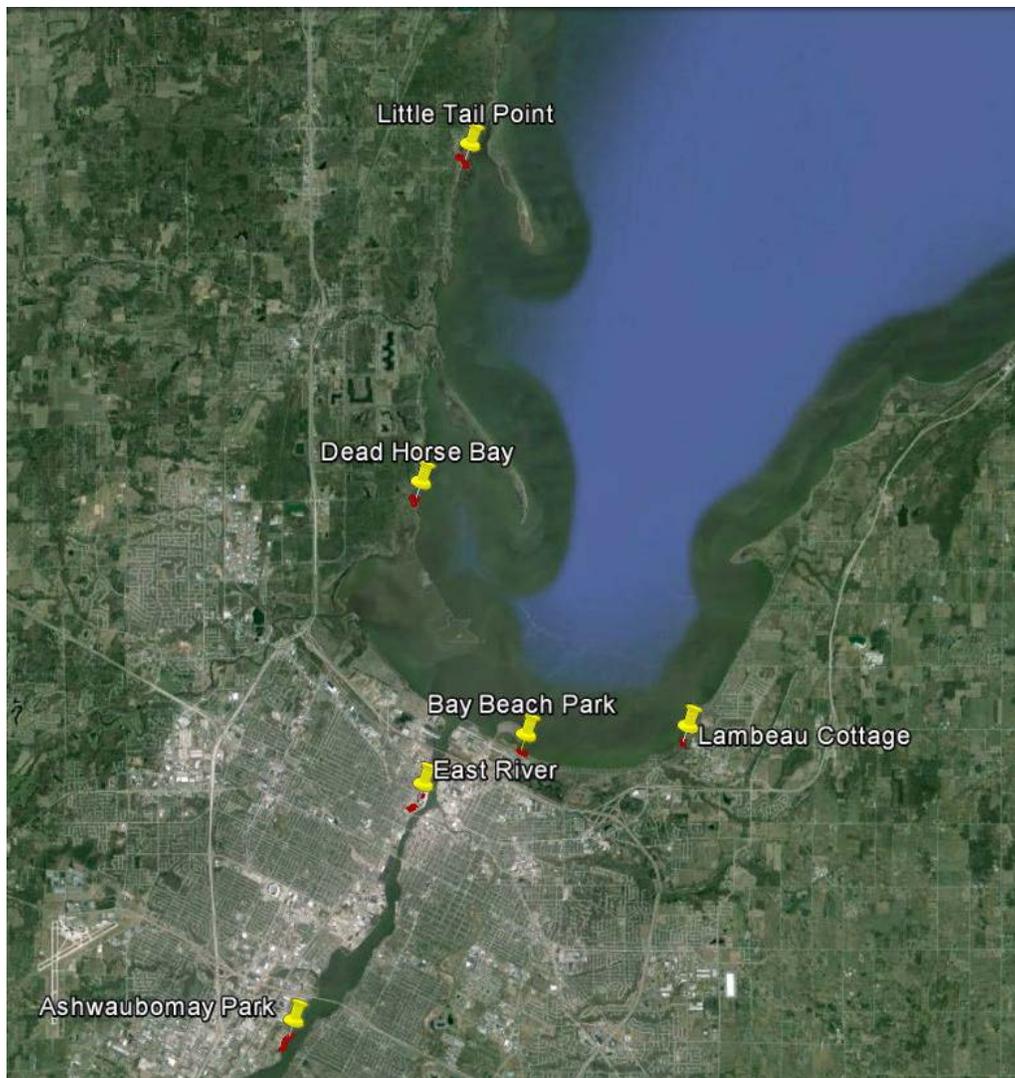


Figure 3. Locations in and near the AOC (Little Tail Point) where tree swallow monitoring has or is occurring within the last five years.

DEGRADATION OF BENTHOS

Target	Status
All remediation actions for known contaminated sediment sources are completed and monitored according to the approved plan and have met their remedial action goal.	In progress
The benthic community IBI within the site being evaluated is statistically similar to a reference site with similar habitat and minimal sediment contamination.	Assessment in progress (2012 and 2014)
Burrowing mayfly (<i>Hexagenia</i>) populations return to the AOC in stable annual abundances between 100-400 nymphs/m ² (measured as a 3-year running average) or as otherwise indicative of adequate levels of dissolved oxygen in overlying waters and uncontaminated surficial sediments in Lake Michigan.	In progress
Sediment toxicity (due to ammonia, PCB, or dissolved oxygen) is not present at levels that are acute or chronically toxic (as defined by relevant, field validated, bioassays with appropriate quality assurance/quality controls) to the benthic community.	Assessment needed
Native benthic communities adequately support the trophic levels that depend upon them.	Assessment needed

Target rationale

The 2009 target reflects the interest of stakeholders in seeing contaminated sediment remediation (contaminated sediments have impacts on benthic communities). It also reflects a desire among some stakeholders to have mayfly populations, which were historically in the area, return.

Rationale for listing

This impairment was originally identified based on studies indicating low species diversity, low numbers of individuals, and a benthic community dominated by oligochaetes and chironomids in the AOC (WDNR, 1993). A burrowing mayfly, *Hexagenia*, was not collected from Green Bay since 1955 and its return was suggested to be a key indicator of macroinvertebrate recovery in Green Bay (Ball et al., 1985). Tests of sediment pore water toxicity from the Lower Fox River determined that ammonia was toxic to a variety of aquatic organisms and possibly the result of not only direct inputs from point sources but also enrichment of the system by various nutrients (Ankley et al., 1990).

Summary of key remedial actions since the 2014 RAP Update and current status

In 2015, the Lower Fox River PCB Cleanup project continued. Project milestones were:

- 515,000 cubic yards of material removed
- 337,740 tons of material were sent to the landfill
- 113 acres were sand covered
- 32 acres were rock capped

In August of 2014, the Integrys Group completed contaminated sediment sampling at the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative site that will be used to inform remedial actions. A cleanup schedule is pending.

Additionally, the U.S. Geological Survey (USGS) sampled the AOC for benthos and plankton in 2012 and again in 2014. They have provided preliminary findings for the studies and are engaged in a peer review process before releasing the final reports.

Next action(s) needed

1. Determine quantitative criteria for BUI removal.
2. Evaluate the results of the 2012 and 2014 USGS benthos assessment.
3. Complete the contaminated sediment cleanups.

Issues (challenges, risks) affecting progress on this BUI

Developing quantitative criteria for BUI removal will require specific technical expertise. More assessments may be necessary before a determination of the BUI status can be made.

RESTRICTIONS ON DREDGING ACTIVITIES

Target	Status
All remediation actions for known contaminated sediment sources are completed and monitored according to the approved remediation plans, the remedial action goals have been achieved, and institutional controls have been implemented.	In progress

Target rationale

The completion of the contaminated sediment cleanups (both the PCB cleanup and the WPS Former Manufactured Gas Plant site) is the driving force behind being able to remove this impairment. This delisting target is not intended to create specific measures that would restrict agency decision-making and will not be used as the basis for cleanup levels for contaminated sites or for regulatory enforcement.

Rationale for listing

This impairment was originally identified due to the presence of toxic substances in sediments that prevented unrestricted dredging and sediment disposal in the AOC. At that time concerns were noted about the presence of more than 100 chemicals including 20 then listed on USEPA's priority list of pollutants that pose a risk to the environment and human health (Allen et al., 1987). Emphasis has been placed on PCBs in the sediments since the remedy to address PCB exposure effectively addresses the other compounds as well.

Summary of key remedial actions since the 2014 RAP Update and current status

In 2015, the Lower Fox River PCB Cleanup project continued. Project milestones were:

- 515,000 cubic yards of material removed
- 337,740 tons of material were sent to the landfill
- 113 acres were sand covered
- 32 acres were rock capped

In August of 2014, the Integrys Group completed contaminated sediment sampling at the WPS Green Bay Former Manufactured Gas Plant Superfund Alternative site that will be used to inform remedial actions. A cleanup schedule is pending.

Next action(s) needed

Complete the contaminated sediment cleanups. In this document, for the purposes of planning with regard to the AOC, WDNR cites that the in-river remedial action work for the PCB cleanup project is expected to conclude by 2018. If the project stays on schedule, however, it is currently scheduled to be complete by the end of 2017. The timeframe for the WPS site is currently unknown.

Issues (challenges, risks) affecting progress on this BUI

Removal of this impairment depends on completion of the two contaminated sediment projects. Any delay in these projects also delays removal of this impairment.

EUTROPHICATION OR UNDESIRABLE ALGAE

Target	Status
Total phosphorus and total suspended solids concentrations at the mouth of the Lower Fox River meet water quality standards and/or water quality targets specified in a State and US EPA approved Total Maximum Daily Load. The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action needed
There are no violations of the minimum dissolved oxygen concentrations established in Wisconsin Administrative Code Chapter NR 102 within the AOC due to excessive sediment deposition or algae growth.	Action needed
No waterbodies within the AOC are included on the 303(d) list of impaired waters due to nutrients or blue-green algae in the most recent Wisconsin Impaired Waters list.	Action needed
<p>Cyanobacteria will be evaluated using the following methodology:</p> <ul style="list-style-type: none"> 90% of the geometric means of at least 5 monthly samples (collected between May 1 and September 30th in at least 2 years) of phytoplankton samples from waterbodies in the AOC contain less than 100,000 cyanobacterial cells/mL or less than 20 µg/L of microcystin-LR. Less than 50 - 60% of the relative biomass of phytoplankton is cyanobacteria when total phosphorus at the mouth of the Lower Fox River reaches the TMDL target of 100 µg/L (0.1 mg/L) 	<p>Assessment needed</p> <p>Assessment needed</p>

Target rationale

The current target (shown above) was developed in 2009 with slight modifications in 2012 and 2013 (full rationale for the current target is provided in the 2014 RAP Update). This target relies heavily on the TMDL, which requires implementation across the very large geographic area that is the Fox-Wolf basin, and the AOC, which requires action in a very focused geographic area. WDNR began a process of engaging stakeholders in 2015 to clarify the geographic bounds of AOC efforts for this BUI and establish AOC-specific measurable endpoints (i.e., endpoints that can be achieved through management actions within the defined geographic bounds established for this BUI). These discussions are expected to result in a proposed target revision in 2016.

Rationale for listing

The original listing of eutrophication or undesirable algae was based on historically elevated phosphorus levels that resulted in hypereutrophic (overly productive) conditions, excessive algal blooms in the AOC, and low dissolved oxygen concentrations in the Lower Bay (WDNR, 1993). These algal blooms contributed to decreased water clarity in the AOC that restricted the growth of underwater plants. More recently, since the invasion of zebra mussels, these blooms are increasingly dominated by potentially toxic cyanobacteria (De Stasio et al., 2008; De Stasio et al., 2014). Cyanobacterial blooms are considered undesirable as they are a less preferred food source for zooplankton and fish and contribute to ammonia toxicity and depleted oxygen in sediments when decomposed by bacteria (WDNR, 1993). These blooms also have the potential to produce toxins that are potentially harmful to humans, pets, and livestock.

Summary of remedial actions since the 2014 RAP Update and current status

In 2015, WDNR engaged stakeholders in developing an alternative target for this BUI. The alternate target is draft, and further discussions are needed with USEPA, stakeholders, and with the counties in the Lower Fox watershed. The draft target consists of three parts:

- A. Writing Nine Key Element plans for each sub-basin in the 2012 Lower Fox River and Lower Green Bay TMDL.
- B. Achieving the load reductions identified by the 9 Key Element Plans through implementation of management measures in the top seven highest agricultural-loading sub-basins for phosphorus and total suspended solids (based on 2012 Lower Fox River & Lower Green Bay TMDL): Lower Fox River, Duck Creek, East River, Apple Creek, Plum Creek, Kankapot Creek, and Bower Creek.
- C. Meeting the water quality objectives in sub-basins listed in Part B of the target (excluding the Lower Fox River sub-basin).

Discussions regarding this potential target change are on-going and will continue into 2016.

Additionally, the Fox-Wolf Watershed Alliance obtained federal and state funding to begin working with partners on TMDL implementation in the Plum and Kankapot Creek subwatersheds, which have an approved nine key element plan. Note that nine key element plans “provide a framework for improving water quality in a holistic manner within a geographic watershed,” (WDNR, 2016) and therefore inventory the necessary actions that are required on-the-ground to improve water quality in a particular watershed. Plum and Kankapot Creek subwatersheds are the highest loading per unit area in the Lower Fox. Therefore, implementation of the actions identified in the nine key element plan for these subwatersheds is a significant step forward in improving water quality in the Lower Fox River.

Outagamie and Brown counties also inventoried the Upper East and Upper Duck subwatersheds and prepared nine key element plans. WDNR and USEPA approval on the plans is currently pending.

Next action(s) needed

Continue target conversations with USEPA, the counties, and other partners and stakeholders.

Issues (challenges, risks) affecting progress on this BUI

We don't know exactly how quickly the system will respond with reductions in phosphorus and sediment. Reductions are an important component, but net increase of nutrients being imported into the system from outside the Lower Fox River basin, e.g., the Upper Fox and Wolf River basins, affect nutrient cycles. Solutions that address these biogeochemical cycling issues may also need to be considered in order to meet overall water quality goals.

RESTRICTIONS ON DRINKING WATER CONSUMPTION, OR TASTE AND ODOR PROBLEMS

Target	Status
Densities of disease-causing organisms or concentrations of hazardous or toxic chemicals or radioactive substances do not exceed human health standards, objectives, or guidelines.	Assessment needed
Taste and odor problems are not present.	Assessment needed
Treatment and costs needed to make raw water suitable for drinking is the standard treatment used in comparable portions of the Great Lakes which are not degraded, specifically disinfection, coagulation, sedimentation, and filtration.	Assessment needed

Target rationale

This target refers to treated drinking water supplies, not the raw source water. WDNR's standards for drinking water in Wisconsin Administrative Code Ch. NR 809 apply after treatment and are evaluated based on samples collected at the point of distribution to the public water supply.

Rationale for Listing

The original listing of restrictions on drinking water as an impaired use was based upon the "unknown risks of toxic substances to human health" and the "health risks of exposure to the multitude of chemicals suspected" to exist in the AOC (Allen et al., 1987). Additional concerns were raised about potential taste and odor problems and high cost of water treatment related to removal of suspended solids, bacteria, and viruses from the water (Allen et al., 1987). An earlier comprehensive water study for Brown County had concluded that Lake Michigan was a preferable water supply over the Fox River or Green Bay because of water quality considerations (Donohue and Associates, 1976). Other factors favoring Lake Michigan as a water supply included the potential for accidental discharges from industries along the Fox River, the long distance from shore to reach an adequate depth for an intake in Green Bay, and potential high operating costs in a treatment plant related to algal growth impacting filtration and taste/odor problems (Donohue and Associates, 1976).

Summary of remedial actions since the 2014 RAP Update and current status

The 2013 RAP Update summarizes information about why local communities are using Lake Michigan as their water supply.

The first two sections of the 2009 Target listed above refer to treated drinking water supplies of communities adjacent to the AOC, not raw source water. The third section of the 2009 Target applies to the treatment and costs necessary to make raw water suitable for drinking and might be considered to apply to AOC waters. The status of this impairment is unknown.

Next action(s) needed

A more extensive data set for cyanobacteria and cyanotoxins is needed within the AOC to determine the current state of this BUI. WDNR will be leading an effort to design the assessment in 2016.

Issues (challenges, risks) affecting progress on this BUI

Assessment of this impairment is challenging because surface waters in the AOC are not currently used as a drinking water supply.

BEACH CLOSINGS

Target	Status
Public swimming beaches within the AOC, including Bay Beach, Communiversity Park, and Long Tail, are open for 95% of the swimming season (between Memorial Day and Labor Day) for any 5 year period based on Wisconsin Coastal Beach monitoring protocols for <i>E. coli</i> monitoring	Assessment of data needed
Public swimming beaches within the AOC, including Bay Beach, Communiversity Park, and Long Tail meet the blue-green algae target for 95% of the swimming season (geometric means of phytoplankton samples contain less than 100,000 cyanobacterial cells/ml or less than 20 µg/L of microcystin-LR based on at least 5 monthly samples over at least 2 years)	Assessment needed (2011 study indicates possible impairment)
No waterbodies within the AOC are included on the list of impaired waters due to pathogen contamination or blue-green algae in the most recent Wisconsin Impaired Waters list	Complete (assessment of blue-green algae data needed)

Target rationale

There was an interest among stakeholders to include Bay Beach, even though the beach has not been a functional public beach for decades. The target is also closely tied with the impaired waters water quality criteria and World Health Organization guidelines.

Rationale for listing

The AOC was historically used for recreational activities, including swimming at Bay Beach on the southern shore of Green Bay near the mouth of the Fox River (Figure 4). Bay Beach closed in 1938 due to excessive bacterial contamination and since that time sedimentation between Renard Island and the beach has reduced the area available for recreational activities (WDNR, 1993).

Summary of remedial actions since the 2014 RAP Update and current status

Bay Beach has been the focus of much interest in the last year. In 2015, WDNR monitored *E. coli* at Bay Beach. WDNR collected weekly samples during the swimming season, and also collected three post-rainfall event samples. *E. coli* levels at the beach were typically below the standard used for issuing a beach advisory. The raw data is available on www.wibeaches.us. Bay-Lake Regional Planning Commission issued a report of their findings for monitoring conducted at Bay Beach from 2012-2014. That report is available from <http://www.baylakerpc.org/about/publications>. The City of Green Bay has indicated they are interested in implementing the designs in the plan and having a swimming beach at Bay Beach by 2018.

A more extensive data set for cyanobacteria and cyanotoxins is needed within the AOC to determine the current state of this BUI. WDNR will be leading an effort to design the assessment in 2016.

Next action(s) needed

Design the assessment and obtain funding.

Issues (challenges, risks) affecting progress on this BUI

Issues that exist in the bay with regard to cyanobacteria and cyanotoxins may be bigger problems than what can be completely addressed through the AOC program. Finding the right balance will take some time and thought.



Figure 4. Recreation areas in the Lower Green Bay and Fox River AOC.

DEGRADATION OF AESTHETICS

Target	Status
Total phosphorus and total suspended solid concentrations at the mouth of the Lower Fox River meet water quality standards and/or water quality targets specified in a State and US EPA approved Total Maximum Daily Load (TMDL). The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action needed
Monitoring data within the AOC and/or surveys for any five year period indicates that water bodies in the AOC do not exhibit unacceptable levels of the following properties in quantities which interfere with the Water Quality Standards for Surface Waters: (a) Substances that will cause objectionable deposits on the shore or in the bed of a body of water shall not be present in such amounts as to interfere with public rights in waters of the state or impair use. (b) Floating or submerged debris, oil, scum, or other material shall not be present in such amounts as to interfere with public rights in waters of the state or impair use. (c) Materials producing color, odor, taste, or unsightliness shall not be present in such amounts as to interfere with public rights in waters of the state or impair use.	Assessment in Progress (initiated 2011)

Target rationale

During the time that the 2009 targets were developed, the first target component was included because of previous RAP documents' statements about the impact of degraded water quality on the visual appearance of the water. It was thought that by meeting the TMDL water quality goals, the visual quality of the water would no longer be degraded.

The second component refers to NR 102.04 of the Wisconsin Administrative Code regarding objectionable properties.

Rationale for Listing

This impairment was originally identified based on the appearance of the AOC's water. WDNR (1993) listed large total suspended solids loads, algal blooms (and occasional odor from decaying algae), and turbidity from wave action as the primary causes of this impairment.

Public perception of the AOC was measured in 1990 using a telephone survey of Brown County residents (Baba et al., 1990). The average ranking of water quality in the Lower Bay near the mouth of the Fox River was 4.1 on a scale of 1 (worst possible) to 10 (best possible). Although this survey did not ask specific questions about aesthetics, responses suggested that people perceived the water quality to be below what would be desirable for boating and swimming.

Summary of remedial actions since the 2014 RAP Update and current status

In early 2015, WDNR consulted with stakeholders regarding its 2015 revision of the volunteer monitoring program. The revision allowed WDNR to incorporate lessons learned from previous years and enhance consistency between the two AOCs that are implementing the program. The program helps to determine whether there are other aesthetic factors, besides algae, that need to be addressed in the AOC. A priority outreach need in 2016 is continued aesthetics monitoring, including retaining existing volunteer monitors and recruiting new volunteer monitors.

Next action(s) needed

Continue monitoring aesthetics in compliance with the conditions in the quality assurance project plan.

Issues (challenges, risks) affecting progress on this BUI

Although volunteer monitoring is cost effective, it is not without costs. WDNR will need to continue to provide support for this project to assess the results. Additional funding may be necessary, pending the survey results, to implement necessary management actions that would need to occur in order to address the impairment.

DEGRADATION OF PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS

Target	Status
<p>Plankton and zooplankton structure and function do not significantly diverge from unimpaired reference conditions with comparable physical and chemical characteristics, recognizing the uncontrollable impact of invasive species. The following specific objectives should also be met:</p> <ul style="list-style-type: none"> – Sources contributing to nutrient enrichment are identified and controlled; and – AOC total phosphorus concentrations consistently meet water quality standards and/or water quality targets of a State and US EPA approved TMDL; and – In lower Green Bay, the amount of energy from phytoplankton and zooplankton that reaches the open water food chain has increased, and the amount of energy reaching the bottom sediments has decreased. (In other words, the carbon transfer efficiency of the phytoplankton and zooplankton levels of the food chain in lower Green Bay is increased such that the amount of energy channeled into the detrital food chain is decreased and the amount of energy channeled into the pelagic food chain is increased). This is expected to occur when phosphorus levels and the corresponding percentage of blue-green algae in the phytoplankton are reduced. 	<p>Assessment in progress for first part of target (2012 and 2014)</p>
<p>Phytoplankton or zooplankton bioassays confirm no significant toxicity in ambient waters in the AOC.</p>	<p>Unknown</p>

Target rationale

The targets were chosen to address changes in the plankton communities that have occurred in the area primarily because of the issues with high phosphorus levels and associated hypereutrophication.

It should be noted that the state of Wisconsin does not have methodology for assessing plankton toxicity, and other AOCs in the state whose delisting targets originally included similar language (notably, the Milwaukee Estuary AOC) have since eliminated that component of the target for this impairment.

Rationale for listing

This impairment was originally identified because excessive nutrients altered both phytoplankton and zooplankton populations in the AOC (WDNR, 1993). Community changes noted included dominance of cyanobacteria in phytoplankton populations, smaller zooplankton with low grazing effectiveness, and a large portion of primary production reaching bottom sediments rather than passing into the pelagic food web (WDNR, 1993).

Summary of remedial actions since the 2014 RAP Update and current status

USGS sampled the AOC for benthos and plankton in 2012 and again in 2014. They have provided preliminary findings for the studies and are engaged in a peer review process before releasing the final reports.

Next action(s) needed

Determine the status of the impairment and verify whether the benthic community in the AOC is impacted. If it is, work to identify specific management actions that are needed.

Issues (challenges, risks) affecting progress on this BUI

The large size of the watershed and its characteristics are likely impacting this BUI. There should be some considerations of what is appropriate to do as part of the remedial goals of the AOC program.

LOSS OF FISH & WILDLIFE HABITAT

Target	Status
Fish and wildlife management goals are achievable as a result of the physical, chemical, and biological integrity of the AOC waters, including wetlands.	Assessment in progress
A balance of diverse habitat types exists within the AOC that supports all life stage requirements of fish and wildlife populations including: <ol style="list-style-type: none"> 1. Multiple wetland types (for example: submerged aquatic vegetation, emergent vegetation, sedge meadows, forested & shrub) that adequately represent historic wetland types 2. Quality fish spawning habitats 3. Islands for colonial nesting birds, amphibians, and furbearers 4. Intact migration corridors (both shoreline and water) 5. Unconsolidated beaches (for shorebirds) 6. Habitat for State or Federally listed species (special concern, threatened, or endangered) 	Assessment in progress
The hydrologic connectivity between wetlands and the AOC is maintained and restored sufficiently to support fish spawning and allow for fish passage.	In progress
The Green Bay portion of the AOC contains water clarity and other conditions suitable for support of a diverse biological community, including a robust and sustainable area of submersed aquatic vegetation in shallow water areas.	Action Needed
The AOC contains a diversity of plants, an abundance of submersed aquatic vegetation, and sufficient invertebrates to provide adequate food supplies to support a diverse assemblage of migratory diving ducks (both mussel and vegetation feeding), fish, and other wildlife (including aquatic invertebrates, amphibians, and reptiles).	Assessment in progress
The AOC meets water quality standards and/or water quality targets of a State and US EPA approved TMDL. The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action Needed
The AOC meets Wisconsin water quality criteria for dissolved oxygen and water temperature that are protective of fish and wildlife populations.	Action Needed
No waterbodies within the AOC are listed as impaired due to physical or water chemistry conditions in the most recent Wisconsin Impaired Waters List (303(d) List).	Action Needed

Target rationale

Stakeholders were concerned that water quality was negatively impacting the AOC in many areas, including fish and wildlife populations. There was also an interest in ensuring that contaminants were addressed (although it's not explicitly stated in the targets) and that a fish and wildlife plan would be developed for the AOC.

WDNR intends to revisit the targets for this BUI in the upcoming year or two and work with technical stakeholders to create final delisting targets whose objectives can be achieved as part of the remedial goals of the AOC program.

Rationale for Listing

The major causes of lost habitat in the AOC listed in the original Remedial Action Plan (WDNR, 1988) and Update (WDNR, 1993) include:

- Habitat destruction and fragmentation due to urban and industrial development, channelization, dredging and filling along the River corridor.
- Wetland losses from human activity and changing water levels and loss of hydrologic connectivity.
- Lack of submerged aquatic vegetation in the Duck Creek delta area of the Lower Bay because of turbid water, hypereutrophication, destruction of the Cat Island Chain of islands by high water and storms, and carp impact on underwater plants and littoral vegetation.
- Silt deposition and resuspension of sediments in the Lower Bay.
- Invasive vegetative species.

Summary of remedial actions since the 2014 RAP Update and current status

2015 saw some early success in re-establishing native aquatic vegetation in the AOC. In 2014, Ducks Unlimited and UW-Green Bay, with support from U.S. Fish and Wildlife Service and WDNR, initiated a project to begin a long-term effort to restore aquatic vegetation, primarily wild rice, wild celery, and hardstem bulrush, near the mouth of Duck Creek behind the newly-restored Cat Island Chain. In late 2014, wild rice was sown in nine test plots, and in 2015, the native plant was observed in eight of the nine test plots. This early success suggests that the wave barrier effect that Cat Island was intended to have may be working. A more extensive effort is planned for next year, along with some additional habitat work in the Peats Lake/Peters Marsh area. This project area and goal is a priority for the AOC for habitat restoration.

WDNR is engaging stakeholders in a habitat planning process for the Cat Island chain. Cat Island has been identified as an early priority for habitat restoration in the AOC. We expect that there will be habitat projects that will be ready to compete for AOC-specific habitat funding opportunities.

A University of Wisconsin – Green Bay team has been working on the fish and wildlife assessment throughout 2015. They have started the process of inventorying past fish and wildlife projects, identifying priority AOC target species for restoration, and conducted bird and amphibian surveys in the project area. They have also mapped habitat types throughout the AOC.

Next action(s) needed

1. Complete AOC habitat and populations assessment and habitat restoration plan. This assessment will be used to assist in refining delisting targets, determining current conditions, and recommending specific actions needed to restore this impairment. It will also identify current and potentially restorable wetlands and rank them for several watershed functions, including wildlife value.
2. Continue the Cat Island Chain Restoration Project.
3. Determine habitat needs and design projects to meet these needs in the Lower Fox River and AOC portion of the Bay.

Issues (challenges, risks) affecting progress on this BUI

- Populations of certain species are mobile and not restricted to habitat simply within the AOC boundary. Therefore, some actions to address the habitat needs of local populations may need to occur in a broader area, beyond that of the AOC boundary.
- Maintenance of implemented projects for invasive species needs to be considered for restoration projects to ensure the projects' long-term success.

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APPENDICES

Appendix A – Lower Green Bay and Fox River BUI Tracking Matrix

Appendix B – Fish and Wildlife Objectives based on the 2009 targets

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Appendix A

Lower Green Bay and Fox River BUI Tracking Matrix

Appendix A

Note that projects listed in the table below are the next clearly delineated action steps that have been identified by WDNR in collaboration with AOC partners and stakeholders to make progress toward delisting the AOC. This list does not necessarily reflect all actions that will ultimately be needed to remove impairments, and will be updated as more information is collected and as actions are completed.

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Lower Green Bay-Fox River AOC Tracking Matrix 2015

Project Name	BUI Addressed	Project Type	Action Type	Action Phases	Project Status	Project Start Date	Project End Date	Project Cost	Project Lead Organization	Funding Sources
Assessment of Benthos and Plankton in Wisconsin's Lake Michigan Areas of Concern-2013	BUI 6 BUI 13	Fish and Wildlife	Assessment	Reporting	In Progress	2013	2016	\$414,300	USGS	USGS
Benthos & Plankton BUIs Evaluation in Wisconsin's Lake Michigan Areas of Concern-2011	BUI 6 BUI 13	Fish and Wildlife	Assessment	Reporting	In Progress	2011	2015	\$451,500	USGS	USGS
Cat Island Chain Restoration-spine construction	BUI 14	Fish and Wildlife	Restoration	Implementation	Completed	2012	2014	\$20,000,000	USACE	USEPA
Determining the Status of Fish Populations in the Lower Fox River/Green Bay AOC	BUI 3	Fish and Wildlife	Assessment	Implementation	In Progress	2015	2016	\$6,000 (e)	WDNR	USEPA
Evaluation of Waterfowl Consumption Advisories	BUI 1	Fish and Wildlife	Assessment	Implementation	In Progress	2012	2016	\$106,743	WDNR	USEPA
Fish Tumors & Other Deformities Assessment	BUI 4	Fish and Wildlife	Assessment	Planning□	Proposed	2018 (e)	Unknown	\$170,400	TBD	USEPA
Lower Fox River PCB Cleanup	BUI 1, BUI 3 BUI 4, BUI 5 BUI 6, BUI 9	Sediment	Remediation	Remedial Implementation	In Progress	Unknown	2017 (e)	\$700,000,000 (e)	USEPA	Responsible Party
Lower Green Bay and Fox River AOC Habitat Restoration Plan and Path Toward Delisting	BUI 3 BUI 14	Fish and Wildlife	Assessment	Planning□	In Progress	2014	2019	\$464,052	UW-Green Bay	USEPA
Point au Sable Wetland Restoration-Phase 1	BUI 14	Fish and Wildlife	Restoration	Confirmation Monitoring & Reporting	Completed	2012	2013	\$150,000	UW-Green Bay	USFWS
Point au Sable Wetland Restoration-Phase 2	BUI 14	Fish and Wildlife	Restoration	Implementation	In Progress	2014	Unknown	\$130,650	UW-Green Bay	Sustain Our Great Lakes
Volunteer Monitoring of Aesthetics	BUI 11	Aesthetics	Assessment	Implementation	In Progress	2011	2017 (e)	\$16,900 (e)	WDNR	USEPA
WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site	BUI 3, BUI 4 BUI 6, BUI 7	Sediment	Remediation	Screening Level Assessment□	In Progress	2014	TBD	Unknown	USEPA	Responsible Party

(e) = estimated

BUI Number Key

BUI #	BUI Name	BUI#	BUI Name
BUI 1	Restrictions on Fish and Wildlife Consumption	BUI 8	Eutrophication or Undesirable Algae or Excessive Loading of Sediments and Nutrients
BUI 2	Tainting of Fish and Wildlife Flavor	BUI 9	Restrictions on Drinking Water Consumption or Taste and Odor Problems
BUI 3	Degraded Fish and Wildlife Populations	BUI 10	Beach Closings and Body Contact Restrictions
BUI 4	Fish Tumors and Other Deformities	BUI 11	Degradation of Aesthetics
BUI 5	Bird or Animal Deformities or Reproductive Problems	BUI 12	Added Costs to Agriculture or Industry
BUI 6	Degradation of Benthos	BUI 13	Degradation of Phytoplankton and Zooplankton Populations
BUI 7	Restrictions on Dredging Activities	BUI 14	Loss of Fish and Wildlife Habitat

Appendix B

Fish and Wildlife Objectives based on the 2009 Targets

Fish Objectives

- Average sport angler harvest over a 3-4 year period of 7,000 **walleyes** harvested annually and 150,000 **yellow perch** harvested annually
- Predator-prey biomass ratio of fish species in the AOC is 1:10 to 1:20
- Lower Fox River capable of supporting a **lake sturgeon** spawning population of a minimum of 750 mature adults (per Welsh et al., 2010).

Wildlife Objectives

- Presence of a diverse array of **colonial waterbirds** such as, but not limited to: great egrets, great blue herons, black-crowned night herons, double-crested cormorants, white pelicans, common terns, Forster's terns, black terns, herring gulls, and ring-billed gulls.
- Resident nesting **waterfowl** production in the Area of Concern of mallards, blue-winged teal, wood ducks, and Canada geese totals at least 1 young produced per acre of brood water.
- Migratory concentrations of **dabbling ducks** reach peak numbers of 5,000 in the Area of Concern.
- Bay habitat improves so that **diving duck** migratory populations increase on the West Shore of Green Bay. Divers should have access to ample submergent vegetation in addition to fingernail clams. A diverse assemblage of diving ducks should be present during migration. Diving duck use of the Bay from the Fox River to the Wisconsin border in Green Bay should reach 2,000,000 use days during fall migration and the species using the Bay should be a mixture of mussel feeding ducks and vegetation feeding ducks.
- A diverse assemblage of **marsh-nesting birds** should be present in suitable habitat in the Lower Bay. An aggregate total of 5 nesting pairs per acre of marsh habitat would indicate a healthy marsh bird community. Rails, grebes, herons, wrens, and blackbirds are some of the groups of birds which should be present.
- **Furbearers** in the AOC should recover to the point that otters and mink are present. Abundant muskrat populations should be present particularly when water conditions in the Lower Bay result in emergent marshes.
- A diverse assemblage of **anurans** including: wood frogs, spring peepers, leopard frogs, American toads, eastern gray tree frogs, green frogs and bullfrogs.