

**REMEDIAL ACTION PLAN UPDATE**  
**for the**  
**LOWER GREEN BAY AND FOX RIVER AREA OF CONCERN**



**April 2018**



**Wisconsin Department of Natural Resources**  
**Office of Great Waters – Mississippi River and Great Lakes**

**Remedial Action Plan Update  
for the  
Lower Green Bay and Fox River Area of Concern  
April 2018**

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**Cover Photo:** Newly hatched Sora chick found in cattail thicket at Peters Marsh. Photo taken by Brie Kupsky.

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.

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Appendix D	Lower Green Bay & Fox River AOCs Fish & Wildlife Habitat Assessment Tools <ul style="list-style-type: none"><li>• Lower Green Bay and Fox River AOC fish and wildlife habitats, including five weighting criteria, composite habitat weights, and baseline condition estimates</li><li>• Lower Green Bay and Fox River AOC priority fish and wildlife species/species groups, with six weighting criteria, composite species/species group weights, and current condition estimates</li></ul>
Appendix E	Preliminary Considerations for Management Action Development for the Lower Green Bay & Fox River Area of Concern's Fish & Wildlife BUIs

## **PURPOSE STATEMENT**

This Remedial Action Plan (RAP), which updates the 2016 RAP, documents and communicates progress made in the AOC in the last year and shares the path forward with our partners and stakeholders. The RAP includes a concise summary of beneficial use impairment status and tracks progress on specific actions that are important for reaching the delisting targets. These “actions” may include on-the-ground restoration projects, monitoring and assessment projects, and stakeholder engagement processes. As the primary agency with the responsibility to develop and implement the RAP, the Wisconsin Department of Natural Resources and the Office of Great Waters is committed to making progress in remediating and restoring Wisconsin’s Areas of Concern. In order to be lasting and effective, the AOC program must continuously improve, evaluating its course as new information and technology become available. Subsequent RAP updates will be produced as needed to incorporate new information.

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 (BUIs) 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.

## **2017 PROGRESS SUMMARY**

The Wisconsin Department of Natural Resources (WDNR) and partners are working to improve conditions in the Lower Green Bay and Fox River Area of Concern (AOC; Figure 1). During the past year much progress has been made on contaminated sediment remediation and beneficial use impairment (BUI) assessments to gather information on BUI status and support decision making. Additional information about the status and next steps for each BUI can be found in later sections of this document. Details about projects in the AOC are included in Appendix C.

In 2017, 558,000 cubic yards of material were dredged as part of the in-river remedial action work for the Lower Fox River polychlorinated biphenyl (PCB) cleanup project. This was accomplished by the use of three hydraulic dredges working simultaneously over 32 weeks of field effort. 346,941 tons of material were sent to the landfill, and 179,800 tons of clean sand were separated from the fine sediment and used beneficially offsite. Sixty-four acres were sand covered with 13.2 acres stone capped. In addition, sampling continued for the Green Bay Manufactured Gas Plant (MGP) site, located at the East River confluence. Sampling (probing) for visual observation of non-aqueous phase liquid (NAPL) occurred at 365 locations to better define impacted areas and help determine remedial action options. Remediation of the MGP site is anticipated to be addressed in 2018 and will be conducted by NCR Corp as part of the Fox River PCB Remediation Project in cooperation with WPSC/We Energies. PCB cleanup on the Fox River has been adjusted, and the active portion of the cleanup is now anticipated to be complete in 2019. Both cleanup projects are key to addressing several BUIs, including **Fish Tumors or Other Deformities, Bird or Animal Deformities or Reproduction Problems, Restrictions on Fish and Wildlife Consumption, Restrictions on Dredging Activities, and Degradation of Benthos.**

The University of Wisconsin-Green Bay (UWGB) and The Nature Conservancy (TNC) completed the AOC fish and wildlife inventory and assessment that began in early 2015, and have submitted the results via a final project report that will be finalized in 2018. The report identified approximately 42% of the total area within the AOC boundaries and 1 km coastal zone buffer to encompass relatively undeveloped and potentially restorable habitats. Additionally, the draft report identified 18 habitat types and 22 population groups within the AOC from which baseline condition scores were calculated using a novel quantitative assessment method established by UWGB. This method integrated a combination of local expert opinions, previous studies, and rapid field assessments to develop the “AOC Fish and Wildlife Habitat and Populations Assessment Tools,” which utilize various criteria to calculate baseline habitat and populations condition scores. This process will allow restoration practitioners to quantitatively track improvements toward the **Loss of Fish and Wildlife Habitat** and **Degradation of Fish and Wildlife Populations** BUIs. The Lower Green Bay & Fox River AOCs Fish & Wildlife Habitat Assessment Tools can be found in Appendix D. Finally, the report provides recommended target revisions and a draft list of preliminary considerations for goals and objectives that are intended to focus restoration actions for both BUIs. It should be noted that UWGB took steps to ensure that the intent of the current target was incorporated into their tools. WDNR has convened a newly established Fish, Wildlife, and Habitat Technical Advisory Committee to reach consensus on target revisions and to begin developing a suite of management actions based on the recommendations provided by UWGB. This effort will utilize a consensus-based approach to consider and potentially recommend the UWGB target revisions and incorporate input from the broader stakeholder group as management actions are developed.

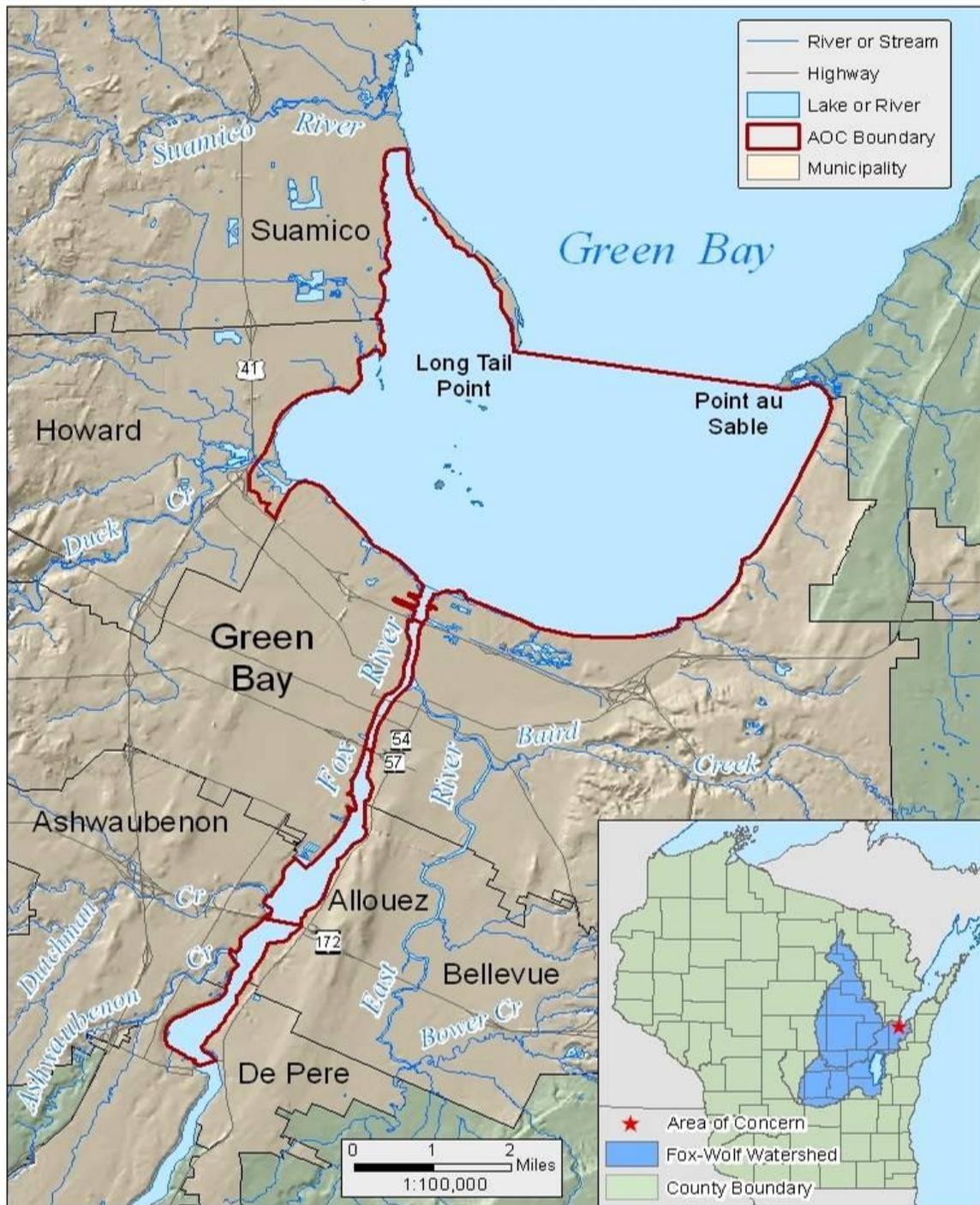
Regarding the **Eutrophication and Undesirable Algae** BUI, WDNR is exploring ways that the AOC program can address this impairment while acknowledging the scope of the program, which focuses on defined geographic areas and legacy pollutants. Given the scope and complexity of the eutrophication issue, the AOC program aims to complement and support efforts that are underway through other

programs and initiatives. In 2016, WDNR and the U.S. Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO) explored the types of actions that AOC Great Lakes Restoration Initiative (GLRI) funds may support. The agencies agreed that a comprehensive approach, drawing support from both the AOC and Nearshore/Nonpoint Focus Areas of GLRI, would be optimal. In 2017, WDNR applied for and was awarded GLRI funds to contract with a facilitator who will assist the agencies with engaging stakeholders in developing a final target and management action list for this BUI. In 2018, WDNR anticipates convening stakeholders and USEPA GLNPO in facilitated meetings to further refine the proposed 2015 target; learn about existing implementation activities and tools for measuring progress; and begin exploring management actions that would complement existing efforts while making progress toward achieving the BUI delisting target (once it is finalized). These discussions will set the stage for the AOC to contribute a defined amount of conservation practice implementation to reduce nutrient loading to the Lower Fox River and Lower Green Bay.

In 2017, WDNR, with its partners at NEW Water and University of Wisconsin – Milwaukee, completed year two of a GLRI grant from USEPA GLNPO to assess cyanobacteria harmful algal blooms in the AOC. This assessment is modeled after techniques developed in western Lake Erie to understand algae blooms there and leverages NEW Water's existing water quality monitoring network. A primary goal of the study is to understand the nature and extent of algae blooms in the lower bay and to develop tools for managing recreational risk. As a secondary benefit, samples collected for this project are also being used to investigate the factors affecting bloom toxicity. As part of a complementary study, investigators at UW-Milwaukee and USGS are using gene sequencing techniques to understand which algae species have a genetic potential for producing toxins and what affects that gene expression. Preliminary observations indicate significant differences in bloom formation between the 2016 and 2017 seasons (similar observations were made in Lake Erie). Results from the assessment will be used to inform the status of the **Beach Closings** and **Restrictions on Drinking Water Consumption** BUIs. In the longer term, this data set may be used to evaluate cyanobacteria algae blooms in the lower bay over time.

Another year of aesthetics monitoring was completed in 2017 in collaboration with the Fox-Wolf Watershed Alliance (FWWA), a local nonprofit organization that has implemented this volunteer program for the second year in a row. The purpose of this program is to assess the status of the **Degradation of Aesthetics** BUI, and determine what, if any, management actions will be necessary to remove this BUI. Preliminary results from the 2015 to 2017 aesthetics monitoring survey years indicate very limited interference by objectionable substances on public use in the waters or shorelines at each survey station, and a generally positive overall aesthetic impression score at all survey stations in the AOC. However, this project's quality assurance plan outlines the need for each station to obtain 30 independent monitoring observations before final scores can be tallied, and only one station (Voyageur Park) has obtained the necessary number of completed data forms to date. Therefore, a grant proposal will be submitted by WDNR to USEPA in March 2018 that will potentially provide another year of funding for the volunteer aesthetics monitoring program (led by FWWA) to obtain the 30 observations needed at each survey site for final data analysis.

Additionally, several lines of evidence exist to suggest that the **Tainting of Fish and Wildlife Flavor** is not an existing impairment, leading WDNR to suggest moving forward with the BUI removal process instead of focusing on additional assessments and/or management action development. The Lower Green Bay and Fox River AOC technical stakeholder group and USEPA have agreed with this path forward, resulting in WDNR preparing a draft removal recommendation that will be available for stakeholder review in 2018, followed by submittal to USEPA for concurrence.



**Figure 1.** The boundaries of the Lower Green Bay and Fox River Area of Concern. For additional information about the history of the AOC and a narrative description of the AOC boundary, please refer to previous RAP documents which are available online: <http://dnr.wi.gov> Search “Lower Green Bay and Fox River AOC”; RAP documents are stored on the “AOC Plans” tab. A listing of previous RAPs, RAP Updates, and important historical documents is included in the References section.

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

Beneficial Use Impairment	Beneficial Use Remains Impaired	Summary Status
Restrictions on fish and wildlife consumption	Yes	Wildlife consumption assessment is complete, and waterfowl consumption advisories remain in place for the AOC. Waterfowl advisories will be reassessed after in-river remediation is complete (with cleanup completion anticipated in 2019, the assessment is currently planned for 2020). Fish consumption advisories for PCBs specific to the AOC will be addressed by the Lower Fox River PCB Cleanup project. Fish consumption advisories for PCBs will be assessed in the Lower Fox River in 2018.
Tainting of fish and wildlife flavor	Suspected	It has been determined that this is not an existing impairment in the AOC. Therefore, with input from stakeholders, WDNR is preparing a draft removal recommendation that will be available for stakeholder review in early 2018, followed by submittal to USEPA for concurrence.
Degradation of fish and wildlife populations	Yes	The assessment for this impairment was completed in 2017. The BUI removal target will be revisited based on the results and recommendations of the final report. A final list of necessary projects to address habitat and population deficiencies will be developed by April 1, 2020 with input from technical experts and local stakeholders that, once implemented, should lead to the removal of the BUI if established metrics are achieved.
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 (with cleanup completion anticipated in 2019, the assessment is currently planned for 2020).
Bird or animal deformities or reproductive problems	Yes	BUI removal depends on completion of contaminated sediment remediation. Tree swallow monitoring stations were added in 2016. The next step will be to develop an assessment strategy.
Degradation of benthos	Yes	Final results from the USGS-led benthos and plankton studies are pending. Next assessment steps will be determined after report conclusions have been reviewed.
Restrictions on dredging activities	Yes	This use will remain impaired until the ongoing 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 defined 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 currently being collected as part of a GLRI-funded project that began in 2016.
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. Data collection began in 2016.
Degradation of aesthetics	Yes	Fox-Wolf Watershed Alliance helped recruit additional volunteers in 2017, and assessment, in the form of the volunteer monitoring program, is in progress.

Degradation of phytoplankton and zooplankton populations	Yes	Final results from the USGS-led benthos and plankton studies are pending. Next assessment steps will be determined after conclusions have been reviewed.
Loss of fish and wildlife habitat	Yes	The assessment for this impairment was completed in 2017. The BUI removal target will be revisited based on the results and recommendations of the final report. A list of management actions will be developed by April 1, 2020 with input from technical experts and stakeholders that, once implemented, should lead to the removal of the BUI if established metrics are achieved.

**BENEFICIAL USE IMPAIRMENT UPDATES**

For each BUI section, the following symbols indicate the status of the management actions listed:

- = Not started
- ➡ = Underway
- ✓ = Complete

**FISH TUMORS OR OTHER DEFORMITIES**

Target	Status
Removal may occur if: <ul style="list-style-type: none"> <li>• All known major sources of PAHs and chlorinated organic compounds within the AOC and tributary watershed have been controlled or eliminated</li> <li>• 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.</li> </ul>	Action needed
OR, in cases where tumors have been reported: <ul style="list-style-type: none"> <li>• 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.</li> </ul>	TBD

**Status**

In 2017, the Lower Fox River PCB cleanup project continued downriver, and additional sampling occurred at the former MGP site, located at the East River confluence. Remediation of the MGP site is anticipated to be addressed in 2018. The active portion of the Fox River PCB cleanup is anticipated to be complete in 2019. See the “Restrictions on Dredging” section for more details.

WDNR’s policy on this BUI is that assessment should occur after dredging for the PCB cleanup has occurred. Because of the altered timeline associated with the completion of the PCB cleanup, WDNR does not expect to be able to begin assessing this impairment until 2020.

**Management actions**

- ➡ Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- Complete an AOC fish tumors assessment once the PCB remedial work has been completed

**BIRD OR ANIMAL DEFORMITIES OR REPRODUCTION 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"> <li>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"> <li>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</li> <li>b. not statistically different than Lake Michigan (at 95% confidence interval), then the BUI can be delisted.</li> </ol> <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> </li> <li>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"> <li>– 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:</li> <li>– 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.</li> </ul> </li> </ol>	<p>Assessment needed</p>

**Status**

In 2017, the Lower Fox River PCB cleanup project continued downriver, and additional sampling occurred at the former MGP site, located at the East River confluence. Remediation of the MGP site is anticipated to be addressed in 2018. The active portion of the Fox River PCB cleanup is anticipated to be complete in 2019. See the “Restrictions on Dredging” section for more details.

New tree swallow monitoring stations were added in 2016. Extensive datasets examining the effects of contaminants on tree swallows and bald eagles currently exist for the AOC. The next step will be to develop an assessment strategy for this impairment when sediment remediation work is completed.

**Management actions**

- Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- Develop BUI assessment strategy

## 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

**Status**

In 2017, the Lower Fox River PCB cleanup project continued downriver, and additional sampling occurred at the former MGP site, located at the East River confluence. Remediation of the MGP site is anticipated to be addressed in 2018. The active portion of the Fox River PCB cleanup is anticipated to be complete in 2019. See the “Restrictions on Dredging” section for more details. Fish consumption advisories for PCBs will be assessed in the Lower Fox River in 2018. Assessment of the Lower Bay may be scheduled in the future. The Superfund program may collect fish for PCB analysis as needed.

Waterfowl consumption advisories were reassessed in 2016, using data from mallards and Canada geese collected from the AOC in 2014 and 2015. The results of the assessment indicated that PCB levels have remained virtually unchanged since the original consumption advisories were issued in 1987, and the advisory for mallards remains (Strom, 2016). A limited consumption advisory for mercury was also proposed with no more than one meal per week recommended for children and women of childbearing age (Strom, 2016). This change will be published in the 2018 Migratory Bird Hunting Regulation booklet and online at <https://dnr.wi.gov/topic/hunt/waterfowl.html> (Sean Strom, personal communication). The waterfowl consumption advisories should be reassessed in 2020 after the Lower Fox River PCB and former MGP site contaminated sediment cleanup projects are complete. Fish consumption advisories for PCBs specific to the AOC will be addressed by the PCB Cleanup project.

**Management actions**

- ➔ Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- Assess waterfowl consumption advisories after sediment cleanup projects have been completed
- Assess fish consumption advisory in the Lower Fox River in 2018

## 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

**Status**

In 2017, 558,000 cubic yards of material were dredged as part of the in-river remedial action work for the Lower Fox River polychlorinated biphenyl (PCB) cleanup project. This was accomplished by the use of three hydraulic dredges working simultaneously over 32 weeks of field effort. 346,941 tons of material were sent to the landfill, and 179,800 tons of clean sand were separated from the fine sediment and used beneficially offsite. Sixty-four acres were sand covered with 13.2 acres stone capped. In addition, sampling continued for the Green Bay Manufactured Gas Plant (MGP) site, located at the East River confluence. Sampling (probing) for visual observation of non-aqueous phase liquid (NAPL) occurred at 365 locations to better define impacted areas and help determine remedial action options. Remediation of the MGP site is anticipated to be addressed in 2018-2019 and will be conducted by NCR Corp as part of the Fox River PCB Remediation Project in cooperation with WPS/We Energies. PCB cleanup on the Fox River has been adjusted, and the active portion of the cleanup is now anticipated to be complete in 2019.

**Management actions**

- Complete the contaminated sediment projects (PCB and former MGP site)

## 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 <sup>2</sup> (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

**Status**

In 2017, the Lower Fox River PCB cleanup project continued downriver, and additional sampling occurred at the former MGP site, located at the East River confluence. Remediation of the MGP site is anticipated to be addressed in 2018. The active portion of the Fox River PCB cleanup is anticipated to be complete in 2019. See the “Restrictions on Dredging” section for more details.

The status of this impairment is currently being assessed. USGS was contracted to assess both the planktonic and benthic communities of the Lake Michigan AOCs and reference rivers. Sampling was completed in 2012 and 2014. The 2012 report is complete and a draft of the 2014 report is currently under review. Additionally, in 2018, WDNR staff will compile existing benthic sampling data from the entire AOC. When the reports and the conclusions are fully evaluated, and the existing benthic data is compiled and reviewed, next steps for this BUI will be determined.

**Management actions**

- ➔ Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- After the USGS final report is received, determine next steps including development and implementation of additional benthos or sediment toxicity assessment project(s) by 2020, as needed.

## 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"> <li>– Sources contributing to nutrient enrichment are identified and controlled; and</li> <li>– AOC total phosphorus concentrations consistently meet water quality standards and/or water quality targets of a State and USEPA approved TMDL; and</li> <li>– 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.</li> </ul>	<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>

**Status**

Discussions with USEPA and stakeholders continue regarding the AOC program's role in addressing eutrophication in the Lower Green Bay and Fox River. More detailed information on the status of these discussions can be found in the "Eutrophication or Undesirable Algae" section.

In 2017, the Lower Fox River PCB cleanup project continued downriver, and additional sampling occurred at the former MGP site, located at the East River confluence. Remediation of the MGP site is anticipated to be addressed in 2018. The active portion of the Fox River PCB cleanup is anticipated to be complete in 2019. See the "Restrictions on Dredging" section for more details.

The status of this impairment is currently being assessed. USGS was contracted to assess both the planktonic and benthic communities of the Lake Michigan AOCs and reference rivers. Sampling was completed in 2012 and 2014. The 2012 report is complete and a draft of the 2014 report is currently under review. When the reports and the conclusions are fully evaluated, next steps for this BUI will be determined.

If the planktonic community is found to be impaired compared to other Lake Michigan rivers, there is a need to investigate if nutrient enrichment and/or toxicity are causes of the plankton impairment. This determination would inform any additional necessary management actions. A target adjustment may also be needed depending on the results of the study.

**Management actions**

- Complete the contaminated sediment projects (PCB and former MGP site)

**Additional actions**

- After USGS final report is received, determine next steps including development and implementation of additional plankton or ambient water column toxicity assessment project(s) by 2020, as needed

## LOSS OF FISH AND 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 Completed
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"> <li>1. Multiple wetland types (for example: submerged aquatic vegetation, emergent vegetation, sedge meadows, forested &amp; shrub) that adequately represent historic wetland types</li> <li>2. Quality fish spawning habitats</li> <li>3. Islands for colonial nesting birds, amphibians, and furbearers</li> <li>4. Intact migration corridors (both shoreline and water)</li> <li>5. Unconsolidated beaches (for shorebirds)</li> <li>6. Habitat for State or Federally listed species (special concern, threatened, or endangered)</li> </ol>	Assessment Completed
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 Completed
The AOC meets water quality standards and/or water quality targets of a State and USEPA 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

**Status**

The University of Wisconsin Green Bay (UWGB) and The Nature Conservancy (TNC) completed a rigorous three-year AOC habitat assessment in 2017. The draft final report identifies 18 habitat types in the AOC and establishes baseline condition scores for each habitat type through a combination of expert opinions from local biologists and rapid field study inputs into an assessment tool created by UWGB (Howe et al., 2018). This “Lower Green Bay & Fox River AOC Fish and Wildlife Habitat Assessment Tool” utilized five criteria to calculate a weighted average ranging from 0 (worst case) to 10 (best case) from which a combined habitat baseline condition score was identified (see Appendix D). Of the total area within the AOC and 1 km coastal zone buffer included in the analysis, approximately 42% was found to be relatively undeveloped land with the potential to qualify as wildlife habitat. Additionally, the report identified two “imperiled” habitats, including undeveloped Great Lakes Beach and Southern Sedge Meadow, both of which were historically widespread, but have suffered considerable losses in both areal extent and quality. Furthermore, the report recommended a revised BUI removal target based on input

from technical stakeholders and experts, and provided several recommendations for management actions in priority areas that will potentially move the current/baseline habitat condition score (3.53) to a recommended target habitat condition score (6.0). This assessment not only provides a meaningful and achievable quantitative method for BUI removal supported by locally-derived data in the AOC, but also establishes a framework for measuring improvements in analogous habitats experiencing similar environmental degradation. Finally, the report provided 16 preliminary considerations for fish and wildlife habitat improvements to guide the development of a management action list for the “Loss of Fish and Wildlife Habitat” BUI (Appendix E). UWGB and TNC presented the results of the assessment to the Lower Green Bay and Fox River (LGBFR) AOC Stakeholders in December 2017, in which an initial discussion was held regarding the feasibility of reaching the recommended habitat condition score needed to justify BUI removal (6.0).

Building on the momentum provided by the completion of the habitat assessment, WDNR submitted a grant proposal to USEPA in March 2018 that would support continued collaboration between the department and UWGB to 1) assist in the development of a list of high priority, cost-effective, and impactful AOC habitat improvement projects (i.e., management action list), 2) provide technical assistance to partners when designing and implementing projects that will maximize efficiency and impact of habitat improvement projects and planning occurring in the AOC, 3) quantitatively track progress made toward the target habitat condition score as projects are implemented, 4) continue to develop and refine the “Lower Green Bay & Fox River AOC Fish and Wildlife Habitat Assessment Tool” as new information becomes available, and 5) produce a user manual that will ensure consistent long-term scoring of habitat restoration projects and habitat condition using the “Lower Green Bay & Fox River AOC Fish and Wildlife Habitat Assessment Tool”.

WDNR has convened the LGBFR AOC Fish, Wildlife and Habitat Technical Advisory Committee (TAC) with the assistance of a Steering Committee consisting of representatives from UWGB, US Fish & Wildlife Service, and USEPA. Through a two-year collaborative process that will be facilitated by UW-Sea Grant, the LGBFR AOC Fish, Wildlife, and Habitat TAC will work together to revisit and possibly update the current BUI removal targets to reflect the UWGB assessment results. The TAC will also develop a consensus-based list of prioritized management actions that address both the “Loss of Fish & Wildlife Habitat” and “Degradation of Fish & Wildlife Populations” BUIs simultaneously. Throughout the process of revising BUI removal targets and developing the management action list, stakeholders will have the opportunity to provide input and recommendations. The final management action list is expected to be submitted to USEPA by April 1, 2020, and is expected to generate a habitat condition score that should lead to the removal of this BUI when collective actions are implemented.

### **Management actions**

Management actions have not been established for this BUI.

### **Additional actions**

- ✓ Complete the fish and wildlife populations assessment
- ➡ Revisit and possibly update the “Loss of Fish and Wildlife Habitat” BUI removal target based upon the results and recommendations provided by the UWGB LGBFR AOC Habitat Restoration Plan and Path Toward Delisting Project Final Report
- ➡ Establish an LGBFR AOC Fish, Wildlife, and Habitat Technical Advisory Committee to develop a final list of implementable management actions by April 1, 2020.

## DEGRADATION OF FISH AND 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	Assessment Completed
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 Completed
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

**Status**

In addition to the advancements made toward the "Loss of Fish and Wildlife Habitat" BUI, the University of Wisconsin Green Bay (UWGB) and The Nature Conservancy (TNC) also completed the three-year fish and wildlife populations assessment. The draft final report identified 1,587 species/taxon groups comprising 19 ecologically similar species groups and 3 species of special importance that occur in the AOC and 1 km coastal buffer, and established baseline condition scores for each population group/species through a combination of expert opinions from local biologists and field study inputs into an assessment tool created by UWGB (Howe et al., 2018). This "Lower Green Bay & Fox River AOC Fish and Wildlife Populations Assessment Tool" utilized six criteria to calculate a weighted average ranging from 0 (worst case) to 10 (best case) from which a combined populations baseline condition score was identified (see Appendix D). The report additionally identified 12 species listed as endangered or threatened that regularly occur in the AOC, 50 species listed as Wisconsin state special concern, and at least 11 species identified as conservation priorities by various conservation organizations. The report also provided a revised, realistic BUI removal target based on input from technical stakeholders and

experts, and provided several recommendations for management actions that will potentially move the current/baseline fish and wildlife population condition score (4.65) to a proposed target fish and wildlife population condition score (6.5). Finally, the report provided 16 preliminary considerations for fish and wildlife habitat improvements intended to directly or indirectly improve fish and wildlife populations in the AOC that will assist the development of a management action list for the “Degradation of Fish and Wildlife Populations” BUI (see Appendix E). UWGB and TNC presented the results of this assessment and a draft list of fish and wildlife population goals and improvement projects to the LGBFR AOC Stakeholders in December 2017, in which an initial discussion was held regarding the feasibility of reaching the fish and wildlife populations condition score needed to justify BUI removal (6.5).

Building on the momentum provided by the completion of the fish and wildlife populations assessment, WDNR submitted a draft grant proposal to USEPA in March 2018 that would support continued collaboration between the department and UWGB to 1) produce a list of high priority, cost-effective, and impactful AOC habitat improvement projects intended to directly or indirectly improve fish and wildlife populations, 2) provide technical assistance to partners when designing and implementing projects that will maximize efficiency and impact of all habitat improvement projects intended to directly or indirectly improve fish and wildlife populations occurring in the AOC, 3) quantitatively track progress made toward the target fish and wildlife populations condition score as projects are implemented, 4) continue to develop and refine the “Lower Green Bay & Fox River AOC Fish and Wildlife Populations Assessment Tool” as new information becomes available, and 5) produce a user manual that will ensure consistent long-term scoring of fish and wildlife populations and condition scores using the “Lower Green Bay & Fox River AOC Fish and Wildlife Populations Assessment Tool”.

WDNR has convened the LGBFR AOC Fish, Wildlife and Habitat Technical Advisory Committee (TAC) with the assistance of a Steering Committee consisting of representatives from UWGB, US Fish & Wildlife Service, and USEPA. Through a two-year collaborative process that will be facilitated by UW-Sea Grant, the LGBFR AOC Fish, Wildlife, and Habitat TAC will work together to revise the current BUI removal targets to reflect the UWGB assessment results, and develop a consensus-based list of prioritized management actions that address both the “Loss of Fish & Wildlife Habitat” and “Degradation of Fish & Wildlife Populations” BUIs simultaneously. Throughout the process of revising BUI removal targets and developing the management action list, stakeholders will have the opportunity to provide input and recommendations. The final management action list is expected to be submitted to USEPA by April 1, 2020, and is expected to generate a habitat condition score that should lead to the removal of this BUI when collective actions are implemented.

### **Management actions**

Management actions have not been established for this BUI.

### **Additional actions**

- ✓ Complete the fish and wildlife populations assessment
- Revisit and possibly update the “Loss of Fish and Wildlife Populations” BUI removal target based upon the results and recommendations provided by the UWGB LGBFR AOC Habitat Restoration Plan and Path Toward Delisting Project Final Report
- Establish an LGBFR AOC Fish, Wildlife, and Habitat Technical Advisory Committee to develop a final list of implementable management actions by April 1, 2020.
- Working with the DNR NHC Program, and the TAC, consider an AOC fresh water mussel assessment and recovery project for implementation starting in 2018.

## 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

**Status**

The remediation to remove PCB-contaminated sediments from the Lower Fox River continued through 2017 with the in-river remedial action work anticipated to be completed in 2019. Once completed, water quality monitoring will be done in the lower part of the bay according to the long-term monitoring plan. Results from this monitoring can be used to assess whether PCBs exceed human health standards as indicated in the first part of the target.

WDNR began an assessment of the potential chemicals and sources of substances implicated in the “Tainting of Fish and Wildlife Flavor” BUI. There is potential for overlap with substances that may cause taste and odor problems in drinking water (e.g., sulfur-containing compounds). The information produced as part of the delisting document for the “Tainting of Fish and Wildlife Flavor” BUI will be evaluated to determine its usability for this BUI as a determination of whether additional assessments are needed for the taste and odor component of the target.

The assessment of algal blooms and associated toxins completed its second year of monitoring in the lower bay. Results from this study can be used to evaluate raw water with source water protection recommendations for drinking water. Additional management actions may be identified depending on the status determination.

**Management actions**

Management actions have not been established for this BUI.

## 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	Complete
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 in progress
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)

### Status

Algae and toxin monitoring began in 2016 and will continue through at least 2018. Although algae blooms in 2016 were relatively mild, cyanobacteria cell counts exceeded the target in virtually all of the samples collected. Microcystin concentrations in sub-surface samples collected approximately 1 foot below the water surface were below the established target. In 2017, algal blooms were observed in late June and from August into October. Preliminary data from 2017 suggests that microcystin results will exceed the target threshold. Microcystin concentrations from samples collected from just below the water surface suggest that the sub-surface samples are likely underestimating the recreational exposure to toxins during visible algal blooms. The project team plans to adjust the sampling plan to evaluate how sample depth may affect the assessment of microcystin concentrations and recreational exposure. In addition, the team has recommended that additional years of continuous monitoring (e.g., buoy or Sonde) are necessary to achieve project objectives.

Since this study began, USEPA released draft recreational criteria for public comment and developed supporting materials for developing monitoring programs and public outreach. These draft criteria use the toxins microcystin and cylindrospermopsin as the primary measurements and recreational thresholds proposed focus on recreational risk to children. The proposed criteria do not establish thresholds for cyanobacterial cell counts. Results generated from this study can be compared to recreational water quality criteria once they are established. At that time, the current target will need to be evaluated to determine whether a target change is appropriate.

### Management actions

Management actions have not been established for this BUI.

## 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 USEPA 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 exceedances 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"> <li>• 90% of the geometric means of at least 5 monthly samples (collected between May 1 and September 30<sup>th</sup> 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.</li> <li>• 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)</li> </ul>	<p>Assessment needed</p> <p>Assessment needed</p>

**Status**

WDNR has been working with partners and stakeholders to refine the outcomes that will define success for the AOC program for the “Eutrophication or Undesirable Algae” impairment. To that end, in 2015, WDNR engaged stakeholders in developing an alternative to the original delisting target (created in 2009) for this BUI. The alternative 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 loading sub-basins for phosphorus and total suspended solids (based on 2012 Lower Fox River and Lower Green Bay TMDL): Lower Fox River, Duck Creek, East River, Apple Creek, Plum Creek, Kankapot (aka Konkapot) 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).

Additionally, in 2017 USEPA awarded a three-year GLRI Focus Area 3 (Nonpoint Source Pollution Impacts on Nearshore Health) grant to Fox Wolf Watershed Alliance (FWWA) to partner with the Brown County Land and Water Conservation Department for implementation of agricultural best management practices in the Upper East River watershed. FWWA continues to advance implementation of a GLRI Focus Area 3 grant in the Plum and Kankapot Creek Watershed in collaboration with project partners including Outagamie, Brown and Calumet County Land Conservation Departments. GLRI Focus Area 3 funding is also supporting the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) in establishing a Lower Fox Demonstration Farms Network and in implementing best management practices in the Lower Fox Watershed (refer to [Great Lakes Restoration Initiative in Wisconsin](#)).

**Management actions**

Management actions have not been established for this BUI.

## DEGRADATION OF AESTHETICS

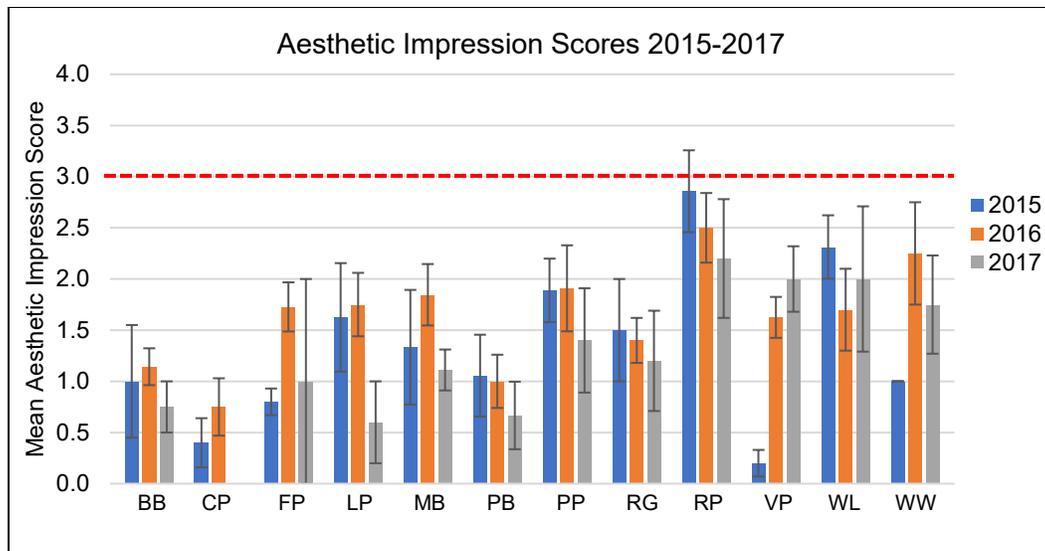
Target	Status
Total phosphorus and total suspended solid concentrations at the mouth of the Lower Fox River meet water quality standards and/or water quality targets specified in a State and USEPA approved Total Maximum Daily Load (TMDL). The approved TMDL targets are summer median concentrations of 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)

**Status**

Discussions with USEPA and stakeholders continue regarding the AOC program's role in addressing eutrophication in the Lower Green Bay and Fox River. More detailed information on the status of these discussions can be found in the "Eutrophication or Undesirable Algae" section.

Another year of aesthetics monitoring was completed in 2017 in collaboration with the Fox-Wolf Watershed Alliance (FWWA), a local nonprofit organization that has implemented this volunteer program for the second year in a row. A total of 38 volunteers submitted 79 completed monitoring forms, with 33 new volunteers participating in the program in 2017. Preliminary results from the 2015 to 2017 aesthetics monitoring survey years indicate very limited interference by objectionable substances on public use in the waters or shorelines at each survey station, and a generally positive overall aesthetic impression score at all survey stations in the AOC (see Figure 2).

Although the trends appear to be positive, this project's quality assurance plan outlines the need for each station to obtain 30 independent monitoring observations before final scores can be tallied, and only one station (Voyageur Park) has obtained the necessary number of completed data forms to date (see Table 2). Therefore, at least one more year of monitoring is needed to collect the minimum number of observations at each station.



**Figure 2.** 2015-2017 mean aesthetic impression scores by year and survey station (BB = Bay Beach; CP = Communiversity Park; FP = Fox Point; LP = Leicht Park; MB = Metro Boat Launch; PB = Perkofski Boat Launch; PP = Porlier Pier; RG = Regatta 220; RP = Riverview Place Park; VP = Voyageur Park; WL = West Lazarro Avenue; WW = Weitor Wharf). **The red dashed line designates the arithmetic mean in which management actions may be necessary if exceeded. No survey stations were found to have an arithmetic mean  $\geq 3$  in any of the three survey years.**

**Table 2.** Number of completed aesthetic monitoring forms received 2015-2017 by year and station.

Station Name	Total Forms 2015	Total Forms 2016	Total Forms 2017	Station Total
Bay Beach	5	14	8	27
Communiversity Park	5	12	7	24
Fox Point Boat Launch	10	11	1	22
Leicht Park	8	8	5	21
Metro Boat Launch	6	13	9	28
Perkofski Boat Launch	9	6	6	21
Porlier Pier	9	11	5	25
Regatta 220	8	10	5	23
Riverview Place Park	7	12	5	24
Voyager Park	10	16	19	45
West Lazarre Ave	8	10	5	23
Weitor Wharf	4	8	3	15
Yearly Total	89	131	78	299

A grant proposal will be submitted by WDNR to USEPA in March 2018 that will potentially provide another year of funding for the volunteer aesthetics monitoring program (led by FWWA) to obtain the 30 observations needed at each survey site for final data analysis.

### Management actions

While management actions have not been established for this BUI, the 2015-2018 aesthetic monitoring program results are expected to help determine what, if any, management actions will be necessary for this BUI by late 2018.

## TAINTING OF FISH AND WILDLIFE FLAVOR

Target	Status
No target was developed in 2009, as this is a suspected impairment.	BUI Removal Recommendation in Progress

**Status**

The “Tainting of Fish and Wildlife Flavor” BUI was identified in the 1993 Remedial Action Plan Update as a suspected BUI, as some complaints of taste and odor problems in the fish harvested from the Lower Fox River below the De Pere Dam had historically been reported to WDNR. Despite these reports from local anglers, little supplemental research was conducted at the time to formally identify if this beneficial use was truly impaired, owing in part to the subjective nature of the impairment. As such, the “Tainting of Fish and Wildlife Flavor” has remained one of two suspected BUIs in the AOC, and no target or management actions have been established to date. However, having reviewed with stakeholders the historical and recent information that can help inform the status of the BUI, WDNR has concluded that there is sufficient evidence available to remove this suspected BUI by referencing the International Joint Commission (IJC) guidelines that address two core motives for listing the “Tainting of Fish and Wildlife Flavor” as a BUI (<http://www.ijc.org/rel/focus/listdelist/lidemain.html#use02>):

- 1) When ambient water quality standards, objectives, or guidelines for anthropogenic substance(s) known to cause tainting are being exceeded

and/or

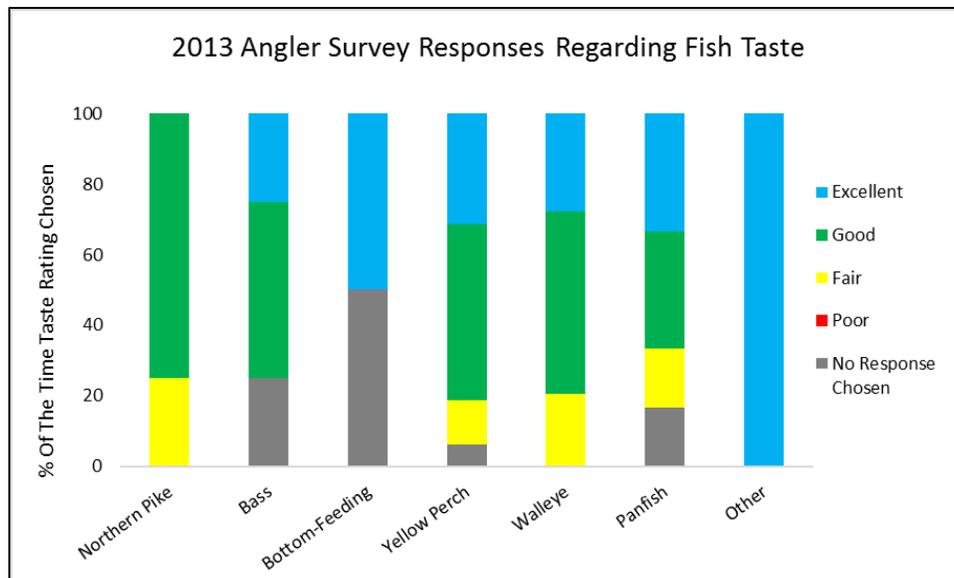
- 2) When survey results have identified tainting of fish or wildlife flavor.

In response to the first listing guideline, several water quality improvements have been made in the Lower Green Bay and Fox River AOC through various state and federal water quality policies and local initiatives. These policies and initiatives, including the Clean Water Act, are expected to have directly and indirectly addressed this suspected BUI by setting effluent limits for taste and odor-causing substances (e.g., phenols, fatty and resin acids, chlorobenzene) discharged in the AOC.

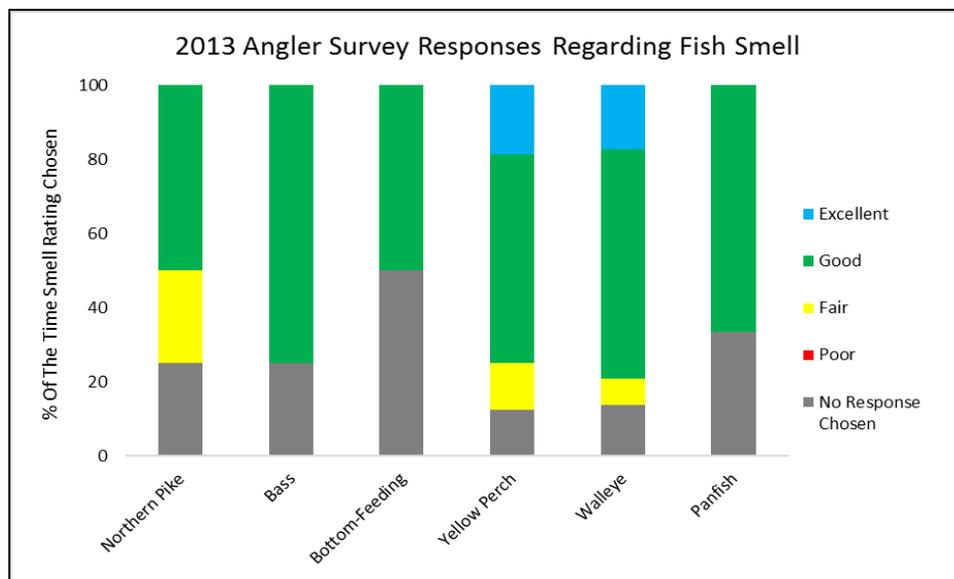
In reference to the second listing guideline, WDNR developed a direct assessment of this BUI through an angler survey that was conducted in 2013 to evaluate perception of fish flavor and/or odor by consumptive users of this resource. None of the respondents who indicated that they consumed fish caught within the AOC reported fish having a “poor” taste or smell, and a “good” or “excellent” rating was given in ~77% and ~74% of responses corresponding to fish taste and smell, respectively (see Table 3 and Figures 3 and 4 below).

**Table 3.** Fish flavor and smell rating frequency from 2013 angler survey responses. Table identifies the percentage of time each taste and smell rating was chosen out of 63 ratings provided in the survey.

	No Response	Poor	Fair	Good	Excellent
<b>Taste</b>	6.35 %	0.00 %	15.87 %	47.62 %	30.16 %
<b>Smell</b>	17.46 %	0.00 %	7.94 %	60.32 %	14.29 %



**Figure 3.** 2013 angler survey fish taste ratings by species/category. Anglers who indicated that they did eat fish caught within the survey area were asked to rate the taste of the fish they had harvested from the AOC. Figure identifies the percentage of time each taste rating was chosen out of 63 ratings indicated in the angler survey.



**Figure 4.** 2013 angler survey fish smell ratings by species/category. Anglers who indicated that they did eat fish caught within the survey area were asked to rate the smell of the fish they had harvested from the AOC. Figure identifies the percentage of time each smell rating was chosen out of 63 ratings indicated in the angler survey.

Finally, while the WDNR does not formally track complaints regarding fish flavor and/or odor, an inquiry of several natural resource and public health officials has identified multiple consecutive years without any complaints received regarding flavor or odor in fish harvested within the AOC.

Taken in whole, several lines of evidence exist to suggest that the “Tainting of Fish and Wildlife Flavor” is not an existing impairment, prompting WDNR to suggest moving forward with the BUI removal process instead of focusing on additional assessments and/or management action development. Meetings with the Lower Green Bay and Fox River AOC Technical Stakeholder group and USEPA have agreed with this

path forward, resulting in WDNR preparing a draft removal recommendation that will be available for stakeholder review in early 2018, followed by submittal to USEPA for concurrence.

**Management actions**

Given that this is a suspected BUI in the Lower Green Bay and Fox River AOC, and there is no data or information to support its designation as a BUI, no management actions have been established to date, and none are expected to be developed in the future.

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## APPENDICES

- Appendix A Acronyms
- Appendix B Definitions
- Appendix C BUI Tracking Matrix
- Appendix D Lower Green Bay & Fox River AOCs Fish & Wildlife Habitat Assessment Tools
- Lower Green Bay and Fox River AOC fish and wildlife habitats, including five weighting criteria, composite habitat weights, and baseline condition estimates
  - Lower Green Bay and Fox River AOC priority fish and wildlife species/species groups, with six weighting criteria, composite species/species group weights, and current condition estimates
- Appendix E Preliminary Considerations for Management Action Development for the Lower Green Bay & Fox River Area of Concern's Fish and Wildlife BUIs

## Appendix A

### List of Acronyms

AOC	Area of Concern
BLRPC	Bay-Lake Regional Planning Commission
BUI	Beneficial Use Impairment
FWWA	Fox-Wolf Watershed Alliance
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
LGBFR	Lower Green Bay and Fox River
µg/L	Micrograms per liter
mg/L	Milligrams per liter
MGP	Manufactured Gas Plant
MS4	Municipal Separate Storm Sewer System
NAPL	Non-aqueous phase liquid
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
ppm	Part per million
RAP	Remedial Action Plan
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
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
UW-Milwaukee	University of Wisconsin - Milwaukee
WDNR	Wisconsin Department of Natural Resources
WPSC	Wisconsin Public Service Corporation

## Appendix B

### 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.

#### **Fish Consumption Advisory**

Some fish from certain waterbodies contain harmful chemicals. These chemicals build up in the fish over time, and can build up in people when they eat the fish. The WDNR routinely tests fish and issues recommendations typically to “eat no more than” or “eat up to,” on how much fish a person could eat based on protecting human health from contaminants that may be found in fish. Current Wisconsin fish consumption advisories are available online at <http://dnr.wi.gov/topic/fishing/consumption/>.

#### **Microcystins**

A class of toxins produced by freshwater cyanobacteria (also known as “blue-green algae”). These chemicals include microcystin-LR, which is the most common 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.

**Waterfowl Consumption Advisory**

Some waterfowl from certain waterbodies contain harmful chemicals. These chemicals build up in the birds over time, and can build up in people who eat them. The WDNR tests waterfowl and issues recommendations on how much a person could eat based on protecting human health from contaminants that may be found in waterfowl. Current Wisconsin waterfowl consumption advisories are available in the Migratory Bird Hunting Regulation booklet and online at <https://dnr.wi.gov/topic/hunt/waterfowl.html>.

## **Appendix C**

### **BUI Tracking Matrix**

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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Project Title/Name	BUI Addressed	Project Type	Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Funding Source(s)	Project Lead Organization
Assessment of Benthos and Plankton in Wisconsin's Lake Michigan Areas of Concern	BUI 6 BUI 13	Fish and Wildlife	Assessment	Reporting	In Progress	2013	2018	\$414,300	USEPA [GLRI]	USGS
Benthos & Plankton BUIs Evaluation in Wisconsin's Lake Michigan Areas of Concern	BUI 6	Fish and Wildlife	Assessment	Reporting	COMPLETED	2011	2015	\$451,500	USEPA [GLRI]	USGS
Cat Island Chain Restoration - spine construction	BUI 14	Fish and Wildlife	Restoration	Implementation	COMPLETED	2012	2014	\$20,000,000	USEPA [GLRI]	USACE
Determining the Status of Fish Populations in the Lower Fox River/Green Bay AOC	BUI 3	Fish and Wildlife	Assessment	Reporting	COMPLETED	2015	2016	\$6,000	USEPA [GLRI] WDNR [Non-GLRI]	WDNR
Evaluation of Waterfowl Consumption Advisories	BUI 1	Fish and Wildlife	Assessment	Reporting	COMPLETED	2012	2016	\$106,743	USEPA [Non-GLRI]	WDNR
Fish Tumors & Other Deformities Assessment	BUI 4	Fish and Wildlife	Assessment	Planning	Established	2019		\$170,400	USEPA [Non-GLRI]	WDNR
Lower Fox River PCB Cleanup	BUI 1 BUI 3 BUI 4 BUI 5 BUI 6 BUI 9	Sediment	Remediation	Remedial Implementation	In Progress	2009	2018	Unknown	Responsible Party [Non-GLRI]	USEPA
Lower Green Bay and Fox River AOC Habitat Restoration Plan and Path Toward Delisting	BUI 3 BUI 14	Fish and Wildlife	Assessment	Implementation	In Progress	2014	2018	\$464,052	USEPA [GLRI]	UW-Green Bay
Point au Sable Wetland Restoration-Phase 1	BUI 14	Fish and Wildlife	Restoration	Confirmation Monitoring & Reporting	COMPLETED	2012	2013	\$150,000	Sustain Our Great Lakes [GLRI]	UW-Green Bay
Point au Sable Wetland Restoration-Phase 2	BUI 14	Fish and Wildlife	Restoration	Confirmation Monitoring & Reporting	COMPLETED	2014	2016	\$130,650	Sustain Our Great Lakes [GLRI]	UW-Green Bay
Volunteer Monitoring of Aesthetics	BUI 11	Aesthetics	Assessment	Implementation	In Progress	2011	2017	\$16,900	USEPA [GLRI]	WDNR
WPS Green Bay Former Manufactured Gas Plant Superfund Alternative Site	BUI 3 BUI 4 BUI 6 BUI 7	Sediment	Remediation	Remedial Engineering Design	In Progress	2014	2018	Unknown	Responsible Party [Non-GLRI]	USEPA

**BUI Number Key**

<b>BUI #</b>	<b>BUI Name</b>	<b>BUI#</b>	<b>BUI Name</b>
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 D**

### **Lower Green Bay & Fox River AOC Fish and Wildlife Habitat and Populations Assessment Tools**

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## Lower Green Bay & Fox River Area of Concern Fish & Wildlife Habitat Assessment Tool

List of Lower Green Bay and Fox River AOC fish and wildlife habitats, including five weighting criteria (scale: 0 = none, 1 = low, 2 = medium, and 3 = high), which produce composite habitat weights (sum of 5 scores). Baseline condition estimates (Cond.) range from 0 = worst possible condition to 10 = best possible condition. Values for AOC conservation status: 1 = S4 status (apparently secure in WI), 2 = S3 status (vulnerable in WI) or connected open water, tributaries, river, etc., and 3 = S2 status (imperiled in WI). Geographic significance describes connectivity to Green Bay or Fox River: 1 = low (inland), 1.5 = low-medium (lowland), 2 = medium (areas along tributaries), and 3 = high (pelagic zone, Fox River, islands, peninsulas, etc.). Based on consensus of local experts, the overall current condition of the “loss of fish and wildlife habitat” BUI in the Lower Green Bay and Fox River AOC is 3.60. (Howe et al., 2018)

Priority Habitat	Historical Importance	AOC Conservation Status	Geographic Significance	Significance to AOC Biodiversity	Functional Significance	Weight	Condition
Great Lakes Beach	3	3	3	3	2	14	2
Southern Sedge Meadow	3	2	3	3	3	14	2
Emergent Marsh (high energy coastal)	3	1	3	3	3	13	4
Submergent Marsh	3	1	3	3	3	13	5
Emergent Marsh (riparian)	3	1	2	3	3	12	3
Fox River Open Water	3	2	3	2	2	12	3
Green Bay Open Water	3	2	3	2	2	12	3
Shrub Carr	3	1	2	3	3	12	4
Tributary Open Water	3	2	3	2	2	12	3
Hardwood Swamp	3	2	1.5	2	3	11.5	5
Emergent Marsh (inland)	2	1	1	2	3	9	4
Open Water (inland)	2	1	1	1	2	7	3
Southern Dry Mesic Forest	1	2	1	1	2	7	5
Emergent Marsh (roadside)	0	1	2	2	1	6	3
Northern Mesic Forest	1	1	1	1	2	6	4
Other Forest	1	1	1	1	1	5	5
Surrogate Grassland (old field)	1	1	1	1	1	5	5
Surrogate Grassland Restored	1	1	1	1	1	5	5
<b>Current Condition</b>							<b>3.60</b>

## Lower Green Bay & Fox River Area of Concern Fish & Wildlife Populations Assessment Tool

Lower Green Bay and Fox River AOC priority fish and wildlife species/species groups, with six weighting criteria (1 = low, 2 = medium, and 3 = high), producing composite species/species group weights (sum of 5 scores). Current condition estimates range from 0 = worst possible condition to 10 = best possible condition. Conservation status: 1 = no status, 2 = some status (e.g., Special Concern), and 3 = high status (e.g., Endangered). Condition scores, based on consensus of local experts, are combined with weights (Formula 1) to yield a composite condition of 4.65 for the “degradation of fish and wildlife populations” BUI. (Howe et al., 2018)

Priority Species or Species Groups	Toxic Sensitivity	Economic Importance	Aquatic Dependence	Keystone Species	Conservation Status	Impact Potential	Weight	Cond.
Colonial waterbirds (breeding)	3	2	3	2	3	3	16	5
Coastal wetland Mustelids	3	3	3	2	1	3	15	4
Tributary fish	2	3	3	2	2	3	15	5
Coastal birds (breeding)	3	2	3	1	3	2	14	6
Fox River fish	3	3	3	2	1	2	14	5
Freshwater Unionid mussels	3	1	3	1	3	3	14	1
Shoreline fish	2	3	3	2	1	3	14	4
Wetland terns	3	2	3	1	3	2	14	3
Muskrat	1	2	3	3	1	3	13	6
Piping Plover	2	3	2	1	3	2	13	2
Anurans	2	1	3	1	2	3	12	7
Bald Eagle (winter)	3	2	2	1	2	2	12	7
Marsh breeding birds	2	2	3	1	2	2	12	6
Nearshore invertebrates	1	1	3	2	2	3	12	3
Shorebirds (migratory)	2	2	3	1	2	2	12	5
Waterfowl (migratory)	2	3	3	1	1	2	12	6
Bats	2	1	1	1	3	3	11	4
Coastal wetland aquatic macroinverts	1	1	3	2	1	3	11	3
Stream macroinverts	1	1	3	2	1	2	10	4
Turtles	2	1	3	1	1	2	10	5
Wooded wetland birds (breeding)	1	2	2	1	1	2	9	6
Landbirds (migratory)	1	2	1	1	1	2	8	7

**Current Condition      4.65**

## **Appendix E**

**Preliminary Considerations for Management Action Development for the Lower Green Bay & Fox River Area of Concern's Fish & Wildlife BUIs**

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# Preliminary Considerations for Management Action Development for the Lower Green Bay & Fox River Area of Concern's Fish and Wildlife BUIs

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Goals	Objectives	Activities	Impacted Habitats + Populations <small>(ordered alphabetically first by habitat)</small>
<p><b>1. Manage and protect AOC islands.</b></p>	<ol style="list-style-type: none"> <li>1. Develop and implement Cat Island Habitat and Wildlife Management Plan that addresses invasive plant species control, strategic placement of dredge material, public access restrictions, predator control, shoreline management, etc.</li> <li>2. Construct and maintain island structures for nesting colonial waterbirds, especially endangered terns.</li> <li>3. Protect and monitor Piping Plover (<i>Charadrius melodus</i>) breeding populations at Cat Island and at least one other location.</li> <li>4. Identify and protect safe roosting areas for wintering Bald Eagles (<i>Haliaeetus leucocephalus</i>) and other seasonal bird populations (e.g., Snowy Owls, <i>Bubo scandiacus</i>).</li> <li>5. Create and manage intermittently flooded shoreline habitat for shorebirds on Green Bay islands and shoals.</li> <li>6. Locate and protect heron rookeries; inform land managers and provide guidance for protection measures.</li> <li>7. Place woody debris for fish habitat.</li> </ol>		<ol style="list-style-type: none"> <li>1. Emergent marsh (high energy coastal), Great Lakes beach, submergent marsh, anurans, colonial waterbirds (breeding), coastal wetland Mustelids, marsh breeding birds, coastal terrestrial macroinvertebrates, Piping Plover, shoreline fish, turtles, and waterfowl (migratory)</li> <li>2. Colonial waterbirds (breeding)</li> <li>3. Piping Plover</li> <li>4. Bald Eagle (winter)</li> <li>5. Coastal terrestrial macro-invertebrates and shorebirds (migratory)</li> <li>6. Colonial waterbirds (breeding)</li> <li>7. Shoreline fish</li> </ol>
<p><b>2. Expand and improve Great Lakes beach habitat.</b></p>	<ol style="list-style-type: none"> <li>8. Control woody successional and invasive plant species, remove accumulated zebra/quagga mussel shells, and restore native vegetation at undeveloped east shore</li> </ol>		<ol style="list-style-type: none"> <li>7. Great Lakes beach, coastal wetland Mustelids, coastal terrestrial macroinvertebrates, shorebirds (migratory), and turtles</li> </ol>

	<p>beaches (Point au Sable, UW-Green Bay campus, Joliet Park, Bay Beach region).</p> <p>9. Conduct biotic inventories along AOC shoreline and if necessary re-establish populations of native turtle species and other beach specialists.</p> <p>10. Identify critical buffer habitats and shorelines with potential den sites for mink, otter, and other shoreline wildlife species.</p> <p>11. Improve natural beach habitat at Longtail Point; identify sensitive areas where human access can be restricted during breeding season of priority species.</p>		<p>8. Great Lakes beach, coastal wetland Mustelids, coastal terrestrial macroinvertebrates, Piping Plover, shorebirds (migratory), and turtles</p> <p>9. Great Lakes beach, coastal wetland Mustelids, coastal terrestrial macroinvertebrates, Piping Plover, shorebirds (migratory), and turtles</p> <p>10. Shorebirds (migratory), turtles, coastal terrestrial macroinvertebrates, coastal wetland Mustelids</p>
<p><b>3. Restore and enhance southern sedge meadow habitat.</b></p>	<p>12. Expand existing southern sedge meadow remnants at the Malchow-Olson Tract, Point au Sable, Fort Howard Wildlife Area, Duck Creek, and small areas upstream along the East River. Control invasive plant species, restore hydrology, and promote the spread of native plant species (especially tussock forming sedge, <i>Carex stricta</i>).</p> <p>13. Restore extensive southern sedge meadow/wet meadow habitat in northern Duck Creek delta (Wisconsin DNR lands east of E. Greenfield Ave).</p>		<p>11. Southern sedge meadow, anurans, bats, coastal wetland aquatic macroinvertebrates, coastal wetland Mustelids, landbirds (migratory), marsh breeding birds, and wetland terns</p> <p>12. Southern sedge meadow, anurans, coastal wetland aquatic macroinvertebrates, coastal wetland Mustelids, landbirds (migratory), marsh breeding birds, and wetland terns</p>
<p><b>4. Improve habitat quality of small AOC tributaries (enhance fish passage, restore natural stream substrates, and protect</b></p>	<p>14. Use The Nature Conservancy's fish passage GIS tool to identify and remove barriers that provide access to potential spawning areas.</p> <p>15. Improve substrate (including gravel, riffles, and pool habitat) and reduce sediment pollution.</p> <p>16. Protect and enhance riparian habitats at Mahon Creek, Wequiock Creek, Duck Creek, and parts of the East River.</p>		<p>13. Emergent marsh (riparian), Fox River open water, tributary open water, coastal wetland Mustelids, Fox River fish, freshwater Unionid mussels, muskrat, stream macroinvertebrates, tributary fish, and turtles</p> <p>14. Fox River open water, tributary open water, Fox River fish,</p>

<p><b>riparian vegetation)</b></p>	<p>17. Reduce magnitude of storm surges (flashiness) by creating or maintaining upstream vegetation buffers and mitigating inputs from stormwater drainages.</p> <p>18. Stabilize falling banks to reduce sediment movement and protect habitat.</p>		<p>freshwater Unionid mussels, and tributary fish</p> <p>15. Emergent marsh (riparian), Fox River open water, tributary open water, coastal wetland Mustelids, freshwater Unionid mussels, muskrat, stream macro-invertebrates, tributary fish, and turtles</p> <p>16. Tributary open water, stream macroinvertebrates, and tributary fish</p> <p>17. Emergent marsh (riparian), Fox River open water, tributary open water, coastal wetland Mustelids, freshwater Unionid mussels, muskrat, stream macro-invertebrates, tributary fish, and turtles</p>
<p><b>5. Improve open water and nearshore fish habitat in lower Green Bay.</b></p>	<p>17. Implement Upper Fox, Wolf, and Lower Fox basin TMDLs.</p> <p>18. Develop or restore important fish spawning and nursery habitats, such as rocky reefs, gravel, cobble, woody debris, and sandy areas for shoreline fish.</p> <p>19. Improve fish spawning substrate at existing shoreline reef structures, such as Renard Island.</p>		<p>17. Nearly all fish and wildlife habitats and populations, especially Green Bay open water, Fox River open water, submergent marsh, anurans, Fox River fish, freshwater Unionid mussels, coastal terrestrial macroinvertebrates, shoreline fish, stream macroinvertebrates, and tributary fish</p> <p>18. Coastal birds (breeding), Fox River fish, coastal terrestrial macroinvertebrates, shoreline fish, and tributary fish</p> <p>19. Coastal birds (breeding) and shoreline fish</p>

<p><b>6. Expand and improve quality of emergent marsh (high energy) complexes.</b></p>	<ul style="list-style-type: none"> <li>20. Control invasive plant species (e.g., <i>Phragmites australis</i>, common reed; <i>Typha × glauca</i>, hybrid cattail) and maintain an appropriate mix of open water native emergent vegetation in west shore marshes.</li> <li>21. Protect nest sites (e.g., tree cavities, snags, artificial nest boxes) for coastal birds (breeding) and establish nesting platforms for Osprey (<i>Pandion haliaetus</i>) and Bald Eagle (<i>Haliaeetus leucocephalus</i>).</li> <li>22. Designate and protect sensitive areas at Dead Horse Bay, Longtail Point, Peters Marsh, Malchow-Olson tract, Point au Sable, Duck Creek Delta, and Duck Creek.</li> <li>23. Create nest structures for wetland terns at Peters Marsh, Duck Creek, and Point au Sable and ensure there are at least 20 breeding pairs of Black Tern (<i>Chlidonias niger</i>) and Forster’s Tern (<i>Sterna forsteri</i>).</li> <li>24. Establish safe road crossings at strategic areas for anurans and turtles.</li> <li>25. Develop long-term management plan for sustaining emergent wetland habitat at sensitive wetlands during both high and low water periods.</li> </ul>		<ul style="list-style-type: none"> <li>20. Emergent marsh (high energy coastal), anurans, bats, coastal birds (breeding), coastal wetland aquatic macroinvertebrates, coastal wetland Mustelids, colonial waterbirds (breeding), landbirds (migratory), marsh breeding birds, muskrat, coastal terrestrial macroinvertebrates, shoreline fish, tributary fish, turtles, waterfowl (migratory), and wetland terns</li> <li>21. Coastal birds (breeding)</li> <li>22. Emergent marsh (high energy coastal), anurans, bats, coastal birds (breeding), coastal wetland aquatic macroinvertebrates, coastal wetland Mustelids, colonial waterbirds (breeding), landbirds (migratory), marsh breeding birds, muskrat, coastal terrestrial macroinvertebrates, shoreline fish, tributary fish, turtles, waterfowl (migratory), and wetland terns</li> <li>23. Wetland terns</li> <li>24. Anurans and turtles</li> <li>25. Emergent marsh (high energy coastal), anurans, coastal birds (breeding), coastal wetland aquatic macroinvertebrates, coastal wetland Mustelids, colonial waterbirds (breeding), marsh breeding birds, muskrat, coastal terrestrial macroinvertebrates, shoreline fish, tributary fish, turtles, waterfowl (migratory), and wetland terns</li> </ul>
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<p><b>7. Expand and improve quality of submerged aquatic vegetation.</b></p>	<p>26. Control introduced plant species (e.g., <i>Myriophyllum spicatum</i>, <i>Najas minor</i>, and <i>Potamogeton crispus</i>) and maintain extensive and high quality submerged aquatic vegetation (SAV) with native plants at Dead Horse Bay, Duck Creek, Peters Marsh, and Point au Sable.</p> <p>27. Determine substrate needs for target plant species and then enhance and restore substrate condition.</p> <p>28. Protect, maintain, and expand SAV biodiversity hotspots.</p>		<p>26. Submergent marsh, anurans, coastal wetland aquatic macro-invertebrates, coastal wetland Mustelids, marsh breeding birds, muskrat, coastal terrestrial macro-invertebrates, shoreline fish, turtles, waterfowl (migratory), and wetland terns</p> <p>27. Submergent marsh</p> <p>28. Submergent marsh</p>
<p><b>8. Protect strategic coastal landscapes through land acquisition or conservation easement.</b></p>	<p>29. Establish conservation easement for Malchow-Olson Tract, unprotected wetlands in Duck Creek delta, and sections of the East River.</p> <p>30. Designate sensitive coastal landscapes at UW-Green Bay's Bay Shore Woods and Beach, Barkhausen Waterfowl Preserve, Cat Island, Point au Sable, and Longtail Point.</p>		<p>29-30. Impacted habitats and populations will depend on the habitats and areas of interest that are protected or purchased.</p>
<p><b>9. Protect large areas of quality wooded wetlands along AOC coast.</b></p>	<p>31. Control invasive woody plants in quality hardwood swamps at Barkhausen, Malchow-Olson Tract, Bay Beach Wildlife Sanctuary, UW-Green Bay's Bay Shore Woods and Beach, and Point au Sable.</p> <p>32. Restore and expand habitats with native fruiting shrubs to improve stopover habitat for migratory land birds.</p>		<p>31. Hardwood swamp, landbirds (migratory), and wooded wetland birds (breeding)</p> <p>32. Landbirds (migratory)</p>
<p><b>10. Re-establish freshwater mussel populations.</b></p>	<p>33. Conduct inventory for remnant freshwater mussel beds and translocate/reintroduce populations at favorable locations. Use published studies (e.g., Morales et al. 2006) to identify optimal sites for re-introduction.</p>		<p>33. Coastal wetland Mustelids, freshwater Unionid mussels, and waterfowl (migratory)</p>
<p><b>11. Improve water quality in Green Bay, Fox River, and</b></p>	<p>34. Promote best management practices and innovative nutrient management measures in Fox River watershed.</p>		<p>34-36. Nearly all fish and wildlife habitats and populations would benefit from improved water quality, especially submergent marsh, anurans, Fox River</p>

<p><b>smaller tributaries.</b></p>	<p>35. Reduce unimpeded flow of toxins, nutrients, and sediments from urban/suburban storm water discharge pipes.</p> <p>36. Implement effective non-point source pollution management plans in smaller watersheds and drainages.</p>		<p>fish, freshwater Unionid mussels, coastal terrestrial macroinvertebrates, shoreline fish, stream macroinvertebrates, and tributary fish</p>
<p><b>12. Designate and protect contiguous wetland habitat gradients at select AOC coastal sites.</b></p>	<p>37. Restore hydrologic gradient ranging from emergent marsh to shrub carr and to hardwood swamp at Peters Marsh, Malchow-Olson Tract, Duck Creek North, Point au Sable, and possibly Ken Euers Wildlife Area.</p>		<p>37. Emergent marsh (high energy coastal), hardwood swamp, shrub carr, southern sedge meadow, anurans, bats, coastal birds (breeding), coastal wetland aquatic macroinvertebrates, coastal wetland Mustelids, colonial waterbirds (breeding), freshwater Unionid mussels, landbirds (migratory), marsh breeding birds, muskrat, coastal terrestrial macroinvertebrates, shorebirds (migratory), shoreline fish, turtles, waterfowl (migratory), wetland terns, and wooded wetland birds (breeding)</p>
<p><b>13. Enhance backwater habitats along Fox River for larval fish and invertebrates</b></p>	<p>38. Remove unwanted debris and reduce invasive species in backwater channel located under Leo Frigo Bridge on east side of Fox River.</p> <p>39. Explore opportunities for creating backwater habitats in vicinity of De Pere Dam and possibly Ashwaubomay Park, National Railroad Museum, and St. Francis Park.</p> <p>40. Evaluate the creation of islands in the Fox River to provide fish and wildlife habitat.</p>		<p>38. Fox River open water, emergent marsh (riparian), Fox River fish, coastal terrestrial macroinvertebrates, shoreline fish, turtles</p> <p>39. Fox River open water, emergent marsh (riparian), Fox River fish, coastal terrestrial macroinvertebrates, shoreline fish, turtles</p> <p>40. Fox River fish, coastal terrestrial macroinvertebrates, shoreline fish, turtles</p>

<p><b>14. Restore rocky and gravel substrates in open Fox River channel at suitable locations.</b></p>	<p>40. Map and subsequently improve benthic substrate in vicinity of the De Pere Dam. 41. Establish multiple rock/gravel reefs at other sites in Fox River.</p>		<p>40. Fox River open water, Fox River fish, coastal terrestrial macro-invertebrates, freshwater Unionid mussels, tributary fish 41. (same as a)</p>
<p><b>15. Control invasive species and improve shoreline habitat at inland wetlands near Green Bay and Fox River shoreline.</b></p>	<p>42. Establish native plants and construct or restore (if necessary) shallow topographic gradient at edges of small wetlands in AOC project area (within 1 km of shoreline) or along Duck Creek, East River, and other tributaries. 43. Work with local public works departments to improve habitat value of retention ponds and other artificial habitats in urban environment. 44. Identify and formally protect existing inland wetlands at Barkhausen Waterfowl Preserve, Duck Creek corridor, Bay Beach Wildlife Sanctuary, City of Green Bay landfill site, Point au Sable, and other areas.</p>		<p>42. Emergent marsh (inland), shrub carr, open water (inland), anurans, coastal birds (breeding), coastal wetland aquatic macro-invertebrates, marsh breeding birds, waterfowl (migratory), landbirds (migratory), colonial waterbirds (breeding), shoreline fish 43. (Same as a) 44. (Same as a)</p>
<p><b>16. Improve or restore floodplain deltas near river mouths at AOC tributaries</b></p>	<p>45. Expand protected zones surrounding lower reaches of Mahon Creek, Wequiock Creek, and other watercourses flowing into east shore of lower Green Bay. 46. Protect or restore backwater habitats near mouth of Fox River, Ashwaubenon Creek, and Dutchman's Creek. 47. Aggressively remove invasive species and restore low shorelines at river mouths of west shore tributaries.</p>		<p>45. Tributary open water, coastal wetland Mustelids, freshwater Unionid mussels, stream macroinvertebrates, tributary fish 46. Tributary open water, anurans, coastal wetland Mustelids, tributary fish 47. Tributary open water, freshwater Unionid mussels, coastal wetland Mustelids, tributary fish</p>