

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

Photo courtesy of Tom Prestby



December 2016



Wisconsin Department of Natural Resources
Office of Great Waters - Mississippi River, Lake Superior & Lake Michigan

Remedial Action Plan Update
for the
Lower Green Bay and Fox River Area of Concern
December 2016

Compiled by Megan O'Shea, WDNR Lower Green Bay and Fox River Area of Concern
Coordinator

With Input and Contributions From:

Kendra Axness, WDNR
Jon Bechle, Brown County
Cheryl Bougie, WDNR
Reena Bowman, USFWS
Amy Carrozzino-Lyon, WDNR
Donalea Dinsmore, WDNR
Rob Elliott, US FWS
Steve Galarneau, WDNR
Erin Giese, UWGB
Mike Grimm, The Nature Conservancy
James Havel, NES Ecological Services
Erin Houghton, NEW Water
Bob Howe, UWGB
John Huff, WDNR
John Kennedy, citizen
Jim Killian, WDNR
Julia Noordyk, UW Sea Grant
Kevin O'Donnell, USEPA
Beth Olson, WDNR
Vic Pappas, WDNR
Kelly Reyer, Fox-Wolf Watershed Alliance
Jessica Schultz, Fox-Wolf Watershed Alliance
Janet Smith, citizen
Trina Soyk, USFWS
Sean Strom, WDNR
Nicole Van Helden, The Nature Conservancy
Chad VandenLangenberg, Fox-Wolf Watershed Alliance
Bobbi Webster, UWGB
Amy Wolfe, UWGB
Courtney Winter, USEPA

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.

TABLE OF CONTENTS

TABLE OF CONTENTS I

PURPOSE STATEMENT..... 1

2016 PROGRESS SUMMARY 2

BENEFICIAL USE IMPAIRMENT UPDATES..... 7

 FISH TUMORS OR OTHER DEFORMITIES 7

 BIRD OR ANIMAL DEFORMITIES OR REPRODUCTION PROBLEMS 8

 RESTRICTIONS ON FISH AND WILDLIFE CONSUMPTION..... 9

 RESTRICTIONS ON DREDGING ACTIVITIES..... 9

 DEGRADATION OF BENTHOS 10

 DEGRADATION OF PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS 11

 LOSS OF FISH AND WILDLIFE HABITAT 12

 DEGRADATION OF FISH AND WILDLIFE POPULATIONS..... 14

 RESTRICTIONS ON DRINKING WATER CONSUMPTION, OR TASTE AND ODOR PROBLEMS..... 15

 BEACH CLOSINGS..... 16

 EUTROPHICATION OR UNDESIRABLE ALGAE 17

 DEGRADATION OF AESTHETICS 18

 TAINTING OF FISH AND WILDLIFE FLAVOR 19

List of Figures

Figure 1. The boundaries of the Lower Green Bay and Fox River Area of Concern4

List of Tables

Table 1. Current Status of Beneficial Use Impairments in the Lower Green Bay and Fox River AOC (Refer to Appendix C for more detail)5

List of Appendices

Appendix A List of Acronyms

Appendix B Definitions

Appendix C BUI Tracking Matrix

Appendix D Contaminant Concentrations in Mallards and Canada Geese from the Fox River/Green Bay Area of Concern

PURPOSE STATEMENT

This Remedial Action Plan (RAP), which updates the 2015 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 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.

2016 PROGRESS SUMMARY

In 2016, 540,007 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. 359,839 tons of material was sent to the landfill, and 19.5 acres were sand covered with 5.7 acres stone capped. This year also included armor capping of 26 acres within the federal navigation channel just south of the Georgia Pacific (Ft. Howard) Turning Basin, using large pieces of granite quarry-spall. Wisconsin Public Service (WPS) and Fox River Cleanup Group had planned to coordinate their cleanup efforts to also address contamination from the former manufactured gas plant (MGP) site on the East River; however, that was delayed for 2016, and is expected to take place in 2017, with the WPS site cleanup being completed by the end of that calendar year. The timeline for the PCB cleanup on the Fox River has been adjusted, and the active portion of the cleanup is now anticipated to be complete in 2018. Both cleanup projects are key to addressing several beneficial use impairments (BUIs), including **Fish Tumors, Bird and Animal Deformities, Restrictions on Fish and Wildlife Consumption, Restrictions on Dredging Activities, and Degraded Benthos**.

The update to the Restoration Plan and Environmental Assessment for the Lower Fox River Natural Resource Damage Assessment (NRDA) was also completed in 2016. The Area of Concern (AOC) is cited within the plan as a priority area, among other areas in the Fox-Wolf basin, for NRDA-funded projects that address aquatic, nearshore, and riparian restoration. More information can be found at www.foxriversrda.org.

Furthermore, the University of Wisconsin – Green Bay (UWGB) and The Nature Conservancy also made substantial progress this year on the fish and wildlife assessment that began in early 2015. This year, we have inventories of all potentially restorable habitats within the AOC, which helps serve as a baseline for any future restoration. We also have draft lists of priority project areas and target species for restoration. Lists of the habitat inventories can be found under the Loss of Fish and Wildlife Habitat section of this document. Because they are draft, the project areas and species lists are not included in this year's update. As part of a separate but related effort for the AOC, UWGB will also develop a survey method for waterfowl where locations for future monitoring will be established and estimates of waterfowl counts recorded. They will also identify and map critical native wetland and submerged aquatic plant remnant areas in the AOC. This inventory may also serve as a benchmark for future restoration projects. All of these efforts address the **Loss of Fish and Wildlife Habitat** and **Degraded Fish and Wildlife Populations** BUIs.

Appendix D to this document also includes the final report for the waterfowl consumption advisory update that was completed in the AOC (**Restrictions on Fish and Wildlife Consumption**). The results of this assessment indicated that the waterfowl consumption advisories for PCBs will remain, and an additional advisory will be issued for mercury.

With regard to the **Eutrophication and Undesirable Algae** BUI, the Wisconsin Department of Natural Resources (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 GLRI funds may support. The agencies agreed that a comprehensive approach, drawing support from both the AOC and Nearshore/Nonpoint Focus Areas of the Great Lakes Restoration Initiative (GLRI), would be optimal. In 2017, WDNR anticipates convening stakeholders and USEPA GLNPO 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.

WDNR also obtained a GLRI grant in 2016 from USEPA GLNPO to complete a more thorough assessment of cyanobacteria harmful algal blooms in the AOC. This assessment builds on a recent study completed by Bay Lake Regional Planning Commission that evaluated conditions around Bay Beach and found that bacteria levels that were comparable to other Lake Michigan beaches. This was a promising finding for the BUI and for future beach restoration efforts; however, the study also acknowledged the need for an algae monitoring strategy to further characterize problems related to harmful algal blooms.

The assessment, which will run from 2016-2018, will provide insight into the recreational risk associated with expanded use of the lower bay. It will assist researchers in developing tools the community can use to manage that risk, as well as provide supporting data for adapting predictive tools developed for Lake Erie to Lower Green Bay. The National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), UW-Milwaukee, and NEW Water are partners in the assessment and contributed to the development of the monitoring strategy. Results from the assessment will be used to inform the status of the **Beach Closings, Eutrophication or Undesirable Algae and Restrictions on Drinking Water Consumption** BUIs.

Additionally, in 2017, WDNR plans to develop an evaluation for the **Tainting of Fish and Wildlife Flavor** BUI. This is a suspected BUI that currently has no target. The evaluation would be used to simultaneously develop a target and determine whether the BUI exists for the AOC.

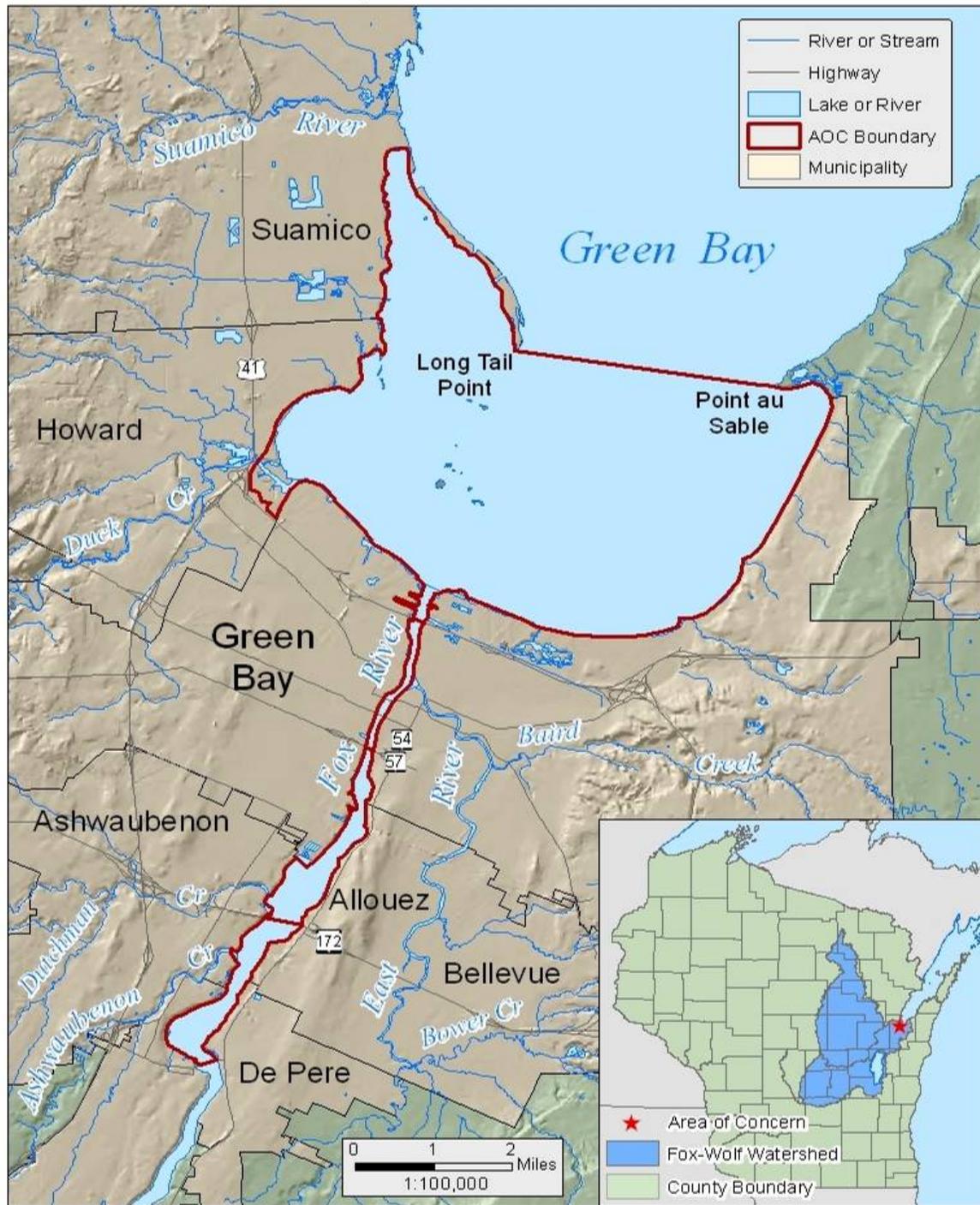


Figure 1. The boundaries of the Lower Green Bay and Fox River Area of Concern. For additional information about the history of the AOC and a narrative description of the AOC boundary, please refer to previous RAP documents which are available online: <http://dnr.wi.gov> Search “Lower Green Bay and Fox 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. Fish consumption advisories for PCBs specific to the AOC will be addressed by the Lower Fox River PCB Cleanup project.
Tainting of fish and wildlife flavor	Suspected	Target development was delayed in 2016, but should be developed in 2017.
Degradation of fish and wildlife populations	Yes	WDNR secured GLRI funding for 2015-2016 to assess habitat and populations in the AOC. Pending those results, a list of necessary projects to address habitat and population deficiencies will be developed. Also currently depends on completion of ongoing Lower Fox River PCB Cleanup and TMDL implementation.
Fish tumors or other deformities	Suspected	BUI will be assessed following WDNR criteria after in-river remedial action work for the Lower Fox River PCB Cleanup is complete (currently scheduled for 2019).
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 in 2017.
Degradation of benthos	Yes	Results from the USGS-led 2012 and 2014 studies are under peer review.
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 2016, and assessment, in the form of the volunteer monitoring program, is in progress.
Degradation of phytoplankton and zooplankton populations	Yes	Results from the USGS-led 2012 and 2014 studies are under peer review.
Loss of fish and wildlife habitat	Yes	The assessment for this impairment is scheduled to be completed in 2017. A list of management actions will then be developed during 2017 that once implemented, will remove the BUI.

BENEFICIAL USE IMPAIRMENT UPDATES

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

- = Not started
- ➔ = Underway

FISH TUMORS OR OTHER DEFORMITIES

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

Status

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 2019.

Management actions

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

Status

Indicator species for this impairment need to be selected. Extensive datasets examining the effects of contaminants on tree swallows and bald eagles currently exist for the AOC.

Management actions

- ➔ Complete the contaminated sediment projects (PCB and former MGP site)
- Finalize BUI metric species

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

Waterfowl consumption advisories have been reassessed since the original consumption advisories were issued in 1987. The results of the assessment indicate that PCB levels have remained virtually unchanged, and the advisory for mallards remains. A limited consumption advisory for mercury has also been proposed with no more than one meal per week recommended for children and women of childbearing age. The report, Contaminant Concentrations in Mallards and Canada Geese from the Fox River/Green Bay Area of Concern, can be found in Appendix D.

Management actions

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

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

The management actions necessary to meet the target for this BUI are underway, and are expected to conclude in 2018.

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 ² (measured as a 3-year running average) or as otherwise indicative of adequate levels of dissolved oxygen in overlying waters and uncontaminated surficial sediments in Lake Michigan.	In progress
Sediment toxicity (due to ammonia, PCB, or dissolved oxygen) is not present at levels that are acute or chronically toxic (as defined by relevant, field validated, bioassays with appropriate quality assurance/quality controls) to the benthic community.	Assessment needed
Native benthic communities adequately support the trophic levels that depend upon them.	Assessment needed

Status

WDNR AOC staff are currently reviewing a draft of the final report from the benthos and plankton assessment that USGS conducted in 2012 and 2014. The final report and results should be available in 2017 and will be used to determine next steps.

Management actions

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

DEGRADATION OF PHYTOPLANKTON AND ZOOPLANKTON POPULATIONS

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

Status

WDNR AOC staff are currently reviewing a draft of the final report from the benthos and plankton assessment that USGS conducted in 2012 and 2014. The final report and results should be available in 2017 and will be used to determine next steps.

Management actions

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

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

Status

UWGB has completed mapping different habitat types within the AOC, which includes the area one kilometer landward of the AOC boundary. The tables below show the inventory of different habitat types in the AOC.

Mapped AOC Habitat Types (listed from most to least common by area)

Habitat	Count	Area(ha)	Area(ac)	MaxArea(ha)
Hardwood Swamp	181	892	2205	136
Emergent Marsh (high energy coastal)	42	513	1268	163
Emergent Marsh (inland)	83	229	566	29
Other Forest	179	191	471	32
Surrogate Grassland	146	174	430	16
Wasteland	54	166	410	77
Submergent Marsh	25	138	341	126
Shrub Carr	24	102	253	18
Northern Mesic Forest	34	65	162	13
Surrogate Grassland (Roadside)	68	58	143	4
Open Water	84	52	128	11
Emergent Marsh (riparian)	12	51	126	35
Great Lakes Beach	38	36	90	15
Southern Dry Mesic Forest	11	30	73	7
Northern Wet Mesic Forest	3	26	65	15
Emergent Marsh Roadside	22	25	63	5
Surrogate Grasslands restored (native grasses)	7	12	29	3
Southern Sedge Meadow	2	1	2	1

The final report for the assessment will be completed in 2017. Additionally, UWGB received additional GLRI funding to include additional waterfowl and vegetation assessments. The methodology developed for those assessments will have value not just to the AOC assessment and determining management actions, but will also have broader applicability beyond the AOC program.

Management actions

- Complete the fish and wildlife populations and habitat assessment

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	Action needed
Populations of traditionally harvested fish species are capable of supporting some level of exploitation	Partially complete (walleye); more assessment needed
The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native furbearers (including mink, muskrats, and otter), amphibians (including spring peepers, leopard frogs, American toads, eastern gray tree frogs, green frogs, bullfrogs, and salamanders), reptiles (including snapping and painted turtles), terns (common and Forster’s), migratory diving ducks, dabbling ducks, marsh nesting birds and island-dependent colonial nesting birds in abundances sufficient to provide ecological function	Assessment in progress
Populations of traditionally harvested wildlife species are capable of supporting some level of exploitation	Assessment in progress
Invasive species (lamprey, carp, gobies, white perch, and others) expansion is minimized and controlled as needed to protect native species within the AOC and upstream	In progress
Contaminant levels in forage fish populations do not impair the reproductive success of fish-eating birds and wildlife (including predatory fish) and meet the criteria established in Annex 1 of the 1978 Great Lakes Water Quality Agreement as amended by Protocol in 1987, specifically “the concentration of total polychlorinated biphenyls in fish tissues (whole fish, calculated on a wet weight basis), should not exceed 0.1 micrograms per gram for the protection of birds and animals which consume fish”	Assessment in progress
The AOC supports fish and wildlife populations at levels consistent with extant fish and wildlife management plan objectives. Specifically, the following objectives should be met unless extant management plans have updated criteria (specific objectives identified in past RAP documents are listed in Appendix B of the 2015 RAP update)	Partially complete; more assessment needed

Status

UWGB is currently working on an approach for quantitatively assessing the status of this impairment. Because this aspect of the project is still in its early stage, we don’t have anything yet to share, but the proposed approach would allow multiple species groups in the AOC to be included as part of the status assessment. More specific information will be available in the 2017 update. Additional management actions may be identified depending on the status determination.

Management actions

- ➔ Complete the fish and wildlife populations and habitat assessment

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 cyanobacteria harmful algal blooms (HABs) assessment that WDNR received funds for in 2016 will be able to assess whether waters in the lower portion of the bay are meeting recommended standards and criteria for cyanobacteria-related drinking water parameters. The assessment is a three-year study and results are anticipated in 2019. 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

From previous data collected by Bay-Lake Regional Planning Commission and WDNR, bacteria levels are typically below state recreational standards. Therefore, the status of the first part of the target has been changed from “assessment of data needed” to “complete.” More information regarding the potential risk of cyanobacteria was necessary, however, and the current assessment that WDNR received funds for will help to determine whether the target components are being met. Assessment of algae is currently underway.

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 US EPA approved Total Maximum Daily Load. The approved TMDL targets are summer median concentrations of 0.10 mg/L TP and 20 mg/L TSS at the mouth of the river.	Action needed
There are no 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"> • 90% of the geometric means of at least 5 monthly samples (collected between May 1 and September 30th in at least 2 years) of phytoplankton samples from waterbodies in the AOC contain less than 100,000 cyanobacterial cells/mL or less than 20 µg/L of microcystin-LR. • Less than 50 - 60% of the relative biomass of phytoplankton is cyanobacteria when total phosphorus at the mouth of the Lower Fox River reaches the TMDL target of 100 µg/L (0.1 mg/L) 	<p>Assessment needed</p> <p>Assessment needed</p>

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

Additionally, Outagamie County obtained a state targeted runoff management (TRM) grant in 2017-2020 for TMDL implementation in the Upper Duck watershed.

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

Status

Over the last year and a half, WDNR has been having discussions with stakeholders and USEPA regarding the AOC’s role in addressing eutrophication in the Lower Fox River, which relates to the first part of this target. In addition, the monitoring protocol for aesthetics, which is similar between the Milwaukee Estuary and Lower Fox River/Green Bay AOCs, was finalized in 2014. This year, WDNR collaborated with the Fox-Wolf Watershed Alliance (FWWA) to help recruit more volunteers in the program. Seventeen new people monitored throughout the monitoring stations in the AOC, submitting 93 complete monitoring forms. According to the project’s quality assurance plan, however, tallying of scores cannot occur for any one station until more than 30 independent observations have been obtained, and no station yet has that many complete data forms.

The table below summarizes how many people monitored at each designated station.

Station name	Number of complete data forms obtained in 2016
Bay Beach	6
Communiversy Park	6
Fox Point Boat Launch	12
Leicht Park	8
Metro Boat Launch	9
Perkofski Boat Launch	5
Porlier Pier	9
Regatta 220	6
Riverview Place Park	10
Voyager Park	10

West Lazarre Ave.	8
Wietor Wharf	4

Participation in the monitoring program increased significantly as a result of FWWA's efforts to recruit volunteers. Next year, WDNR will again partner with them to recruit new volunteers and increase the number of complete data sheets. Another contributing factor that seemed to bolster participation was the use this year of an electronic data sheet, where volunteers could access the form from electronic devices. This cut down on the number of data forms that were quality control flagged, as nearly all fields must be filled in before the electronic data form can be submitted.

Management actions

Management actions have not been established for this BUI.

TAINTING OF FISH AND WILDLIFE FLAVOR

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

Status

In 2017, WDNR plans to develop an assessment for this BUI to determine whether it exists as an impairment for the AOC. WDNR will involve stakeholders in that assessment.

Management actions

Management actions have not been established for this BUI.

List of Previous Remedial Action Plans, Updates, and other important historical documents:

Allen, P., J. Sullivan, L. Persson, et. al. (1987). Toxic substances management technical advisory committee report. WDNR PUBL-WR-166 87.

Cadmus Group Inc. (2012). Total Maximum Daily Load and Watershed Management Plan for total phosphorus and total suspended solids in the Lower Fox River Basin and Lower Green Bay. <http://dnr.wi.gov/water/projectDetail.aspx?key=16084305>.

Fox River/Green Bay Natural Resource Trustee Council. (2016). Lower Fox River and Green Bay Natural Resource Damage Assessment and Restoration: Update to the Restoration Plan and Environmental Assessment. <http://www.foxrivernrda.org/wp-content/uploads/2016/07/2016-Update-to-the-Restoration-Plan-and-Environmental-Assessment.pdf>.

Stratus Consulting Inc. (1999). Injuries to avian resources, Lower Fox River/Green Bay Natural Resource Damage Assessment Final Report. <http://www.fws.gov/midwest/es/ec/nrda/FoxRiverNRDA/documents/bird.pdf>

Wisconsin Department of Natural Resources. (1988). Lower Green Bay Remedial Action Plan. PUBL-WR-175-87 REV 88 <http://dnr.wi.gov/topic/greatlakes/documents/LowerGreenBayRAP.pdf>

Wisconsin Department of Natural Resources. (1993). Lower Green Bay Remedial Action Plan 1993 Update. <http://dnr.wi.gov/topic/greatlakes/documents/LowerGreenBayRAPupdate.pdf>.

Wisconsin Department of Natural Resources. (2009). Lower Green Bay and Fox River Area of Concern Beneficial Use Impairment Delisting Targets. <http://dnr.wi.gov/topic/greatlakes/documents/LowerGreenBayFinalReport.pdf>.

Wisconsin Department of Natural Resources. (2011). Stage 2 Remedial Action Plan Update for the Lower Green Bay and Fox River Area of Concern. <http://dnr.wi.gov/topic/greatlakes/documents/Stage2RAPGreenBay.pdf>.

Wisconsin Department of Natural Resources. (2012). Remedial Action Plan Update for the Lower Green Bay and Fox River Area of Concern. <http://dnr.wi.gov/topic/greatlakes/documents/RAP-UpdateLGBFR2012final.pdf>.

Wisconsin Department of Natural Resources. (2013). Remedial Action Plan Update for the Lower Green Bay and Fox River Area of Concern. <http://dnr.wi.gov/topic/greatlakes/documents/LGB-FR2013FinalRAPupdate.pdf>.

Wisconsin Department of Natural Resources. (2014). Remedial Action Plan Update for the Lower Green Bay and Fox River Area of Concern. <http://dnr.wi.gov/topic/greatlakes/documents/LGB-FR2014FinalRAPupdate.pdf>.

Wisconsin Department of Natural Resources. (2015). Remedial Action Plan Update for the Lower Green Bay and Fox River Area of Concern. <http://dnr.wi.gov/topic/greatlakes/documents/LGBFRAOCRAP2015.pdf>.

Wisconsin Department of Natural Resources. (2013). Wisconsin 2014 Consolidated Assessment and Listing Methodology (WisCALM) for Clean Water Act Section 305(b), 314, and 303(d) Integrated Reporting. Bureau of Water Quality.

<http://dnr.wi.gov/water/wsSWIMSDocument.ashx?documentSeqNo=84480270>.

Wisconsin Department of Natural Resources. (2016). Choose wisely: A health guide for eating fish in Wisconsin. PUBL-FH-824 2016.

<http://dnr.wi.gov/topic/fishing/documents/consumption/ChooseWisely2016Web.pdf>.

Wisconsin Department of Natural Resources. (2016). 2014 Wisconsin migratory bird regulations.

PUBL-WM-010 2016. <http://dnr.wi.gov/files/PDF/pubs/wm/WM0010.pdf>.

APPENDICES

- Appendix A Acronyms
- Appendix B Definitions
- Appendix C BUI Tracking Matrix
- Appendix D Contaminant Concentrations in Mallards and Canada Geese from the Fox River/Green Bay Area of Concern

(page left intentionally blank)

Appendix A

List of Acronyms

AOC	Area of Concern
BUI	Beneficial Use Impairment
FWWA	Fox-Wolf Watershed Alliance
GLNPO	Great Lakes National Program Office
GLRI	Great Lakes Restoration Initiative
µg/L	Micrograms per liter
mg/L	Milligrams per liter
MGP	Manufactured gas plant
NRDA	Natural Resource Damage Assessment
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
ppm	Part per million
RAP	Remedial Action Plan
TMDL	Total Maximum Daily Load
TP	Total phosphorus
TSS	Total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
UWGB	University of Wisconsin – Green Bay
WDNR	Wisconsin Department of Natural Resources
WPS	Wisconsin Public Service

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.

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.

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.

(page left intentionally blank)

Lower Green Bay-Fox River AOC Tracking Matrix 2016

Project Title/Name	BUI Addressed	Project Type	Action Type	Action Modifier	Project Status	Project Start Date	Project End Date	Project Cost	Primary Funding Source	Project Lead Organization
Assessment of Benthos and Plankton in Wisconsin's Lake Michigan Areas of Concern	BUI 6	Fish and Wildlife	Assessment	Reporting	In Progress	2013	2016	\$414,300	USGS [GLRI]	USGS
Benthos & Plankton BUIs Evaluation in Wisconsin's Lake Michigan Areas of Concern	BUI 6	Fish and Wildlife	Assessment	Completed	COMPLETED	2011	2015	\$451,500	USGS [GLRI]	USGS
Cat Island Chain Restoration - spine construction	BUI 14	Fish and Wildlife	Restoration	Confirmation Monitoring and Reporting	COMPLETED	2012	2014	\$20,000,000	USEPA [GLRI]	U.S. Army Corps of Engineers
Determining the Status of Fish Populations in the Lower Fox River/Green Bay AOC	BUI 3	Fish and Wildlife	Assessment	Planning	In Progress	2015	2016	\$6,000	USEPA [GLRI]	WDNR
Evaluation of Waterfowl Consumption Advisories	BUI 1	Fish and Wildlife	Assessment	Completed	COMPLETED	2012	2016	\$106,743	USEPA [Non-GLRI]	WDNR
Fish Tumors & Other Deformities Assessment	BUI 4	Fish and Wildlife	Assessment	Not Started	Established	2019	TBD	\$170,400	USEPA [GLRI]	
Lower Fox River PCB Cleanup	BUI 1, BUI 3, BUI 4, BUI 5, BUI 6, BUI 9	Sediment	Remediation	Remedial Implementation	In Progress	2009	2017	\$700,000,000	Responsible Party [Non-GLRI]	USEPA
Lower Green Bay and Fox River AOC Habitat Restoration Plan and Path Towards Delisting	BUI 3, BUI 14	Fish and Wildlife	Assessment	Planning	In Progress	2014	2018	\$464,052	USEPA [GLRI]	UW-Green Bay
Point au Sable Wetland Restoration-Phase 1	BUI 14	Fish and Wildlife	Restoration	Completed	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	Completed	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 Plan Superfund Alternative Site	BUI 3, BUI 4, BUI 6, BUI 7	Sediment	Remediation	Remedial Engineering Design	In Progress	2014	2018	Not Yet Determined	Responsible Party [Non-GLRI]	USEPA

BUI Number Key

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

Appendix D

Contaminant Concentrations in Mallards and Canada Geese from the Fox River/Green Bay Area of Concern

**CONTAMINANT CONCENTRATIONS IN MALLARDS AND CANADA GEESE
FROM THE FOX RIVER/GREEN BAY AREA OF CONCERN**

Sean M. Strom
WI Department of Natural Resources
Bureau of Wildlife Management

November 9, 2016

INTRODUCTION

Waterfowl consumption advisories within the Fox River/Green Bay Area of Concern (AOC) have been in place since 1987. The current advisory is the result of contamination from polychlorinated biphenyls (PCBs). However, the advisory has not been re-evaluated since its inception. As part of the AOC de-listing process, we re-examined the status of the advisory to determine if the existing advisory can be removed or if any additional advisories are warranted.

Persistent, bioaccumulative, and toxic (PBT) chemicals are of concern because of evidence that they cause long-term harm to human health and the environment. Examples of PBT chemicals include PCBs, dioxins, organochlorine pesticides, and mercury). Among environmental contaminants, PBTs pose special challenges because they do not break down or become diluted in the environment as easily as some chemicals. PBTs increase in concentration in the bodies of animals at each level of the food chain. This is particularly evident in aquatic environments with PBTs moving from contaminated sediment through the food chain up to predatory fish. These fish are the major source of exposure to humans and wildlife that consume these fish, and cumulative exposure can be high enough to cause problems in both humans and wildlife. Although it may take months or years of regularly eating contaminated waterfowl or fish to build up amounts which are a health concern, the risk should not be ignored. Health problems which may result from the contaminants found in waterfowl range from small changes in health that are hard to detect to birth defects and cancer. Mothers who eat highly contaminated fish for many years before becoming pregnant may have children who are slower to develop and learn.

Polychlorinated biphenyls are considered a PBT chemical which are ubiquitous in the Wisconsin Great Lakes and have been shown to biomagnify up the food chain. PCBs are considered to be probable human carcinogens based on its association with liver tumors of laboratory rats (USEPA 1997). Recent EPA documents have termed the findings of some human studies as “suggestive” of an association between human cancer and PCB exposure (USEPA 1997). PCBs are also associated with immunological effects in animals and some developmental effects in humans. All of the current consumption advisories within the WI AOCs are the direct result of PCB contamination.

There is a waterfowl consumption advisory currently in place for mallard ducks within the Fox River/Green Bay AOC. The advisory recommends that people remove all skin and visible fat before cooking mallard ducks taken from the Fox River from the DePere Dam to lower Green Bay. The objective of this study was to sample waterfowl tissue for PCBs and legacy contaminants (PCBs, lead (Pb), mercury (Hg), DDT/DDE, and organochlorine pesticides) in order to determine whether revisions to the existing waterfowl consumption advisory are appropriate.

We realize the difficulty in linking mobile and migratory waterfowl to environmental contamination within an AOC, and using that as the basis for a local consumption advisory. To address this issue, we focused on collecting adult mallards known to be members of a resident flock. In addition to resident mallards, we also collected samples from resident Canada geese which should also reflect local conditions in terms of contaminants.

METHODS

Mallards were collected from the Green Bay Wildlife Sanctuary which is located within the AOC boundaries. Canada geese were collected within the AOC during banding operations as well as during nuisance geese round-ups conducted by USDA-Wildlife Services. All carcasses were processed in an identical manner. Briefly, approximately 10 x 12 cm was plucked from the breast of each carcass to

expose skin, and a 20 g sample of breast muscle with skin-on was dissected. Samples were placed into a labeled plastic bag and submitted to the WI State Lab of Hygiene (WSLH) for analysis. Samples were analyzed for PCBs, lead (Pb), mercury (Hg), DDT/DDE, and organochlorine pesticides.

Advisories for human consumption (Table 1) were obtained from the Protocol for a Uniform Great Lakes Fish Consumption Advisory (GLSFATF 1993), the Health Guide for People Who Eat Sport Fish from Wisconsin Waters (WDNR and WDH 1994), and Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed (USFDA 1994).

Wildlife Health staff evaluated and interpreted sample results from the WSLH. Results for each contaminant was compared with the associated critical advisory concentration in food to determine if consumption advisories could be repealed or new advisories are warranted. This process included consultation with the Department of Health Services (DHS) on the interpretation of results.

RESULTS and DISCUSSION

PCBs

Detectable levels of PCBs were observed in 8 of the 14 samples from resident mallards (range ND – 1.4 µg/g), and the mean concentration (0.34 ± 0.42 µg/g) was above advisory concentrations (Table 2). PCBs were detected in 3 of the 21 samples of resident Canada geese (range ND – 0.15), but the mean concentration (0.03 µg/g) was below any advisory concentration.

METALS

Lead. Lead was detected in 9 of the 14 samples collected from resident mallards (range ND – 0.25 µg/g) (Table 2). However, the mean Pb concentration (0.04 µg/g) was below the advisory concentration of 0.05 µg/g, therefore, an advisory due to Pb contamination is not necessary. Lead was detected at low concentrations in 19 of the 21 Canada goose samples (range ND – 0.02). The mean Pb concentration was below the proposed 0.05 µg/g advisory level.

There is no single standard for permissible amounts of lead in food. Furthermore, FDA regulatory standards and guidelines for Pb in food are complicated by the relatively recent recognition (ATSDR 2007, EPA 2007) of Pb as a probable human carcinogen. However, for meat and fat products, an international consensus standard of 0.05 ppm is under discussion (FDA 2000).

Mercury. Mercury was detected in every sample from resident mallards (range 0.01 – 0.34 µg/g). The mean Hg concentration in mallards (0.10 µg/g) (Table 2) is high enough to warrant a limited consumption advisory of “no more than 1 meal/week” for children and for women of childbearing years. Mercury was also detected in 19 of the 21 Canada goose samples (range ND – 0.004) but the average concentration was well below any advisory concentration.

Cadmium. Wisconsin does not routinely test for Cd in fish as part of the fish consumption advisory program and therefore, Wisconsin does not have an advisory concentration for Cd. However, Iowa uses a Cd concentration of 0.3 µg/g as a level of concern. Although, this concentration is not used as an advisory guideline, it does serve as a point of comparison. Cadmium was detected in 9 of the 14 samples from mallards, but the concentrations were very low and the mean concentration (0.10 µg/g) was below the level of concern (Table 2). The average Cd concentration in Canada geese (0.02 µg/g) was also below the level of concern.

CONCLUSIONS AND RECOMMENDATIONS

Comparing results of PCB levels in mallards from the current sample collection with samples collected in the late-1980s indicate PCB levels have changed little over the last 25 years. In addition, based on levels of Hg observed in mallards, we recommend the current advisory to be revised to “no more than 1 meal/week” for children and women of childbearing years. Furthermore, based on recommendations of a report assessing the risk of the consumption of potentially contaminated waterfowl (Lee 2014), we recommend that in addition to mallards, the advisory should include all dabbling ducks (subfamily *Anatinae*). In addition, consumers of dabbling ducks harvested from the Fox River/Lower Green Bay should refrain from eating other waterfowl or fish with known consumption advisories based on Hg.

The levels of various contaminants observed in resident Canada geese were below any advisory concentration or level of concern. Therefore, no consumption advisories are recommended for Canada geese in the AOC.

LITERATURE CITED

ATSDR. 2007. *ch. 8 in Toxicological Profile for Lead*. Agency for Toxic Substances and Disease Registry, Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

<http://www.atsdr.cdc.gov/toxprofiles/tp13.pdf>

Great Lakes Sport Fish Advisory Task Force (GLSFATF). 1993. Protocol for a Uniform Great Lakes Fish Consumption Advisory.

Lee, M.L. 2014. Risk Assessment for Human Consumption of Waterfowl on the Sheboygan River. Capstone Project: U.W. Madison School of Veterinary Medicine.

United States Environmental Protection Agency. 1997. Integrated Risk Information System (IRIS). <http://www.epa.gov/iriswebp/iris/>

United States Environmental Protection Agency. 2007. *Integrated Exposure Uptake Biokinetic Model (IEUBK) for lead in children, ver.1.0*. Internet: www.epa.gov/superfund/lead.

United States Food and Drug Administration (USFDA). 1994. Action Levels for Poisonous or Deleterious Substances in Human Food and Animal Feed.

United States Food and Drug Administration (USFDA). 2000. Emerging international contaminant issues: Development of Codex alimentarius standards to address the issues. Food Safety Magazine, Feb. 2000. reprinted by: U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition. Internet: <http://www.cfsan.fda.gov/~cjm/codexfa2.html>

Wisconsin Department of Natural Resources (WDNR) and Wisconsin Division of Health (WDH). 1994. Health Guide for People Who Eat Sport Fish from Wisconsin W

Table 1. Human Health Consumption Advisory Critical Concentrations in Fish or Meat Products.

CONTAMINANT	MINIMUM DETECTION LIMIT (µg/g)	ADVISORY CONCENTRATION (µg/g)			
		Unlimited consumption	No more than 1 meal/Week	No more than 1 meal/Month	Do Not Eat
PCB	0.04	<0.05	0.06 - 0.22	0.22 – 1.0	>2.0
Mercury (Children under age 15, pregnant women and women of childbearing age)	0.004	<0.05	0.05 - 0.22	0.22 – 0.95	>0.95
Lead	0.005	<0.05	n/a	n/a	n/a
Cadmium	0.0045	<0.3*	n/a	n/a	n/a

*Level of concern rather than advisory concentration

Table 2: Total PCB, cadmium, mercury, and lead concentrations (average \pm standard deviation) in waterfowl collected from the Fox River/Green Bay AOC

Species	Sample Size	PCBs ($\mu\text{g/g}$)	Cd ($\mu\text{g/g}$)	Hg ($\mu\text{g/g}$)	Pb ($\mu\text{g/g}$)
Mallard	14	0.34 \pm 0.42	0.01 \pm 0.01	0.10 \pm 0.10	0.04 \pm 0.07
Canada Goose	21	0.03 \pm 0.03	0.02 \pm 0.07	0.002 \pm 0.001	0.01 \pm 0.01