Evaluating Progress Toward Removing Fish and Wildlife Habitat and Populations Beneficial Use Impairments in the Lower Green Bay & Fox River Area of Concern

Instructions for Evaluating Before and After Restoration and Enhancement Projects using Fish & Wildlife Habitat and Populations Assessment Tools

Submitted to the Wisconsin Department of Natural Resources and the U.S. Environmental Protection Agency

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Executive Summary

- The Lower Green Bay and Fox River Area of Concern (LGBFR AOC) is one of the most ecologically important regions in the Great Lakes and supports diverse fish and wildlife populations within a mosaic of different aquatic and coastal habitats.

- However, fish and wildlife populations in the LGBFR AOC face many challenges, including habitat loss and degradation, invasive species introductions, and poor water quality due to pollution caused by nutrient runoff, toxins, and other pollutants.

- The LGBFR AOC was originally designated as an AOC in the late 1980s by the International Joint Commission of Canada and the U.S. due to the identification of 13 beneficial use impairments (BUI), which are characteristics or reasons why this region is impaired, such as animal deformities, eutrophication, and degradation of benthos to name a few.

- In this document, we focus on the two fish and wildlife-related BUIs, namely the “Loss of Fish and Wildlife Habitat” BUI and “Degradation of Fish and Wildlife Populations” BUI.

- Through past efforts, we have identified 18 priority habitats and 22 priority fish and wildlife population groups as key elements to the LGBFR AOC ecosystem and present an assessment process for evaluating the condition or “health” of the two fish and wildlife BUIs.

- We created MS Excel tools for assessing the conditions of the “Loss of Fish and Wildlife Habitat” and “Degradation of Fish and Wildlife Populations” BUIs, which use a combination of current conditions of the 18 priority habitats and 22 priority populations. Each tool calculates a weighted average of condition based on a series of weightings applied to each priority habitat and population and their associated conditions and produces a final value ranging from 0 (poor) to 10 (excellent) that describes the overall condition of each BUI. The condition of a priority habitat or population is determined through newly collected field data (e.g., number of nests, total acreage and quality of a habitat, designation of a critical habitat area) and then compiled into a metric, which is converted into a condition score ranging from 0 (poor) to 10 (excellent).

- The purpose of this document is to provide guidance and instruction on:
    - Assessing conditions of these two fish and wildlife BUIs before and after restoration or enhancement work is completed on fish and wildlife habitats or populations;
    - How to use our two MS Excel tools, which will each calculate a final condition score ranging from 0 (poor) to 10 (excellent) describing the condition or “health” of each BUI;
    - How to implement our priority habitat and population metrics, which convert newly collected field data into condition scores ranging from 0 to 10; and
    - Ultimately using these tools to track progress towards the removal of each fish and wildlife BUI.

- The content described here is based on our original work in addition to ideas provided by multiple experts and stakeholders representing agencies, non-profit organizations, universities, government, and other entities.

- We published additional information about these priority habitats and populations, BUI assessment tools, and other background material on a website hosted by UW-Green Bay: http://www.uwgb.edu/green-bay-area-of-concern/.

Introduction

In the late 1980s, the International Joint Commission of Canada and the U.S. designated the Lower Green Bay and Fox River Area of Concern (LGBFR AOC) as a Great Lakes Area of Concern because it was considered heavily impaired due to poor water quality in the lower bay of Green Bay, habitat loss and degradation, concern for fish and wildlife (e.g., deformities, tumors), and other beneficial use impairments (BUI). The boundaries of the LGBFR AOC extend from Point au Sable along the eastern shoreline to Longtail Point on the west shore of the lower bay and down the Fox River to the De Pere Dam (Figure 1.1). The Wisconsin Department of Natural Resources (WDNR) coordinates and tracks improvements made in the LGBFR AOC and works with the U.S. Environmental Protection Agency (USEPA) to determine when or if a BUI can be removed from the list of 13 BUIs for this AOC.

In 2015-2017 in collaboration with the WDNR and others, University of Wisconsin-Green Bay researchers developed an assessment process for evaluating the condition or "health" of two LGBFR AOC BUIs, namely the "Loss of Fish and Wildlife Habitat" and "Degradation of Fish and Wildlife Populations" (Howe et al. 2018a). Their initial assessment included the area within 1 km landward of the ordinary high water mark of the LGBFR AOC boundary (Figure 1.1). During this 3-year investigation, they identified 18 priority habitats and 22 priority fish and wildlife population groups as key elements to the LGBFR AOC ecosystem. Using these priority habitats and populations, they developed simple assessment tools in MS Excel that calculate an overall condition score of each BUI that ranges from 0 (poor condition) to 10 (excellent condition), which are then used to evaluate progress made towards BUI removal targets.

In this document, we provide a detailed set of instructions for evaluating improvements made to the condition or "health" of each fish and wildlife BUI both before and after restoration and enhancement projects are completed. In Chapter 1, we describe how the Fish & Wildlife BUI Assessment Process works, which involves 3 steps: 1) completing a restoration or enhancement project, 2) conducting field monitoring of priority habitats and populations, and 3) assessing the conditions of priority habitats and populations and of each fish and wildlife BUI to evaluate the success of a project and progress towards BUI removal targets. Assessing the conditions of each fish and wildlife BUI is conducted using the Howe et al. (2018a) Fish & Wildlife Assessment Tools in MS Excel. Chapter 2 provides detailed instructions on how to use these tools through the use of screenshots and examples. Calculating a final condition score (that ranges from 0 [poor] to 10 [excellent]) for each fish and wildlife BUI requires the assessment of conditions of one or all of the 18 priority habitats and 22 priority populations (Chapter 3). Newly collected field data on these

habitats and populations, such as species occupancy or habitat acreage and quality, are then compiled into individual metrics, which are converted using a curve into a condition score that also ranges from 0 (poor) to 10 (excellent). We describe our assessment metrics and methods, conversion curves, and proposed field monitoring data in Chapter 3. Finally, in Chapter 4 we present a timeline and means in which BUI progress will be evaluated for the 18 priority habitats and 22 priority populations individually as well as the comprehensive BUI condition scores needed to evaluate progress toward removing these two fish and wildlife BUIs.

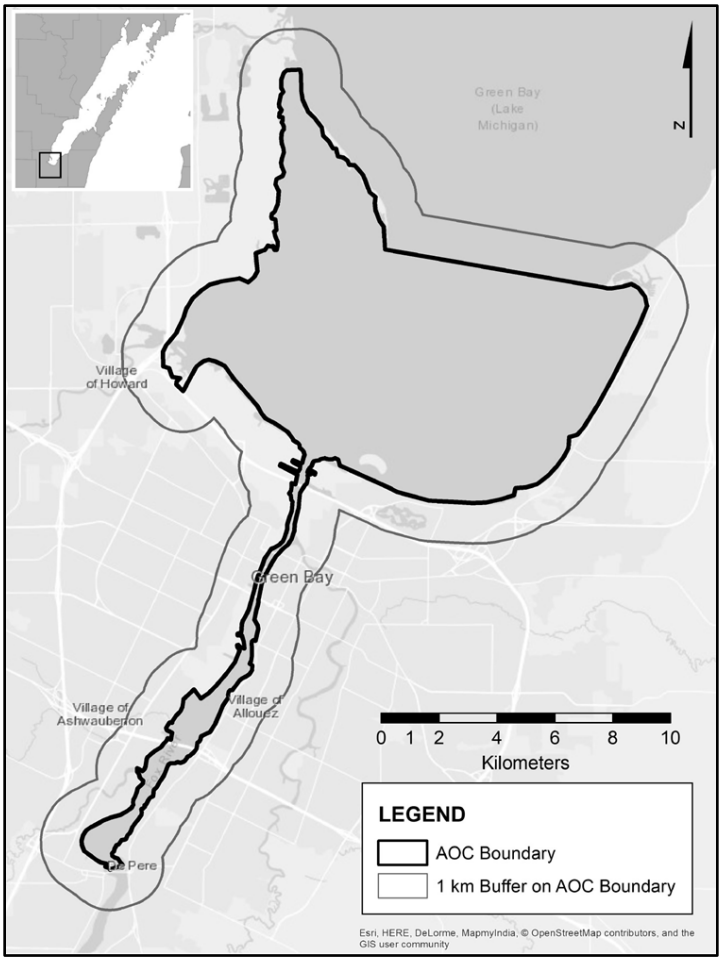


Figure 1.1. Map showing the Lower Green Bay and Fox River Area of Concern (AOC) boundary (thick black line), defined as the area within 1 km of shoreline at Lake Michigan/Green Bay high water level of 177.2 m AMSL, or roughly 1 km inland (thin black line).

Chapter 1: Fish & Wildlife Beneficial Use Impairment Assessment Process

Investigators from the University of Wisconsin-Green Bay developed a quantitative framework for the removal of the two fish and wildlife BUIs in the LGBFR AOC (Howe et al. 2018a,b). The recommended BUI removal strategy was based on a 3-year investigation (2015-2017) by UW-Green Bay staff and students and collaborators from The Nature Conservancy, with ongoing participation by local experts, WDNR and U.S. Environmental Protection Agency (USEPA) staff, and community stakeholders. The plan identifies and prioritizes 18 natural habitats

and 22 populations as core elements of the lower Green Bay ecosystem. BUI removal will be justified when restoration efforts significantly improve some combination of these priority habitats and populations, yielding weighted averages of condition that exceed the respective quantitative BUI removal targets (Howe et al. 2018a,b).

UW-Green Bay's recommended framework for the LGBFR AOC is consistent with AOC delisting principles outlined by the U.S. Remedial Action Plan (RAP) Workgroup convened by the USEPA's Great Lakes National Program Office (GLNPO) in 2001 (United States Policy Committee 2001). Specifically, the BUI removal targets have measurable indicators and are reasonable, locally derived, and supported by data and rationale.

The process for BUI removal involves three steps (Figure 1.2), implemented through an adaptive management framework of monitoring and ongoing re-assessment of LGBFR AOC priority habitats and populations. The top half of the assessment process diagram corresponds to the "Loss of Fish and Wildlife Habitat BUI," while the bottom half of the diagram corresponds to the "Degradation of Fish and Wildlife Populations BUI" (Figure 1.2).

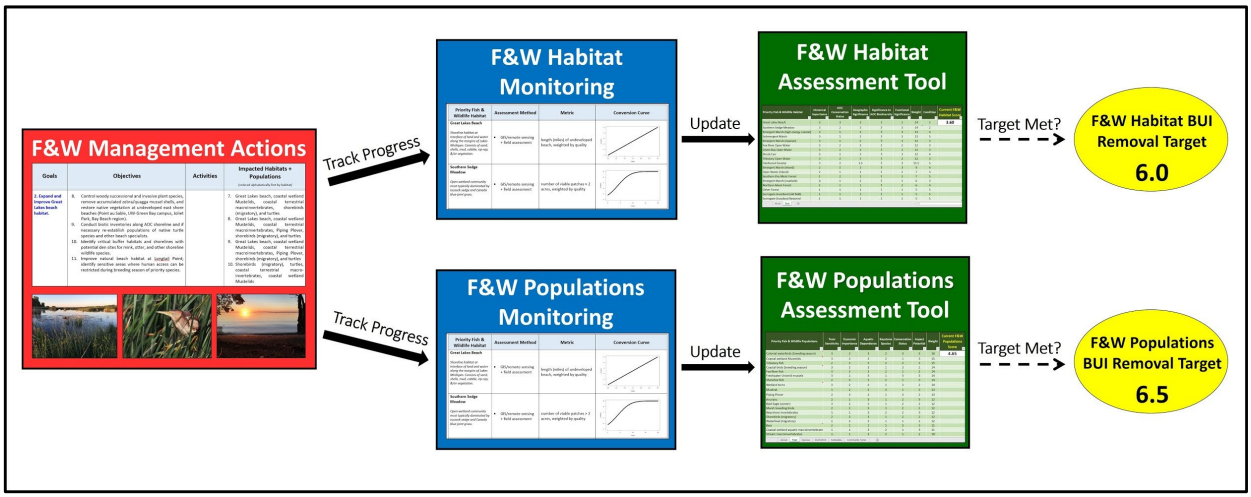


Figure 1.2. Assessment process diagram for the Lower Green Bay and Fox River Area of Concern Fish and Wildlife Beneficial Use Impairments (BUI): Loss of Fish and Wildlife Habitats (top half of diagram) and Degradation of Fish and Wildlife Populations (lower half of diagram). Diagram reads left to right starting with the implementation of management actions or projects (red box), and then continues onto tracking the progress of projects through field monitoring and application of metrics (blue boxes), updating the Fish and Wildlife Assessment Tools (green boxes), and determining whether each BUI removal targets have been met (yellow circles).

Figure 1.2 reads left to right:

- *Step 1 - Complete a Management Action(s) or Project(s) (red box in Figure 1.2)*:
    - The completion of a suite of management actions or projects (e.g., wetland restoration, habitat enhancements, installation of nesting platforms, invasive species control) will lead to the improvements of one or more of the 18 priority habitats or 22 priority populations. Each management action or project will be unique and may only affect a single habitat or population or some combination of habitats and populations.

- *Step 2 - Track the Progress of a Management Action(s) or Project(s) through Field Monitoring of Habitats and/or Populations (blue boxes in Figure 1.2)*:
    - Once a project or management action is completed, evaluating whether any improvements were made to one or more of the 18 priority habitats and 22 priority populations is critical. To determine if improvements were made, field monitoring data are collected after a project(s) is completed on all relevant, affected priority habitats and populations. Using simple conversion curves, these monitoring data are converted to standard (0-10) condition scores for each priority habitat and population where 0 is poor or degraded condition and 10 is excellent or near pristine condition. For each conversion curve, the x-axis is the collected field monitoring data (e.g., # of nesting pairs), and the y-axis is the converted condition score ranging from 0 to 10. More details on these curves in Chapter 3.
- *Step 3 - Update the Habitat and Populations Assessment Tools (green boxes in Figure 1.2)*:
    - Once projects are completed and priority habitats and populations are monitored and converted into corresponding condition scores, then one must update the overall condition scores for each of the BUIs. One simply enters the updated condition scores of the appropriate priority habitats and populations into each of the Fish and Wildlife Assessment Tools, which each calculate an overall weighted average of LGBFR AOC condition for each BUI. These quantitative assessment tools have been developed for each BUI to easily calculate this overall LGBFR AOC condition, which ranges from 0 (worst condition) to 10 (best possible condition). The 0-10 scale of the BUI conditions mirrors the 0-10 scale of each priority habitat and population.
    - Once the overall LGBFR AOC condition reaches or exceeds the removal target (6.0 [+/- 20%] for fish and wildlife habitats and 6.5 [+/- 20%] for fish and wildlife populations; see yellow circles in Figure 1.2) for an adequately sustained period (e.g., 3 years), then the BUI can be justifiably removed. Additional details on BUI removal targets are found in Chapter 4.

Coordination of management actions is key to the cost-effective application of this assessment framework. Many options are available for habitat and population improvement in the LGBFR AOC, but the outcomes of these measures are not equally effective. Some efforts will have significantly greater impacts than others depending on the habitats and populations affected since priority habitats and populations have different weightings. Each BUI can be re-evaluated anytime a management action or project is completed.

Chapter 2: How-To Guide on Using the Fish & Wildlife Assessment Tools

Purpose

The purpose of this chapter is to provide a simple yet detailed, step-by-step guide on how to use the Fish and Wildlife Assessment Tools using MS Excel that clearly explains Steps 2 and 3 described in Chapter 1 with visual aids. This chapter is written with the intent that anyone with a basic knowledge on this project and monitoring plan can update these assessment tools on

their own with little to no assistance. This chapter initially begins with background material on how each of the Fish and Wildlife Assessment Tools were originally developed.

Background on the Development of the Fish and Wildlife Habitat Assessment Tool

The Fish and Wildlife (F&W) Habitat Assessment Tool (Table 2.1) assesses the condition or "health" of the LGBFR AOC's F&W Habitat Beneficial Use Impairment (BUI), or a combination of current conditions of 18 priority habitats in the LGBFR AOC. These 18 priority habitats were initially chosen by Howe, Wolf, and Giese by including nearly all of those identified in the original Remedial Action Plan, identifying those they mapped during a habitat mapping effort in 2015, and subsequently having them reviewed by many experts and stakeholders, the Wisconsin Department of Natural Resources, and the U.S. Environmental Protection Agency in 2016-2019. Each of the 18 priority habitats are defined and described in great depth in Howe et al. (2018b) and in Table 2.2.

Table 2.1. Fish and Wildlife (F&W) Habitat Assessment Tool for the Lower Green Bay and Fox River Area of Concern (LGBFR AOC), which calculates a weighted average ranging from 0 (worst condition) to 10 (best condition) that describes the condition or health of the F&W Habitat Beneficial Use Impairment (BUI). The final condition value is based on the weighted average of conditions of 18 priority habitats found in the LGBFR AOC. Current condition of the F&W Habitat BUI is a 3.60. The tool is a separate downloadable document used in MS Excel. Note the small red triangles in the upper right-hand corner of some of the visible cells indicate comment bubbles that provide more information when using the MS Excel tool. The version of the tool displayed below is from 17 September 2019.

Priority Fish & Wildlife Habitat	Historical Importance	State Rank	Global Rank	AOC Conservation Status	Geographic Significance	Significance to AOC Biodiversity	Functional Significance	Weight	Condition	Subscore	Current F&W Habitat Score
Great Lakes Beach	3	S2	G3	3	3	3	2	14	2	28	3.60
Wet Meadow	3	S3	G4	2	3	3	3	14	2	28	
Emergent Marsh (high energy coastal)	3	S4	G4	1	3	3	3	13	4	52	
Submergent Marsh	3	S4	G5	1	3	3	3	13	5	65	
Emergent Marsh (riparian)	3	S4	G4	1	2	3	3	12	3	36	
Fox River Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Green Bay Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Shrub Carr	3	S4	G5	1	2	3	3	12	4	48	
Tributary Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Hardwood Swamp	3	S3	G4	2	1.5	2	3	11.5	5	57.5	
Emergent Marsh (inland)	2	S4	G4	1	1	2	3	9	4	36	
Open Water (inland)	2	N/A	N/A	1	1	1	2	7	3	21	
Southern Dry Mesic Forest	1	S3	G4	2	1	1	2	7	5	35	
Emergent Marsh (roadside)	0	N/A	N/A	1	2	2	1	6	3	18	
Northern Mesic Forest	1	S4	G4	1	1	1	2	6	4	24	
Other Forest	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland (old field)	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland Restored	1	N/A	N/A	1	1	1	1	5	5	25	

Table 2.2. Descriptions of the 18 priority habitats used in the Lower Green Bay and Fox River Area of Concern Habitat Assessment Tool sorted by weight (Table 2.1). Additional habitat descriptions included in Howe et al. (2018b).

Priority Habitat	Description
Great Lakes Beach	Shoreline habitat with sand, rock, vegetation, or shells as substrate at the interface of land and water along the margins of Lakes Michigan
Wet Meadow	Wet meadow habitat largely follows the WDNR Southern Sedge Meadow natural community description, described as open wetland in which various sedges (e.g., *Carex* spp.) and Canada bluejoint grass (*Calamagrostis canadensis*) dominate. However, this plant community definition has been expanded to additional characteristics observed in wet prairies, wet-mesic prairies, conservation meadows, etc. as an attempt to focus more on the functions provided by these transitional habitats (e.g., pollinator, nesting habitat, etc.)
Emergent Marsh (high energy coastal)	Open wetland positioned along the coast with standing water in some part of area that is dominated by emergent vegetation (e.g., cattail [*Typha* spp.], bulrush [*Schoenoplectus* spp], common reed [*Phragmites australis*], reed canary grass [*Phalaris arundinacea*]); affected by wave action, seiche, ice, etc.
Submergent Marsh	Herbaceous community of aquatic macrophytes in lakes, ponds, and rivers dominated by pondweeds (*Potamogeton* spp.), eel-grass (*Vallisneria americana*), water-milfoil (*Myriophyllum* spp.), etc.
Emergent Marsh (riparian)	Open wetland positioned along rivers, streams, and creeks that is dominated by emergent vegetation (e.g., cattail [*Typha* spp.], bulrush [*Schoenoplectus* spp], common reed [*Phragmites australis*], reed canary grass [*Phalaris arundinacea*])
Fox River Open Water	Open water of the Fox River (i.e., lower Fox River), which is a third order stream that flows northeast starting from Lake Winnebago and emptying into the bay of Green Bay
Green Bay Open Water	Open water/pelagic zone of the lower bay of Green Bay, which is the western arm of Lake Michigan
Shrub Carr	Transitional habitat between open wetlands and forested wetlands dominated by tall shrubs such as dogwoods (*Cornus* spp.), meadowsweet (*Spiraea alba*), and various willows (*Salix* spp.)
Tributary Open Water	Open water of tributaries whose boundaries fall within the 1 km of the LGBFR AOC boundary; nearly every river, stream, and creek found within these boundaries empty into the bay of Green Bay or the Fox River
Hardwood Swamp	Wet forest dominated by green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), cottonwood (*Populus deltoides*), swamp white oak (*Quercus bicolor*), and/or elm (*Ulmus* spp.)
Emergent Marsh (inland)	Open wetland on circumneutral to alkaline, mineral soils around the margins of inland ponds and lakes, and dominated by emergent vegetation (e.g., cattails [*Typha* spp.], bulrushes [*Schoenoplectus* spp.], common reed [*Phragmites australis*], reed canary grass [*Phalaris arundinacea*]), etc.
Open Water (inland)	Open water of inland bodies of water, including ponds, lakes, lagoons, and retention ponds

Southern Dry Mesic Forest	Upland forests characterized by an oak-dominated canopy of both red oak (*Quercus rubra*) and white oak (*Quercus alba*), though American basswood (*Tilia americana*), sugar maple (*Acer saccharum*), and shagbark hickory (*Carya ovata*) may also be present
Emergent Marsh (roadside)	Emergent marshes growing in wet roadside ditches that often hold standing water until mid-summer that include dominants, such as common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*), cattails (*Typha* spp.), etc.
Northern Mesic Forest	Mesic forests dominated by sugar maple (*Acer saccharum*), basswood (*Tilia americana*), green ash (*Fraxinus pennsylvanica*), and black walnut (*Juglans nigra*); younger secondary forests may also include eastern cottonwood (*Populus deltoides*) and trembling aspen (*Populus tremuloides*) as canopy dominants
Other Forest	Early successional forests typically dominated by trembling aspen (*Populus tremuloides*), green ash (*Fraxinus pennsylvanica*), and eastern cottonwood (*Populus deltoides*), with wetter sites sometimes including box elder (*Acer negundo*) and willow (*Salix* spp.); may also include pine plantations or other plantings
Surrogate Grassland (old field)	Open, non-forested habitats dominated by grasses, shrubs, and a few trees that also include hayfields, pastures, parks, and mowed fields
Surrogate Grassland Restored	Open grasslands that are restored to a native prairie or grassland habitat and dominated by species such as Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), and switch grass (*Panicum virgatum*)

In order to use this tool, one must assess the condition of one, several, or all priority habitats by conducting field monitoring (described in detail below and in Chapter 3). Howe et al. (2018a,b) established a weighting system in order to identify those priority habitats that are most critical to and would have the largest impact on the LGBFR AOC if that particular priority habitat was improved in terms of quality (e.g., restoration project). One can evaluate the overall condition of these 18 priority habitats in the LGBFR AOC by using this tool. With this weighting system and the newly assessed conditions of priority habitats, the tool then calculates a weighted average score ranging from 0 (maximally degraded) to 10 (minimally degraded) that describes the “health” or “ecological condition” of the priority habitats in the LGBFR AOC (i.e., the F&W Habitat BUI condition score). Improvements made to priority habitats with higher weights will have a greater effect on overall fish and wildlife habitat quality.

In order to develop this weighting system, they first distinguished each priority habitat using 5 criteria:

1. Historical Importance
    a. Purpose: To distinguish priority habitats that were historically significant
    b. Ranks: 0 = none (e.g., Emergent Marsh [roadside]), 1 = low, 2 = medium, and 3 = high (e.g., Great Lakes Beach)
2. AOC Conservation Status
    a. Purpose: To determine how rare or uncommon a priority habitat is

    b. Ranks: 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); habitats with no known status were assigned based on expert opinion
3. Geographic Significance
    a. Purpose: To distinguish where priority habitats are located within the LGBFR AOC, giving higher weight to areas located in the pelagic zone or along the shoreline since the official LGBFR AOC boundary traces the coastal zone of the Bay of Green Bay
    b. Ranks: 1 = low (inland areas), 1.5 = low-medium (lowland areas), 2 = medium (areas along tributaries), and 3 = high (pelagic zone, Fox River open water, islands, peninsulas, significant coastal presence)
4. Significance to AOC Biodiversity
    a. Purpose: To identify how important a priority habitat is to LGBFR AOC biodiversity
    b. Ranks: 1 = low (e.g., Surrogate Grasslands), 2 = medium, and 3 = high (e.g., Great Lakes Beach, marshes)
5. Functional Significance
    a. Purpose: To identify functional significance of a priority habitat in terms of ecological (e.g., flood abatement) and ecosystem services
    b. Ranks: 1 = low (e.g., Surrogate Grasslands), 2 = medium, and 3 = high (e.g., marshes)

Each of the ranks (0-3) of the above five criteria for each of the 18 priority habitats were summed, which produced a single number ranging from 5 to 14 called a weight. Priority habitats with high weights (e.g., 12-14) are significantly more important to the LGBFR AOC's fish and wildlife habitats in comparison to those with lower weights (e.g., 5-7). This tool calculates a weighted average using the weights assigned to each priority habitat (e.g., 5-14) and the recently assessed conditions of each priority habitat. Field data of each habitat are converted into a number ranging from 0 (poor quality) to 10 (good quality; these conversions are described in detail below and in Chapter 3). The final score (the weighted average) also ranges from 0 (maximally degraded) to 10 (minimally degraded) and describes the overall “health” or condition of all priority habitats, or the LGBFR AOC F&W Habitat BUI.

Note that a weighted average is similar to a mathematical average, except that instead of treating each of the values equally, it allows some values to contribute more or less to the overall average than other values. This assessment tool first takes the newly assessed condition value of each priority habitat (ranges from 0 to 10) and multiples it by the associated weight (5-14), producing a subscore for each priority habitat. The subscores are then summed and divided by the sum of the priority habitat weights. Management actions, projects, and activities conducted on these highly weighted habitats (especially those with low current condition) will have the greatest impact or effect on the overall F&W Habitat BUI condition score.

Background on the Development of the Fish and Wildlife Populations Assessment Tool

The Fish and Wildlife (F&W) Populations Assessment Tool (Table 2.3) assesses the condition or "health" of the LGBFR AOC’s F&W Populations Beneficial Use Impairment (BUI), or

a combination of current conditions of 22 priority populations in the LGBFR AOC. These 22 priority populations were initially chosen by Howe, Wolf, and Giese by including nearly all of those identified in the original Remedial Action Plan, identifying those they surveyed in 2015-2017, and subsequently having them reviewed by many experts and stakeholders, the Wisconsin Department of Natural Resources, and the U.S. Environmental Protection Agency in 2016-2019. Each of the 22 priority populations are defined and described in great depth in Howe et al. (2018b) and in Table 2.4.

Table 2.3. Fish and Wildlife (F&W) Populations Assessment Tool for the Lower Green Bay and Fox River Area of Concern (LGBFR AOC), which calculates a weighted average ranging from 0 (worst condition) to 10 (best condition) that describes the condition or health of the F&W Populations Beneficial Use Impairment (BUI). The final condition value is based on the weighted average of conditions of 22 priority populations found in the LGBFR AOC. Current condition of the F&W Populations BUI is a 4.85. The tool is a separate downloadable document used in MS Excel. Note the small red triangles in the upper right-hand corner of some of the visible cells indicate comment bubbles that provide more information when using the MS Excel tool. The version of the tool displayed below is from 31 October 2019.

Priority Fish & Wildlife Populations	Toxic Sensitivity	Economic Importance	Aquatic Dependence	Keystone Species	Conservation Status	Impact Potential	Weight	Current Condition	Subscore	Current F&W Populations Score
Colonial waterbirds (breeding season)	3	2	3	2	3	3	16	5	80	4.85
Coastal wetland Mustelids	3	3	3	2	1	3	15	6	90	
Tributary fish	2	3	3	2	2	3	15	5	75	
Coastal birds (breeding season)	3	2	3	1	3	2	14	6	84	
Fox River fish	3	3	3	2	1	2	14	5	70	
Freshwater Unionid mussels	3	1	3	1	3	3	14	1	14	
Shoreline fish	2	3	3	2	1	3	14	4	56	
Wetland terns	3	2	3	1	3	2	14	5	70	
Muskrat	1	2	3	3	1	3	13	6	78	
Shorebirds (breeding)	2	2	3	1	2	2	12	3.5	42	
Anurans	2	1	3	1	2	3	12	7	84	
Bald Eagle/Osprey (breeding)	3	2	3	2	2	2	14	5	70	
Marsh breeding birds	2	2	3	1	2	2	12	6	72	
Coastal terrestrial macroinvertebrates	1	1	3	2	2	3	12	3	36	
Shorebirds (migratory)	2	2	3	1	2	2	12	5	60	
Waterfowl (migratory)	2	3	3	1	1	2	12	6	72	
Bats	2	1	1	1	3	3	11	4	44	
Coastal wetland aquatic macroinvertebrates	1	1	3	2	1	3	11	3	33	
Stream macroinvertebrates	1	1	3	2	1	2	10	4	40	
Turtles	2	1	3	1	1	2	10	5	50	
Wooded wetland birds (breeding season)	1	2	2	1	1	2	9	6	54	
Landbirds (migratory)	1	2	1	1	1	2	8	7	56	

Table 2.4. Descriptions of the 22 priority populations used in the Lower Green Bay and Fox River Area of Concern Habitat Assessment Tool sorted by weight (Table 2.3). Additional population descriptions included in Howe et al. (2018b).

Priority Population	Description
Colonial Waterbirds (breeding season)	Colonially-breeding waterbirds: American White Pelican (*Pelecanus erythrorhynchos*), Double-crested Cormorant (*Phalacrocorax auritus*), Caspian Tern (*Hydroprogne caspia*), Common Tern (*Sterna hirundo*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Great Egret (*Ardea alba*), Herring Gull (*Larus argentatus*), and Ring-billed Gull (*Larus delawarensis*)
Coastal Wetland Mustelids	Semi-aquatic carnivores in the family Mustelidae: North American river otter (*Lontra canadensis*) and American mink (*Neovison vison*)
Tributary Fish	Fish species that utilize small tributaries or streams (up to the 1 km LGBFR AOC boundary) for residency, reproduction, or for nursery habitat, including but not limited to: suckers (*Catostomidae* spp.), minnows (*Cyprinidae* spp.), northern pike (*Esox lucia*), yellow perch (*Perca flavescens*), etc.
Coastal Birds (breeding season)	Coastal birds that use the nearshore environment for breeding or feeding, including aerial insectivores (e.g., swallows) and fish-eating birds (Belted Kingfisher [*Megaceryle alcyon*] and Green Heron [*Butorides virescens*]), but excludes a few bird species because they are covered in other bird population groups (e.g., Bald Eagle/Osprey [breeding], Shorebirds [breeding])
Fox River Fish	Fish species that use the Fox River north of the De Pere dam as residents, seasonal migrants, or for development during critical life stages, including but not limited to: sunfishes and basses (Centrarchidae), channel catfish (*Ictalurus punctatus*), lake whitefish (*Coregonus clupeaformis*), lake sturgeon (*Acipenser fulvescens*), walleye (*Sander vitreus*), etc.
Freshwater Unionid Mussels	Native Unionid mussels, including but not limited to giant floater (*Pyganodon grandis*), mapleleaf (*Quadrula quadrula*), spike (*Elliptio dilatata*), and others
Shoreline Fish	Fish species that inhabit shoreline areas and shallow open water, including but not limited to: smallmouth bass (*Micropterus dolomieu*), muskellunge (*Esox masquinongy*), yellow perch (*Perca flavescens*), walleye (*Sander vitreus*), etc.
Wetland Terns	Include Forster's Tern (*Sterna forsteri*) and Black Tern (*Chlidonias niger*), which breed in wetlands and forage nearby in wetlands and other nearshore habitats, especially emergent/submergent marshes and open water
Muskrat	Muskrat (*Ondatra zibethicus*), which is a key component to emergent wetland ecosystems since they serve as ecological engineers because of how much vegetation they consume
Shorebirds (breeding)	Breeding shorebirds, which include Killdeer (*Charadrius vociferus*), Spotted Sandpiper (*Actitis macularius*), and any other potential rare breeder (e.g., Piping Plover [*Charadrius melodus*], Wilson's Phalarope [*Phalaropus tricolor*])

Anurans	Include seven frog and one toad species: American toad (*Bufo americanus*), American bullfrog (*Lithobates catesbeianus*), green frog (*Lithobates clamitans*), gray treefrogs (*Hyla chrysoscelis* and *Hyla versicolor*), northern leopard frog (*Lithobates pipiens*), spring peeper (*Pseudacris crucifer*), and wood frog (*Lithobates sylvaticus*)
Bald Eagle/Osprey (breeding)	Breeding Bald Eagles (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*)
Marsh Breeding Birds	Breeding birds regularly found in emergent marshes, including individual bird species and bird groups (e.g., rails), but excluding Wetland Terns and other species (e.g., Osprey [*Pandion haliaetus*]), which are covered in other bird population groups
Coastal Terrestrial Macroinvertebrates	Terrestrial or semi-terrestrial macroinvertebrates that use habitats including Great Lakes beach, marsh/sedge meadows, wet forests, or upland areas (including pollinators)
Shorebirds (migratory)	Group consisting of approximately 25+ shorebirds (Order Charadriiformes) that regularly use shoreline, coastal, and wetland habitats in the LGBFR AOC as stopover habitat during spring or fall migration
Waterfowl (migratory)	Geese, swans, waterbirds (e.g., American Coot [*Fulica americana*]) and ducks, including diving ducks (e.g., scaup [*Aythya* spp.]) and sea ducks (e.g., Long-tailed Duck [*Clangula hyemalis*]) as well as dabbling ducks (e.g., Gadwall [*Anas strepera*], Mallard [*Anas platyrhynchos*]), that migrate during spring
Bats	Include breeding and migratory cave-roosting bats (big brown bat [*Eptesicus fuscus*], little brown bat [*Myotis lucifugus*], northern long-eared bat [*Myotis septentrionalis*], and tri-colored bat/eastern pipistrelle [*Perimyotis subflavus*]) and tree bats (silver-haired bat [*Lasionycteris noctivagans*], eastern red bat [*Lasiurus borealis*], and hoary bat [*Lasiurus cinereus*])
Coastal Wetland Aquatic Macroinvertebrates	Invertebrate communities of Great Lakes coastal wetlands, including open water zooplankton, bottom-dwelling zoobenthos, epiphytic invertebrates (attached to vegetation and other objects), and surface-dwelling neuston
Stream Macroinvertebrates	Invertebrates that use small tributaries that enter lower Green Bay and the Fox River within the LGBFR AOC boundary, including but not limited to Wequiock Creek, Mahon Creek, Ashwaubenon Creek, Dutchman Creek, and others
Turtles	Any turtle species, including common (eastern snapping [*Chelydra serpentina*] and painted turtle [*Chrysemys picta*]) or rare species (e.g., spiny softshell [*Apalone spinifera*], wood [*Glyptemys insculpta*], and Blanding's [*Emydoidea blandingii*] turtle)
Wooded Wetland Birds (breeding season)	Birds that breed in hardwood swamps, which include forest-dwelling woodpeckers, vireos, flycatchers, cuckoos, nuthatches, thrushes, warblers, and a few other species, as well as shrub carr-affiliated species
Landbirds (migratory)	Woodpeckers, cuckoos, nightjars, hummingbirds, and perching birds (Order Passeriformes) that use terrestrial habitats as migratory stopover habitat during spring or fall migration

In order to use this tool, one must assess the condition of one, several, or all priority populations by conducting field monitoring (described in detail below and in Chapter 3). Howe et al. (2018a,b) established a weighting system in order to identify those priority populations that are most critical to and would have the largest impact on the LGBFR AOC if that particular priority population was improved in terms of quality (e.g., enhancement project). One can evaluate the overall condition of these populations in the LGBFR AOC by using this tool. With this weighting system and the newly assessed conditions of priority populations, the tool then calculates a weighted average score ranging from 0 (maximally degraded) to 10 (minimally degraded) that describes the "health" or "ecological condition" of the priority populations in the LGBFR AOC (i.e., the F&W Populations BUI condition score). Improvements made to priority populations with higher weights will have a greater effect on overall fish and wildlife habitat quality.

In order to develop this weighting system, they first distinguished each priority population using 6 criteria:

1. Toxic Sensitivity
    a. Purpose: To identify species that are sensitive to toxins (e.g., PCBs, pollution)
    b. Ranks: 1 = low (e.g., Wooded Wetland Birds [breeding]), 2 = medium, and 3 = high (e.g., Colonial Waterbirds [breeding season])
2. Economic Importance
    a. Purpose: To identify species that hold economic importance (e.g., hunting, recreation)
    b. Ranks: 1 = low (e.g., Bats), 2 = medium, and 3 = high (e.g., Shoreline Fish)
3. Aquatic Dependence
    a. Purpose: To distinguish species that are dependent upon aquatic systems
    b. Ranks: 1 = low (e.g., Landbirds [migratory]), 2 = medium, and 3 = high (e.g., Stream Macroinvertebrates)
4. Keystone Species
    a. Purpose: To identify species that play an important role in an ecosystem; if that species is removed, the components that make up that ecosystem become drastically affected (e.g., numbers of individuals of another species may significantly increase or decrease)
    b. Ranks: 1 = low (e.g., Anurans), 2 = medium, and 3 = high (e.g., Muskrat)
5. Conservation Status
    a. Purpose: To determine how rare or uncommon a priority population is
    b. Ranks: 1 = no status, 2 = some status (e.g., Special Concern), and 3 = high status (e.g., Endangered)
6. Impact Potential
    a. Purpose: To differentiate species most positively impacted if restoration actions were conducted within the LGBFR AOC (i.e., migratory wildlife spend significant parts of their lives elsewhere and thus may be affected by factors outside the LGBFR AOC in comparison to residents)
    b. Ranks: 1 = low (e.g., Turtles), 2 = medium, and 3 = high (e.g., Freshwater Unionid Mussels)

Each of the ranks (1-3) of the above six criteria for each of the 22 priority populations were summed, which produced a single number ranging from 8 to 16 called a weight. Priority populations with high weights (e.g., 14-16) are significantly more important to the LGBFR AOC's fish and wildlife habitats in comparison to those with lower weights (e.g., 8-10). This tool calculates a weighted average using the weights assigned to each priority population (e.g., 8-16) and the recently assessed conditions of each priority population. Field data of each population are converted into a number ranging from 0 (poor quality) to 10 (good quality; these conversions are described in detail below and in Chapter 3). The final score (the weighted average) also ranges from 0 (maximally degraded) to 10 (minimally degraded) and describes the overall "health" or condition of all priority populations, or the LGBFR AOC F&W Populations BUI.

Like the LGBFR AOC F&W Habitats BUI calculation, a weighted average is similar to a mathematical average, except that instead of treating each of the values equally, it allows some values to contribute more or less to the overall average than other values. This assessment tool first takes the newly assessed condition value of each priority population (ranges from 0 to 10) and multiples it by the associated weight (8-16), producing a subscore for each priority population. The subscores are then summed and divided by the sum of the priority population weights. Management actions, projects, and activities conducted on these highly weighted populations (especially those with low current condition) will have the greatest impact or effect on the overall F&W Populations BUI condition score.

Steps on How to Use the Fish and Wildlife Assessment Tools

Once a management action or project is completed at a specific site or across multiple sites within the LGBFR AOC, evaluating the effect that improvement(s) had on one or multiple priority habitats and populations will be of great interest to see how much progress has been made towards reaching each BUI removal target (6.0 for habitats, 6.5 for populations). Some projects will have more of an impact than others depending on the restoration or enhancement activity and the impacted habitats or populations since their weightings vary. These assessment tools can be updated any time an improvement was made, no matter how large or small and no matter how many habitats or populations were affected. The final BUI condition scores can also increase or decrease depending on the effect a project had on a particular habitat or population. Condition scores of priority habitats and populations may also go up or down.

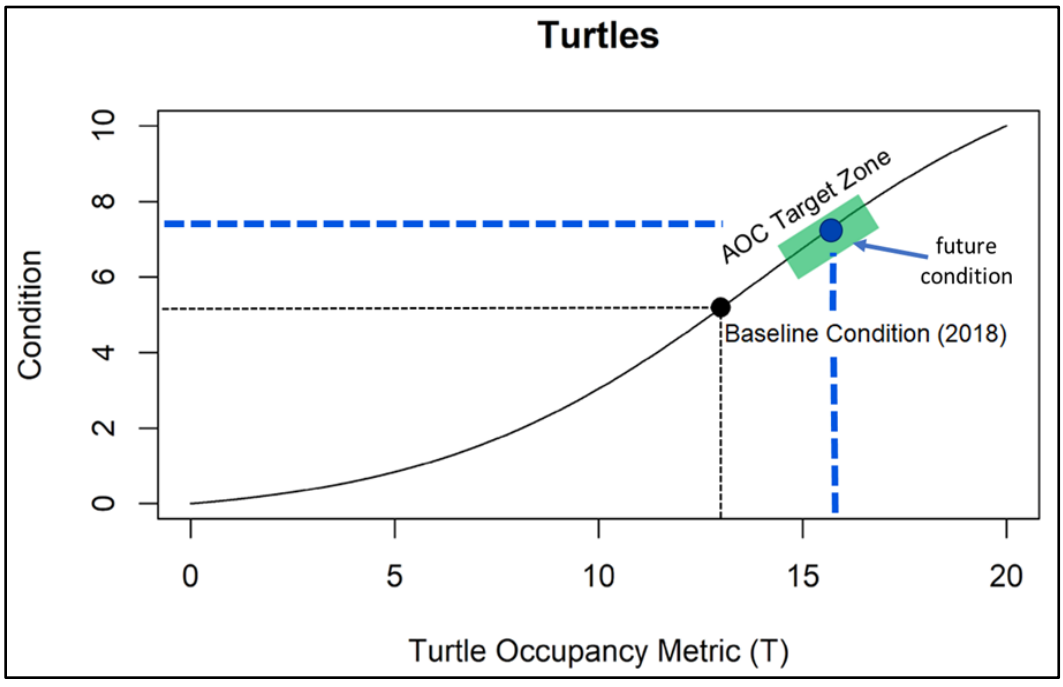
<u>Steps for Using the MS Excel Fish & Wildlife Habitat and Populations Assessment Tools</u>

1. Note which habitat(s) and population(s) were affected by your management action, project, or activity, which should be clearly stated in a project proposal.
    a. Each tool must be updated separately, though most restoration and enhancement projects will likely affect multiple habitats and populations.

2. Assess the quality or condition of one or multiple priority habitats and populations by collecting standardized field monitoring data (as shown in blue box in Figure 1.2 of Chapter 1; see full list of metrics in Chapter 3).
    a. Example: If invasive plant species were removed from the shoreline, marsh, and Great Lakes beach areas, then habitat for Turtles should improve. In order to determine if

the condition of the Turtles population group actually does improve, one must conduct field surveys at multiple sites across the LGBFR AOC. An expert field observer would document the presence of eastern snapping turtle, painted turtle, and rare turtles (Blanding's, wood, or spiny softshell) at 6 predetermined sites located in the LGBFR AOC. See Step 3 below for a continuation of this example.

3. Using habitat and population conversion curves (as shown in blue box in Figure 1.2 of Chapter 1; see full list of metrics in Chapter 3), convert the raw field data into condition scores ranging from 0 to 10 for each impacted habitat(s) and population(s).
    a. Example: Turtle example from Step 2 continued. These collected turtle field data would be converted into a Turtle Occupancy Index (T) where one sums the total number of sites that snapping turtles (*Chelydra serpentina*), painted turtles (*Chrysemys picta*), and any rare turtle species are each documented at a maximum of 6 sites per species within the LGBFR AOC (see Chapter 3). For example, if an observer detected the two common turtle species (eastern snapping and painted) at 6 of the 6 sites and one rarer species (say spiny softshell) at 4 of the 6 sites, then T = 6 + 6 + 4 = 16. One uses the conversion curve below to find T = 16 along the x-axis and then convert the index to a condition score (C) ranging from 0 to 10, which in this example would be C = 7.5 (i.e., trace along the dotted lines until you reach the solid curve line, which convert the field data on the x-axis [Turtle Index] to the Condition value on the y-axis). In this example, Turtles would have improved from a condition of 5 in 2018 to a condition of 7.5 after this project was completed, making it successful for turtles. Note that in this example, one would also want to collect field data on shoreline habitats and convert those data into condition scores as well. The AOC Target Zone (depicted by a green box) is an expected range of conditions that a population or habitat may be improved after enhancement or restoration projects are implemented (see Chapter 3 for more details).



4. Before updating any information in the MS Excel tools, note and record the current F&W Habitat and Population BUI scores in order to see how the current project or management action changes the final BUI scores. See cells outlined in blue below.

Priority Fish & Wildlife Habitat	Historical Importance	State Rank	Global Rank	AOC Conservation Status	Geographic Significance	Significance to AOC Biodiversity	Functional Significance	Weight	Condition	Subscore	Current F&W Habitat Score
Great Lakes Beach	3	S2	G3	3	3	3	2	14	2	28	3.60
Wet Meadow	3	S3	G4	2	3	3	3	14	2	28	
Emergent Marsh (high energy coastal)	3	S4	G4	1	3	3	3	13	4	52	
Submergent Marsh	3	S4	G5	1	3	3	3	13	5	65	
Emergent Marsh (riparian)	3	S4	G4	1	2	3	3	12	3	36	
Fox River Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Green Bay Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Shrub Carr	3	S4	G5	1	2	3	3	12	4	48	
Tributary Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Hardwood Swamp	3	S3	G4	2	1.5	2	3	11.5	5	57.5	
Emergent Marsh (inland)	2	S4	G4	1	1	2	3	9	4	36	
Open Water (inland)	2	N/A	N/A	1	1	1	2	7	3	21	
Southern Dry Mesic Forest	1	S3	G4	2	1	1	2	7	5	35	
Emergent Marsh (roadside)	0	N/A	N/A	1	2	2	1	6	3	18	
Northern Mesic Forest	1	S4	G4	1	1	1	2	6	4	24	
Other Forest	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland (old field)	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland Restored	1	N/A	N/A	1	1	1	1	5	5	25	

Priority Fish & Wildlife Populations	Toxic Sensitivity	Economic Importance	Aquatic Dependence	Keystone Species	Conservation Status	Impact Potential	Weight	Current Condition	Subscore	Current F&W Populations Score
Colonial waterbirds (breeding season)	3	2	3	2	3	3	16	5	80	4.85
Coastal wetland Mustelids	3	3	3	2	1	3	15	6	90	
Tributary fish	2	3	3	2	2	3	15	5	75	
Coastal birds (breeding season)	3	2	3	1	3	2	14	6	84	
Fox River fish	3	3	3	2	1	2	14	5	70	
Freshwater Unionid mussels	3	1	3	1	3	3	14	1	14	
Shoreline fish	2	3	3	2	1	3	14	4	56	
Wetland terns	3	2	3	1	3	2	14	5	70	
Muskrat	1	2	3	3	1	3	13	6	78	
Shorebirds (breeding)	2	2	3	1	2	2	12	3.5	42	
Anurans	2	1	3	1	2	3	12	7	84	
Bald Eagle/Osprey (breeding)	3	2	3	2	2	2	14	5	70	
Marsh breeding birds	2	2	3	1	2	2	12	6	72	
Coastal terrestrial macroinvertebrates	1	1	3	2	2	3	12	3	36	
Shorebirds (migratory)	2	2	3	1	2	2	12	5	60	
Waterfowl (migratory)	2	3	3	1	1	2	12	6	72	
Bats	2	1	1	1	3	3	11	4	44	
Coastal wetland aquatic macroinvertebrates	1	1	3	2	1	3	11	3	33	
Stream macroinvertebrates	1	1	3	2	1	2	10	4	40	
Turtles	2	1	3	1	1	2	10	5	50	
Wooded wetland birds (breeding season)	1	2	2	1	1	2	9	6	54	
Landbirds (migratory)	1	2	1	1	1	2	8	7	56	

5. Enter the updated condition scores for each affected priority habitat into the F&W Habitat Assessment Tool using MS Excel. Use the column entitled “Condition” that is highlighted in dark green and emphasized in a thick blue outline (see below).

Priority Fish & Wildlife Habitat	Historical Importance	State Rank	Global Rank	AOC Conservation Status	Geographic Significance	Significance to AOC Biodiversity	Functional Significance	Weight	Condition	Subscore	Current F&W Habitat Score
Great Lakes Beach	3	S2	G3	3	3	3	2	14	2	28	3.60
Wet Meadow	3	S3	G4	2	3	3	3	14	2	28	
Emergent Marsh (high energy coastal)	3	S4	G4	1	3	3	3	13	4	52	
Submergent Marsh	3	S4	G5	1	3	3	3	13	5	65	
Emergent Marsh (riparian)	3	S4	G4	1	2	3	3	12	3	36	
Fox River Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Green Bay Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Shrub Carr	3	S4	G5	1	2	3	3	12	4	48	
Tributary Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Hardwood Swamp	3	S3	G4	2	1.5	2	3	11.5	5	57.5	
Emergent Marsh (inland)	2	S4	G4	1	1	2	3	9	4	36	
Open Water (inland)	2	N/A	N/A	1	1	1	2	7	3	21	
Southern Dry Mesic Forest	1	S3	G4	2	1	1	2	7	5	35	
Emergent Marsh (roadside)	0	N/A	N/A	1	2	2	1	6	3	18	
Northern Mesic Forest	1	S4	G4	1	1	1	2	6	4	24	
Other Forest	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland (old field)	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland Restored	1	N/A	N/A	1	1	1	1	5	5	25	

6. Enter the updated condition scores for each affected priority population into the F&W Populations Assessment Tool using MS Excel. Use the column entitled “Condition” that is highlighted in dark green and emphasized in a thick blue outline (see below).

Priority Fish & Wildlife Populations	Toxic Sensitivity	Economic Importance	Aquatic Dependence	Keystone Species	Conservation Status	Impact Potential	Weight	Current Condition	Subscore	Current F&W Populations Score
Colonial waterbirds (breeding season)	3	2	3	2	3	3	16	5	80	4.85
Coastal wetland Mustelids	3	3	3	2	1	3	15	6	90	
Tributary fish	2	3	3	2	2	3	15	5	75	
Coastal birds (breeding season)	3	2	3	1	3	2	14	6	84	
Fox River fish	3	3	3	2	1	2	14	5	70	
Freshwater Unionid mussels	3	1	3	1	3	3	14	1	14	
Shoreline fish	2	3	3	2	1	3	14	4	56	
Wetland terns	3	2	3	1	3	2	14	5	70	
Muskrat	1	2	3	3	1	3	13	6	78	
Shorebirds (breeding)	2	2	3	1	2	2	12	3.5	42	
Anurans	2	1	3	1	2	3	12	7	84	
Bald Eagle/Osprey (breeding)	3	2	3	2	2	2	14	5	70	
Marsh breeding birds	2	2	3	1	2	2	12	6	72	
Coastal terrestrial macroinvertebrates	1	1	3	2	2	3	12	3	36	
Shorebirds (migratory)	2	2	3	1	2	2	12	5	60	
Waterfowl (migratory)	2	3	3	1	1	2	12	6	72	
Bats	2	1	1	1	3	3	11	4	44	
Coastal wetland aquatic macroinvertebrates	1	1	3	2	1	3	11	3	33	
Stream macroinvertebrates	1	1	3	2	1	2	10	4	40	
Turtles	2	1	3	1	1	2	10	5	50	
Wooded wetland birds (breeding season)	1	2	2	1	1	2	9	6	54	
Landbirds (migratory)	1	2	1	1	1	2	8	7	56	

7. Once you finish entering the condition scores in both the F&W Habitat and Populations Assessment Tools, the final F&W Habitat and Population BUI scores will update automatically. Record the final scores to document changes to the BUI scores (see screenshots from Step 4 above).

8. Compare these newly calculated F&W Habitat and Populations Scores with previous calculations (see Step 4 above) and the BUI removal targets (6.0 for the Habitat BUI; 6.5 for the Populations BUI).

Application of the Fish and Wildlife Assessment Tools Using a Hypothetical Example

Purpose

To better understand the eight steps outlined above, the purpose of this section is to step through a hypothetical example of an enhancement project in hardwood swamp habitats. This sample project will explain the steps to take once a project or activity is completed by conducting field monitoring on affected habitats and populations, converting the field data into condition scores ranging from 0 to 10, updating the F&W Assessment Tools, and comparing the final Habitat and Populations BUI scores against the BUI removal targets.

Hypothetical Management Action

In this hypothetical example, let's assume that the Wisconsin Department of Natural Resources, Brown County, City of Green Bay, and University of Wisconsin-Green Bay decided to collaborate on a project whose goals are to:

- Treat and remove invasive woody understory plants (e.g., buckthorn, honeysuckle) in hardwood swamps throughout publicly-owned properties within the LGBFR AOC and replace with native woody understory plants (e.g., cherry, dogwood, wild grape [*Vitis riparia*]) through plantings.
- Improve (or create if needed) multi-layer habitat structure (e.g., canopy, sub-canopy, ground) in the forest.
- Maintain den/roost trees in hardwood swamps for birds.
- Construct and post outreach and education signage about Migratory Landbird Designated Habitat Areas (DHAs; see Chapter 3 for more details on DHAs) at strategic and visible locations to the public to sites that do not already have them.

After project completion and a maintenance period has passed, one would next monitor and assess the condition of the affected habitats and populations that should have improved from this project and see how much the F&W Habitat and Populations BUIs improved in terms of overall condition by applying the MS Excel F&W Assessment Tools. Note, however, that baseline conditions of priority habitats and populations were largely based on expert opinion prior to these metrics being finalized.

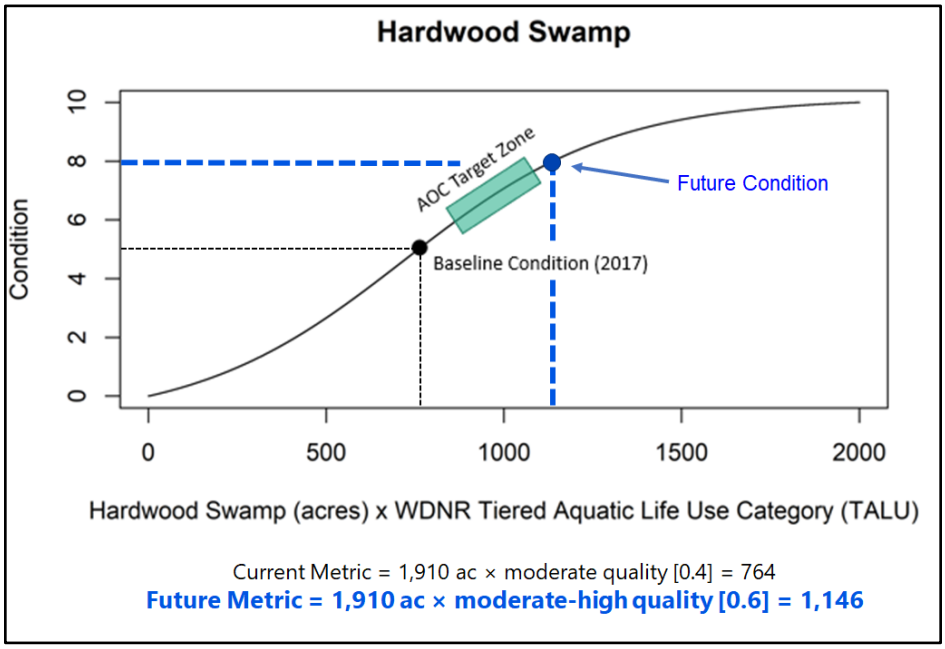
Steps for Using the MS Excel Fish & Wildlife Assessment Tools Using this Example

1. *Note which habitat(s) and population(s) were affected by your management action, project, or activity, which should be clearly stated in a project proposal.*
    a. In this example, the following habitats and populations would likely be improved by this project:
        i. Hardwood Swamp
        ii. Wooded Wetland Birds (breeding)
        iii. Landbirds (migratory)

2. *Assess the quality or condition of one or multiple priority habitats and populations by collecting standardized field monitoring data (as shown in blue box in Figure 1.2 of Chapter 1; see full list of metrics and field monitoring methods found in Chapter 3).*
    a. Hardwood Swamp
        i. Conduct a field assessment of habitat quality of hardwood swamps across the treated areas using the WDNR Tiered Aquatic Life Use Categories.
    b. Wooded Wetland Birds (breeding)
        i. Conduct 10-minute, unlimited-distance breeding bird point counts at multiple locations across hardwood swamps of publicly-owned lands in the LGBFR AOC. Enter these point count data into the Wooded Wetland Birds (breeding) Index of Ecological Condition (IEC) calculator to obtain a condition score ranging from 0 (worst condition) to 10 (best condition).
    c. Landbirds (migratory)
        i. Evaluate and count the number of Migratory Landbird DHAs.

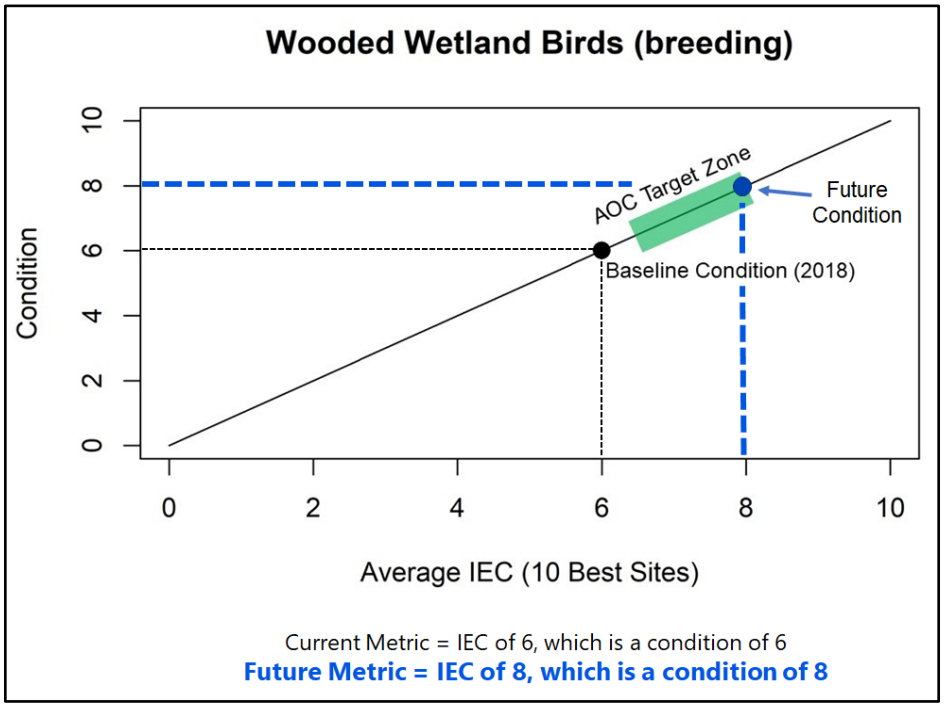
3. *Using habitat and population conversion curves (as shown in blue box in Figure 1.2 of Chapter 1; see full list of metrics in Chapter 3), convert the raw field data into condition scores ranging from 0 to 10 for each impacted habitat(s) and population(s).*
    a. Hardwood Swamp:

        Prior to this enhancement project, Hardwood Swamps had a condition of 5, which was based on expert opinion (estimated moderate quality of 0.4 on a basic 0 = bad to 1 = good scale [1,910 ac × 0.4 = 764]). Because of the invasive species management work, however, Hardwood Swamps improved to a condition of 8.0 (1,910 ac × 0.6 quality = 1,146), where forests were assessed at a Tier 2 "Good" Tiered Aquatic Life Use Category of 6 that was multiplied by 0.1 (= quality multiplier of 0.6), which lines up with a condition of about 8.0 along the conversion curve.



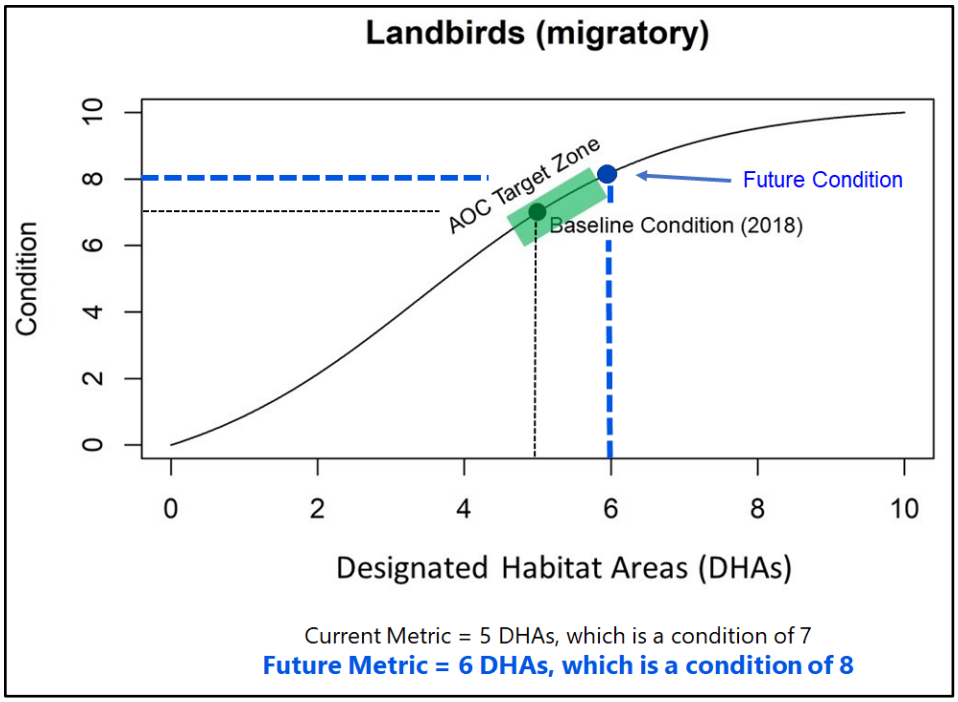
b. Wooded Wetland Birds (breeding)

Prior to this enhancement project, Wooded Wetland Birds (breeding) had a condition of 6, determined through expert opinion. Because of the invasive species management work, however, hardwood swamps improved and provided better habitat for these nesting birds. Thus, this bird group's IEC increased to an 8, which converts to a condition of 8.0 since the conversion curve is a 1:1 relationship), which also falls within the AOC Target Zone (see Chapter 3).



c. Landbirds (migratory)

Prior to this enhancement project, Landbirds (migratory) had a condition of 7, determined through expert opinion (because there were 5 existing DHAs in the LGBFR AOC, which gets converted into a condition score of 7.0 once you trace the dotted line to the conversion curve). Because of the invasive species management work, however, hardwood swamps improved and provided better migratory habitat and food for these migrating birds and 1 more DHA was designated. Thus, this bird group's number of DHAs increased by 1 to a total of 6 DHAs, which converts to a condition of 8.0).



4. *Before updating any information in the MS Excel tools, note and record the current F&W Habitat and Population BUI scores in order to see how the current project or management action changes the final BUI scores.*
    a. Note the current F&W Habitat BUI score is 3.60, and the current F&W Populations BUI score is 4.75 out of 10 (see blue box outlines below). Note current condition scores of the impacted habitats and populations are as follows: Hardwood Swamp = 5, Wooded Wetland Birds (breeding) = 6, and Landbirds (migratory) = 7.

Priority Fish & Wildlife Habitat	Historical Importance	State Rank	Global Rank	AOC Conservation Status	Geographic Significance	Significance to AOC Biodiversity	Functional Significance	Weight	Condition	Subscore	Current F&W Habitat Score
Great Lakes Beach	3	S2	G3	3	3	3	2	14	2	28	3.60
Wet Meadow	3	S3	G4	2	3	3	3	14	2	28	
Emergent Marsh (high energy coastal)	3	S4	G4	1	3	3	3	13	4	52	
Submergent Marsh	3	S4	G5	1	3	3	3	13	5	65	
Emergent Marsh (riparian)	3	S4	G4	1	2	3	3	12	3	36	
Fox River Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Green Bay Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Shrub Carr	3	S4	G5	1	2	3	3	12	4	48	
Tributary Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Hardwood Swamp	3	S3	G4	2	1.5	2	3	11.5	5	57.5	
Emergent Marsh (inland)	2	S4	G4	1	1	2	3	9	4	36	
Open Water (inland)	2	N/A	N/A	1	1	1	2	7	3	21	
Southern Dry Mesic Forest	1	S3	G4	2	1	1	2	7	5	35	
Emergent Marsh (roadside)	0	N/A	N/A	1	2	2	1	6	3	18	
Northern Mesic Forest	1	S4	G4	1	1	1	2	6	4	24	
Other Forest	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland (old field)	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland Restored	1	N/A	N/A	1	1	1	1	5	5	25	

Priority Fish & Wildlife Populations	Toxic Sensitivity	Economic Importance	Aquatic Dependence	Keystone Species	Conservation Status	Impact Potential	Weight	Current Condition	Subscore	Current F&W Populations Score
Colonial waterbirds (breeding season)	3	2	3	2	3	3	16	5	80	4.85
Coastal wetland Mustelids	3	3	3	2	1	3	15	6	90	
Tributary fish	2	3	3	2	2	3	15	5	75	
Coastal birds (breeding season)	3	2	3	1	3	2	14	6	84	
Fox River fish	3	3	3	2	1	2	14	5	70	
Freshwater Unionid mussels	3	1	3	1	3	3	14	1	14	
Shoreline fish	2	3	3	2	1	3	14	4	56	
Wetland terns	3	2	3	1	3	2	14	5	70	
Muskrat	1	2	3	3	1	3	13	6	78	
Shorebirds (breeding)	2	2	3	1	2	2	12	3.5	42	
Anurans	2	1	3	1	2	3	12	7	84	
Bald Eagle/Osprey (breeding)	3	2	3	2	2	2	14	5	70	
Marsh breeding birds	2	2	3	1	2	2	12	6	72	
Coastal terrestrial macroinvertebrates	1	1	3	2	2	3	12	3	36	
Shorebirds (migratory)	2	2	3	1	2	2	12	5	60	
Waterfowl (migratory)	2	3	3	1	1	2	12	6	72	
Bats	2	1	1	1	3	3	11	4	44	
Coastal wetland aquatic macroinvertebrates	1	1	3	2	1	3	11	3	33	
Stream macroinvertebrates	1	1	3	2	1	2	10	4	40	
Turtles	2	1	3	1	1	2	10	5	50	
Wooded wetland birds (breeding season)	1	2	2	1	1	2	9	6	54	
Landbirds (migratory)	1	2	1	1	1	2	8	7	56	

5. *Enter the updated condition scores for each affected priority habitat into the F&W Habitat Assessment Tool using MS Excel. Use the column entitled "Condition" that is highlighted in dark green and emphasized in a thick yellow outline (see below).*
    a. Note newly updated condition score of Hardwood Swamp = 8.

Priority Fish & Wildlife Habitat	Historical Importance	State Rank	Global Rank	AOC Conservation Status	Geographic Significance	Significance to AOC Biodiversity	Functional Significance	Weight	Condition	Subscore	Current F&W Habitat Score
Great Lakes Beach	3	S2	G3	3	3	3	2	14	2	28	3.79
Wet Meadow	3	S3	G4	2	3	3	3	14	2	28	
Emergent Marsh (high energy coastal)	3	S4	G4	1	3	3	3	13	4	52	
Submergent Marsh	3	S4	G5	1	3	3	3	13	5	65	
Emergent Marsh (riparian)	3	S4	G4	1	2	3	3	12	3	36	
Fox River Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Green Bay Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Shrub Carr	3	S4	G5	1	2	3	3	12	4	48	
Tributary Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Hardwood Swamp	3	S3	G4	2	1.5	2	3	11.5	8	92	
Emergent Marsh (inland)	2	S4	G4	1	1	2	3	9	4	36	
Open Water (inland)	2	N/A	N/A	1	1	1	2	7	3	21	
Southern Dry Mesic Forest	1	S3	G4	2	1	1	2	7	5	35	
Emergent Marsh (roadside)	0	N/A	N/A	1	2	2	1	6	3	18	
Northern Mesic Forest	1	S4	G4	1	1	1	2	6	4	24	
Other Forest	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland (old field)	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland Restored	1	N/A	N/A	1	1	1	1	5	5	25	

6. *Enter the updated condition scores for each affected priority population into the F&W Populations Assessment Tool using MS Excel. Use the column entitled "Condition" that is highlighted in dark green and emphasized in a thick yellow outline (see below).*
    a. Note newly updated condition scores of Landbirds (migratory) = 8 and Wooded Wetland Birds (breeding season) = 8.

Priority Fish & Wildlife Populations	Toxic Sensitivity	Economic Importance	Aquatic Dependence	Keystone Species	Conservation Status	Impact Potential	Weight	Current Condition	Subscore	Current F&W Populations Score
Colonial waterbirds (breeding season)	3	2	3	2	3	3	16	5	80	4.95
Coastal wetland Mustelids	3	3	3	2	1	3	15	6	90	
Tributary fish	2	3	3	2	2	3	15	5	75	
Coastal birds (breeding season)	3	2	3	1	3	2	14	6	84	
Fox River fish	3	3	3	2	1	2	14	5	70	
Freshwater Unionid mussels	3	1	3	1	3	3	14	1	14	
Shoreline fish	2	3	3	2	1	3	14	4	56	
Wetland terns	3	2	3	1	3	2	14	5	70	
Muskrat	1	2	3	3	1	3	13	6	78	
Shorebirds (breeding)	2	2	3	1	2	2	12	3.5	42	
Anurans	2	1	3	1	2	3	12	7	84	
Bald Eagle/Osprey (breeding)	3	2	3	2	2	2	14	5	70	
Marsh breeding birds	2	2	3	1	2	2	12	6	72	
Coastal terrestrial macroinvertebrates	1	1	3	2	2	3	12	3	36	
Shorebirds (migratory)	2	2	3	1	2	2	12	5	60	
Waterfowl (migratory)	2	3	3	1	1	2	12	6	72	
Bats	2	1	1	1	3	3	11	4	44	
Coastal wetland aquatic macroinvertebrates	1	1	3	2	1	3	11	3	33	
Stream macroinvertebrates	1	1	3	2	1	2	10	4	40	
Turtles	2	1	3	1	1	2	10	5	50	
Wooded wetland birds (breeding season)	1	2	2	1	1	2	9	8	72	
Landbirds (migratory)	1	2	1	1	1	2	8	8	64	

7. *Once you finish entering the condition scores in both the F&W Habitat and Populations Assessment Tools, the final F&W Habitat and Population BUI scores will update automatically. Record the final scores to document changes to the BUI scores.*
    a. New scores outlined in blue below.

Priority Fish & Wildlife Habitat	Historical Importance	State Rank	Global Rank	AOC Conservation Status	Geographic Significance	Significance to AOC Biodiversity	Functional Significance	Weight	Condition	Subscore	Current F&W Habitat Score
Great Lakes Beach	3	S2	G3	3	3	3	2	14	2	28	3.79
Wet Meadow	3	S3	G4	2	3	3	3	14	2	28	
Emergent Marsh (high energy coastal)	3	S4	G4	1	3	3	3	13	4	52	
Submergent Marsh	3	S4	G5	1	3	3	3	13	5	65	
Emergent Marsh (riparian)	3	S4	G4	1	2	3	3	12	3	36	
Fox River Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Green Bay Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Shrub Carr	3	S4	G5	1	2	3	3	12	4	48	
Tributary Open Water	3	N/A	N/A	2	3	2	2	12	3	36	
Hardwood Swamp	3	S3	G4	2	1.5	2	3	11.5	8	92	
Emergent Marsh (inland)	2	S4	G4	1	1	2	3	9	4	36	
Open Water (inland)	2	N/A	N/A	1	1	1	2	7	3	21	
Southern Dry Mesic Forest	1	S3	G4	2	1	1	2	7	5	35	
Emergent Marsh (roadside)	0	N/A	N/A	1	2	2	1	6	3	18	
Northern Mesic Forest	1	S4	G4	1	1	1	2	6	4	24	
Other Forest	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland (old field)	1	N/A	N/A	1	1	1	1	5	5	25	
Surrogate Grassland Restored	1	N/A	N/A	1	1	1	1	5	5	25	

Priority Fish & Wildlife Populations	Toxic Sensitivity	Economic Importance	Aquatic Dependence	Keystone Species	Conservation Status	Impact Potential	Weight	Current Condition	Subscore	Current F&W Populations Score
Colonial waterbirds (breeding season)	3	2	3	2	3	3	16	5	80	4.95
Coastal wetland Mustelids	3	3	3	2	1	3	15	6	90	
Tributary fish	2	3	3	2	2	3	15	5	75	
Coastal birds (breeding season)	3	2	3	1	3	2	14	6	84	
Fox River fish	3	3	3	2	1	2	14	5	70	
Freshwater Unionid mussels	3	1	3	1	3	3	14	1	14	
Shoreline fish	2	3	3	2	1	3	14	4	56	
Wetland terns	3	2	3	1	3	2	14	5	70	
Muskrat	1	2	3	3	1	3	13	6	78	
Shorebirds (breeding)	2	2	3	1	2	2	12	3.5	42	
Anurans	2	1	3	1	2	3	12	7	84	
Bald Eagle/Osprey (breeding)	3	2	3	2	2	2	14	5	70	
Marsh breeding birds	2	2	3	1	2	2	12	6	72	
Coastal terrestrial macroinvertebrates	1	1	3	2	2	3	12	3	36	
Shorebirds (migratory)	2	2	3	1	2	2	12	5	60	
Waterfowl (migratory)	2	3	3	1	1	2	12	6	72	
Bats	2	1	1	1	3	3	11	4	44	
Coastal wetland aquatic macroinvertebrates	1	1	3	2	1	3	11	3	33	
Stream macroinvertebrates	1	1	3	2	1	2	10	4	40	
Turtles	2	1	3	1	1	2	10	5	50	
Wooded wetland birds (breeding season)	1	2	2	1	1	2	9	8	72	
Landbirds (migratory)	1	2	1	1	1	2	8	8	64	

8. *Compare these newly calculated F&W Habitat and Populations Scores with previous calculations (see Step 4 above) and the BUI removal targets (6.0 for the Habitat BUI; 6.5 for the Populations BUI).*
    a. Previous F&W Habitat Score: 3.60; New Post-Project F&W Habitat Score: 3.79
        i. Since the F&W Habitat BUI removal target is 6.00, the final F&W Habitat Score needs to increase/improve by 2.40. With this one project, the condition score improved by 0.19 (=3.79-3.60), or roughly 8% progress towards reaching the BUI removal target. The final F&W Habitat BUI score did not improve very much with this one project since it only improved a single habitat. Many more restoration and enhancement projects on multiple habitats will be needed in order to reach the BUI removal target.

    b. Previous F&W Populations Score: 4.85; New Post-Project F&W Populations Score: 4.95
        i. Since the F&W Populations BUI removal target is 6.50, the final F&W Populations Score needs to increase/improve by 1.75. With this one project, the condition score improved by 0.10 (=4.95-4.85), or roughly 5.7% progress towards reaching the target. The final F&W Populations BUI score did not improve very much with this one project since the only two populations that improved were weighted low (weight of 8 for Landbirds [migratory] and weight of 9 for Wooded Wetland Birds [breeding season]). More restoration and enhancement projects on other population groups will be needed in order to reach the BUI removal target.

Chapter 3: Fish and Wildlife Habitat and Population Metrics

Purpose

The purpose of this chapter is to explain and provide documentation for metrics for the 18 priority habitats and 22 priority populations so that they can be used effectively for tracking changes in the conditions of each of these groups and ultimately BUI condition scores. Each metric will include the following subsections to describe them:

- Description of the assessment method and metric with an example (if needed)
- Conversion curve, which converts a field metric into a condition score ranging from 0 (poor) to 10 (ideal or good), denotes baseline condition and year, and identifies the AOC Target Zone (i.e., expected range of conditions that a population or habitat may be improved after enhancement or restoration projects are implemented). More details below.
- Rationale for choosing an assessment method, metric, conversion curve, or field method
- Listing and description of the assessment method and/or data to be used in the metric, which may be data collected for an existing program or will be newly collected data
- All other relevant information (e.g., data form, protocol) is provided in the appendices or referenced in text

Descriptions of the Types of Conversion Curves Used

Our strategy for removing the fish and wildlife BUIs in the LGBFR AOC includes the application of conversion curves for assessing the current status of the 18 priority habitats and 22 priority population groups. These curves (or lines) illustrate mathematical formulas that convert field measurements (e.g., number of nesting colonies of Colonial Waterbirds) into a standard scale ranging from 0 (poorest possible condition) to 10 (best possible condition). Once converted to a standardized scale, field measurements of any type and magnitude can be compared and combined to provide an overall score of the BUI conditions. Parameters of all conversion curves found in Appendix 1.

In some cases, the conversion curves are simply straight lines, or *linear*, ranging from 0 to the maximum value of the metric (Figure 3.1). This is the case for the multi-species Index of Ecological Condition (IEC), which applies a built-in process for converting field observations into a 0-10 scale (Howe et al. 2007, Gnass Giese et al. 2015). In other cases, the conversion curves are non-linear, representing a simple mathematical function. These non-linear curves can reflect variations in the importance or precision of the metric across the range of possible values. For example, a *concave curve* (Figure 3.1) implies that changes in the metric at low values yield relatively modest or “slow” changes in condition score. At higher values, relatively small increases or decreases in the metric will yield more rapid changes in the score. At the opposite extreme, a *convex curve* (Figure 3.1) implies that changes in the field metric at low values will greatly impact the standardized condition score, whereas changes at high values have relatively minor impact on the score. A *sigmoid curve* (Figure 3.1) implies that the most impactful changes in condition occur at intermediate values of the field metric. These different-shaped curves can help guide restoration efforts. If the current condition lies in a region where the conversion curve is relatively flat, efforts to increase the value of the metric (e.g., increasing the number of breeding pairs) will have relatively low impact on improving the population or habitat condition and therefore minimal impact on progress toward the BUI removal goals. In this case, efforts to “move the needle” toward the target condition might be more effective if directed at other priority populations or habitats. Likewise, if current condition lies near a region of steep increase, small changes in the metric will be particularly significant.

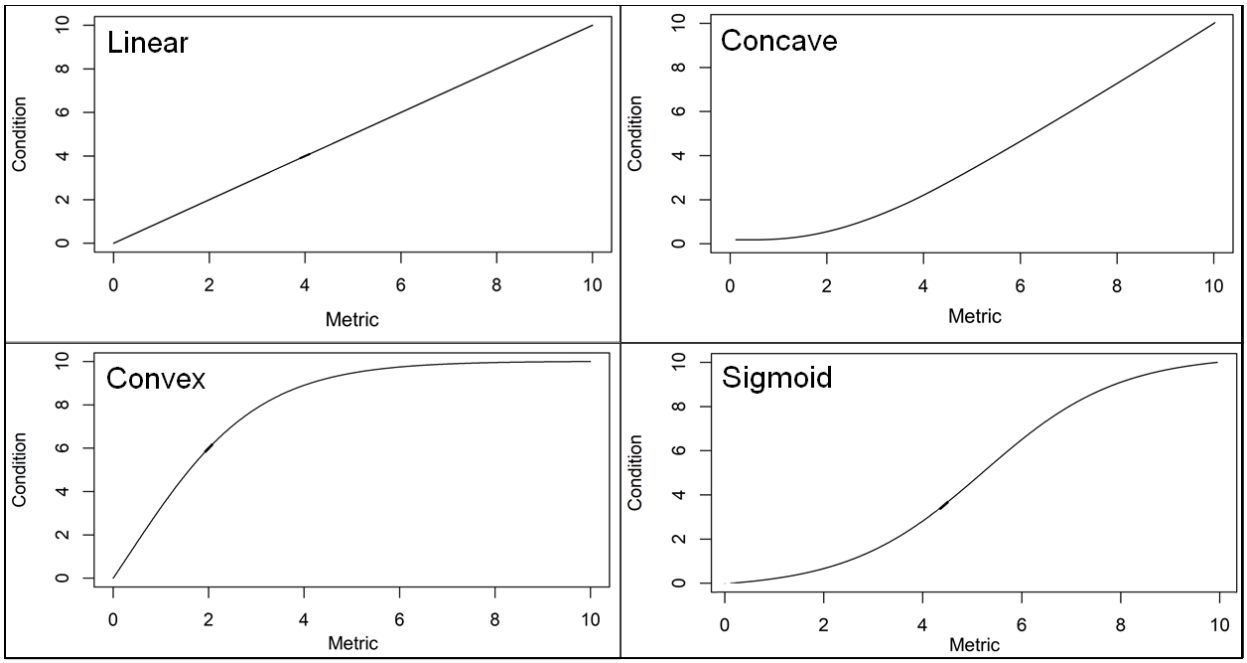


Figure 3.1. Example conversion curves, which convert field measurements (e.g., number of nesting colonies of Colonial Waterbirds) into a standard scale ranging from 0 (poorest possible condition) to 10 (best possible condition): linear, concave, convex, and sigmoid.

Although the conversion curves might seem unnecessarily complicated, they introduce an ecologically meaningful and transparent framework for tracking the progress of restoration efforts. All of the mathematical conversions have been automated, so users can simply enter the raw field measurement on a computer or web-based interface, resulting in an instant standardized score indicating the current status of individual wildlife populations or habitats as well as the overall restoration status of the LGBFR AOC.

Description of AOC Target Zones

AOC Target Zones are depicted on conversion curve figures by a green box for each individual priority population and habitat and are the zone in which a population or habitat is expected/planned to be improved after enhancement or restoration projects are implemented. These AOC Target Zones were determined in consultation with subject matter experts, taking into account several factors including AOC goals and achievability. In general, each of the AOC Target Zones for priority population metrics range from 6.5 to 8.0, as a cumulative BUI target zone of 6.5 is necessary to remove the BUI. However, it is likely that some populations will not reach the 6.5 goal, in which case it would be necessary for other populations to exceed a score of 6.5 to reach the cumulative BUI condition score required for BUI removal. The same reasoning is applied to habitat target zones, though they generally range from 6.0 to 7.5. In cases where experts agreed that reaching the general target zone of 6.5 - 8.0 for priority populations and 6.0 - 7.5 for priority habitats would be very difficult given factors outside the LGBFR AOC (e.g., watershed issues, climate change, water level fluctuations), a lower condition score AOC Target Zone was applied (see Coastal Wetland Aquatic Macroinvertebrates for example). Lastly, it is important to note that fish and wildlife populations and habitats are not static and can fluctuate at multiple time scales, making it important to track condition in the future even if they are currently within the AOC Target Zone (e.g. Anurans, Landbirds [migratory]).

Descriptions of the Types of Populations Metrics Used

Metrics for the 22 priority populations can be categorized into one of four metric types (Figure 3.2):

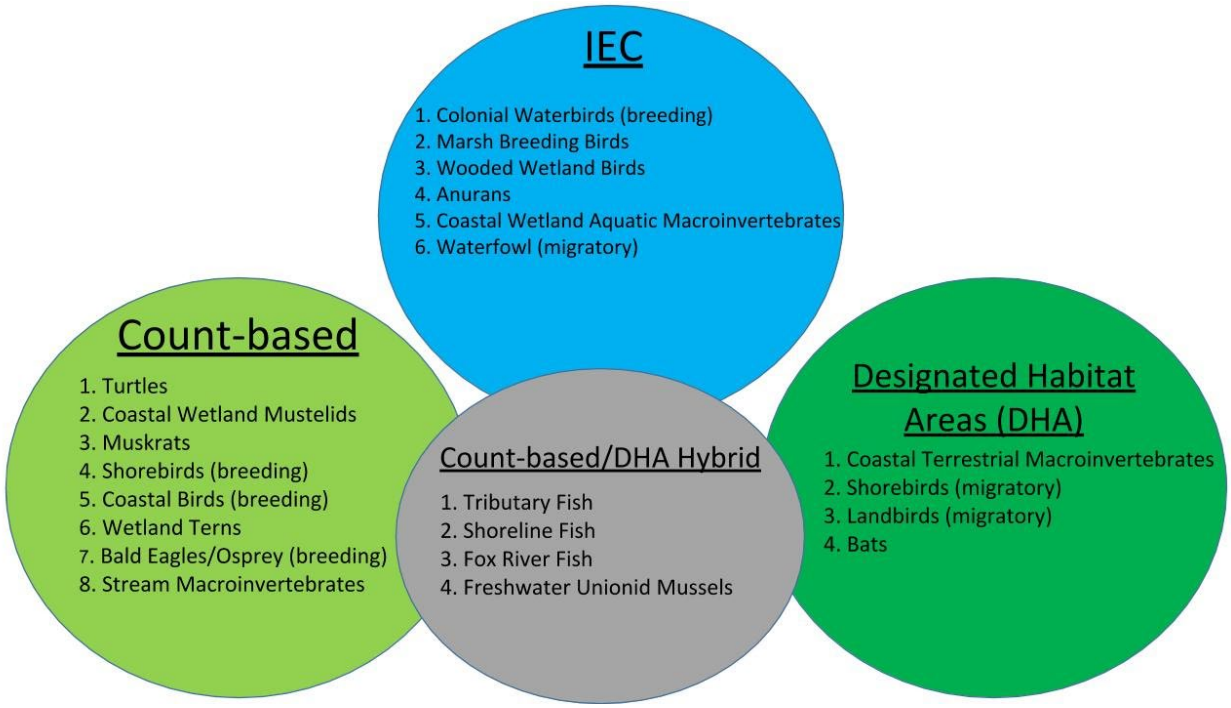


Figure 3.2. Metrics for the 22 priority populations can be categorized into one of four metric types: Index of Ecological Condition (IEC), count-based, Designated Habitat Area (DHA), or a hybrid between a count-based metric and DHA.

1. Index of Ecological Condition (IEC)
    - Reasons for including population groups in this category include: 1) the population group consists of multiple species or assemblages (IECs can easily incorporate responses of multiple species into a final condition score that describes the entire group) rather than just a few species (e.g., see Count-based Data below) and/or 2) IECs were already largely developed for these population groups for other efforts (e.g., Great Lakes Coastal Wetland Monitoring Program) with accompanying field methods, making them easy to adopt.

    - The Index of Ecological Condition (IEC) is an ecological indicator method originally developed by Howe et al. (2007) that uses a group(s) of organisms (e.g., birds, plants, invertebrates) to indicate the ecological health or condition of an ecosystem (e.g., marsh, forest). It uses newly collected field monitoring data (e.g., nest counts, point count data) and known species' sensitivities (biotic response [BR] functions) to iteratively calculate an index or value (=IEC) that ranges from 0 (poor) to 10 (excellent), which ultimately describes the health or condition of an ecosystem. It has been successfully applied to Great Lakes coastal wetlands (e.g., Howe et al. 2007), northern mesic forests (Gnass Giese et al. 2015), and inland lakes (Butterfield 2010); however, this effort will introduce the first application of the IEC to indicate the health or condition of a population group, rather than an ecosystem.

With this effort, we will apply the IEC method to indicate the condition of Colonial Waterbirds, Marsh Breeding Birds, Wooded Wetland Birds (breeding), Anurans, Coastal Wetland Aquatic Macroinvertebrates, and Waterfowl (migratory) in the LGBFR AOC.

- In order to build an IEC model, one must first capture how individual species respond to a gradient of environmental condition (ranging from 0 [poor] to 10 [excellent]), which is done using BR-functions (Figure 3.3). In past applications listed above, these functions have been developed using quantitative data; however, it is equally possible to generate these curves based on expert opinion, when quantitative data are not readily available. For the LGBFR AOC efforts, we have constructed BR-functions based on both quantitative information (e.g., Anurans) as well as expert opinion (e.g., Colonial Waterbirds).

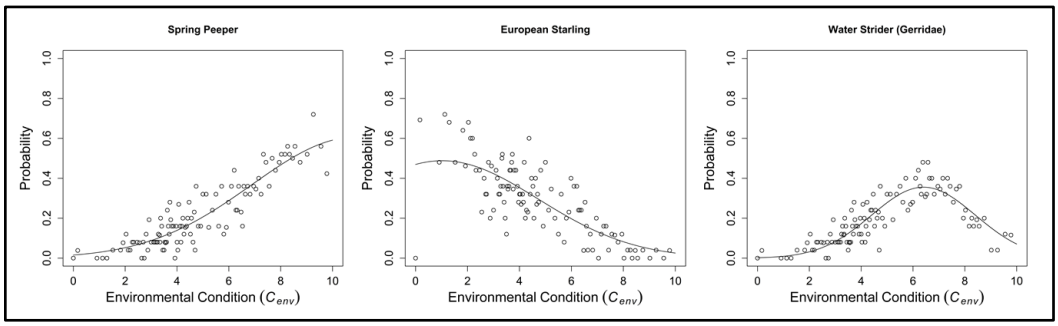


Figure 3.3. Example biotic response (BR) functions. The x-axis is a gradient of condition (C_{env}) that ranges from poor (values close to 0) to excellent (values near 10), and the y-axis is some measurable variable for the species of interest (e.g., probability of detection, # of nests). One can generate a variety of differently shaped curves that capture a variety of sensitivities as shown above in these examples: 1) spring peeper (*Pseudacris crucifer*) is a sensitive positive species where it is absent or nearly absent in poor conditions (values near 0-4) but common in good or excellent conditions (values near 7-10), 2) European Starling (*Sturnus vulgaris*) is a sensitive negative species that is common in poor conditions but absent or nearly absent in higher quality conditions, and 3) water strider (Gerridae) is a modal species where it is most common at intermediate values of condition (values near 5-8).

- Once BR-functions are constructed, an IEC that describes the condition or health of a population group uses newly collected field monitoring data (e.g., nest counts, point count data) and the known species' sensitivities (=BR-functions) to iteratively calculate an index or value (=IEC) that ranges from 0 (poor) to 10 (excellent), which ultimately describes the health or condition of an ecosystem or population group.

2. Count-based Data
    - Reasons for including population groups in this category include: 1) the population can be monitored and assessed easily, 2) the population is highly impacted by the environmental conditions in the LGBFR AOC year-round (not migratory), 3) the population is migratory but is reliant on environmental conditions in the LGBFR AOC to complete its life cycle, 4) the population group consists of just a few species and not an assemblage (compare to IEC above), and/or 5) there is not necessarily

high confidence that habitat improvements alone will improve the population (e.g., Stream Macroinvertebrates), thus precluding it from being included in project-based metric categories described below.

- Metrics for several of these priority populations are based on collected field data (i.e., “count-based data”) that are either already being collected by biologists for existing programs coordinated by agencies and other organizations or data that can be easily collected by contracted biologists in the future. Count-based data can come in many forms, such as catch per unit effort, number of sites a species or population group was detected, number of nests, etc. These data are then entered into a basic formula to obtain the final metric, or in some cases the collected data are the metric (e.g., number of sites), which is then converted into a condition score ranging from 0 to 10 using the conversion curves.

3. Designated Habitat Area
    - Reasons for including population groups in this category include: 1) the population is migratory and therefore impacted by stressors outside the LGBFR AOC boundaries, 2) the population does not have established monitoring/assessment protocols or is challenging to monitor, and/or 3) there is a high confidence that establishing new or improving existing habitat will lead to improvements in the population group. It would be expensive and time consuming to compile count-based and IEC data for all population groups. Therefore, because of the above listed reasons, DHAs still allow for critical population groups to be included in the population assessment and overall BUI condition score. Thus, whether or not a population utilizes a DHA is not factored into the final condition score for the population group.

    - A Designated Habitat Area (DHA) in the LGBFR AOC is an explicitly mapped site that provides or will provide a significant example of one of 18 priority habitat types, or conditions that benefit one or more of the 22 priority populations. In order to qualify as a DHA, three conditions must be satisfied: 1) the DHA must be large enough to sustain a viable natural community or significant habitat for a critical stage in the life cycle of the target population or consist of multiple smaller landscape units that together support target species; 2) the owner(s) or public stewards of the property must agree in writing to manage the site according to a list of best practices that significantly benefit the targeted habitat or wildlife populations; 3) the site will be accessible for ongoing monitoring of habitat quality or targeted wildlife populations.

    - Details of best management practices will be developed by appropriate experts with reference to relevant scientific literature and approved by the Wisconsin Department of Natural Resources. The best management practices will vary among DHAs depending on the targeted habitat type(s) or wildlife populations. In some cases, the targeted habitat or wildlife population might not be present at the site, although the goal is to create and maintain conditions that will support the target(s).

- DHAs follow the models of other protected area networks such as Special Areas of Conservation in Europe (https://ec.europa.eu/environment/nature/natura2000/sites_hab/index_en.htm, accessed on 30 September 2019), Important Bird Areas in Europe and North America (https://www.audubon.org/important-bird-areas and https://www.birdlife.org/worldwide/programme-additional-info/important-bird-and-biodiversity-areas-ibas, accessed on 30 September 2019), and Wetlands of International Importance (https://www.ramsar.org/about/wetlands-of-international-importance-ramsar-sites, accessed on 30 September 2019). DHAs are protected voluntarily through a continuous, participatory, and ecologically rigorous process that promotes the effective conservation of wildlife habitats and populations (biodiversity) in the LGBFR AOC. Designation of a DHA does not preclude other uses of the area, including hunting, fishing, hiking, and other activities that are compatible with the best management practices.

- If desired, though not required, Friends Groups, Boy/Girl Scout troops, bird clubs, or other volunteer groups could initiate and implement an "Adopt-A-DHA" program where the interested group might help with long-term maintenance of a DHA by helping with invasive species management, trail maintenance, garbage pick-up, sign maintenance, etc.

4. Hybrid Metric of Designated Habitat Areas (DHA) + Count-based Data
    - Reasons for including population groups in this category include: 1) the population is highly impacted by lake-wide issues not isolated to the LGBFR AOC boundaries but is also reliant on environmental conditions within the LGBFR AOC boundaries to complete part or all of their life cycle, 2) there is a high confidence that establishing new or improving existing habitat will lead to improvements in the population group, and/or 3) assessment efforts for the population already exist or could easily be conducted.

    - The DHA/count-based metric is a hybrid approach whereby the condition score of a population can be increased to a point by establishing DHAs but cannot exceed a score threshold unless the population has been demonstrated to utilize the DHA under various life stages. DHA qualifications described above are still required, but population group assessment of the DHA performance must be conducted in order to improve the condition score.

Priority Fish and Wildlife Populations' Metrics

Descriptions of the 22 priority population metrics are listed below. Otherwise, click on each of the population groups (organized into wildlife metric groups below) to quickly and easily access the metrics' content found below. Descriptions of each population are provided in Table 2.4 above in Chapter 2.

Index of Ecological Condition Metrics:

- Colonial Waterbirds (breeding season)
- Marsh Breeding Birds
- Wooded Wetland Birds (breeding season)
- Anurans

- Coastal Wetland Aquatic Macroinvertebrates
- Waterfowl (migratory)

Count-based Metrics:
- Turtles
- Coastal Wetland Mustelids
- Muskrat
- Shorebirds (breeding)
- Coastal Birds (breeding)
- Wetland Terns
- Bald Eagle/Osprey (breeding)
- Stream Macroinvertebrates

Designated Habitat Area (DHA) Metrics:
- Coastal Terrestrial Macroinvertebrates
- Shorebirds (migratory)
- Landbirds (migratory)
- Bats

Count-based/DHA Hybrid Metrics:
- Tributary Fish
- Shoreline Fish
- Fox River Fish
- Freshwater Unionid Mussels

Colonial Waterbirds *(IEC)*

Assessment Description: This group will be evaluated using a Colonial Waterbird Index of Ecological Condition (IEC). The IEC in this case is based on a weighted average of species-specific conversion curves defined by expert opinion. The final value can be calculated directly without iteration, unlike the typical IEC method used for other taxa. Biotic response (BR) functions (like in Figure 3.3) were constructed using the number of nests for 8 species (American White Pelican [*Pelecanus erythrorhynchos*], Double-crested Cormorant [*Phalacrocorax auritus*], Caspian Tern [*Hydroprogne caspia*], Common Tern [*Sterna hirundo*], Black-crowned Night-Heron [*Nycticorax nycticorax*], Great Egret [*Ardea alba*], Herring Gull [*Larus argentatus*], and Ring-billed Gull [*Larus delawarensis*]) by estimating the optimum number of nests for the LGBFR AOC based on local expert opinion using a subjective environmental reference gradient of condition (y-axis) that ranges from 0 (poor) to 10 (good). The conversion curve for this group is a linear 1:1 curve where an IEC score of 10 is a condition (C) score of 10 (Figure 3.4).

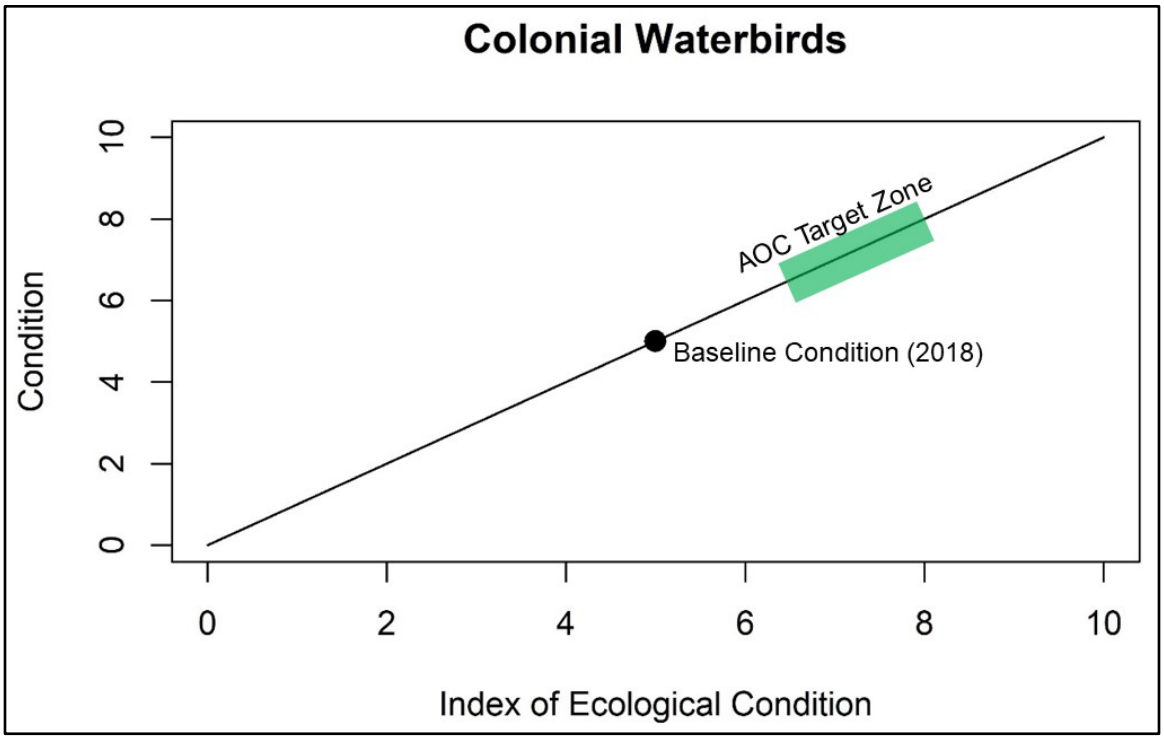


Figure 3.4. Colonial Waterbirds conversion curve, which uses the Colonial Waterbirds Index of Ecological Condition (IEC) metric. The x-axis is a Colonial Waterbirds IEC based on nest counts and ranges from 0 (no birds, poor condition) to 10 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition of Colonial Waterbirds was determined in 2018 through expert opinion; going forward nest count data will be used to determine condition. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Local bird experts met in September 2018 and again in May 2019 to discuss the metric and monitoring methods for this population group. The metrics team proposed using an IEC because this method appropriately incorporates responses of multiple species into a final condition score that describes the entire group. Local experts agreed with this approach and designed BR-functions that incorporate an optimum number of nests, carrying capacities, species interactions, and historical information on these species.

Assessment Method: This group will be evaluated using the U.S. Department of Agriculture (USDA) Wildlife Services' annual nest counts as part of their Double-crested Cormorant management surveys on the Cat Island Wave Barrier, Lone Tree Island, and other sites in northeastern Wisconsin. The WDNR also contributes to this effort and will help attain additional data for Herring and Ring-billed Gulls, which are not included in USDA's surveys. Surveys will begin in 2028 after restoration and enhancement projects are complete and continue for 3 years (see Chapter 4).

Marsh Breeding Birds *(IEC)*

Assessment Description: This group will be evaluated using a Marsh Breeding Birds Index of Ecological Condition (IEC) that was modified from the bird-based IEC developed for the Great

Lakes Coastal Wetland Monitoring Program (CWMP; e.g., Uzarski et al. 2017). For single species (e.g., Swamp Sparrow, *Melospiza georgiana*) and species groups (e.g., bitterns, rails), biotic response (BR) functions (like in Figure 3.3) were constructed using the probability of detection (x-axis) from CWMP breeding bird point count data that were collected throughout the Great Lakes coastal zone. The environmental reference gradient of condition (y-axis) was generated using a series of GIS and other landscape variables (e.g., wetland area). The conversion curve for this group is a linear 1:1 curve where an average IEC score (from the 10 best point count locations) of 10 is a condition (C) score of 10 (Figure 3.5).

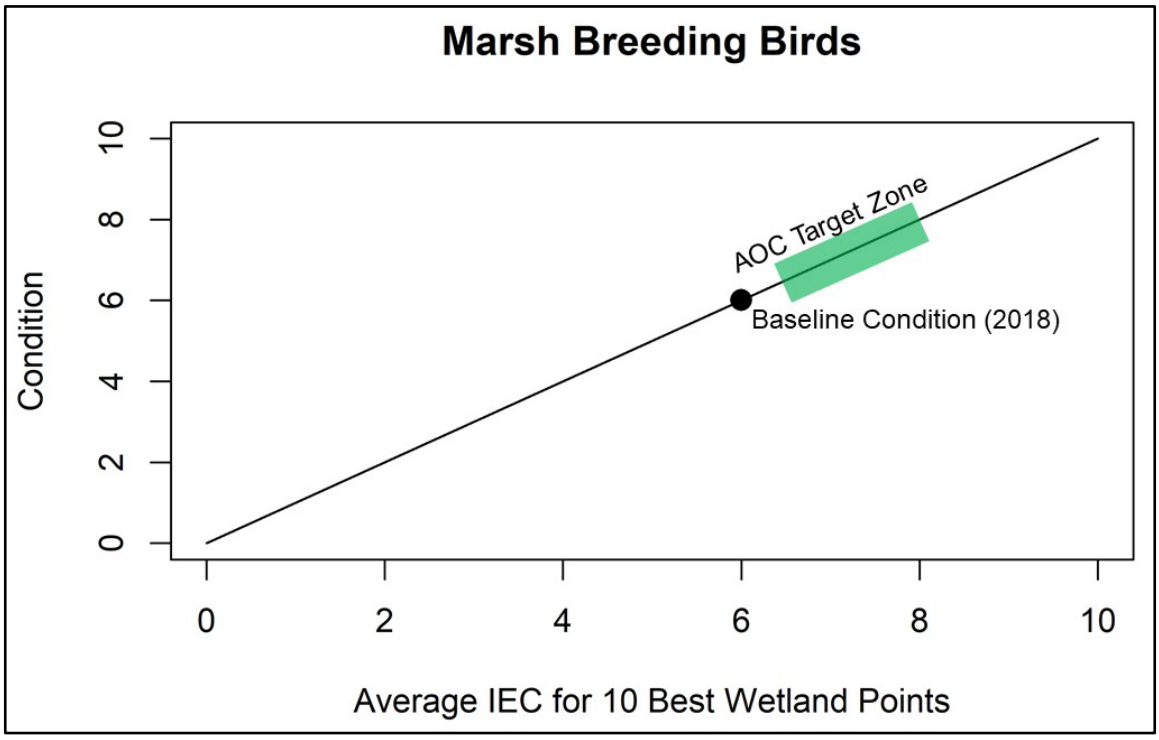


Figure 3.5. Marsh Breeding Birds conversion curve, which uses the Marsh Breeding Birds Index of Ecological Condition (IEC) metric. The x-axis is calculated as an average Marsh Breeding Birds IEC from the 10 best wetland point count locations and ranges from 0 (no birds, poor condition) to 10 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert opinion; going forward point counts will be used to determine condition. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: The metrics team decided to use an IEC metric for this population group because Howe, Giese, and others from the CWMP already developed an IEC that uses breeding bird point count data to assess the health of Great Lakes coastal wetlands. The existing index was easily modified and applied to the LGBFR AOC for the assessment of Marsh Breeding Birds.

Assessment Method: Bird data used for this population group's metric will be collected following the CWMP marshbird monitoring protocol (Uzarski et al. 2017). Bird surveys will be conducted at multiple locations by trained, certified observers throughout the LGBFR AOC's emergent marshes using 10-minute unlimited-distance stationary point counts, in which all birds seen or heard are recorded during a 10-minute period regardless of the distance to the observer. Surveys may be

conducted during the breeding bird survey window, roughly the end of May through 10 July. Each point count location will be sampled once in the early morning and once in the early evening or morning with at least 15 days in between samples. The first 5-minutes of the survey consists of passive listening followed by a loud broadcast of secretive marsh-nesting species (e.g., rails). The protocol and a sample data sheet are found in Appendix 2. Sampling locations for the project will be chosen by expert field crews based on sites selected for the CWMP, though additional sampling points may be needed given the strict site criteria needed for the CWMP (e.g., wetland must be at least 9.9 ac [4 ha] in size), which can easily be an added CWMP benchmark site(s). Currently, CWMP breeding marshbird data are collected and organized by the University of Wisconsin-Green Bay (UW-Green Bay) Cofrin Center for Biodiversity's (CCB) field crew (Principal Investigator: Robert Howe; Team Coordinator: Erin Giese). Data collected by the CCB can be shared with the LGBFR AOC project. IECs will be calculated for each point count location, and then an average IEC will be calculated based on the 10 best wetland samples. Surveys will begin in 2028 after restoration and enhancement projects are complete and continue for 3 years (see Chapter 4). With Great Lakes Restoration Initiative (GLRI) funding, the CWMP runs on a 5-year cycle and so far has been funded twice (2011-2015; 2016-2020). Within a year of the 5-year period, a batch of randomly selected Great Lakes coastal wetland complexes are sampled, though all possible coastal wetlands are chosen for sampling within the 5-year period (most of which get sampled). Some wetlands are resampled across multiple years, though the majority are surveyed just once in the 5-year period; however, crews can add additional sites for sampling as "benchmark" sites if a local need arrives (e.g., post-restoration verification monitoring). Generally bird field crews return to the same point count locations when returning to a wetland complex that was sampled in the past. Future funding is not guaranteed (but likely) and greatly needed for continuing this important program.

Wooded Wetland Birds *(IEC)*

Assessment Description: This group will be evaluated using a Wooded Wetland Birds Index of Ecological Condition (IEC) that was modified from the bird-based northern hardwood forest IEC developed by Gnass Giese et al. (2015). Biotic response (BR) functions of single species were constructed using the probability of detection (x-axis) from breeding bird point count data that were collected throughout northern hardwood forests of northeastern Wisconsin and Michigan between 2003 and 2010 and in old growth forests in 1993-94 (Gnass Giese et al. 2015). Bird communities in northern hardwood forests and hardwood swamp forests are very similar, though some bird species were excluded from the Wooded Wetland Birds IEC due to geographic range issues. The environmental reference gradient of condition (y-axis) was generated using a variety of GIS variables, including land cover (e.g., % natural habitat, % agriculture), road density, edge density and other edge variables, distance to nearest road, and housing density (Gnass Giese et al. 2015). The conversion curve for this group is linear and 1:1 where an average IEC score (calculated using the top 10 best point count locations) of 10 is a condition (C) score of 10 (Figure 3.6).

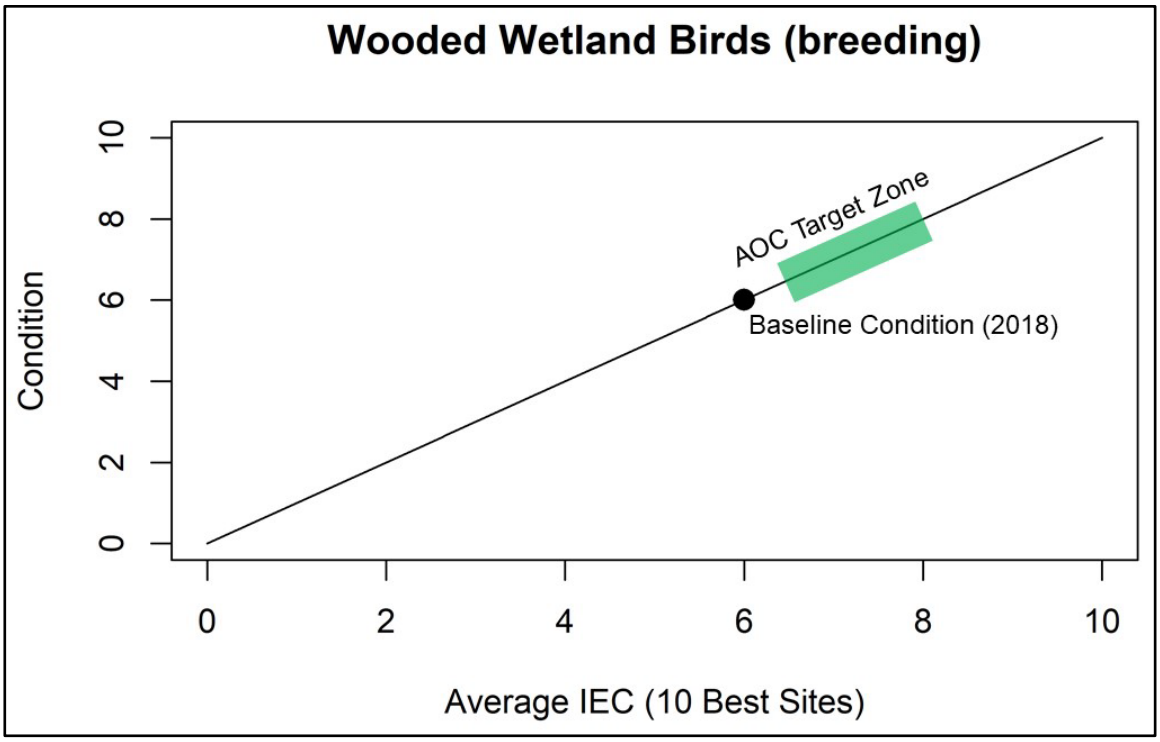


Figure 3.6. Wooded Wetland Birds (breeding) conversion curve, which uses the Wooded Wetland Birds Index of Ecological Condition (IEC) metric, which is based on Gnass Giese et al. (2015). The x-axis is calculated as an average Wooded Wetland Birds IEC based on the 10 best multiple point count locations and ranges from 0 (no birds, poor condition) to 10 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). The baseline condition score was determined through expert opinion; going forward point counts will be used to determine condition. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: The metrics team decided to use an IEC metric for this population group because Giese, Howe, Wolf, and others already developed a similar IEC that was built on breeding bird point count data to assess the health northern hardwood forests (Gnass Giese et al. 2015). The existing index was easily modified and applied to the LGBFR AOC for the assessment of Wooded Wetland Birds.

Assessment Method: Bird data used for this population group's metric will be collected by a contractor following the Knutson et al. (2008) monitoring protocol starting in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4). Bird surveys will be conducted at multiple locations by trained, certified observers throughout the LGBFR AOC's wooded wetlands using 10-minute unlimited-distance stationary point counts, in which all birds seen or heard are recorded during a 10-minute period regardless of the distance to the observer. Sampling locations will be field scouted and established by the trained contractor. Surveys may be conducted during the breeding bird survey window, roughly the end of May through 10 July, though preferably throughout June, in the early morning hours. A sample data sheet and protocol are provided in Appendix 3. IECs will be calculated for each point count location, and then an average IEC will be calculated based on the 10 best forest samples.

Anurans *(IEC)*

Assessment Description: This group will be evaluated using an Anuran Index of Ecological Condition (IEC) that was modified from the anuran-based IEC developed for the Great Lakes Coastal Wetland Monitoring Program (CWMP; e.g., Uzarski et al. 2017). Using the probability of detection (x-axis) from CWMP breeding anuran point count data that were collected throughout the Great Lakes coastal zone, biotic response (BR) functions were constructed for multiple anuran species (e.g., spring peeper [*Pseudacris crucifer*]). The environmental reference gradient of condition (y-axis) was generated using a series of GIS and other landscape variables (e.g., wetland area). The conversion curve for this group is a linear 1:1 curve where an average IEC score (from the 10 best point count locations) of 10 is a condition (C) score of 10 (Figure 3.7).

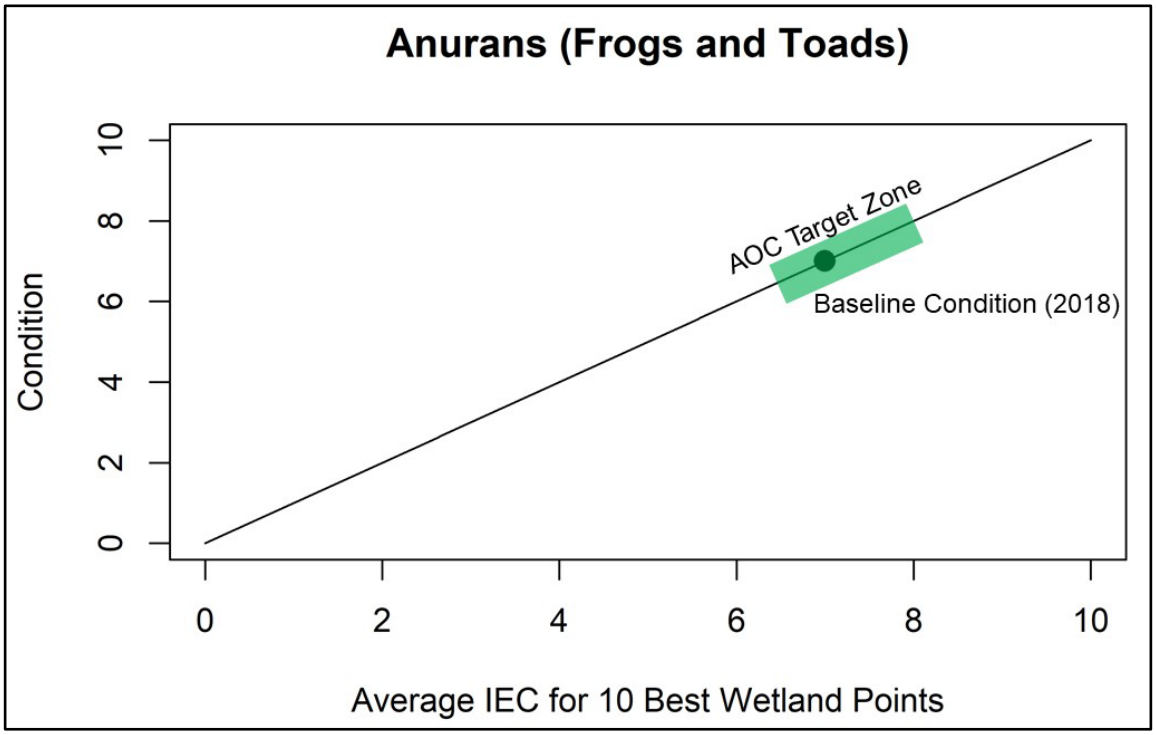


Figure 3.7. Anurans conversion curve, which uses the Anuran Index of Ecological Condition (IEC) metric. The x-axis is calculated as an average Anuran IEC based on the 10 best point count locations and ranges from 0 (no anurans, poor condition) to 10 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). The baseline condition score was determined through expert opinion; going forward point counts will be used to determine condition. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: The metrics team decided to use an IEC metric for this population group because Howe, Giese, and others from the CWMP already developed an IEC that uses breeding anuran point count data to assess the health of Great Lakes coastal wetlands. The existing index was modified and applied to the LGBFR AOC for the assessment of Anurans.

Assessment Method: Anuran (frogs/toads) data used for this population group's metric will be collected following the CWMP anuran monitoring protocol (Uzarski et al. 2017) starting in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see

Chapter 4). Anuran surveys will be conducted at multiple locations by trained, certified observers throughout the LGBFR AOC's emergent marshes using 3-minute unlimited-distance stationary point counts, in which all calling anurans are recorded regardless of the distance to the observer (anurans are only detected and recorded by sound). Surveys may be conducted during the breeding anuran survey window, starting as early as mid-late March through 10 July. Each point count location will be sampled 3 times during a single season with at least 15 days in between samples. The protocol and a sample data sheet are found in Appendix 4. Sampling locations for the project will be chosen by expert field crews based on sites selected for the CWMP, though additional sampling points may be needed given the strict site criteria needed for the CWMP (e.g., wetland must be at least 9.9 ac [4 ha] in size), which can easily be an added CWMP benchmark site(s). Currently, CWMP anuran data are collected and organized by the University of Wisconsin-Green Bay (UW-Green Bay) Cofrin Center for Biodiversity's (CCB) field crew (Principal Investigator: Robert Howe; Team Coordinator: Erin Giese). Data collected by the CCB can be shared with the LGBFR AOC project. IECs will be calculated for each point count location, and then an average IEC will be calculated based on the 10 best point count locations. With Great Lakes Restoration Initiative (GLRI) funding, the CWMP runs on a 5-year cycle and so far has been funded twice (2011-2015; 2016-2020). Within a year of the 5-year period, a batch of randomly selected Great Lakes coastal wetland complexes are sampled, though all possible coastal wetlands are chosen for sampling within the 5-year period (most of which get sampled). Some wetlands are resampled across multiple years, though the majority are surveyed just once in the 5-year period; however, crews can add additional sites for sampling as "benchmark" sites if a local need arrives (e.g., post-restoration verification monitoring). Generally anuran field crews return to the same point count locations when returning to a wetland complex that was sampled in the past. Future funding is not guaranteed (but likely) and greatly needed for continuing this important program.

Coastal Wetland Aquatic Macroinvertebrates *(IEC)*

Assessment Description: This group will be evaluated using a Coastal Wetland Aquatic Macroinvertebrate Index of Ecological Condition (IEC) that was modified from the aquatic macroinvertebrate-based IEC developed for the Great Lakes Coastal Wetland Monitoring Program (CWMP; e.g., Uzarski et al. 2017). Using CWMP invertebrate data that were collected throughout the Great Lakes coastal zone, biotic response (BR) functions were constructed for multiple taxa. The environmental reference gradient of condition was generated using a series of GIS and other landscape variables. The conversion curve for this group is a linear 1:1 curve where an IEC score of 10 is a condition (C) score of 10 (Figure 3.8).

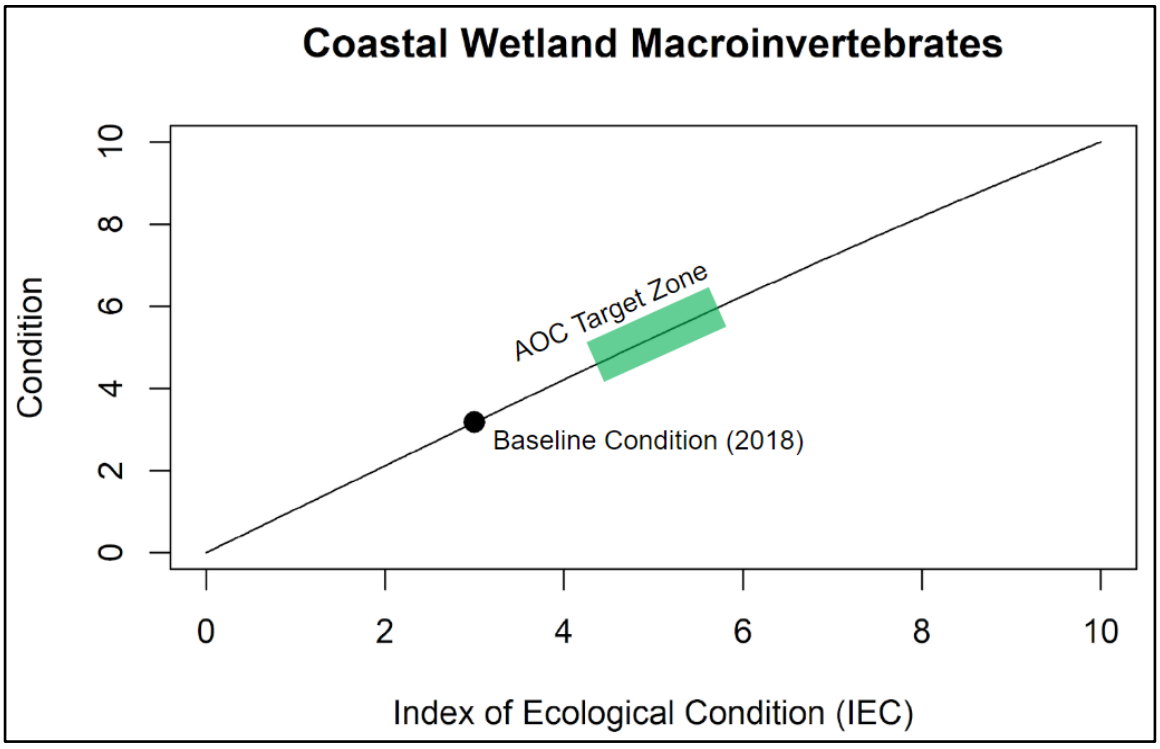


Figure 3.8. Coastal Wetland Aquatic Macroinvertebrates conversion curve, which uses the Coastal Wetland Aquatic Macroinvertebrates Index of Ecological Condition (IEC) metric. The x-axis is calculated as an average Coastal Wetland Aquatic Macroinvertebrates IEC based on multiple wetland surveys and ranges from 0 (no invertebrates, poor condition) to 10 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition of Coastal Wetland Aquatic Macroinvertebrates was determined through expert opinion; going forward wetland CWMP surveys will be used to determine condition. The AOC Target Zone ranges from 4.5 to 6.

Assessment Rationale: The metrics team decided to use an IEC metric for this population group because Howe and others from the CWMP already developed an IEC that uses coastal wetland aquatic macroinvertebrate data to assess the health of Great Lakes coastal wetlands. The existing index was modified and applied to the LGBFR AOC for the assessment of Coastal Wetland Aquatic Macroinvertebrates.

Assessment Method: This population group will be monitored through the Great Lakes Coastal Wetland Monitoring Program (CWMP) following methods described in Uzarski et al. (2017) that were modified from Burton et al. (2008). Aquatic invertebrate surveys will begin in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4). They will be conducted in emergent marshes (high energy coastal and riparian) between late-June through early September and in two different vegetation zones: inner *Schoenoplectus* zone (area closest to shore) and outer *Schoenoplectus* zone (outer part of wetland near open water). Invertebrates are sampled within each of these two zones using dip net sweeps and identified in person at the time of sampling or later in a laboratory. Because of the difficulties of identifying invertebrates, collected specimens were identified to the lowest level possible (e.g., genus), otherwise to class, order, or family. The CWMP aquatic invertebrate protocol and data sheet are available for download online: https://www.greatlakeswetlands.org/Sampling- protocols. With

Great Lakes Restoration Initiative (GLRI) funding, the CWMP runs on a 5-year cycle and so far has been funded twice (2011-2015; 2016-2020). Within a year of the 5-year period, a batch of randomly selected Great Lakes coastal wetland complexes are sampled, though all possible coastal wetlands are chosen for sampling within the 5-year period (many of which get sampled). Some wetlands are resampled across multiple years, though the majority are surveyed just once in the 5-year period; however, crews can add additional sites for sampling as "benchmark" sites if a local need arrives (e.g., post-restoration verification monitoring). Sampling locations for the project will be chosen by expert field crews based on sites selected for the CWMP, though additional locations may be needed given the strict site criteria needed for the CWMP (e.g., wetland must be at least 9.9 ac [4 ha] in size), which can easily be an added CWMP benchmark site(s). Future funding is not guaranteed (but likely) and greatly needed for continuing this important program.

Waterfowl (migratory) *(IEC)*

Assessment Description: This group will be evaluated using a Migratory Waterfowl Index of Ecological Condition (IEC). Biotic response (BR) functions were constructed using a subjective environmental reference gradient of condition (y-axis) that ranges from 0 (poor) to 10 (good) and the following variables (x-axis), which are based on migratory waterfowl data collected in 2016-17 (Howe et al. 2018b):

1. Log diving duck abundance (top 3 points during spring)
2. Log marsh duck abundance excluding Mallard (top 3 points during spring)
3. Log goose/swan (*Cygnus* spp.) abundance (top 3 points during spring)
4. Log abundance of "other waterfowl" during spring
5. Log Mallard abundance during spring
6. Diving duck species richness (spring)
7. Marsh duck species richness (spring)
8. Goose species richness (spring)
9. "Other" waterfowl species richness (spring)

The final Migratory Waterfowl IEC incorporates spring waterfowl abundance and species richness data collected from spring migratory waterfowl, land-based stationary point count surveys (Howe et al. 2018b). The conversion curve for this group is a linear 1:1 curve where an IEC score (BR-function values are chosen from multiple point counts) of 10 is a condition (C) score of 10 (Figure 3.9).

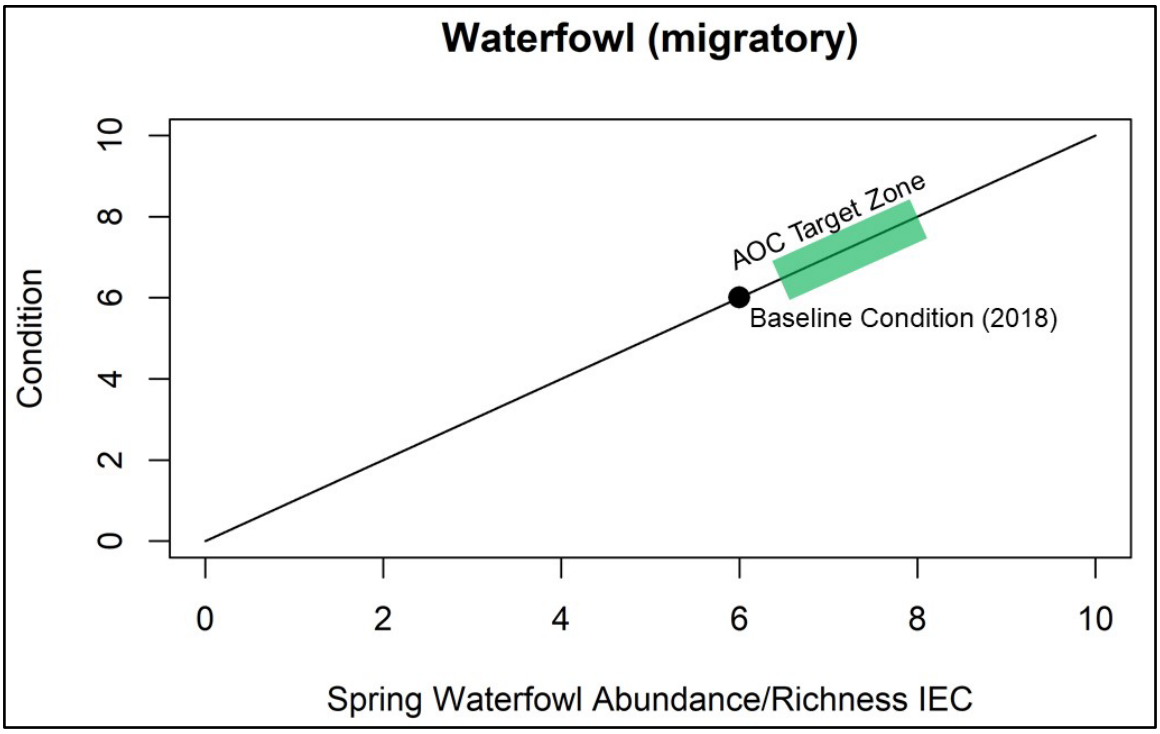


Figure 3.9. Waterfowl (migratory) conversion curve, which uses the Migratory Waterfowl Index of Ecological Condition (IEC) metric. The x-axis is calculated as spring waterfowl abundance/species richness IEC based on multiple point count surveys and ranges from 0 (no birds, poor condition) to 10 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert opinion; going forward point count surveys will be used to determine condition. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Bird experts from multiple agencies and organizations met with UW-Green Bay and WDNR staff on 29 April 2019 to discuss the development of a metric and monitoring strategy for this population group. The group decided to monitor migratory waterfowl during spring migration, rather than fall, because it is a more critical period for them and avoids the fall hunting season, which may impact how and where waterfowl are found during migration. Rather than using WDNR airplane transect waterfowl surveys, which are expensive and typically run in the fall, the group decided to use the Howe et al. (2018b) protocol, which are cheaper, land-based surveys. Experts discussed developing two conversion curves, one that incorporates the number of individuals and one for species richness; however, this method does not easily allow for one to tease out differences between dabbling and diving ducks. Because diving duck numbers can be so high, they can also overwhelm dabblers. Therefore, the metrics team decided to develop an IEC that accounts for species richness and the abundance of both diving and dabbling ducks.

Assessment Method: This population group will be evaluated by a contractor who will conduct land-based, unlimited-distance point count surveys at 8 locations in the LGBFR AOC during spring migration (1 March - 31 May) following the protocol outlined by Howe et al. (2018b) in Appendix 5. In short, waterfowl species and total number of individuals seen or heard during a minimum of 15 minutes are recorded on a data form. Waterfowl rafts are drawn on maps at each

point count location. Each point count location is surveyed at least twice a week during spring migration. Locations are shown in the Figure 1 map of Appendix 1.3 in Howe et al. (2018b). Surveys will begin in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4).

Turtles *(Count-based Data)*

Assessment Description: This population group will be evaluated using a Turtle Occupancy Metric (T):

$$T = sites_{snapping} + sites_{painted} + sites_{rare1} + \ldots\ldots + sites_{rare\text{-}x}$$

where T is the summed total number of sites that snapping turtles (*Chelydra serpentina*), painted turtles (*Chrysemys picta*), and any uncommon or rare turtle species (=rare1 to rare-x) are each documented at a maximum of 6 sites per species within the LGBFR AOC where $T \geq 0$. Turtles will be monitored at the following 6 sites: 1) lower Fox River, 2) southern bay of Green Bay centered around Bay Beach Wildlife Sanctuary, 3) Point au Sable and the east shore, 4) Duck Creek, 5) Cat Island Wave Barrier and Peters Marsh, and 6) Longtail Point/Dead Horse Bay. Rare or less common turtle species include spiny softshell (*Apalone spinifera*), Blanding's (*Emydoidea blandingii*), wood (*Glyptemys insculpta*), and others. Metric T is converted into a condition score (C) ranging from 0 to 10 (Figure 3.10). Generally, $T \leq 21$ where snapping turtle, painted turtle, and one uncommon turtle species are reported at all 6 sites and one uncommon species is found at half of the sites. If additional rare species are reported and $T > 21$, then $C = 10$.

Example: If snapping turtles are observed at 4 of the 6 possible sites (Duck Creek, Point au Sable, Bay Beach Wildlife Sanctuary, and Longtail Point), painted turtles are observed at 3 sites (Longtail Point, Cat Island/Peters Marsh, Point au Sable), and spiny softshell turtles are observed at 2 sites (lower Fox River and Point au Sable), then $T = 4 + 3 + 2 = 9$ and $C = 3$. In this example, Turtle condition is well below the AOC Target Zone (Figure 3.10).

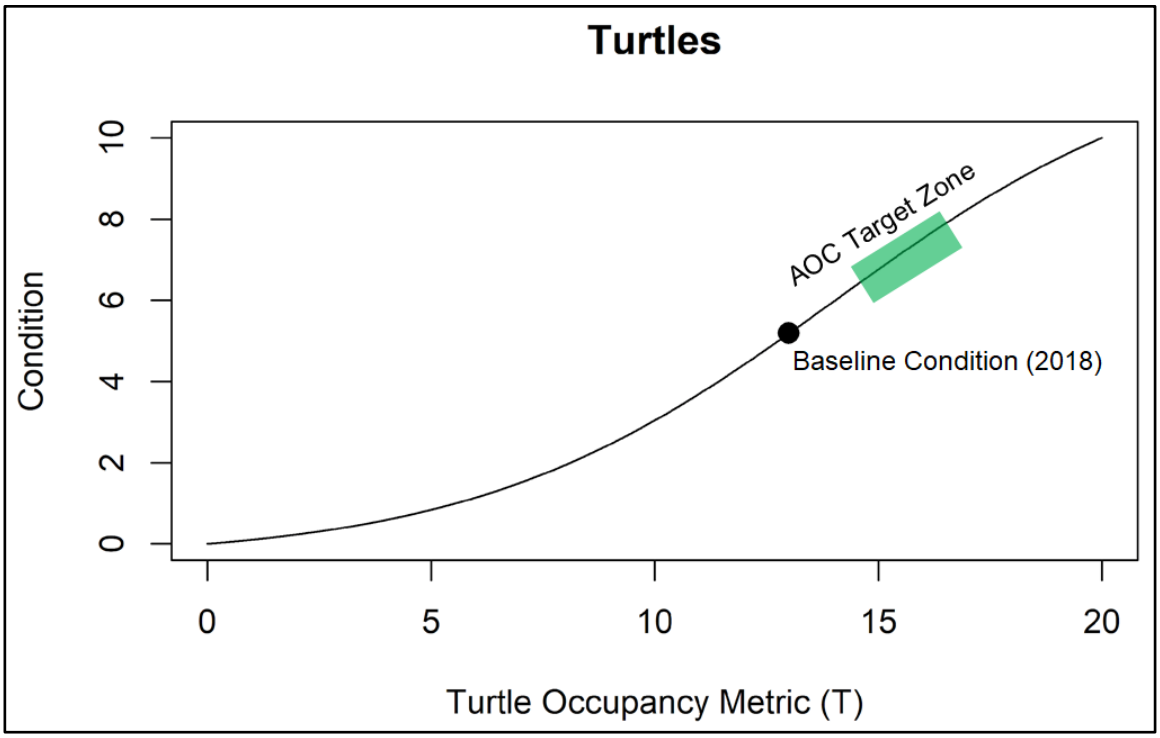


Figure 3.10. The Turtle Occupancy Metric (T), is the summed total number of sites that snapping turtles (*Chelydra serpentina*), painted turtles (*Chrysemys picta*), and any uncommon or rare turtle species (e.g., spiny softshell, *Apalone spinifera*) are reported in the Lower Green Bay and Fox River Area of Concern. T ranges from 0 (no turtles) to 21 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). The baseline condition score was determined through expert knowledge on turtle occupancy in the LGBFR AOC; going forward it will be determined via field surveys described below. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Turtle experts met with UW-Green Bay and WDNR staff on 6 March 2019 to discuss the development of a metric and monitoring strategy for this population group. They discussed different possible sampling methods of turtles, including trapping and nest searches to quantify reproduction and age-classes as well as visual surveys, though no uniform sampling method accurately surveys all possible turtles. Trapping and nest searching are also labor, time, and financially intensive. Because of how tolerant and common they are, snapping and painted turtles should occur at all 6 sites. Conversely, Blanding's, spiny softshell, and wood turtles are less common in the LGBFR AOC and have low detection probabilities (spiny softshell turtles, for example, can be somewhat cryptic). Wood turtles are a Wisconsin state-threatened species. As a result, Turtles as a population group will not be greatly penalized if only the two common turtle species (snapping and painted) are reported at all 6 sites but only a few of the less common or rare turtles are found. Turtle experts have indicated that with enhancement projects, spiny softshell turtles could potentially be found at all 6 sites (e.g., Fox River) and Blanding's at half of the sites (e.g., west shore, Bay Beach). One of the only places wood turtles might occur in the LGBFR AOC is Duck Creek since they are more sensitive and prefer cleaner streams.

Assessment Method: This group will be monitored by a contractor through visual basking or swimming turtle surveys within each of the 6 sites in the LGBFR AOC. Fisheries data collected by groups such as the USFWS and WDNR, WDNR turtle road crossing surveys, and other

incidental reports (e.g., other wildlife monitoring, driving surveys, roadkill reports, nesting records) will also help supplement this dataset. The best time to document or find nesting turtles is during the first couple of weeks of June. Surveys will begin in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4).

Coastal Wetland Mustelids *(Count-based Data)*

Assessment Description: This population group will be evaluated using a Mustelid Abundance Metric (M):

$$M = \left(7 \times \frac{\text{AocCPUE}_{\text{otter}}}{\text{StateCPUE}_{\text{otter}}}\right) + \left(3 \times \frac{\text{AocCPUE}_{\text{mink}}}{\text{StateCPUE}_{\text{mink}}}\right)$$

where $\text{AocCPUE}_{\text{otter}}$ is the catch per unit effort (CPUE) of North American river otter (*Lontra canadensis*) within one zip code of the Bay of Green Bay shoreline representing the LGBFR AOC, $\text{StateCPUE}_{\text{otter}}$ is the CPUE of otter across the state of Wisconsin, $\text{AocCPUE}_{\text{mink}}$ is the CPUE of American mink (*Neovison vison*) within one zip code of the Bay of Green Bay representing the LGBFR AOC, and $\text{StateCPUE}_{\text{mink}}$ is the CPUE of mink in Wisconsin. CPUE is calculated by the WDNR as the number of otter or mink trapped within a given year divided by the product of the number of traps set in one day and the total number of trap days within a given year. The ratio of LGBFR AOC CPUE to statewide CPUE for otter is weighted by 7, while this same ratio for mink is weighted by 3 (see “Rationale” below for details). These weighted ratios are then summed to equal M where $M \geq 0$. The value of M can range widely depending on whether LGBFR AOC CPUE exceeds state levels. Metric M is converted into a condition score (C) ranging from 0 to 10 (Figure 3.11). Generally, M will be less than or equal to 10, unless more otter and mink are caught in the LGBFR AOC than across the state. If $M > 10$, then $C = 10$.

Example: In a given year, if otter CPUE within the LGBFR AOC was 0.2, statewide CPUE for otter was 0.5, and mink CPUE in both the LGBFR AOC and across the state of Wisconsin were 0.5, then $M = (7 \times [0.2/0.5]) + (3 \times [0.5/0.5]) = 2.8 + 3.0 = 5.8$. For $M = 5.8$, $C = \sim 8.5$.

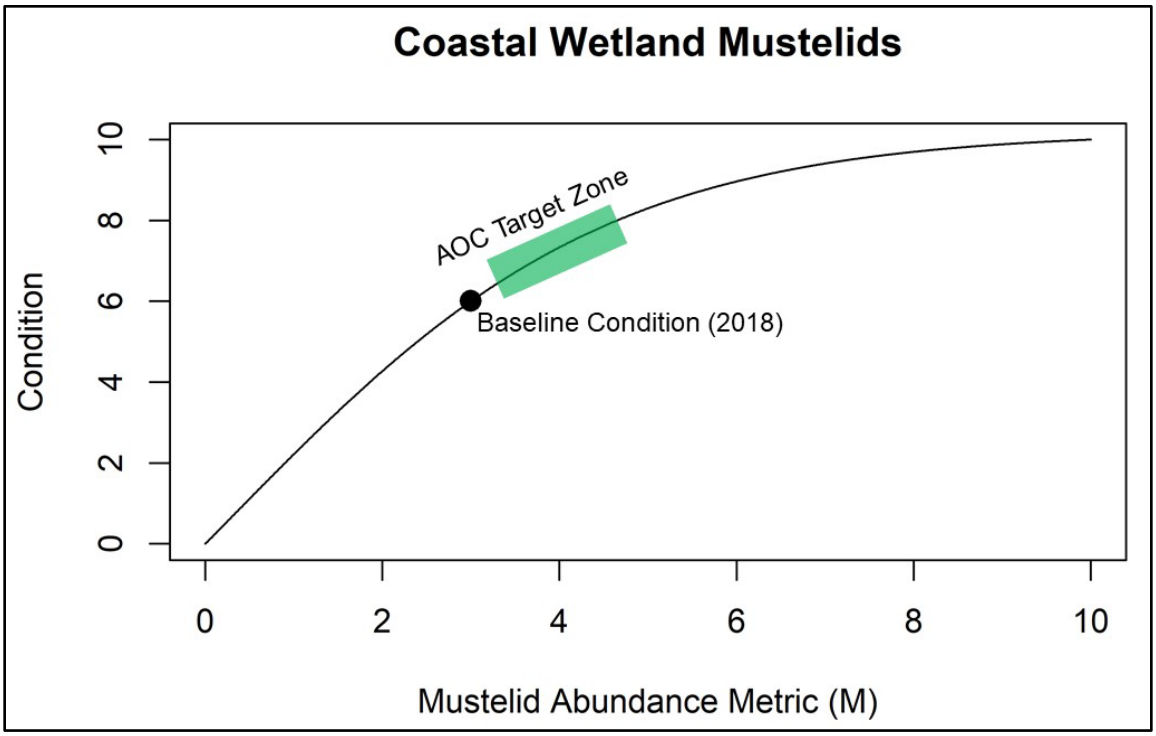


Figure 3.11. The Mustelid Abundance Metric (M), the metric used to monitor Coastal Wetland Mustelids (North American river otter [*Lontra canadensis*] and American mink [*Neovison vison*]). M ranges from 0 (no mustelids) to 10 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert opinion; going forward it will be determined via survey methods detailed below. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Local mammal experts met with UW-Green Bay and WDNR staff on 14 February 2019 to discuss the development of a metric and monitoring strategy for this population group. They discussed different possible sampling methods of both otters and mink, including the use of aerial surveys, stream crossing surveys, roadkill reports, camera traps, and furbearer trapping data, and the possibility of developing an index that combined several of these methodologies. An index that incorporated multiple field methodologies, however, would likely be expensive and time consuming. State mammal expert, Brian Dhuey from the WDNR, suggested this simpler CPUE approach described here. CPUE allows one to control for uneven sampling effort for each species and annual fluctuations in fur prices. According to local mammal experts, mink populations are generally intact, while otter numbers are lower in the LGBFR AOC than they used to be historically, which is why otter is weighted higher (7) than mink (3) in the Mustelid Abundance Metric. Otter are also bigger in size and require larger territories. Once a narrative using this CPUE approach was written, local mammal experts reviewed it and fully endorsed this new strategy, including supporting the otter and mink weightings in the metric.

Assessment Method: Starting in 2028, WDNR annual otter trapper data surveys will be used to evaluate this population group, though mink data will also need to be collected since they are not currently documented through WDNR efforts, after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4).

Muskrat *(Count-based Data)*

Assessment Description: This population group will be evaluated using a Muskrat Abundance Metric (Mk):

$$Mk = \frac{AocCPUE_{muskrat}}{StateCPUE_{muskrat}}$$

where $AocCPUE_{muskrat}$ is the catch per unit effort (CPUE) of Muskrats (*Ondatra zibethicus*) within one zip code of the Bay of Green Bay shoreline representing the LGBFR AOC and $StateCPUE_{muskrat}$ is the CPUE of Muskrats across the state of Wisconsin where Mk ≥ 0. CPUE is calculated by the WDNR as the number of Muskrats trapped within a given year divided by the product of the number of traps set in one day and the total number of trap days within a given year. Metric Mk is converted into a condition score (C) ranging from 0 to 10 (Figure 3.12). The value of Mk generally ranges between 0 and 1 unless LGBFR AOC CPUE exceeds state levels (i.e., Mk > 1). If Mk > 1, then C = 10.

Example: In a given year, if muskrat CPUE within the LGBFR AOC was 0.8 and statewide CPUE was 0.9, then Mk = (0.8/0.9) = 0.89. For Mk = 0.89, C = ~9.5.

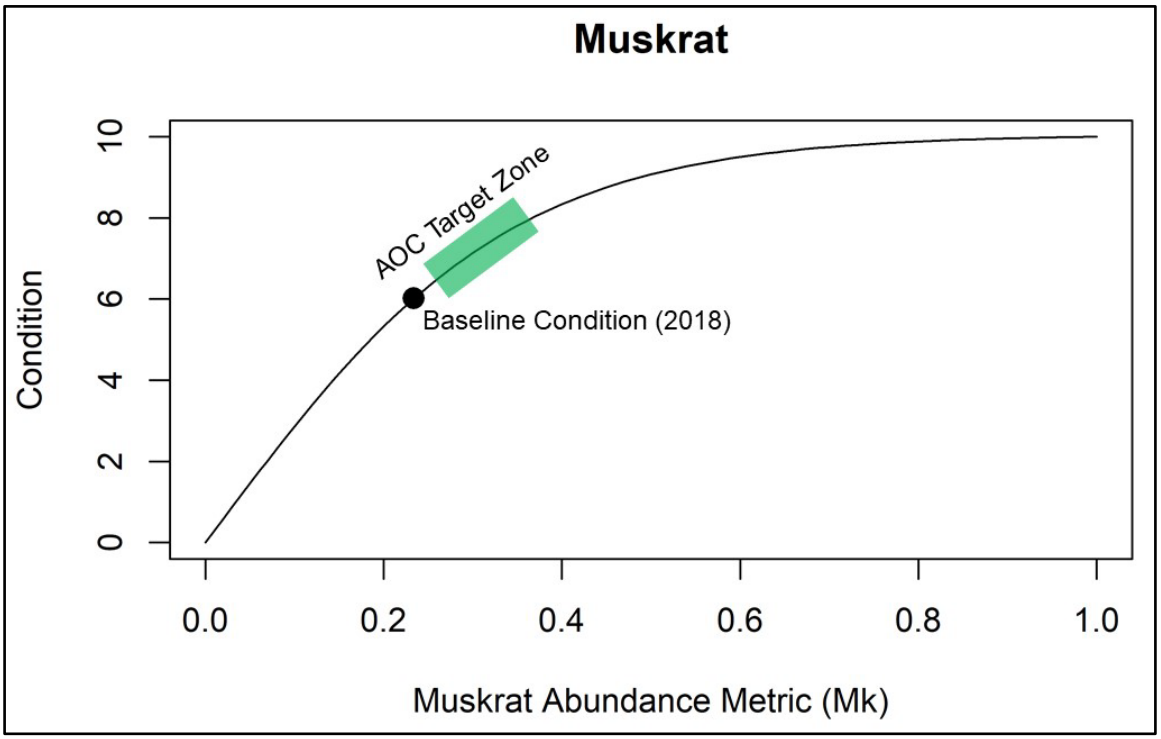


Figure 3.12. The Muskrat Abundance Metric (Mk), the metric used to monitor Muskrats (*Ondatra zibethicus*), ranges from 0 (no mustelids) to 1 (ideal condition). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert opinion; going forward it will be determined via survey methods detailed below. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Local mammal experts met with UW-Green Bay and WDNR staff on 14 February 2019 to discuss the development of a metric and monitoring strategy for this population

group. They discussed the possibility of monitoring Muskrats by counting Muskrat structures using satellite imagery and estimating densities; however, this method can be challenging since Muskrats do not continuously use the same structure year after year, and it may be too time consuming and expensive to conduct this type of assessment. State mammal expert, Brian Dhuey from the WDNR, suggested this simpler CPUE approach described here. CPUE allows one to control for uneven sampling effort for each species and annual fluctuations in fur prices. Once a narrative using this CPUE approach was written, local mammal experts reviewed it and fully supported this new strategy.

Assessment Method: WDNR annual trapper data will be used to monitor and evaluate this population group starting in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4).

Shorebirds (breeding) *(Count-based Data)*

Assessment Description: This population group will be evaluated using a Shorebirds (breeding) Occupancy Index (Sb):

$$Sb = sites_{killdeer} + sites_{spotted} + sites_{rare1} + \ldots\ldots + sites_{rare\text{-}x}$$

where Sb is the summed total number of sites that Killdeer (*Charadrius vociferus*), Spotted Sandpiper (*Actitis macularius*), and any rare shorebird species (=rare1 to rare-x) are each documented as breeding at a maximum of 4 sites per species within the LGBFR AOC where Sb ≥ 0. Breeding shorebirds will be monitored at the following 4 sites: 1) Cat Island Wave Barrier, 2) Longtail Point, 3) Point au Sable, and 4) any other unspecified site within the LGBFR AOC (e.g., UW-Green Bay campus). Rare or less common shorebird species include Piping Plover (*Charadrius melodus*), Wilson's Phalarope (*Phalaropus tricolor*), American Avocet (*Recurvirostra americana*), and others. Metric Sb is converted into a condition score (C) ranging from 0 to 10 (Figure 3.13). Generally, Sb ≤ 16 where Killdeer, Spotted Sandpiper, and at least 2 rare species (e.g., Piping Plover, Wilson's Phalarope) are documented as breeding at all 4 sites. If additional rare species are reported and T > 16, then C = 10.

Example: If Killdeer are confirmed as breeding at all of the 4 possible sites (Cat Island, Longtail Point, Point au Sable, and Bay Beach Wildlife Sanctuary), Spotted Sandpipers are breeding at 2 sites (Cat Island and UW-Green Bay campus), and 2 rare species are breeding at 1 site each (Piping Plover and Wilson's Phalarope at Cat Island), then Sb = 4 + 2 + 2 = 8 and C = 5.

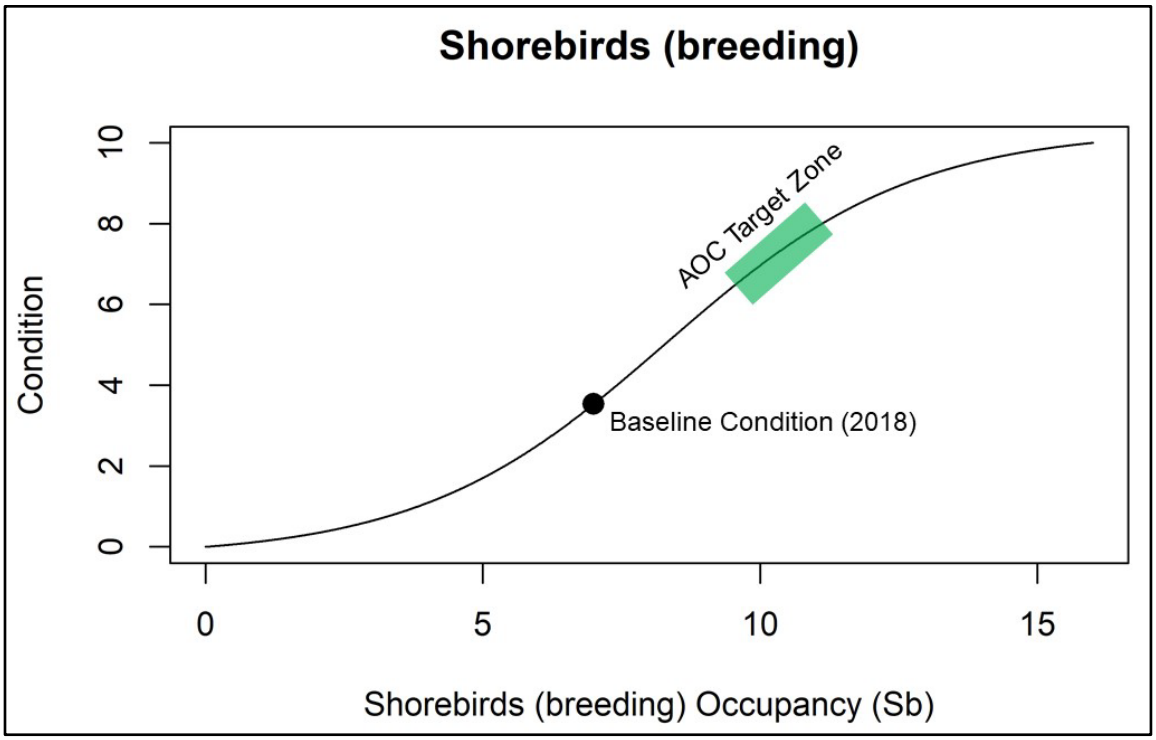


Figure 3.13. The Shorebirds (breeding) Occupancy Index (Sb), the metric used to monitor breeding shorebirds, is the summed total number of sites that Killdeer (*Charadrius vociferus*), Spotted Sandpiper (*Actitis macularius*), and any rare shorebird species (e.g., Piping Plover, *Charadrius melodus*) are documented as breeding in the Lower Green Bay and Fox River Area of Concern. Sb ranges from 0 (no breeding shorebirds) to 16 (ideal condition where Killdeer, Spotted Sandpiper, and 2 rare species are reported breeding at 4 monitoring sites). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was based on data collected during the Wisconsin Breeding Bird Atlas II Project (2015-2019); going forward it will be determined using these same atlasing field methods. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Bird experts from multiple agencies and organizations met with UW-Green Bay and WDNR staff on 29 April 2019 to discuss the development of a metric and monitoring strategy for this population group. Originally, Piping Plover was its own population group, and Spotted Sandpiper and Killdeer were a part of the Coastal Birds (breeding) group. However, participants expressed concern about Piping Plover being its own population group because it is a single species, listed as endangered, and thus affected by potential outside factors that are independent of work conducted in the LGBFR AOC. Therefore, the group proposed to create a new group of breeding shorebirds that includes more than just nesting Piping Plover but instead multiple shorebird species that nest in similar substrates. Breeding shorebird species, Wilson's Snipe (*Gallinago delicata*), was excluded from this group because it nests in marshes and is in the Marsh Breeding Birds population group. The group of bird experts initially discussed developing an IEC for this population group that would be based on point count surveys; however, the Metrics Team decided to simplify the metric by using a count-based approach as described here that also requires the documentation of breeding, which is better than presence/absence data collected using point counts. Current condition (C = 3.5) is based on data collected during the Wisconsin Breeding Bird Atlas II Project (2015-2019), in which the following species bred at

each of the 4 sites: Cat Island Wave Barrier (Killdeer, Spotted Sandpiper, Piping Plover, and Wilson's Phalarope), Longtail Point (Spotted Sandpiper), Point au Sable (no breeding confirmations of any of these shorebird species), and Killdeer and Spotted Sandpiper nesting at other locations in the LGBFR AOC (Sb = 7, C = 3.5). In the future, Killdeer and Spotted Sandpiper would almost certainly nest at Point au Sable (since they have in the past), Piping Plover (under the right conditions) might nest at Longtail Point or Point au Sable, and another rare breeding shorebird might nest at a site in the LGBFR AOC.

Assessment Method: Following the general atlasing protocol used in the Wisconsin Breeding Bird Atlas II Project (WBBA2), which was completed in 2015-2019, breeding shorebirds (excluding Piping Plover) will be monitored by contracted bird biologists at four sites in the LGBFR AOC (Cat Island, Longtail Point, Point au Sable, and any other unspecified site within the LGBFR AOC [e.g., UW-Green Bay campus]) during the summer, roughly late May through mid-late July (Appendix 6). Atlasing surveys will begin in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4). The goal of general atlasing is to search for and document breeding behavior of birds in a specified area. In order to document breeding for the Shorebirds (breeding) group, one must confirm breeding by observing any number of behaviors, including but not limited to: 1) giving a distraction display (e.g., feigning a broken wing), 2) occupying/incubating a nest, 3) finding recently fledged young, 4) finding a nest with eggs, or 5) finding a nest with young (see complete list of "Confirmed" breeding codes in Appendix 6). As soon as a species is confirmed at least once at 1 of the 4 sites, the observer can continue documenting breeding activity for the other species. Because of its endangered status, Piping Plovers will be extensively monitored by the USFWS with assistance from the WDNR, UW-Green Bay, and others. Plovers are checked daily to document egg laying, incubation, and chick hatching and fledging.

Coastal Birds (breeding) *(Count-based Data)*

Assessment Description: This population group will be evaluated using a Coastal Birds Metric (Cb):

$$Cb = sites_{king} + sites_{green} + sites_{tree} + sites_{cliff} + sites_{other}$$

where Cb is the summed total number of sites that Belted Kingfisher (*Megaceryle alcyon*; =king), Green Heron (*Butorides virescens*; =green), Tree Swallow (*Tachycineta bicolor*; = tree), Cliff Swallow (*Petrochelidon pyrrhonota*; =cliff), and 1 of 3 other species (=other; Purple Martin [*Progne subis*], Bank Swallow [*Riparia riparia*], or Northern Rough-winged Swallow [*Stelgidopteryx serripennis*]) are each documented as breeding at a maximum of 3 sites per species within the LGBFR AOC where $0 \leq Cb \leq 15$. Breeding coastal birds will be monitored within the following 3 areas/sites: 1) west shore of the bay, 2) east shore of the bay, and 3) Fox River. Metric Cb is converted into a condition score (C) ranging from 0 to 10 (Figure 3.14). When counting breeding records for the 3 "other" possible species, a site gets counted if 1 or more of the 3 species are found breeding within that same site/area. The maximum number of sites that can be included in Cb in the "other" category is 3.

Example: If Belted Kingfisher is confirmed as breeding at 1 of the 3 possible sites (Bay Beach Wildlife Sanctuary along the east shore), Green Heron is confirmed as breeding at 1 site (Barkhausen Waterfowl Preserve along the west shore), Tree Swallows are confirmed as breeding at 3 sites (Abbey Pond on the Fox River, Point au Sable on the east shore, and Longtail Point on the west shore), Cliff Swallow is confirmed as breeding at 2 sites (under the Highway 172 bridge along the Fox River and under I-41 bridge on the west shore), and Purple Martin and Northern Rough-winged Swallow are both found breeding at different sites along the west shore, then Cb = 1 + 1 + 3 + 2 + 1 = 8 and C = ~4.5. Each of the "other" species do not get counted twice as breeding along the west shore.

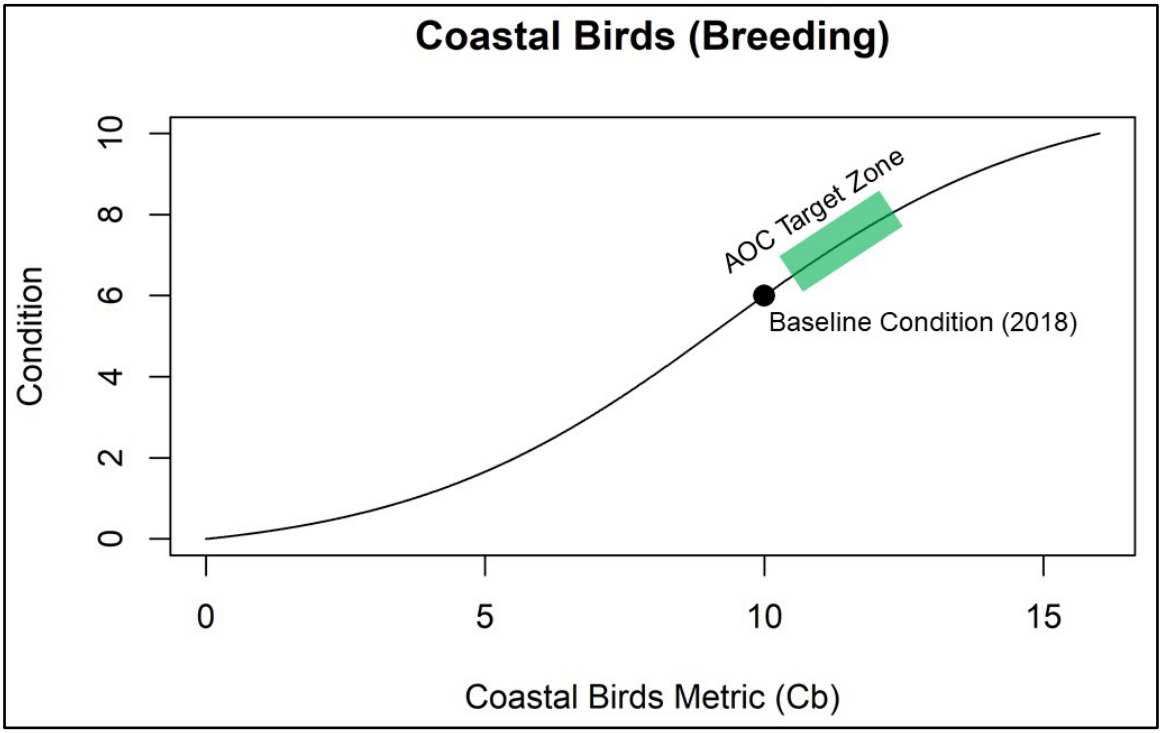


Figure 3.14. The Coastal Birds Metric (Cb), the metric used to monitor breeding shorebirds, is the summed total number of sites that Belted Kingfisher (*Megaceryle alcyon*), Green Heron (*Butorides virescens*), Tree Swallow (*Tachycineta bicolor*), Cliff Swallow (*Petrochelidon pyrrhonota*), and 1 of 3 other species (Purple Martin [*Progne subis*], Bank Swallow [*Riparia riparia*], or Northern Rough-winged Swallow [*Stelgidopteryx serripennis*]) are each documented as breeding at a maximum of 3 sites per species within the Lower Green Bay and Fox River Area of Concern. Cb ranges from 0 (no breeding coastal birds) to 15 (ideal condition where Belted Kingfisher, Green Heron, Tree Swallow, Cliff Swallow, and some other less common species are reported breeding at 3 monitoring sites). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was based on data collected during the Wisconsin Breeding Bird Atlas II Project (2015-2019); going forward it will be determined using these same atlasing field methods. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Coastal Birds (breeding) consists of aerial foraging birds (e.g., swallows) and fish-eating birds but excludes Colonial Waterbirds, Wetland Terns, Osprey, and Bald Eagle. Because the included species have a variety of nesting strategies, the metrics team decided that using the atlasing protocol and counting sites would be simpler and easier than creating an IEC

metric. Monitoring large study areas (west shore, east shore, and Fox River) were chosen over single sites because this group of species has very different nesting strategies. Selecting single sites might make it impossible to document breeding for all possible species because of a lack of appropriate habitat. Tree Swallow and Cliff Swallow were chosen over the other swallow/martin species because they are easier to document breeding behavior but each fill different nesting niches. For example, Tree Swallows are cavity nesters (using natural cavities in trees or nest boxes), while Cliff Swallows build mud nests under bridges and on cliffs/buildings (Barn Swallows fill the same niche but tend to inhabit more agricultural and developed areas and thus were excluded).

Assessment Method: Following the general atlasing protocol used in the Wisconsin Breeding Bird Atlas II Project (WBBA2), which was completed in 2015-2019, breeding coastal birds will be monitored by contracted bird biologists at 3 sites in the LGBFR AOC (along the west shore, east shore, and Fox River) during the summer, roughly late May through mid-late July (Appendix 6). Atlasing surveys will begin in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4). The goal of general atlasing is to search for and document breeding behavior of birds in a specified area. In order to document breeding for the Coastal Birds (breeding) group, one must confirm breeding by observing any number of behaviors, including but not limited to: 1) occupying/incubating a nest, 2) carrying nest material (e.g., mud, sticks), 3) finding recently fledged young, 4) finding a nest with eggs, or 5) finding a nest with young (see complete list of “Confirmed” breeding codes in Appendix 6; excluding finding a used nest). As soon as a species is confirmed at least once at 1 of the 3 sites, the observer can continue documenting breeding activity for the other species.

Wetland Terns *(Count-based Data)*

Assessment Description: This population group will be evaluated using the number of nesting colonies of Forster’s Terns (*Sterna forsteri*) and Black Terns (*Chlidonias niger*) that are at least 1 km apart from each other. Colony location information will be obtained from the WDNR’s annual counts of the number of nesting pairs of both species. Within the LGBFR AOC, Wetland Terns could hold at least 10 nesting colonies at the following locations: Duck Creek (2 colonies), Peters Marsh (2 colonies), Dead Horse Bay (2 colonies), Point au Sable (1 colony), Ken Euers Nature Preserve (1 colony), Tank Farm wetland (1 colony), and Cat Island Wave Barrier (1 colony). There are two conversion curves, one for Forster’s Tern, which has nested successfully in the LGBFR AOC in recent years, and one for Black Tern, which is suspected of nesting in the LGBFR AOC recently though had a tremendous presence historically (Figure 3.15). Because Black Terns are more difficult to get nesting successfully in the LGBFR AOC, condition improves by 1 if you have at least 1 Black Tern colony (top dotted curve in Figure 3.15). If you have no nesting Black Terns but 10 Forster’s Tern colonies, then the condition will be an 8. Condition can never reach a 10 unless you have at least 1 Black Tern colony and at least 10 Forster’s Tern colonies. If no Forster’s Terns are nesting in the LGBFR AOC but there is 1 Black Tern colony, then the condition will be 1. If there are >10 nesting colonies of Forster’s Tern plus 1 Black Tern colony, then C = 10.

Example: If there are 2 nesting colonies of Forster’s Terns at Duck Creek and 2 colonies in Peters Marsh with 1 nesting Black Tern colony in Dead Horse Bay, then the x-axis value is 2 + 2 = 4 for

the Forster's Tern colonies with a converted condition of 5. Because there was also 1 Black Tern nesting colony, 1 is added to the condition of 5 such that the final overall Wetland Terns' condition score is 7.

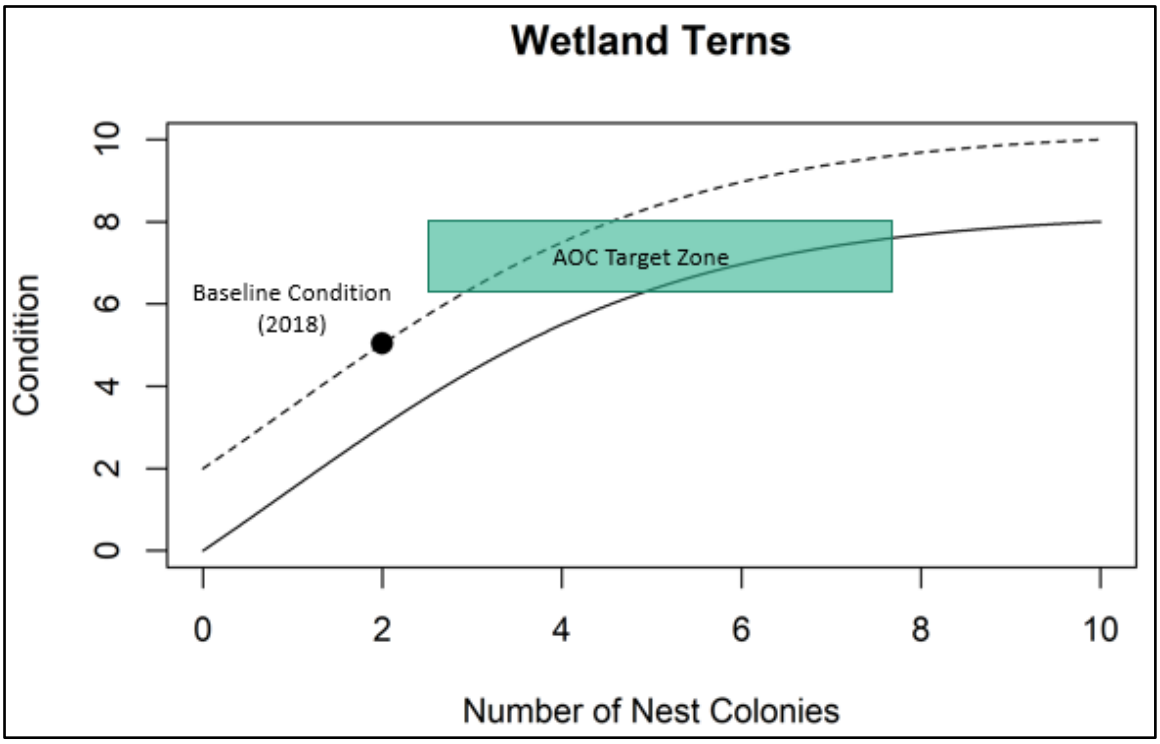


Figure 3.15. The metric for monitoring breeding Wetland Terns is the number of nesting colonies of Forster's Terns (*Sterna forsteri*) and Black Terns (*Chlidonias niger*) that are geographically located at least 1 km apart from each other within the Lower Green Bay and Fox River Area of Concern with a maximum of 10 possible nesting colonies (x-axis). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). The bottom conversion curve (solid line) is for Forster's Terns, while the top curve (dotted line) is for Black Terns (condition improves by 1 whenever at least 1 Black Tern nesting colony is found). Baseline condition was determined through local field observations made by the Wisconsin Department of Natural Resources and others; going forward it will be determined through nest colony surveys. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Bird experts from multiple agencies and organizations met with UW-Green Bay and WDNR staff on 29 April 2019 to discuss the development of a metric and monitoring strategy for this population group. The group discussed monitoring Wetland Terns using nest counts, number of breeding pairs, and nesting colonies and weighed the pros and cons of each strategy. Counting nesting pairs and nests in dense vegetation can be logistically difficult and potentially damaging to nests, though the WDNR is already counting the number of nesting pairs of these two species. The metrics team, however, decided later to use the number of nesting colonies to avoid these logistical issues. The number of nesting pairs may also drastically fluctuate year to year due to water level changes, which is challenging when trying to track condition improvements from restoration and enhancement projects. A nesting colony could have 1-2 nesting pairs or a dozen, which documents presence more easily.

Assessment Method: WDNR annual surveys of Forster's and Black Terns will be used to evaluate this population group starting in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4). They count the number of nesting pairs, though location information from these surveys could easily be extracted and converted into the number of nesting colonies at least 1 km apart.

Bald Eagles/Osprey (breeding) *(Count-based Data)*

Assessment Description: This population group will be evaluated using the number of nests of Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*) within the LGBFR AOC. Nest information will be obtained from the WDNR's annual surveys of both species. The LGBFR AOC could likely hold no more than 10 Bald Eagle nests at the following locations (in some cases a site could hold more than 1 nest): Bay Beach Wildlife Sanctuary, Point au Sable, Brown County Fairgrounds, Ashwaubomay Memorial River Park, Longtail Point/Dead Horse Bay, Barkhausen Waterfowl Preserve, Duck Creek, and perhaps others. There are two conversion curves, one for Bald Eagle, which has nested successfully in the LGBFR AOC in recent years, and one for Osprey, which does not currently nest in the LGBFR AOC (Figure 3.16). According to a WDNR report (https://dnr.wi.gov/topic/WildlifeHabitat/documents/reports/eagleosprey_surv4.pdf), 8 Bald Eagles bred in Brown County, Wisconsin in 2018, though the WBBA2 reported roughly 4-5 nests within the LGBFR AOC boundaries during 2015-2019. Although Osprey do not currently nest in the LGBFR AOC, they have successfully nested nearby at the Izaak Walton League's Osprey Point property in Ledgeview in 2015 (WBBA2), have tried building a nest at Bay Beach Wildlife Sanctuary in 2019 (WBBA2), and have been reported during the breeding season at multiple locations throughout the LGBFR AOC (e.g., UW-Green Bay campus, along the Fox River, Point au Sable, Barkhausen Waterfowl Preserve) according to WBBA2 and eBird records (eBird 2019). Because Osprey are more difficult to get nesting successfully in the LGBFR AOC, condition improves by 2 if there is at least 1 Osprey nest (second curve in Figure 3.16). If there are no nesting Osprey but 10 Bald Eagle nests, then the condition will be an 8. Condition can never reach a 10 unless there is at least 1 Osprey nest and 10 Bald Eagle nests. If Bald Eagles do not nest in the LGBFR AOC but there is 1 Osprey nest, then the condition is 2.

Example: If there are 6 Bald Eagle nests and 1 Osprey nest in the LGBFR AOC, then the x-axis value is 6 for the Bald Eagle nests with a converted condition of 6. Because 1 Osprey nest was reported, 2 is added to the condition of 6 such that the final overall condition score of Bald Eagles/Osprey (breeding) is 8.

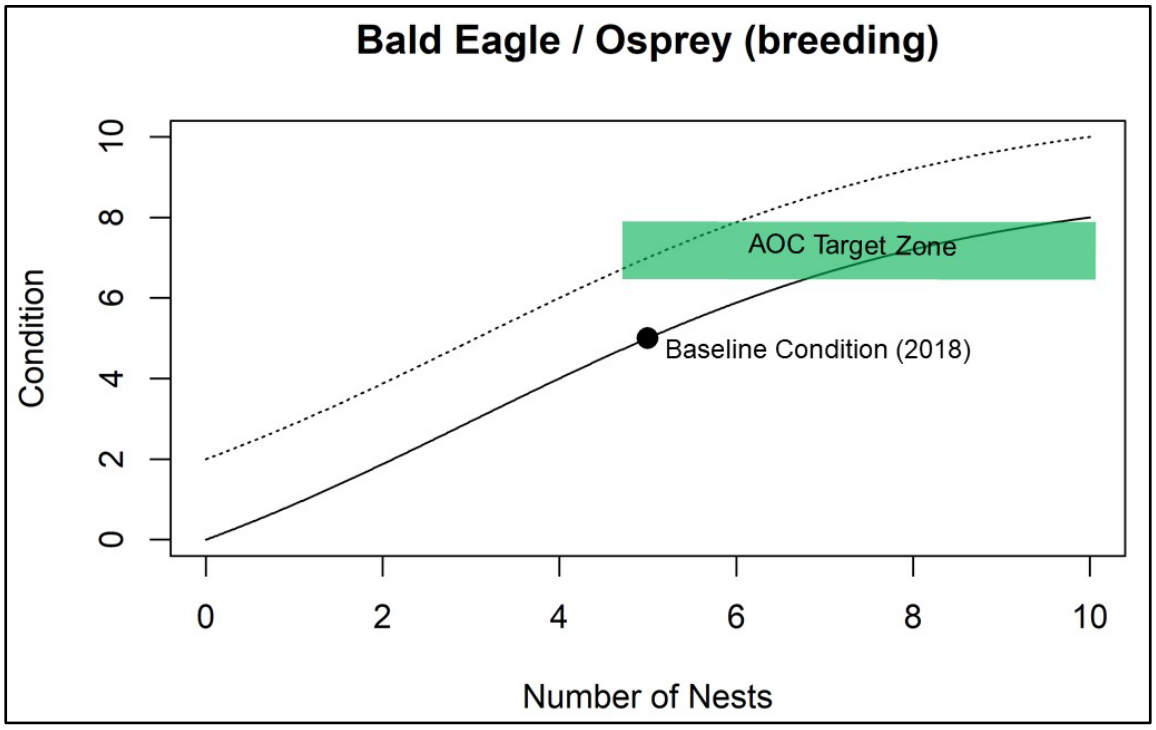


Figure 3.16. The metric for monitoring breeding Bald Eagles (*Haliaeetus leucocephalus*)/Osprey (*Pandion haliaetus*) is the number of nests in the Lower Green Bay and Fox River Area of Concern with a maximum of 10 possible nests (x-axis). The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). The bottom conversion curve (solid line) is for Bald Eagles, while the top curve (dotted line) is for Osprey (condition improves by 2 whenever at least 1 Osprey nest is found). Baseline condition was determined through local field observations from multiple sources; going forward it will be determined through nest surveys. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Bird experts from multiple agencies and organizations met with UW-Green Bay and WDNR staff on 29 April 2019 to discuss the development of a metric and monitoring strategy for this population group. The group discussed whether it was more appropriate to monitor nests or count the number of individuals seen using the LGBFR AOC, such as those birds that spend their summers feeding in this area but not breeding. They decided that nesting birds would provide more information to the LGBFR AOC Program since it measures reproduction and the ultimate use of this area. Plus, counting nests is somewhat easy since they are large and visible. The group originally discussed capping the number of Bald Eagle nests at 20; however, the metrics team met later and does not think that this system can or should hold that many nests. There is an upper limit on the number of Bald Eagles this system can meet, especially since they consume and use resources that some of our other fish and wildlife population groups rely on. The LGBFR AOC can likely only support 1 or 2 Osprey nests given that Bald Eagles and Osprey may compete with each other for food resources, territories, and nest sites.

Assessment Method: WDNR annual surveys of Bald Eagle and Osprey nests will be used to evaluate this population group starting in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4).

Stream Macroinvertebrates *(Count-based Data)*

Assessment Description: This population group will be evaluated in Wequiock Creek, Mahon Creek, two unnamed tributaries located on the east shore, Ashwaubenon Creek, and Dutchman Creek using the Citizen Monitoring Biotic Index Samples at each of the aforementioned sampling sites should be collected within the same 300' stream section targeting riffles, undercut banks, and snag/woody areas. All macroinvertebrates found in the samples must be identified to at least Family in order to calculate a Citizen Monitoring Biotic Index value. The average Citizen Monitoring Biotic Index across all six survey sites will be used to determine this population group's condition. Typically, Citizen Monitoring Biotic Index scores range from 1.0 to 2.0, which is defined as a stream in "poor" health, scores between 2.1 and 2.5 are defined as "fair," and scores between 2.6 and 3.5 are defined as "good." However, the Citizen Monitoring Biotic Index for this metric ranges from 1.0 to 2.5 or from "poor" to "fair" in order to most accurately reflect what one can expect from the stream macroinvertebrate community in samples collected within 1 km of the LGBFR AOC boundary (Figure 3.17).

Example: If the average Citizen Monitoring Biotic Index across all 6 sites is a 2.1 (value along the x-axis), then the 2.1 value is converted to a condition score of ~8.

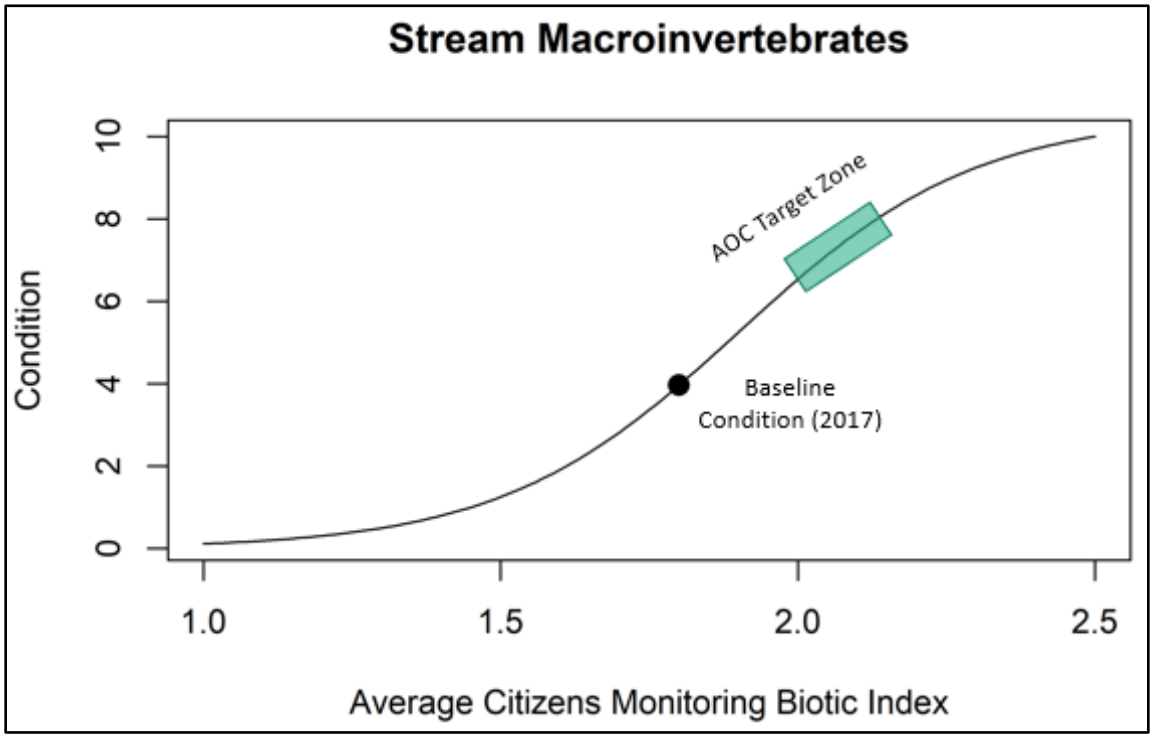


Figure 3.17. Stream Macroinvertebrates conversion curve, which uses the Citizen Monitoring Biotic Index metric that ranges from 1.0 to 2.5. The y-axis is this population's converted condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through surveys conducted in 2019. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Stream macroinvertebrate experts met with UW-Green Bay and WDNR staff on 2 April 2019 to discuss the development of a metric and monitoring strategy for this population group. Various monitoring protocols (kicknet and Hester-Dendy), survey areas

(wadeable and non-wadeable), and biotic indices (M-IBI vs. H-IBI) were discussed and generally agreed upon as being potentially inappropriate given the setting of where the monitoring would occur (i.e., within 1 km of the LGBFR AOC boundary). Typically, stream macroinvertebrate surveys are conducted in higher reaches of streams, and in this case, stream sites within 1 km of the LGBFR AOC boundary are heavily influenced by seiche dynamics, often do not have the habitat types targeted for surveys (rock substrates), and are deeper than what is typically targeted for wadeable surveys. It was determined at that meeting that the best approach would be to conduct baseline surveys in various WDNR mapped tributaries within the 1 km boundary and make a determination on monitoring protocol, survey areas, and biotic index to utilize as the metric. Baseline Hester-Dendy surveys were conducted from July to September 2019 in Duck Creek, Dutchman Creek, Ashwaubenon Creek, and East River, and baseline kicknet surveys were completed on 30 September and 1 October 2019 at various mapped LGBFR AOC tributaries. Results of the kicknet surveys indicated that WDNR-mapped tributaries on the west shore do not appropriately reflect a stream macroinvertebrate community within the 1 km boundary and that kicknet surveys should only be completed in wadeable areas of Wequiock, Mahon, the two unnamed east shore tributaries, Ashwaubenon Creek, and Dutchman Creek. The Citizen Biotic Monitoring Index was chosen because it allows comparisons under variable site conditions experienced in the selected AOC tributaries (multiple habitat types sampled using this protocol) and the protocol is cost-effective and efficient. Hester-Dendy samplers in non-wadeable sites can also be used to expand the dataset but are not required to determine population condition, as this method is not directly comparable to the Citizen Monitoring Biotic Index. The average kicknet HBI score in 2019 was determined to be ~ 1.8 or “poor,” and the LGBFR AOC Target Zone is to obtain a score of greater than or equal to a 2.0 or “fair.” The full Citizen Biotic Monitoring Index scale is not included in the metric as stream macroinvertebrate experts did not think that getting a score above the 2.5 or “fair” is an achievable target for the LGBFR AOC.

Assessment Method: Kicknet surveys targeting riffles, undercut banks, snags/woody debris, and leaf packs at six wadeable sites in the LGBFR AOC will be used to evaluate this population group by a contractor. Hester-Dendy samples can also be included in calculating a Non-wadeable MIBI score at non-wadeable sites but is not necessary for generating the overall population group condition score. Surveys will begin in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4).

Coastal Terrestrial Macroinvertebrates *(Designated Habitat Area)*

Assessment Description: This population group will be evaluated using the number of Designated Habitat Areas (DHAs) for Coastal Terrestrial Macroinvertebrates (CTM) where 10 DHAs equals a condition score of 10 (Figure 3.18). To meet the needs of targeted CTM groups, including tiger beetles, butterflies, bees, and other invertebrates, a minimum of three CTM DHAs of each of three critical habitat types (Great Lakes beach, marsh/sedge meadow, and upland) must be included to attain a condition score of 10. When appropriate, a DHA may consist of a cluster of smaller, individual landscape units that together, increase overall habitat connectivity. In addition to the general guidelines for DHAs, each CTM DHA must have a site-specific management plan, which includes the following:

1. A list of targeted CTM species to benefit from the DHA. This should include relevant biological criteria required for the success of the CTM species, including considerations of life stages, nesting/shelter habitat, food sources, etc. Please refer to appropriate USFWS, WDNR, or UW-Green Bay references for this information.

2. A list of appropriate seed mixtures and plant types for the DHA to meet the habitat needs of the targeted CTMs. This should include plant-specific management instructions to ensure successful integration.

3. A long-term maintenance plan featuring best management practices (timing of prescribed burns, etc.) and criteria to determine the success of the DHA during follow-up monitoring (what the site should look like based on the seed-mixture, etc.) should be included. Additionally a list of appropriate threats, such as mowing and invasive species, and a list of appropriate contacts/authorities to communicate these threats to should be included.

4. Relevant outreach information that can be displayed via signs or other dissemination platforms to increase public awareness of CTM DHAs, including site goals, benefited species, instructions to avoid threats (e.g., no spraying), etc.

CTM DHAs should cultivate partnerships with national, regional, state, and local initiatives, including but not limited to the USFWS and WDNR.

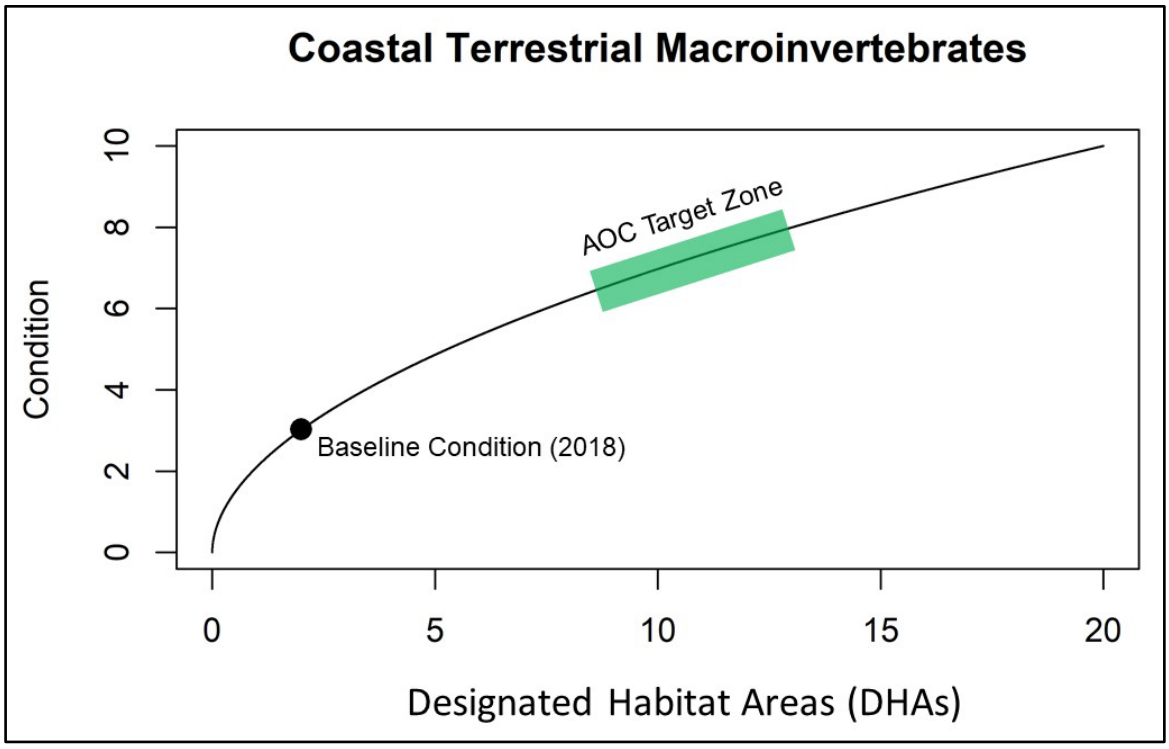


Figure 3.18. Coastal Terrestrial Macroinvertebrates assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the number of Designated Habitat Areas (DHAs) scaled from 0 to 10. The y-axis is the population group's condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert opinion; going forward it will be determined by the number of Designated Habitat Areas intended to provide habitat for coastal terrestrial macroinvertebrates established in the AOC. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Invertebrate experts met with WDNR and UW-Green Bay staff to discuss how to monitor and assess CTMs on 6 February 2019 and 20 May 2019. Due to the difficulty and uncertainty of monitoring individual CTM species, the group decided to apply the DHA concept to this population group in order to meet species' needs via appropriate seed mixtures and management plans based on expert opinions. A preliminary draft CTM DHA was presented to local experts at the 18 November 2019 TAC meeting, which was well received.

Assessment Method: CTM DHAs will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining and managing their site(s) as a Coastal Terrestrial Macroinvertebrate DHA(s) (see Chapter 4). Current and potential CTM DHA sites are provided in Appendix 7, Table A7.1.

Shorebirds (migratory) *(Designated Habitat Area)*

Assessment Description: This population group will be evaluated using the concept of a Designated Habitat Area (DHA), which aims to provide long-term protection for migratory shorebirds in the LGBFR AOC, where 5 DHAs equals a condition score of 10 (conversion curve is linear; Figure 3.19). The metric, DHA, is converted into a condition score (C) ranging from 0 to 10 along the conversion curve (Figure 3.19). Potential Migratory Shorebird DHAs include: Point

au Sable Nature Preserve, Cat Island Wave Barrier, UW-Green Bay, Longtail Point, Ken Euers Nature Preserve, Bay Beach Wildlife Sanctuary, Barkhausen Waterfowl Preserve, and Duck Creek.

Migratory Shorebird DHAs should encompass a significant area of open mudflats, sandy beach, and/or grassy meadow that are maintained as dynamic wetland systems where periodic flooding alternates with periods of exposed substrate. Ideally, Migratory Shorebird DHAs will be coastal areas where natural disturbance regimes caused by wind-driven seiches and seasonal changes in water levels produce the desired coastal feeding areas. Management actions should be timed to produce undisturbed shallow water habitats or mudflats during critical migration periods. Targets of these DHAs will be an assemblage of more than 30 shorebird species that use lower Green Bay as stopover habitat. At least 15 of these species, including the federally endangered Piping Plover (*Charadrius melodus*) and the threatened *rufa* subspecies of Red Knot (*Calidris canutus*), are listed as highly imperiled or as high continental concern. Habitat should vary among species, ranging from rocky or sandy beaches along Green Bay's east shore for Ruddy Turnstone (*Arenaria interpres*) to extensive open mudflats on the west shore for large waders like godwits (*Limosa* spp.) and Willet (*Tringa semipalmata*). Flooded meadows and beaches with short grasses or sedges also are used extensively by species like Pectoral Sandpiper (*Calidris melanotos*), dowitchers (*Limnodromus* spp.), yellowlegs (*Tringa* spp.), and others. Because of the ephemeral nature of mudflats and grassy meadows, Migratory Shorebird DHAs should extend beyond narrow coastal habitats that are suitable only during certain years or under certain conditions.

In addition to the above-mentioned general guidelines, the following best management practices must be implemented within a Migratory Shorebird DHA:

1. Remove or control invasive plant species (possibly including aggressive native species) to help maintain open feeding habitats or grassy meadows.

2. Minimize or prohibit human disturbance during peak migration periods (April-early June; late July-early October). Disturbance by domestic dogs is especially harmful and should be prohibited in the DHA.

3. Construct and display educational signage at strategic locations to increase public awareness of Migratory Shorebird DHAs and the LGBFR AOC restoration activities.

4. Try to establish heterogeneity in flooding regimes and substrates to maximize food resources (e.g., invertebrate populations).

5. When possible, reduce the risks of predation during critical migration periods by limiting access of mammalian and avian predators to feeding areas and minimizing the number of perching sites for predatory birds.

Migratory Shorebird DHAs should be coordinated among multiple agencies and programs. Shorebird management plans should be developed at large geographic scales and should be linked with private, federal, state, and local agencies, including but not limited to the U.S. Fish and Wildlife Service's Mississippi Flyway (https://www.fws.gov/birds/management/ flyways.php), Upper Mississippi and Great Lakes Joint Venture (https://umgljv.org/), Midwest Migration Network (https://midwestmigrationnetwork.org/), Wisconsin Stopover Initiative (http://www.wisconsinbirds.org/migratory/), and National Audubon's Important Bird Areas (https://www.audubon.org/important-bird-areas). Large-scale conservation plans including the North American Waterfowl Management Plan, Partners In Flight, U.S. Shorebird Conservation Plan, and North American Colonial Waterbird Conservation Plan can provide additional guidance when establishing and managing Migratory Shorebird DHAs.

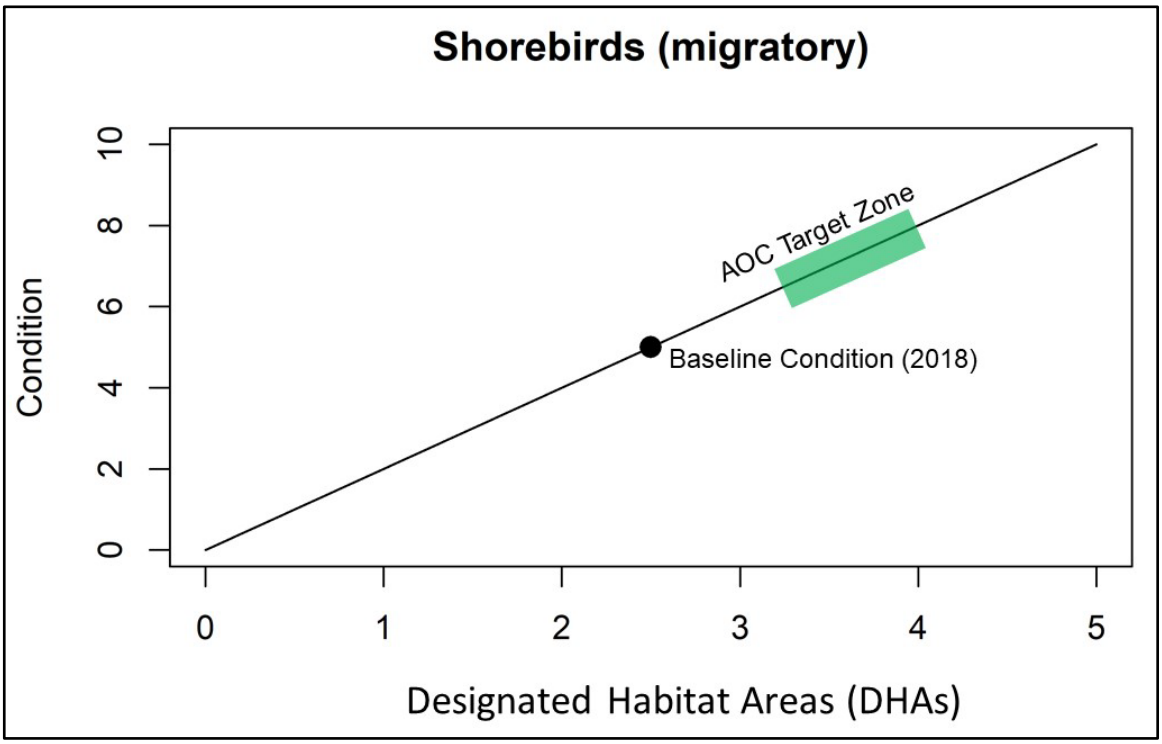


Figure 3.19. Shorebirds (migratory) assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the number of Designated Habitat Areas (DHAs) scaled from 0 to 5. The y-axis is the population group's condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert opinion; going forward it will be determined by the number of Designated Habitat Areas intended to provide habitat for migratory shorebirds established in the AOC. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Local bird experts met on 29 April 2019 to discuss this population group's metric and monitoring strategy. Originally, the group discussed monitoring Shorebirds (migratory) using point counts at multiple locations in the LGBFR AOC and building an IEC. However, the metrics team decided that a more effective strategy for improving the condition of migratory shorebirds is to create DHAs that will improve and protect critical habitat that they need during migratory stopover periods.

Assessment Method: Migratory Shorebird DHAs will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining and managing their site(s) as a Migratory Shorebird DHA(s) (see Chapter 4). Current and potential CTM DHA sites are provided in Appendix 7, Table A7.2.

Landbirds (migratory) *(Designated Habitat Area)*

Assessment Description: This population group will be evaluated using the concept of a Designated Habitat Area (DHA), which aims to provide long-term protection for migratory landbirds in the LGBFR AOC, where 10 DHAs equals a condition score of 10 (Figure 3.20). The metric, DHA, is converted into a condition score (C) ranging from 0 to 10 along the sigmoid conversion curve (Figure 3.20). A Migratory Landbird DHA should encompass several acres of natural or semi-natural habitat and be managed for the benefit of migratory landbird species, which include woodpeckers, cuckoos, nightjars, hummingbirds, and perching birds (Order Passeriformes) that use terrestrial habitats as migratory stopover habitat during spring (15 April-31 May) or fall migration (1 September-15 October). A Migratory Landbird DHA must fall within the boundaries of an existing National Audubon Important Bird Areas (IBA; https://www.audubon.org/important-bird-areas) or WDNR Natural Heritage Inventory Migratory Bird Concentration Site whenever possible. In addition to the general guidelines for DHAs, the following best management practices must be implemented at a site for it to be classified as a Migratory Landbird DHA:

1. Invasive plant species should be removed or controlled to help promote the establishment of native understory vegetation. In particular, non-native understory species like buckthorn (*Rhamnus cathartica* and *Frangula alnus*), invasive honeysuckles (*Lonicera* spp.), and garlic mustard (*Alliaria petiolata*) should be removed.

2. Native trees and shrubs should be planted when needed. Examples of desirable native species include wild grape (*Vitis riparia*), dogwood (*Cornus* spp.), cherry (*Prunus* spp.), willow (*Salix* spp.), and others, especially fruiting shrubs for food during fall migration and plants that improve insect abundance during spring migration.

3. Maintain roost/den trees in forests or woodlands.

4. Manage vegetation to create multi-layer habitat structure (e.g., canopy, sub-canopy, ground). DHAs might be developed in grasslands, shrublands, and forested habitats or a mosaic of these habitats.

5. Construct and display outreach and educational signage to increase public awareness of Migratory Landbird DHAs and the LGBFR AOC restoration activities.

Migratory landbird DHAs should also cultivate partnerships with national, regional, state, and local initiatives, including but not limited to, the U.S. Fish and Wildlife Service's Mississippi Flyway (https://www.fws.gov/birds/management/flyways.php), Upper Mississippi and Great Lakes Joint Venture (https://umgljv.org/), Midwest Migration Network

(https://midwestmigrationnetwork.org/), Wisconsin Stopover Initiative (http://www.wisconsinbirds.org/migratory/), and National Audubon's IBAs (https://www.audubon. org/important-bird-areas).

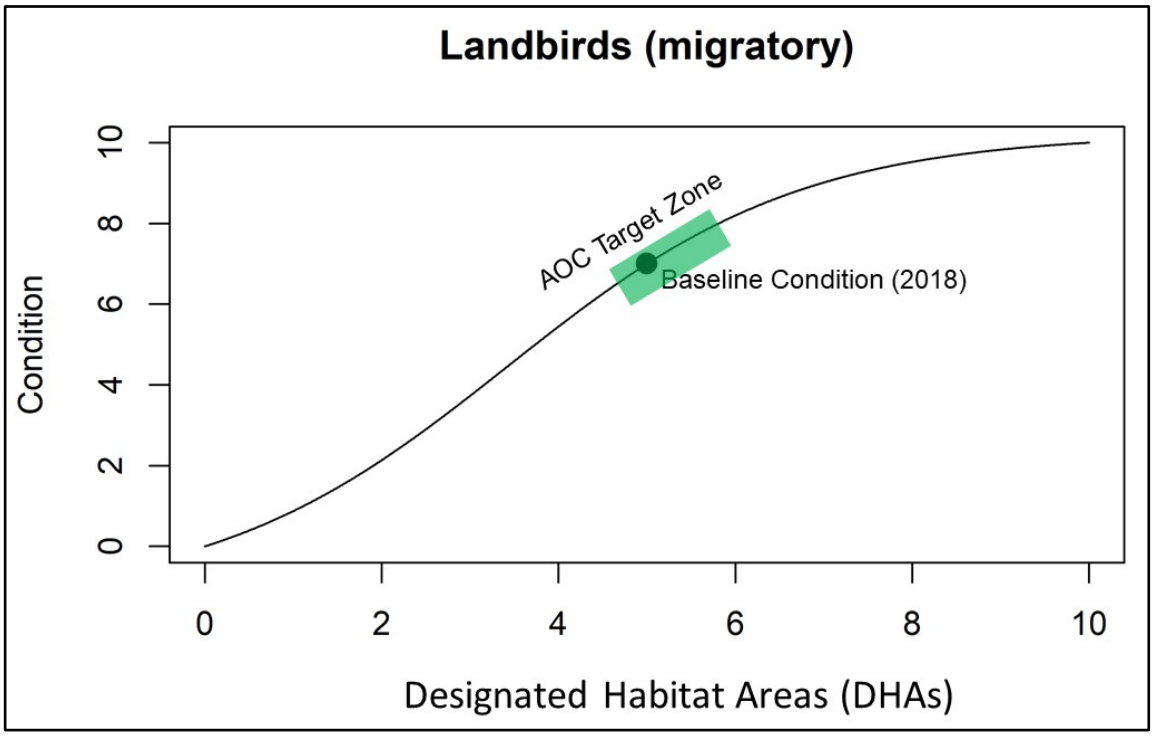


Figure 3.20. Landbirds (migratory) assessment for the Lower Green Bay and Fox River Area of Concern (LGBFR AOC). The x-axis represents the number of Designated Habitat Areas (DHAs) scaled from 0 to 10. The y-axis is the population group's condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert knowledge of important migratory landbird areas; going forward it will be determined by the number of Designated Habitat Areas intended to provide habitat for Migratory Landbirds established in the LGBFR AOC. The AOC Target Zone ranges from 6.5 to 8. Note that the baseline condition of Migratory Landbirds already falls in the AOC Target Zone; however, DHA signage and confirmation of long-term maintenance are still needed at these existing DHAs.

Assessment Rationale: Local bird experts met on 29 April 2019 to discuss this population group's metric and monitoring strategy. Originally, the group discussed monitoring Landbirds (migratory) by conducting 5-minute, unlimited-distance point counts at multiple locations within 6 migratory hotspot locations in the LGBFR AOC. They were originally going to use two conversion curves that accounted for the number of individuals and species richness based on the best counts from fall or spring. However, the metrics team decided that a more effective strategy for improving the condition of migratory landbirds is to create DHAs that will improve and protect critical habitat that they need during migratory stopover periods. A preliminary draft Migratory Landbird DHA was presented to local bird experts at the 18 November 2019 TAC meeting, which was well received. They suggested that Migratory Bird DHAs must also be located within the boundaries of an IBA or Migratory Bird Concentration Site, which was subsequently added.

Assessment Method: Migratory Landbird DHAs will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining and managing their site(s)

as a Migratory Landbird DHA(s) (see Chapter 4). Current and potential CTM DHA sites are provided in Appendix 7, Table A7.3.

Bats *(Designated Habitat Area)*

Assessment Description: This population group will be evaluated using the concept of a Designated Habitat Area (DHA), which aims to provide long-term protection for Bats in the LGBFR AOC, where 10 DHAs equals a condition score of 10 (Figure 3.21). The metric, DHA, is converted into a condition score (C) ranging from 0 to 10 along the linear, 1:1 conversion curve (Figure 3.21). Designated Habitat Areas (DHAs) aim to provide long-term protection for both migratory and breeding bats in the Lower Green Bay and Fox River Area of Concern (LGBFR AOC). Bat DHAs should encompass several acres of natural older upland and lowland forest habitat or the installation of artificial structures, such as bat houses in semi-natural areas, and be managed for the benefit of both tree and hibernaculum-dwelling bat species. In addition to the general guidelines for DHAs, the following best management practices must be implemented:

1. Forestry management practices that encourage natural edge habitat (e.g., emergent marsh v. forest) and wooded corridors along roads, trails, and watercourses to encourage bat roosting and foraging. Exotic invasive understory species like buckthorn (*Rhamnus cathartica* and *Frangula alnus*) and invasive honeysuckles (*Lonicera* spp.) should be removed or thinned along corridors.

2. Exotic burdock (*Arctium minus*) should be removed along foraging corridors as the seeds can trap bats and cause death.

3. Native snags or dying trees, trees with exfoliating bark, and large-diameter deciduous and coniferous trees should be protected and maintained when possible, particularly during the breeding season of 1 June to 15 August.

4. Ephemeral woodland pools should be protected and maintained as important foraging and water sources.

5. Known hibernaculum areas should be protected from human disturbance from 15 August to 15 May, to help discourage the spread of white-nose syndrome.

6. Artificial structures should follow construction and placement per the Wisconsin Department of Natural Resources guidance.

7. Construct and display outreach and educational signage to increase public awareness of Bat DHAs and the LGBFR AOC restoration activities.

Bat DHAs should cultivate partnerships with national, regional, state, and local initiatives, including but not limited to the U.S. Fish and Wildlife Service, Wisconsin Aquatic and Terrestrial Resources Inventory, and Midwest Bat Working Group.

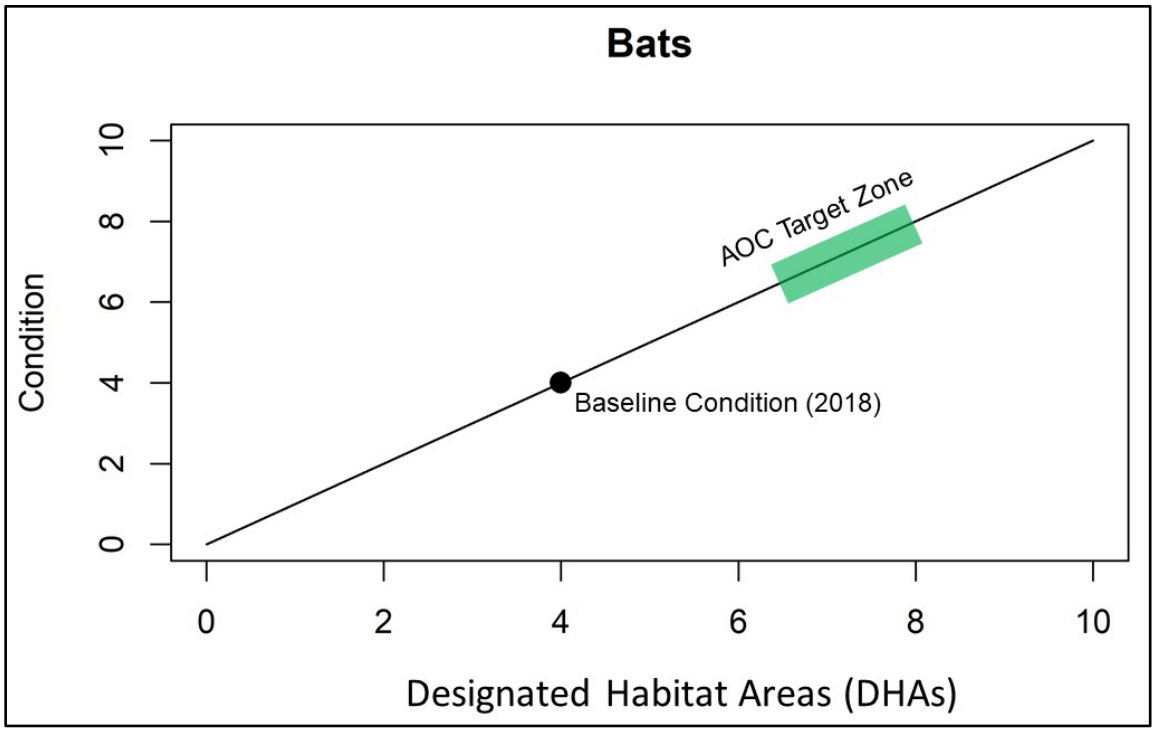


Figure 3.21. Bats assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the number of Designated Habitat Areas (DHAs) scaled from 0 to 10. The y-axis is the population group's condition ranging from poor condition (0) to good/ideal condition (10). Baseline condition was determined through expert opinion; going forward it will be determined by the number of Designated Habitat Areas intended to provide habitat for bats established in the AOC. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: The metrics team decided that an effective strategy for improving the condition of Bats is to create DHAs that will improve and protect critical habitat that they need during breeding and migratory stopover periods. A preliminary draft Bats DHA was presented to local experts at the 18 November 2019 TAC meeting, which was well received.

Assessment Method: Bat DHAs will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining and managing their site(s) as a Bat DHA(s) (see Chapter 4). Current and potential CTM DHA sites are provided in Appendix 7, Table A7.4.

Tributary Fish *(Count-based/DHA Hybrid)*

Assessment Description: This population group will be evaluated using the number of implemented Designated Habitat Areas (DHAs)/Count-based Hybrid metric approach for Tributary Fish (Figure 3.22). Tributary Fish DHAs should represent the habitat types critical for spawning, nursery, and others within tributaries by a diverse array of fishes. These habitat types include but are not limited to: various substrates (e.g., boulder, cobble, gravel etc.), coarse woody habitat, and submerged aquatic vegetation. Tributary Fish DHAs must be located within the AOC boundary (up to 1 km inland) in a tributary beginning where the natural shoreline ends (or based on expert opinion of where "tributary" habitat begins). A DHA may consist of a cluster of smaller, individual habitat units that are geographically co-located (e.g., restoring multiple submerged

aquatic vegetation patches across a given DHA) or a single, larger habitat site where appropriate (e.g., a northern pike [*Esox lucius*] spawning wetland scrape). In addition to the general guidelines for DHAs, each Tributary Fish DHA should have a site-specific management plan which includes the following:

1. A list of target species to benefit from each Tributary Fish DHA (e.g., a DHA containing coarse woody habitat placement would target centrarchids and channel catfish [*Ictalurus punctatus*] whereas a DHA containing submerged aquatic vegetation restoration would target yellow perch [*Perca flavescens*] and northern pike).

2. A habitat plan including details on the type and estimated amount of habitat to be implemented at the Tributary Fish DHA (e.g., 4 ac of substrate additions comprised of 20% cobble of size 20.3-30.5 cm [8-12”] and 80% gravel of size 2.5-7.6 cm [1-3”]). Habitat requirements of the target species, best management practices, water levels, boating, and regulations must also be considered when designing a habitat plan.

3. A monitoring plan listing target adult, juvenile/larval, and rare/sensitive fish species that will be monitored for at each DHA (see “Monitoring Plan and Resulting Dataset” section below).

4. A long-term maintenance plan considering the degradation of the Tributary Fish DHA as a result of erosion, siltation, invasive species, ice damage, water currents, etc. should also be included. This should include the life expectancy for the DHA and outline required timeframes and methods for regular maintenance.

Example: Starting at the baseline condition (x-axis DHA/count-based metric = 4, y-axis condition = 5) in Figure 3.22, if 2 new DHAs are implemented and monitoring confirms target adult species at both DHAs, then the new position on the x-axis following the curve is 7 (5 + 2 = 7) and the new position on the y-axis is 7. If monitoring also confirmed a larval or juvenile species at 1 of the 2 DHAs, an additional increase on the y-axis of 1 is added, resulting in a new condition of 8 (7 + 1 = 8). This increase of 1 is calculated by assigning a 0 to DHAs without a larval or juvenile species detected, and by assigning a 2 to DHAs with a larval or juvenile species detected (per the secondary curve) and then calculating the average ([0 + 2] / 2 = 1).

List of Tributary Fish DHA sites as well as adult, juvenile/young of year, and rare/sensitive target fish species and their respective monitoring criteria are provided in Appendix 7, Table A7.5.

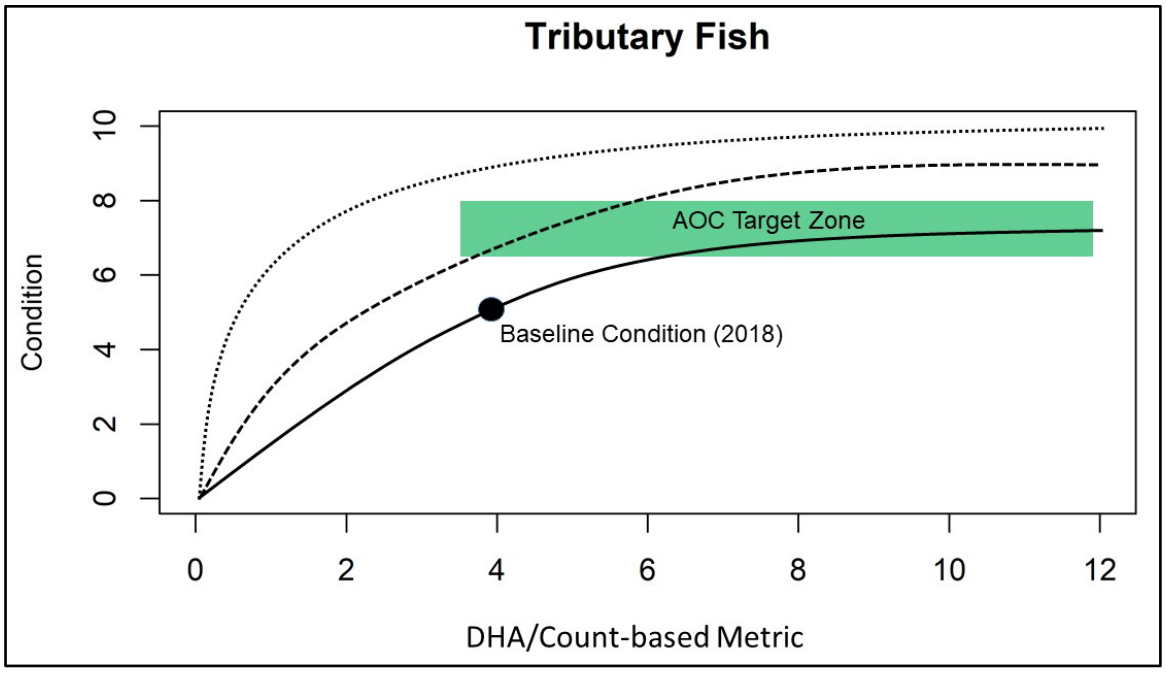


Figure 3.22. Designated Habitat Area/Count-based metric for evaluating the condition of the Tributary Fish population group. Curves represent DHA-specific criteria for adult target species (solid black line), juvenile or larval species (middle, square dotted line), and rare or sensitive species (top, small dotted line). Baseline condition was determined through expert opinion; going forward it will be determined through surveys detailed below. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Our team held multiple meetings with fish experts in 2018-2019 to discuss critical habitat needs, potential projects, and existing monitoring datasets for this group. It was decided that we could leverage monitoring data/efforts that already exist to create a robust approach, which pairs occupancy of the target species at each DHA to attempt to document if the project is meeting its design goals. Partners and experts also placed high importance on benefiting additional life stages and rare/sensitive species through DHAs. As a result, the metrics team implemented secondary and tertiary curves for these groups. While above and beyond the scope of the AOC Program, reaching these secondary and tertiary curves is not required within the AOC target zone for this population. However, as we recognize that benefits to additional life stages and occupancy by rare/sensitive species are likely to be realized in the long term, keeping these additional curves will not hinder progress towards removal targets, rather, if these longer-term goals are realized in the interim, they allow for additional condition increases towards the AOC target zone. This approach was presented to and agreed upon by the TAC on 22 October 2019.

Assessment Method: Each DHA will have a specific monitoring plan listing both an adult and additional life stage of a target species that will be monitored for determining the success of the Tributary Fish DHA. The goal of monitoring is to confirm the occupancy of a target species within the relative area of the DHA. Starting in 2028 after restoration and enhancement projects are complete, fish sampling will be conducted by the existing WDNR fisheries and USFWS Aquatic Invasive Species programs, though monitoring is flexible with respect to gear type, duration, and

season conducted, and will continue for 3 years (see Chapter 4). There may be multiple target species included for a given DHA, and the additional life stage may include any of the following where best appropriate: eggs, larval, young-of-year, or juvenile fish. A dataset and/or monitoring effort should be outlined in the DHA management plan (e.g., USFWS Aquatic Invasive Species early detection and monitoring team's fall electrofishing survey). Additionally, a rare or sensitive species must be identified for potential occupancy of each DHA.

Shoreline Fish *(Count-based/DHA Hybrid)*

Assessment Description: This population group will be evaluated using the number of implemented Designated Habitat Areas (DHAs)/Count-based Hybrid metric approach for Shoreline Fish (Figure 3.23). Shoreline Fish DHAs should represent the habitat types critical for spawning and other uses with respect to the transitory nature and seasonal use of these habitats by some shoreline fishes. These habitat types include but are not limited to: various substrates (e.g., boulder, cobble, gravel etc.), coarse woody habitat, and submerged aquatic vegetation. Shoreline Fish DHAs must be located within the LGBFR AOC boundary starting at the confluence of the Fox River and lower Green Bay. A DHA may consist of a cluster of smaller, individual habitat units that are geographically co-located (e.g., multiple boulder piles distributed across a given DHA) or a single, larger habitat site where appropriate (e.g., spawning reef). In addition to the general guidelines for DHAs, each Shoreline Fish DHA should have a site-specific management plan which includes the following:

1. A list of target species to benefit from each Shoreline Fish DHA (e.g., a DHA containing offshore boulder placement would target walleye [*Sander vitreus*], smallmouth bass [*Micropterus dolomieu*], and muskellunge [*Esox masquinongy*] whereas a DHA containing submerged aquatic vegetation restoration would target centrarchids and northern pike).

2. A habitat plan including details on the type and estimated amount of habitat to be implemented at the Shoreline Fish DHA (e.g., 4 ac of substrate additions comprised of 20% cobble of size 20.3-30.5 cm [8-12"] and 80% gravel of size 2.5-7.6 cm [1-3"]). Habitat requirements of the target species, best management practices, water levels, boating, and regulations must also be considered when designing a habitat plan.

3. A monitoring plan listing target adult, juvenile/larval, and rare/sensitive fish species that will be monitored at each DHA (see "Monitoring Plan and Resulting Dataset" section below).

4. A long-term maintenance plan considering the degradation of the Shoreline Fish DHA as a result of erosion, siltation, invasive species, ice damage, water currents, etc. should also be included. This should include the life expectancy for the DHA and outline required timeframes and methods for regular maintenance.

Example: Starting at the baseline condition (x-axis DHA/count-based metric = 3.5, y-axis condition = 4) in Figure 3.23, if 2 new DHAs are implemented and monitoring confirms target adult species at both DHAs, then the new position on the x-axis following the curve is 5.5 (3.5 + 2 = 5.5) and

the new position on the y-axis is 5. If monitoring also confirmed a larval or juvenile target species at 1 of the 2 DHAs, an additional increase on the y-axis of 1 is added, resulting in a new condition of 6 (5 + 1 = 6). This increase of 1 is calculated by assigning a 0 to DHAs without a larval or juvenile species detected, and by assigning a 2 to DHAs with a larval or juvenile species detected (per the secondary curve) and then calculating the average ([0 + 2] / 2 = 1).

List of Shoreline Fish DHA sites as well as adult, juvenile/young of year, and rare/sensitive target fish species and their respective monitoring criteria are provided in Appendix 7, Table A7.6.

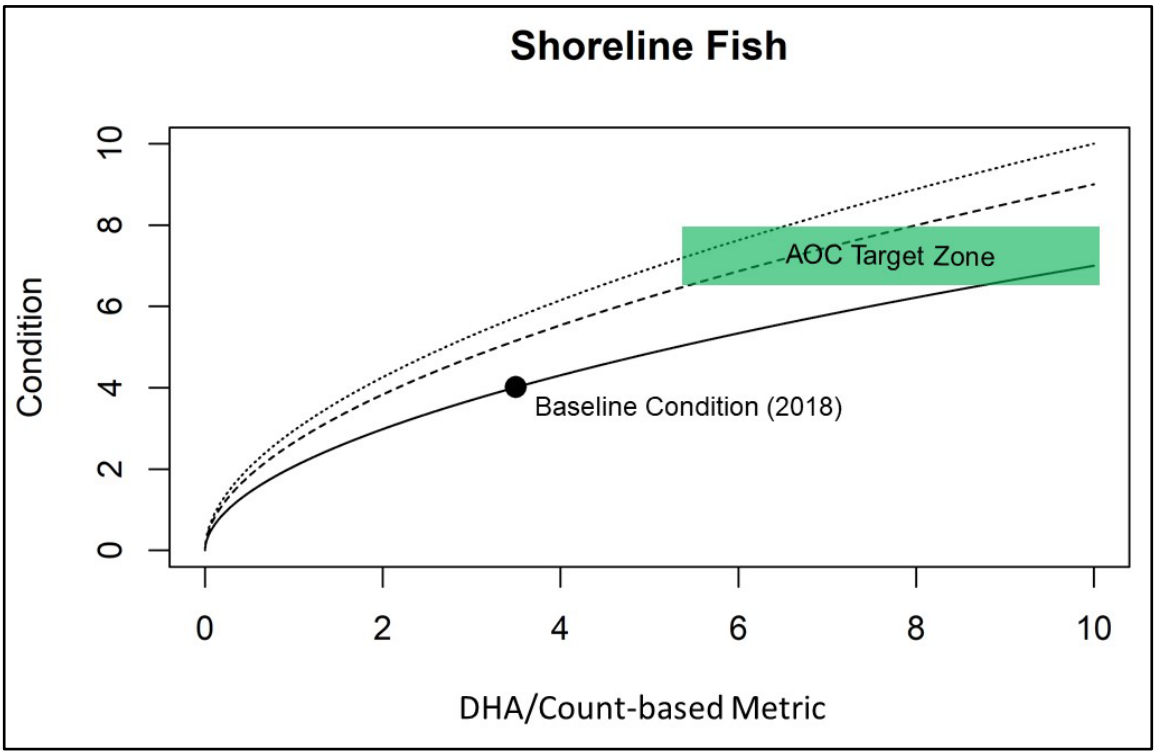


Figure 3.23. Designated Habitat Area/Count-based metric for evaluating the condition of the Shoreline Fish population group. Curves represent DHA-specific criteria for adult indicator species (solid black line), juvenile or larval species (middle, long dotted line), and rare or sensitive species (top, small dotted line). Baseline condition was determined through expert opinion; going forward it will be determined through surveys detailed below. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Our team held multiple meetings with fish experts in 2019-2019 to discuss critical habitat needs, potential projects, and existing monitoring datasets for this group. It was decided that we could leverage monitoring data/efforts that already exist to create a robust approach, which pairs occupancy of the target species at each DHA to attempt to document if the project is meeting its design goals. Partners and experts also placed high importance on benefiting additional life stages and rare/sensitive species through DHAs. As a result, the metrics team implemented secondary and tertiary curves for these groups. While above and beyond the scope of the AOC Program, reaching these secondary and tertiary curves is not required within the AOC target zone for this population. However, as we recognize that benefits to additional life stages and occupancy by rare/sensitive species are likely to be realized in the long term, keeping

these additional curves will not hinder progress towards removal targets, rather, if these longer-term goals are realized in the interim, they allow for additional condition increases towards the AOC target zone. This approach was presented to and agreed upon by the TAC on 22 October 2019.

Assessment Method: Each DHA will have a specific monitoring plan listing both an adult and additional life stage of a target species that will be monitored for determining the success of the Shoreline Fish DHA. The goal of monitoring is to confirm the occupancy of a target species within the relative area of the DHA. Starting in 2028 after restoration and enhancement projects are complete, fish sampling will be conducted by the existing WDNR fisheries and USFWS Aquatic Invasive Species programs, though monitoring is flexible with respect to gear type, duration, and season conducted, and will continue for 3 years (see Chapter 4). There may be multiple target species included for a given DHA, and the additional life stage may include any of the following where best appropriate: eggs, larval, young-of-year, or juvenile fish. A dataset and/or monitoring effort should be outlined in the DHA management plan (e.g., USFWS Aquatic Invasive Species early detection and monitoring team's fall electrofishing survey). Additionally, a rare or sensitive species must be identified for potential occupancy of each DHA.

Fox River Fish *(Count-based/DHA Hybrid)*

Assessment Description: This population group will be evaluated using the number of implemented Designated Habitat Areas (DHAs)/Count-based Hybrid metric approach for Fox River Fish (Figure 3.24). Fox River Fish DHAs should represent the habitat types critical to a diverse array of Fox River annual and seasonal resident fish species for spawning and other uses. These habitat types include but are not limited to: various substrates (e.g., boulder, cobble, gravel etc.), coarse woody habitat, and submerged aquatic vegetation. Fox River Fish DHAs must be located between the De Pere Dam and the Fox River confluence with lower Green Bay. A DHA may consist of a cluster of smaller, individual habitat units that are geographically co-located (e.g., multiple coarse woody habitat structures distributed across a given DHA) or a single, larger habitat site where appropriate (e.g., spawning reef). In addition to the general guidelines for DHAs, each Fox River Fish DHA should have a site-specific management plan which includes the following:

1. A list of target species to benefit from each Fox River Fish DHA (e.g., a DHA containing large cobble/boulder placement would target lake sturgeon [*Acipenser fulvescens*] and lake whitefish [*Coregonus clupeaformis*], whereas a DHA containing submerged aquatic vegetation restoration would primarily target centrarchids and muskellunge).

2. A habitat plan including details on the type and estimated amount of habitat to be implemented at the Fox River Fish DHA (e.g., 4 ac of substrate additions comprised of 20% cobble of size 20.3-30.5 cm [8-12"] and 80% gravel of size 2.5-7.6 cm [1-3"]). Habitat requirements of the target species, best management practices, water levels, boating, and regulations must also be considered when designing a habitat plan.

3. A monitoring plan listing target adult, juvenile/larval, and rare/sensitive fish species that will be monitored at each DHA (see “Monitoring Plan and Resulting Dataset” section below).

4. A long-term maintenance plan considering the degradation of the Fox River Fish DHA as a result of erosion, siltation, invasive species, ice damage, water currents, etc. should also be included. This should include the life expectancy for the DHA and outline required timeframes and methods for regular maintenance.

Example: Starting at the baseline condition (x-axis DHA/count-based metric = 3, y-axis condition = 5) in Figure 3.24, if 2 new DHAs are implemented and monitoring confirms target adult species at both DHAs, then the new position on the x-axis following the curve is 5 (3 + 2 =5) and the new position on the y-axis is 6. If monitoring also confirmed a larval or juvenile species at 1 of the 2 DHAs, an additional increase on the y-axis of 1 is added, resulting in a new condition of 7 (6 + 1 = 7). This increase of 1 is calculated by assigning a 0 to DHAs without a larval or juvenile species detected, and by assigning a 2 to DHAs with a larval or juvenile species detected (per the secondary curve) and then calculating the average ([0 + 2] / 2 = 1).

List of Fox River Fish DHA sites as well as adult, juvenile/young of year, and rare/sensitive target fish species and their respective monitoring criteria are provided in Appendix 7, Table A7.7.

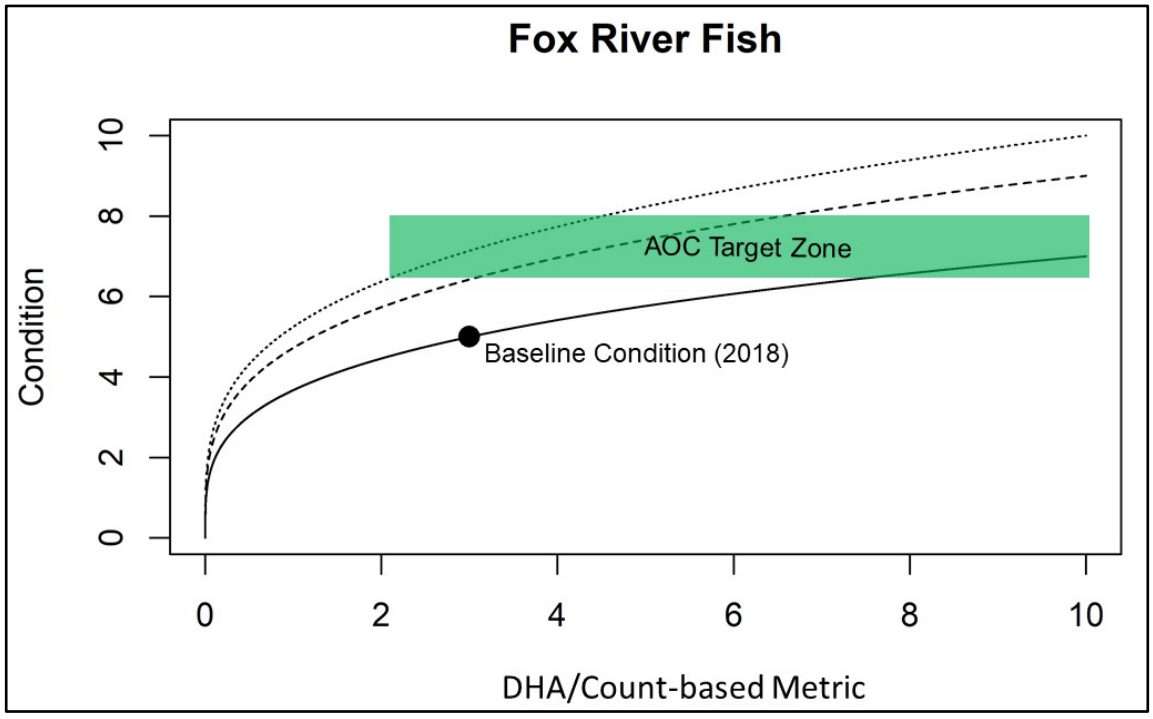


Figure 3.24. Designated Habitat Area/Count-based metric for evaluating the condition of the Fox River Fish population group. Curves represent DHA-specific criteria for adult indicator species (solid black line), juvenile or larval species (middle, long dotted line), and rare or sensitive species (top, small dotted line). Baseline was condition was determined through expert opinion; going forward it will be determined through surveys detailed below. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: Our team held multiple meetings with fish experts in 2018-2019 to discuss critical habitat needs, potential projects, and existing monitoring datasets for this group. It was decided that existing monitoring data/efforts could be leveraged to create a robust approach, which pairs occupancy of the target species at each DHA to attempt to document if the project is meeting its design goals. Partners and experts also placed high importance on benefiting additional life stages and rare/sensitive species through DHAs. As a result, the metrics team implemented secondary and tertiary curves for these groups. While above and beyond the scope of the AOC Program, reaching these secondary and tertiary curves is not required within the AOC target zone for this population. However, as we recognize that benefits to additional life stages and occupancy by rare/sensitive species are likely to be realized in the long term, keeping these additional curves will not hinder progress towards removal targets, rather, if these longer-term goals are realized in the interim, they allow for additional condition increases towards the AOC target zone. This approach was presented to and agreed upon by the TAC on 22 October 2019.

Assessment Method: Each DHA will have a specific monitoring plan listing both an adult and additional life stage of a target species that will be monitored for determining the success of the Fox River Fish DHA. The goal of monitoring is to confirm the occupancy of a target species within the relative area of the DHA. Starting in 2028 after restoration and enhancement projects are complete, fish sampling will be conducted by the existing WDNR fisheries and USFWS Aquatic Invasive Species programs, though monitoring is flexible with respect to gear type, duration, and season conducted, and will continue for 3 years (see Chapter 4). There may be multiple target species included for a given DHA and the additional life stage may include any of the following where best appropriate: eggs, larval, young-of-year, or juvenile fish. A dataset and/or monitoring effort should be outlined in the DHA management plan (e.g., USFWS Aquatic Invasive Species early detection and monitoring team's fall electrofishing survey). Additionally, a rare or sensitive species must be identified for potential occupancy of each DHA.

Freshwater Unionid Mussels *(Count-based/DHA Hybrid)*

Assessment Description: This population group will be evaluated by the number of freshwater Unionid mussel DHAs established in the AOC. Additionally, each DHA must have observations of at least one adult "Opportunistic/Unstable" species and one adult "Keystone/Stable" species (solid line) to be counted toward the condition score. The condition score for this group cannot exceed a threshold of 6.5 unless at least one "Rare" species is observed, or, the DHA demonstrates natural reproduction of at least one "Keystone/Stable" or "Rare/Extirpated" species. Where an individual DHA meets this secondary criteria, an increased condition score will be assigned following the dotted line (Figure 3.25).

Example: Starting at the baseline condition (x-axis DHA/count-based metric = 1.5, y-axis condition = 1) in Figure 3.25, if 4 new DHAs are implemented and monitoring confirms the presence of both an adult opportunistic and an adult keystone/stable species at all 5.5 total DHAs, then the new position on the x-axis following the curve is 5.5 (1.5 + 4 = 5.5) and the new position on the y-axis is 6. If further monitoring confirms natural recruitment of a keystone/stable mussel species at 2 of the 5.5 total DHAs, an additional increase on the y-axis of 1 is added, resulting in a new condition

of 7 (6 + 1 = 7). This increase of 1 is calculated by assigning a 0 to DHAs without observed natural recruitment and by assigning a 3 to DHAs with observed natural recruitment (per the secondary curve) and then calculating the average ([0 + 0 + 0 + 0 + 3 + 3] / 6 = 1).

List of Freshwater Unionid Mussel DHA sites, specified mussel groups that must be observed to meet both baseline and secondary monitoring criteria, and a proposed data source and collector are provided in Appendix 7, Table A7.8.

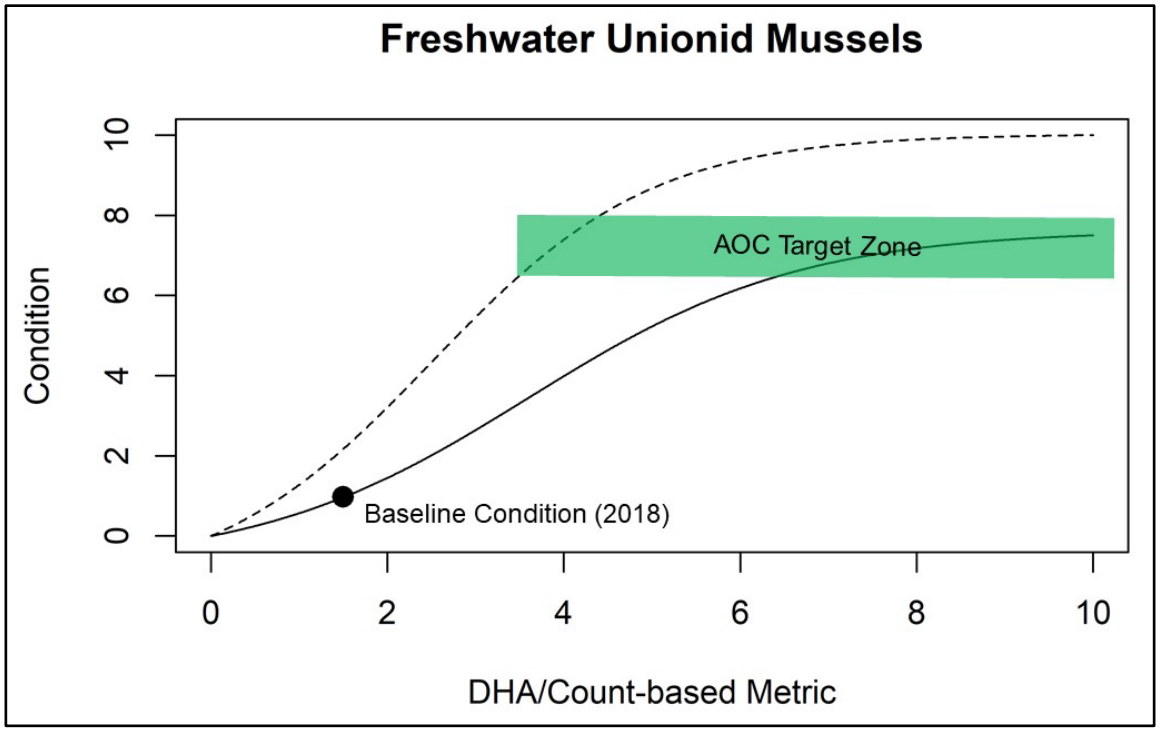


Figure 3.25. Designated Habitat Area/Count-based metric for evaluating the condition of the Freshwater Unionid Mussel population group. Curves represent DHA-specific criteria for occupancy of adult opportunistic and keystone/stable mussel spp. (solid black line), and occupancy of adult rare mussel spp. and/or documented reproduction of a keystone/stable or rare mussel spp. (dotted line). The baseline condition score was determined through expert opinion; going forward it will be determined through surveys detailed below. The AOC Target Zone ranges from 6.5 to 8.

Assessment Rationale: The establishment of protected habitat is an important step toward improving native freshwater Unionid mussels in the LGBFR AOC, and this action alone will be partially counted toward the final condition score for this priority population. Potential restoration sites that were identified as having both softer substrates and possibly lower zebra mussel (*Dreissena polymorpha*) colonization include Renard Island, Ashwaubenon Creek, Duck Creek, Dutchman Creek, Wequiock Creek, and various areas of the Fox River. However, it is important to acknowledge that native Unionid freshwater mussels face several other barriers to re-establishment and overall population condition in the LGBFR AOC that are both lake-wide and LGBFR AOC-specific issues, including invasion by exotic species, such as round gobies (*Neogobius melanostomus*) and dreissenid mussels, population declines in host fish, and water quality. While these impediments to restoring a healthy native Unionid mussel population will likely

exist within the LGBFR AOC even after management actions are implemented, this population group differs from other such priority populations using DHA-alone metrics in that they are not migratory or difficult/inappropriate to monitor within the LGBFR AOC boundaries. Native freshwater Unionid mussels are long lived and primarily stationary in their environment, which makes this population group largely dependent on local environmental conditions in the LGBFR AOC in determining their overall condition. As such, it is important to also consider the actual utilization of habitat by this priority population in determining the overall condition score. In order to do this, a meeting on 27 March 2019 was held with several statewide mussel experts in which native freshwater Unionid mussel species were grouped into opportunistic/unstable species, stable/keystone species, and rare species (Table 3.1).

Table 3.1. Categories of native freshwater Unionid mussels in the Lower Green Bay and Fox River Area of Concern: opportunistic/unstable, stable/keystone species, and rare species with information on whether they were important historically (H) or contemporary (C), associated host fish, and required habitat. Each of these categories are factored into the conversion curves for evaluating the condition of this population group (Figure 3.25).

Opportunistic/Unstable				
Species	**Common Name**	**Historic (H)/ Contemporary (C)**	**Host Fish(es)**	**Habitat**
Pyganodon grandis	Giant Floater	H+C	Generalist	Areas with reduced flow
Leptodea fragilis	Fragile Papershell	H+C	Freshwater drum	Streams of all sizes in mud, sand, or gravel
Utterbackia imbecillis	Paper pondshell	C	Various centrarchids	Ponds, lakes, or mud-bottomed pools of creeks and rivers
Stable/Keystone Species				
Species	**Common Name**	**Historic (H)/ Contemporary (C)**	**Host Fish(es)**	**Habitat**
Quadrula quadrula	Mapleleaf	H+C	Catfishes	Medium-sized streams to large rivers; adjusts well to impoundments

Amblema plicata	Three-ridge	H+C	Generalist, though catfishes important	Medium-sized streams to large rivers; adjusts well to impoundments
Lampsilis siliquoidea	Fatmucket	H+C	Generalist, though centrarchids important	Shallow water near aquatic vegetation
Lampsilis cardium	Plain pocketbook	C	White crappie, centrarchids, perch	Small creeks to large rivers in mud, sand, or gravel
Toxolasma parvum	Lilliput*	C	Green sunfish, bluegill, white crappie	Ponds, lakes, and creeks to large rivers in mud, sand, or fine gravel
Fusconaia flava	Wabash pigtoe	H+C	Minnows	Medium-sized streams to large rivers
Lasmigona complanata	White Heelsplitter	H+C	Generalist	Areas with reduced flow
Quadrula pustulosa	Pimpleback	H	Black bullhead, channel catfish, flathead catfish, brown bullhead	Medium to large rivers in mud, sand, or gravel
Rare Species				
Species	**Common Name**	**Historic (H)/ Contemporary (C)**	**Host Fish(es)**	**Habitat**
Ligumia recta	Black sandshell	H+C	American eel, bluegill, and white crappie	Found in varying sizes of creeks, rives, and lakes with sand and gravel bottoms and moderate current

Elliptio dilatata	Spike	H+C	Darters and perches, basses and sunfishes also might be important hosts	Sloughs and main channel borders
Potamilus alatus	Pink heelsplitter	H	Freshwater drum?	Medium to large rivers in mud or mixed mud, sand, and gravel
Obliquaria relfexa	Threehorn wartyback	H	Common shiner, longnose dace	Large rivers in muddy sand to gravel
Strophitus undulates	Creeper	H	Generalist	Small streams, but also in the Miss. River
Lasmigona costata	Fluted-shell	H	Banded darter, longnose dace, northern hogsucker	Medium to large rivers in sand, mud, or fine gravel areas with slow to moderate flow

Mussel DHAs will be paired with habitat considerations for target Fox River, shoreline, or tributary host fish.

Assessment Method: Occupancy and surveys targeted at determining reproduction of mussel species at established Mussel DHAs in the LGBFR AOC will be used to evaluate this population group by WDNR and/or a contractor. Surveys will begin in 2028 after restoration and enhancement projects are complete and will continue for 1-3 years (see Chapter 4).

Priority Fish and Wildlife Habitat Metrics

Descriptions of the 18 priority habitat metrics are listed below. Otherwise, click on each habitat name (grouped by metric) to quickly and easily access the metrics' content found below. Descriptions of each habitat are provided in Table 2.2 above in Chapter 2. Priority habitats have been categorized into two groups:

Habitats in which quality and area improvements should be realized to increase the overall Habitat BUI condition score:

- Great Lakes Beach
- Wet Meadow
- Emergent Marsh (high energy coastal)

- Submergent Marsh
- Emergent Marsh (riparian)
- Fox River Open Water
- Green Bay Open Water
- Tributary Open Water
- Surrogate Grassland (restored)

Habitats in which only quality improvements will be realized to increase the overall Habitat BUI condition score:

- Open Water (inland)
- Shrub Carr
- Hardwood Swamp
- Emergent Marsh (inland)
- Emergent Marsh (roadside)
- Southern Dry Mesic Forest
- Northern Mesic Forest
- Other Forest
- Surrogate Grassland (old field)

Great Lakes Beach

Assessment Description: This priority habitat will be evaluated using a Great Lakes Beach Metric (B):

$$B = (0.25 \times km_{nomgmt}) + (0.50 \times km_{recreate}) + (0.75 \times km_{c\text{-}mgmt}) + (1.0 \times km_{restrictmgmt})$$

where B is the summation of the number of kilometers of beach that are not managed or restricted (=nomgmt) multiplied by a quality weight of 0.25, the number of kilometers of beach that are managed for recreational purposes (=recreate) multiplied by a quality weight of 0.50, the number of kilometers of beach that are managed for conservation purposes (=c-mgmt) multiplied by a quality weight of 0.75, and the number of kilometers of beach that are managed for conservation *and* have imposed recreational restrictions (=restrictmgmt) multiplied by a quality weight of 1.0. Descriptions of these three management categories are described below. Metric B ranges between 0 and 25 km and is converted into a condition score (C) ranging from 0 to 10 (Figure 3.26). Currently there are approximately 20 km of Great Lakes Beach in the LGBFR AOC (with little to no management or restrictions), though there is potential to add this habitat along the southwestern shoreline of the lower bay, in a few locations around the Cat Island Wave Barrier, and possibly at other sites.

Linear kilometers of Great Lakes Beach habitat will be assessed based on different management strategies that are implemented and maintained by landowners:

1. *No Management* (=nomgmt in metric B formula above): Great Lakes Beaches that have no regular or persistent management activities or recreational restrictions imposed on them.

2. *Recreational Management* (=recreate in metric B formula above): Great Lakes Beaches that are managed for recreational purposes, some of which have conservation or wildlife value.

3. *Conservation Management* (=c-mgmt in metric B formula above): Great Lakes Beaches that have the following conservation-directed management activities conducted at them:
    a. YManage and control invasive plant species (e.g., *Phragmites australis*).
    b. Maintain an open portion(s) of beach.
    c. Remove unnatural shoreline features whenever possible (e.g., rip-rap).
    d. Clear persistent zebra/quagga mussel piles as needed.
    e. Clear garbage along the Great Lakes Beach shoreline as needed.

4. *Conservation Management and Recreational Restrictions* (=restrictmgmt in metric B formula above): Great Lakes Beaches that are considered “managed” for conservation (#3 strategy above) *and* have the following recreational restrictions imposed on them:
    a. Restrict human access to Great Lakes Beach shorelines during critical periods for wildlife (e.g., migratory shorebirds, shoreline fish, invertebrates).
    b. Prohibit domestic dogs (on and off leash) from accessing beach shorelines.
    c. Construct and display educational signage at strategic locations to increase public awareness of the managed and restricted Great Lakes Beaches and the LGBFR AOC restoration activities.

Example: If 8 km of Great Lakes Beach shoreline have no management, 3 km are recreationally managed, 6 km are managed for conservation, and 3 km have management and human/dog restrictions, then metric B = (0.25 × 8 km) + (0.5 × 3 km) + (0.75 × 6 km) + (1 × 3 km) = 2 + 1.5 + 4.5 + 3 = 11 (x-axis). The converted condition (y-axis) is 7.

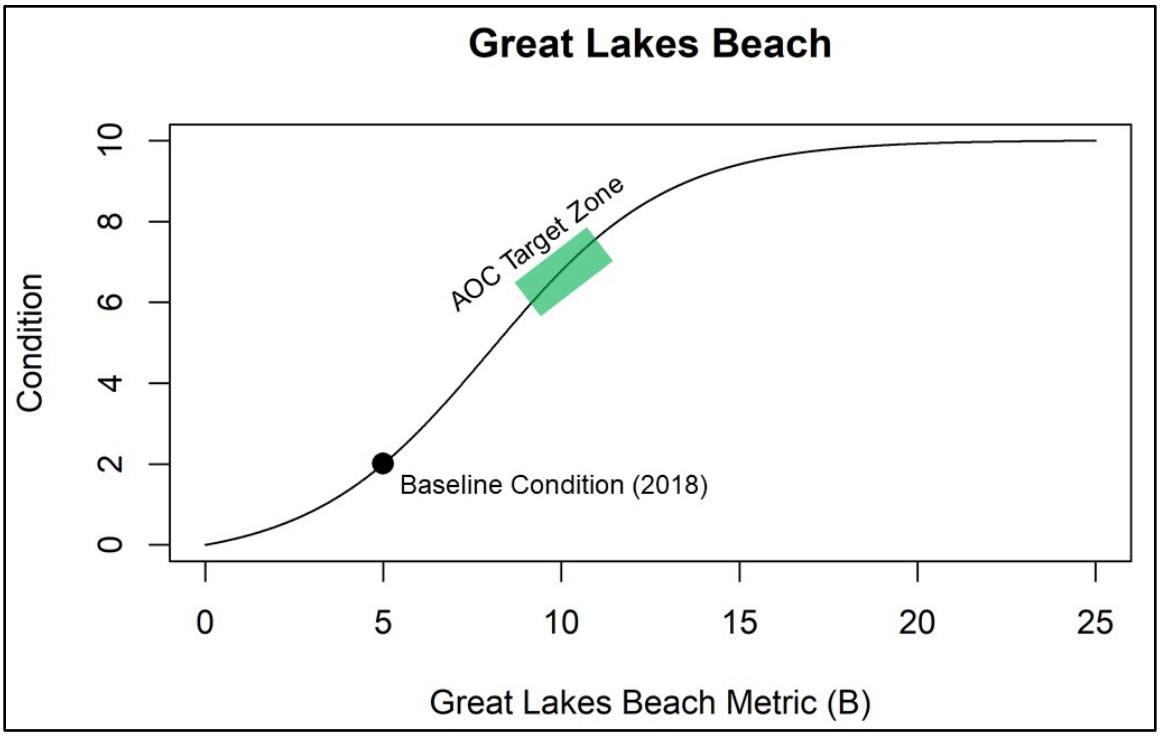


Figure 3.26. The metric for assessing Great Lakes Beach habitat in the Lower Green Bay and Fox River Area of Concern, Great Lakes Beach Metric (B), is a summation of linear kilometers of beach that are multiplied by different quality weights based on whether the beach is managed or not (for conservation or recreational purposes) or has additional recreational restrictions (x-axis). The baseline beach metric (B) = $(0.25 \times 20\ km_{nomgmt}) + (0.50 \times 0\ km_{recreate}) + (0.75 \times 0\ km_{c\text{-}mgmt}) + (1.0 \times 0\ km_{restrictmgmt})$ is equal to 5 on the x-axis. The baseline B metric was initially determined through expert opinion; going forward the B metric will be determined by calculating the linear kilometers of beach under the various management categories described above. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and a baseline (B) of 5 is equal to a condition of 2 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: At a meeting on 23 April 2019, local experts discussed both the types and quality of Great Lakes Beach habitat in the context of Lake Michigan and the LGBFR AOC, an overall vision of what Great Lakes Beach habitat should look like in the LGBFR AOC, and potential management activities that should be conducted at beaches in the LGBFR AOC. The metrics team decided to incorporate ideas generated from this meeting and other past discussions (e.g., TAC meeting on 18 November 2019) into this Great Lakes Beach Metric and recognize that measuring the quality of beach is very challenging. They also decided that because of the dynamic nature of the coastal zone, with fluctuating water levels, that it would be best to measure linear stretches of beach rather than area, which can change hourly.

Assessment Method: Management status of stretches of Great Lakes Beach shoreline will be evaluated by the WDNR LGBFR AOC Coordinator and TAC. Individual landowners are responsible for maintaining and managing their site(s) (see Chapter 4).

Wet Meadow

Assessment Description: This habitat will be evaluated by calculating the Combined Standardized Scores (ranges from 0 [poor quality] to 50 [high quality]) of the Wet Meadow zone during field surveys (see "Monitoring Plan and Resulting Dataset" below) and multiplying that value by the current total area of available Wet Meadow throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.27). With the way this conversion curve is designed, if the total existing Wet Meadow is of moderate quality, then the condition score will be the same if half of that available Wet Meadow is of high quality. Currently, there are approximately 1.8 acres of high quality Wet Meadow habitat in the LGBFR AOC, though there is significant potential to increase the area of this important and historically relevant habitat in several areas of the LGBFR AOC.

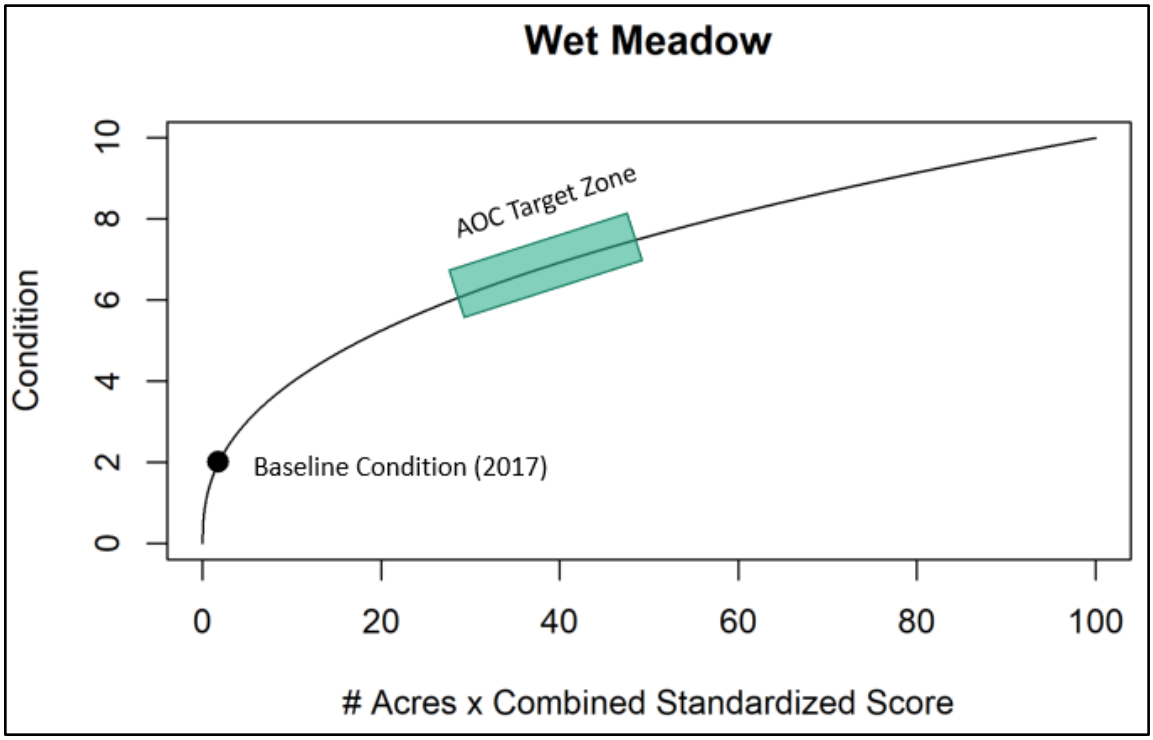


Figure 3.27. Wet Meadow assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Wet Meadow in acres multiplied by a quality index and is scaled from 0 (no quality meadow) to 60 (ideal condition or quality meadow). The baseline Wet Meadow index was calculated to be 1.8 acres × 1.0 (high quality) is equal to 1.8 on the x-axis. Baseline quality was initially determined through expert opinion; going forward wet meadow quality will be determined by the Combined Standardized Score of plants collected in the Wet Meadow zone following the Great Lakes Coastal Wetland Monitoring Program protocol (Uzarski et al. 2017). The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Wet Meadow index of 1.8 is equal to a condition of 2 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Kupsky, Howe, and Giese held a conference call on 23 September 2019 with Valerie Brady (University of Minnesota Duluth) and Donald Uzarski (Central Michigan University) to discuss the application of the existing Great Lakes Coastal Wetland Monitoring

Program's (CWMP) vegetation sampling protocol to coastal marshes in the LGBFR AOC. Brady and Uzarski both supported the application of this protocol to LGBFR AOC marsh monitoring efforts and agreed to help however needed, including training field crews and sharing/interpreting data. Generally, CWMP sampling takes place along transects that traverse southern sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. The metrics team decided to separate the plant data by zone (and using their Combined Standardized Scores by plant zone) in order to better evaluate conditions of four priority coastal marsh habitats: Wet Meadow, Emergent Marsh (high energy coastal), Emergent Marsh (riparian), and Submergent Marsh. Collecting data along transects across these habitats also better accounts for the dynamic nature of the coastal zone due to fluctuating water levels, seiche, wave action, ice, etc.

Assessment Method: Plant data used for this habitat's metric will be collected following the CWMP vegetation monitoring protocol (Uzarski et al. 2017). Monitoring will begin in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4). Plant surveys will be conducted at multiple wetlands by trained, certified observers throughout the LGBFR AOC's emergent marshes using transects, which traverse southern sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. Sampling locations for the project will be chosen by expert field crews based on sites selected for the CWMP, though additional sampling points may be needed given the strict site criteria needed for the CWMP (e.g., wetland must be at least 9.9 ac [4 ha] in size), which can easily be an added CWMP benchmark site(s). Currently, CWMP marshes are surveyed in the Green Bay area by Nicholas Danz (University of Wisconsin-Superior) in collaboration with CWMP principal investigators Uzarski and Brady. They have agreed to share past and future plant data for LGBFR AOC efforts and may also be able to sample additional wetlands if needed by adding CWMP benchmark site(s), if, for example, a wetland that the LGBFR AOC needs sampling does not meet the sampling criteria of the CWMP. The CWMP samples wetlands that are at least 9.9 ac [4 ha] in size, dominated by open, herbaceous emergent plants, and connected to and influenced by a Great Lake. The protocol and a sample data sheet are available online: https://www.greatlakeswetlands.org/docs/QAPPs_SOPs/GLCWMP_Vegetation_SOP_June_4_2018.pdf. Data collected for CWMP will be used not only for this habitat but also for Emergent Marsh (high energy coastal), Emergent Marsh (riparian), and Submergent Marsh. In order to calculate metric values for each of these four priority habitats, a data table will need to be requested from CWMP principal investigators that includes the Combined Standardized Scores and plant zone. To calculate the area of Wet Meadow and other coastal wetland habitats, the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons given how much water levels fluctuate and affect the coastal zone. Once that shapefile is edited, then one can use ArcGIS to calculate habitat areas. With Great Lakes Restoration Initiative (GLRI) funding, the CWMP runs on a 5-year cycle and so far has been funded twice (2011-2015; 2016-2020). Within a year of the 5-year period, a batch of randomly selected Great Lakes coastal wetland complexes are sampled, though all possible coastal wetlands are chosen for sampling within the 5-year period (most of which get sampled). Some wetlands are resampled across multiple years, though the majority are surveyed just once in the 5-year period; however, crews can add additional sites

for sampling as “benchmark” sites if a local need arrives (e.g., post-restoration verification monitoring). Future funding is not guaranteed (but likely) and greatly needed for continuing this important program.

Emergent Marsh (high energy coastal)

Assessment Description: This habitat will be evaluated by calculating the Combined Standardized Scores (ranges from 0 [poor quality] to 50 [high quality]) of the Emergent Marsh (high energy coastal) zone during field surveys (see “Monitoring Plan and Resulting Dataset” below) and multiplying that value by the current total area of available Emergent Marsh (high energy coastal) throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.28). With the way this conversion curve is designed, if the total existing marsh is of moderate quality, then the condition score will be the same if half of that available marsh is of high quality. Currently, there are approximately 870 acres of variable quality Emergent Marsh (high energy coastal) habitat in the LGBFR AOC, though there is significant potential to increase the area of this important and historically relevant habitat in the Duck Creek Delta and other sites in the LGBFR AOC.

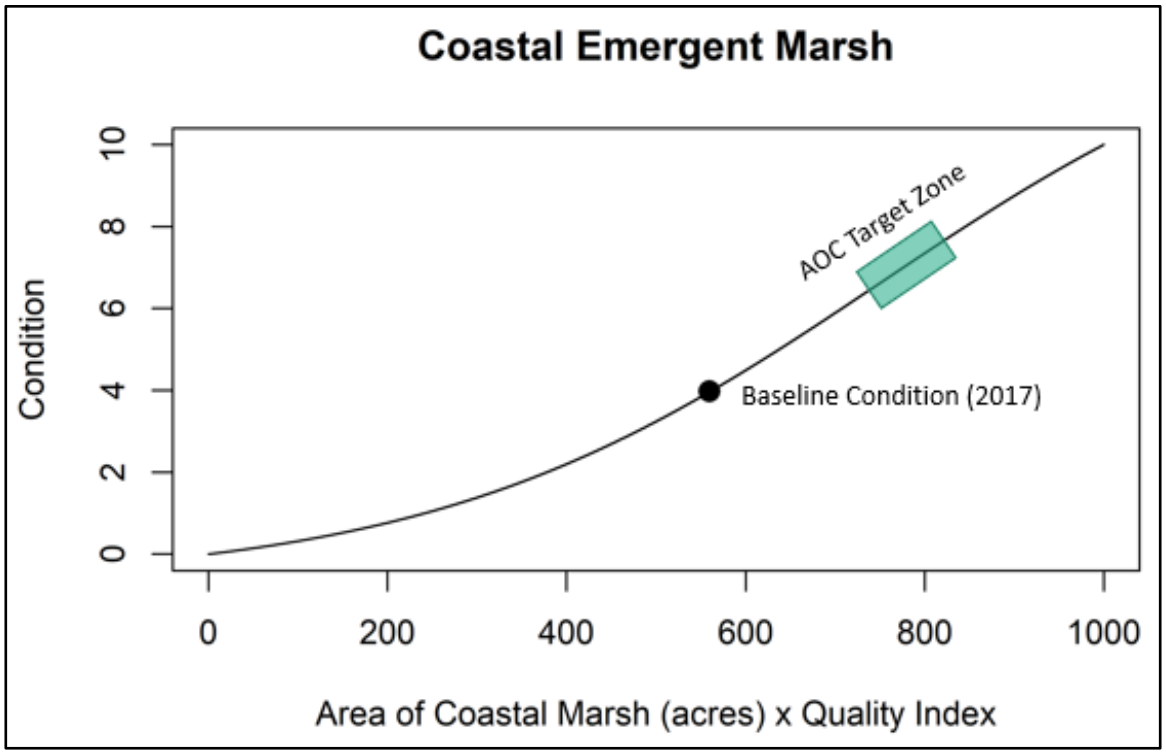


Figure 3.28. Emergent Marsh (high energy coastal) assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Emergent Marsh (high energy coastal) in acres multiplied by a quality index and is scaled from 0 (no quality coastal marsh) to 1,000 (ideal condition or quality coastal marsh). The baseline Emergent Marsh (high energy coastal) index was calculated as 870 acres × 0.65 (moderate quality) and is equal to 565.5 on the x-axis. Baseline quality was initially determined through expert opinion; going forward marsh quality will be determined by the Combined Standardized Score of plants collected in the emergent marsh plant zone following the Great Lakes Coastal Wetland Monitoring Program protocol (Uzarski et al. 2017). The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Emergent Marsh (high energy coastal) index of 565.5 is equal to a condition of 4 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Kupsky, Howe, and Giese held a conference call on 23 September 2019 with Valerie Brady (University of Minnesota Duluth) and Donald Uzarski (Central Michigan University) to discuss the application of the existing Great Lakes Coastal Wetland Monitoring Program's (CWMP) vegetation sampling protocol to coastal marshes in the LGBFR AOC. Brady and Uzarski both supported the application of this protocol to LGBFR AOC marsh monitoring efforts and agreed to help however needed, including training field crews and sharing/interpreting data. Generally, CWMP sampling takes place along transects that traverse sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. The metrics team decided to separate the plant data by zone (and using their Combined Standardized Scores by plant zone) in order to better evaluate conditions of four priority coastal marsh habitats: Wet Meadow, Emergent Marsh (high energy coastal), Emergent Marsh (riparian), and Submergent Marsh. Collecting data along transects across these habitats also better accounts for the dynamic nature of the coastal zone due to fluctuating water levels, seiche, wave action, ice, etc.

Assessment Method: Plant data used for this habitat's metric will be collected following the CWMP vegetation monitoring protocol (Uzarski et al. 2017). Monitoring will begin in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4). Plant surveys will be conducted at multiple wetlands by trained, certified observers throughout the LGBFR AOC's emergent marshes using transects, which traverse sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. Sampling locations for the project will be chosen by expert field crews based on sites selected for the CWMP, though additional sampling points may be needed given the strict site criteria needed for the CWMP (e.g., wetland must be at least 9.9 ac [4 ha] in size), which can easily be an added CWMP benchmark site(s). Currently, CWMP marshes are surveyed in the Green Bay area by Nicholas Danz (University of Wisconsin-Superior) in collaboration with CWMP principal investigators Uzarski and Brady. They have agreed to share past and future plant data for LGBFR AOC efforts and may also be able to sample additional wetlands if needed by adding CWMP benchmark site(s), if, for example, a wetland that the LGBFR AOC needs sampling does not meet the sampling criteria of the CWMP. The CWMP samples wetlands that are at least 9.9 ac [4 ha] in size, dominated by open, herbaceous emergent plants, and connected to and influenced by a Great Lake. The protocol and a sample data sheet are available online: https://www.greatlakeswetlands.org/docs/QAPPs_SOPs/GLCWMP_Vegetation_SOP_June_4_2018.pdf. Data collected for CWMP will be used not only for this habitat but also for Wet Meadow, Emergent Marsh (riparian), and Submergent Marsh. In order to calculate metric values for each of these four priority habitats, a data table will need to be requested from CWMP principal investigators that includes the Combined Standardized Scores and plant zone. To calculate the area of Emergent Marsh (high energy coastal) and other coastal wetland habitats, the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons given how much water levels fluctuate and affect the coastal zone. Once that shapefile is edited, then one can use ArcGIS to calculate habitat areas. With Great Lakes Restoration Initiative (GLRI) funding, the CWMP runs on a 5-year cycle and so far has been funded twice (2011-2015; 2016-2020). Within a year of the 5-year period, a batch of randomly selected Great Lakes coastal wetland complexes are sampled, though all possible coastal wetlands are chosen for sampling within the 5-year period (most of which get sampled). Some wetlands are resampled across multiple years, though the majority are surveyed just once in the 5-year period; however, crews can add additional sites for sampling as "benchmark" sites if a local need arrives (e.g., post-restoration verification monitoring). Future funding is not guaranteed (but likely) and greatly needed for continuing this important program.

Submergent Marsh

Assessment Description: This habitat will be evaluated by calculating the Combined Standardized Scores (ranges from 0 [poor quality] to 50 [high quality]) of the Submergent Marsh zone during field surveys (see "Monitoring Plan and Resulting Dataset" below) and multiplying that value by the current total area of available Submergent Marsh throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.29). With the way this conversion curve is designed, if the total existing Submergent Marsh is of moderate quality, then the condition score will be the

same if half of that available marsh is of high quality. Currently, there are approximately 193 acres of variable quality Submergent Marsh habitat in the LGBFR AOC, though there is significant potential to increase the area of this important and historically relevant habitat in the Duck Creek Delta, several areas along the Fox River, and other sites in the LGBFR AOC.

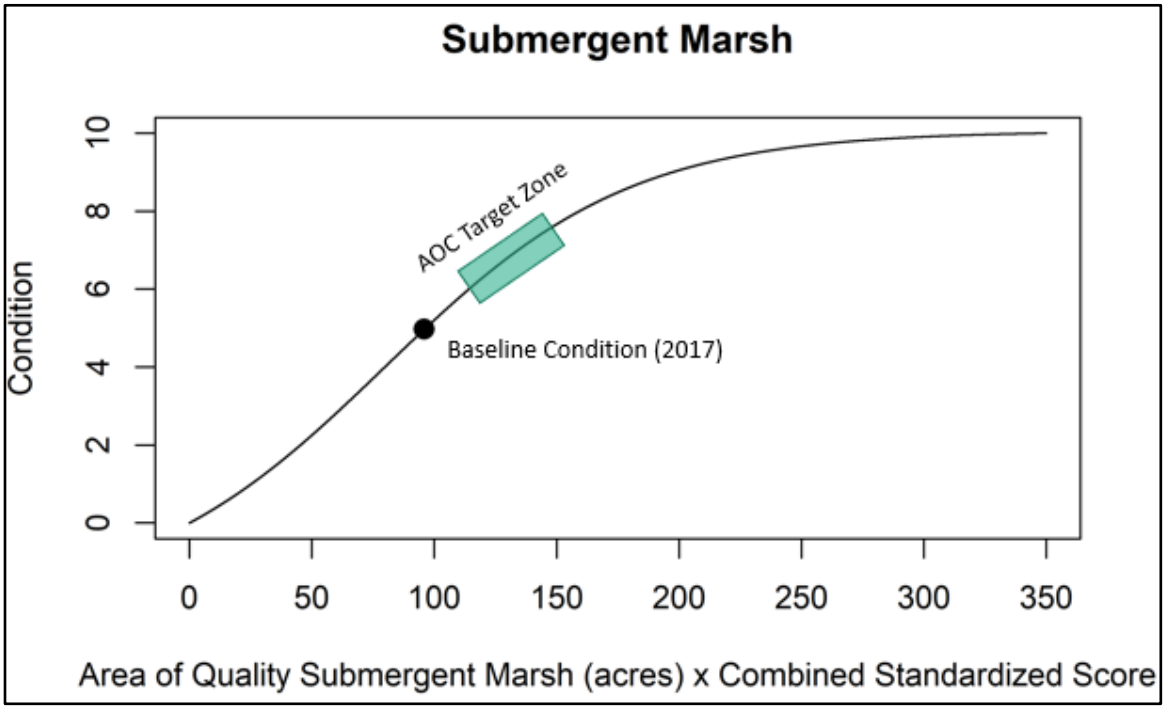


Figure 3.29. Submergent Marsh assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Submergent Marsh in acres multiplied by a quality index and is scaled from 0 (no quality coastal marsh) to 350 (ideal condition or quality coastal marsh). The baseline Submergent Marsh index was calculated as 192.5 acres × 0.5 (moderate quality) and is equal to 96.25 on the x-axis. Baseline quality was initially determined through expert opinion; going forward marsh quality will be determined by the Combined Standardized Score of plants collected in the submergent marsh plant zone following the Great Lakes Coastal Wetland Monitoring Program protocol (Uzarski et al. 2017). The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Submergent Marsh index of 96.25 is equal to a condition of 5 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Kupsky, Howe, and Giese held a conference call on 23 September 2019 with Valerie Brady (University of Minnesota Duluth) and Donald Uzarski (Central Michigan University) to discuss the application of the existing Great Lakes Coastal Wetland Monitoring Program's (CWMP) vegetation sampling protocol to coastal marshes in the LGBFR AOC. Brady and Uzarski both supported the application of this protocol to LGBFR AOC marsh monitoring efforts and agreed to help however needed, including training field crews and sharing/interpreting data. Generally, CWMP sampling takes place along transects that traverse sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. The metrics team decided to separate the plant data by zone (and using their Combined Standardized Scores by plant zone) in order to better evaluate conditions of four priority coastal marsh habitats: Wet Meadow, Emergent Marsh (high energy coastal), Emergent Marsh (riparian), and Submergent

Marsh. Collecting data along transects across these habitats also better accounts for the dynamic nature of the coastal zone due to fluctuating water levels, seiche, wave action, ice, etc.

Assessment Method: Plant data used for this habitat's metric will be collected following the CWMP vegetation monitoring protocol (Uzarski et al. 2017). Monitoring will begin in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4). Plant surveys will be conducted at multiple wetlands by trained, certified observers throughout the LGBFR AOC's emergent marshes using transects, which traverse sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. Sampling locations for the project will be chosen by expert field crews based on sites selected for the CWMP, though additional sampling points may be needed given the strict site criteria needed for the CWMP (e.g., wetland must be at least 9.9 ac [4 ha] in size), which can easily be an added CWMP benchmark site(s). Currently, CWMP marshes are surveyed in the Green Bay area by Nicholas Danz (University of Wisconsin-Superior) in collaboration with CWMP principal investigators Uzarski and Brady. They have agreed to share past and future plant data for LGBFR AOC efforts and may also be able to sample additional wetlands if needed by adding CWMP benchmark site(s), if, for example, a wetland that the LGBFR AOC needs sampling does not meet the sampling criteria of the CWMP. The CWMP samples wetlands that are at least 9.9 ac [4 ha] in size, dominated by open, herbaceous emergent plants, and connected to and influenced by a Great Lake. The protocol and a sample data sheet are available online: https://www.greatlakeswetlands.org/docs/QAPPs_SOPs/GLCWMP_Vegetation_SOP_June_4_2018.pdf. Data collected for CWMP will be used not only for this habitat but also for Wet Meadow, Emergent Marsh (riparian), and Emergent Marsh (high energy coastal). In order to calculate metric values for each of these four priority habitats, a data table will need to be requested from CWMP principal investigators that includes the Combined Standardized Scores and plant zone. To calculate the area of Submergent Marsh and other coastal wetland habitats, the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons given how much water levels fluctuate and affect the coastal zone. Once that shapefile is edited, then one can use ArcGIS to calculate habitat areas. With Great Lakes Restoration Initiative (GLRI) funding, the CWMP runs on a 5-year cycle and so far has been funded twice (2011-2015; 2016-2020). Within a year of the 5-year period, a batch of randomly selected Great Lakes coastal wetland complexes are sampled, though all possible coastal wetlands are chosen for sampling within the 5-year period (most of which get sampled). Some wetlands are resampled across multiple years, though the majority are surveyed just once in the 5-year period; however, crews can add additional sites for sampling as "benchmark" sites if a local need arrives (e.g., post-restoration verification monitoring). Future funding is not guaranteed (but likely) and greatly needed for continuing this important program.

Emergent Marsh (riparian)

Assessment Description: This habitat will be evaluated by calculating the Combined Standardized Scores (ranges from 0 [poor quality] to 50 [high quality]) of the Emergent Marsh (riparian) zone during field surveys (see "Monitoring Plan and Resulting Dataset" below) and multiplying that value by the current total area of available Emergent Marsh (riparian) throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted

into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.30). With the way this conversion curve is designed, if the total existing marsh is of moderate quality, then the condition score will be the same if half of that available marsh is of high quality. Currently, there are approximately 165 acres of variable quality Emergent Marsh (riparian) habitat in the LGBFR AOC, though there is significant potential to increase the area of this important and historically relevant habitat in the Fox River and other tributary sites in the LGBFR AOC.

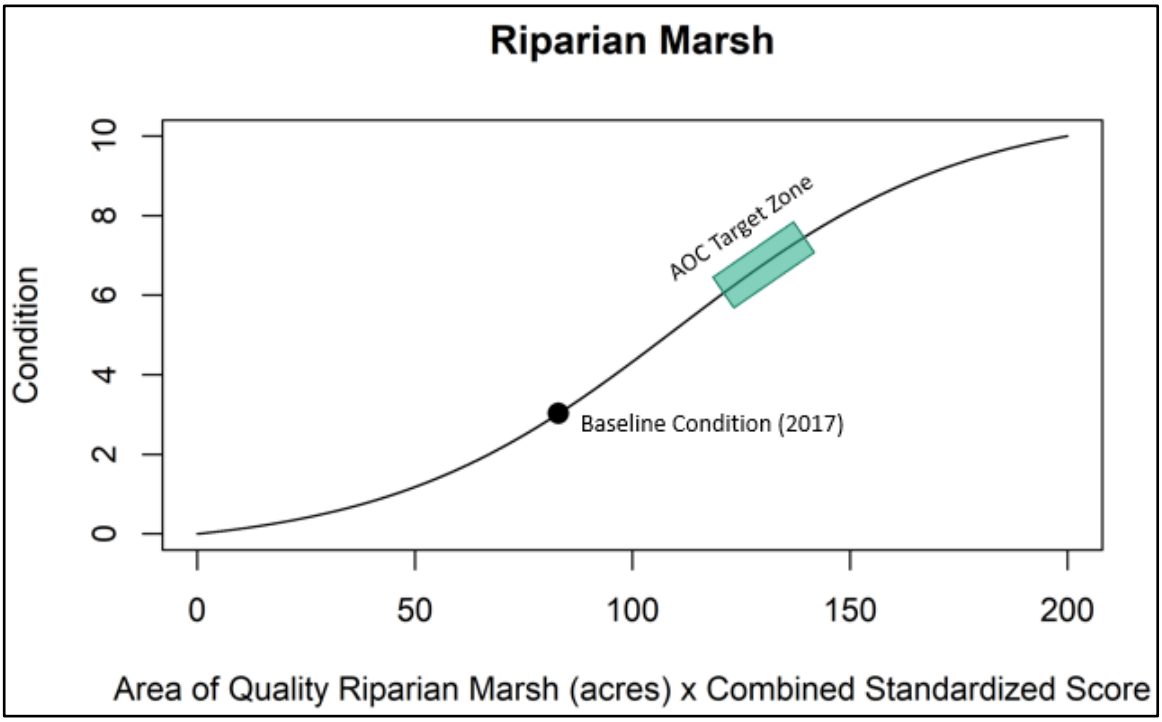


Figure 3.30. Emergent Marsh (riparian) assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Emergent Marsh (riparian) in acres multiplied by a quality index and is scaled from 0 (no quality riparian marsh) to 200 (ideal condition or quality riparian marsh). The baseline Emergent Marsh (riparian) index was calculated as 165 acres × 0.5 (moderate quality) and is equal to 82.5 on the x-axis. Baseline quality was initially determined through expert opinion; going forward marsh quality will be determined by the Combined Standardized Score of plants collected in the emergent marsh plant zone following the Great Lakes Coastal Wetland Monitoring Program protocol (Uzarski et al. 2017). The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Emergent marsh (riparian) index of 82.5 is equal to a condition of 3 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Kupsky, Howe, and Giese held a conference call on 23 September 2019 with Valerie Brady (University of Minnesota Duluth) and Donald Uzarski (Central Michigan University) to discuss the application of the existing Great Lakes Coastal Wetland Monitoring Program's (CWMP) vegetation sampling protocol to coastal marshes in the LGBFR AOC. Brady and Uzarski both supported the application of this protocol to LGBFR AOC marsh monitoring efforts and agreed to help however needed, including training field crews and sharing/interpreting data. Generally, CWMP sampling takes place along transects that traverse sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. The metrics team decided to separate the plant data by zone (and using their Combined Standardized Scores by

plant zone) in order to better evaluate conditions of four priority coastal marsh habitats: Wet Meadow, Emergent Marsh (high energy coastal), Emergent Marsh (riparian), and Submergent Marsh. Collecting data along transects across these habitats also better accounts for the dynamic nature of the coastal zone due to fluctuating water levels, seiche, wave action, ice, etc.

Assessment Method: Plant data used for this habitat's metric will be collected following the CWMP vegetation monitoring protocol (Uzarski et al. 2017). Monitoring will begin in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4). Plant surveys will be conducted at multiple wetlands by trained, certified observers throughout the LGBFR AOC's emergent marshes using transects, which traverse sedge meadow, emergent marsh (high energy coastal or riparian), and submergent plant zones. Sampling locations for the project will be chosen by expert field crews based on sites selected for the CWMP, though additional sampling points may be needed given the strict site criteria needed for the CWMP (e.g., wetland must be at least 9.9 ac [4 ha] in size), which can easily be an added CWMP benchmark site(s). Currently, CWMP marshes are surveyed in the Green Bay area by Nicholas Danz (University of Wisconsin-Superior) in collaboration with CWMP principal investigators Uzarski and Brady. They have agreed to share past and future plant data for LGBFR AOC efforts and may also be able to sample additional wetlands if needed by adding CWMP benchmark site(s), if, for example, a wetland that the LGBFR AOC needs sampling does not meet the sampling criteria of the CWMP. The CWMP samples wetlands that are at least 9.9 ac [4 ha] in size, dominated by open, herbaceous emergent plants, and connected to and influenced by a Great Lake. The protocol and a sample data sheet are available online: https://www.greatlakeswetlands.org/docs/QAPPs_SOPs/GLCWMP_Vegetation_SOP_June_4_2018.pdf. Data collected for CWMP will be used not only for this habitat but also for Wet Meadow, Emergent Marsh (high energy coastal), and Submergent Marsh. In order to calculate metric values for each of these four priority habitats, a data table will need to be requested from CWMP principal investigators that includes the Combined Standardized Scores and plant zone. To calculate the area of Emergent Marsh (riparian) and other coastal wetland habitats, the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons given how much water levels fluctuate and affect the coastal zone. Once that shapefile is edited, then one can use ArcGIS to calculate habitat areas. With Great Lakes Restoration Initiative (GLRI) funding, the CWMP runs on a 5-year cycle and so far has been funded twice (2011-2015; 2016-2020). Within a year of the 5-year period, a batch of randomly selected Great Lakes coastal wetland complexes are sampled, though all possible coastal wetlands are chosen for sampling within the 5-year period (most of which get sampled). Some wetlands are resampled across multiple years, though the majority are surveyed just once in the 5-year period; however, crews can add additional sites for sampling as "benchmark" sites if a local need arrives (e.g., post-restoration verification monitoring). Future funding is not guaranteed (but likely) and greatly needed for continuing this important program.

Fox River Open Water

Assessment Description: This habitat group will be evaluated by counting the number of implemented Fish and Mussel Designated Habitat Areas (DHAs) located between the De Pere Dam and the Fox River confluence with lower Green Bay. In addition to being implemented, each DHA will also have an associated mean dissolved oxygen (DO) target which must be met in >90% of measurements based on continuous monitoring, for the DHA to be counted. This target will be measured at the depth where habitat augmentation is occuring (typically the benthic zone), and will be based on the Wisconsin Department of Natural Resources' warm water rivers and lake aquatic life use thresholds (≥5.0 mg/L DO). Waters with more than 10% of value under this threshold are listed as impaired in Wisconsin. Please reference the WDNR 2020 WisCalm Guidance Document for more information. Monitoring plans for DHAs will be determined on a case-by-case basis by the TAC. A condition score of 10 can be reached when 7 additional DHAs have been implemented, which also meet their dissolved oxygen target (Figure 3.31).

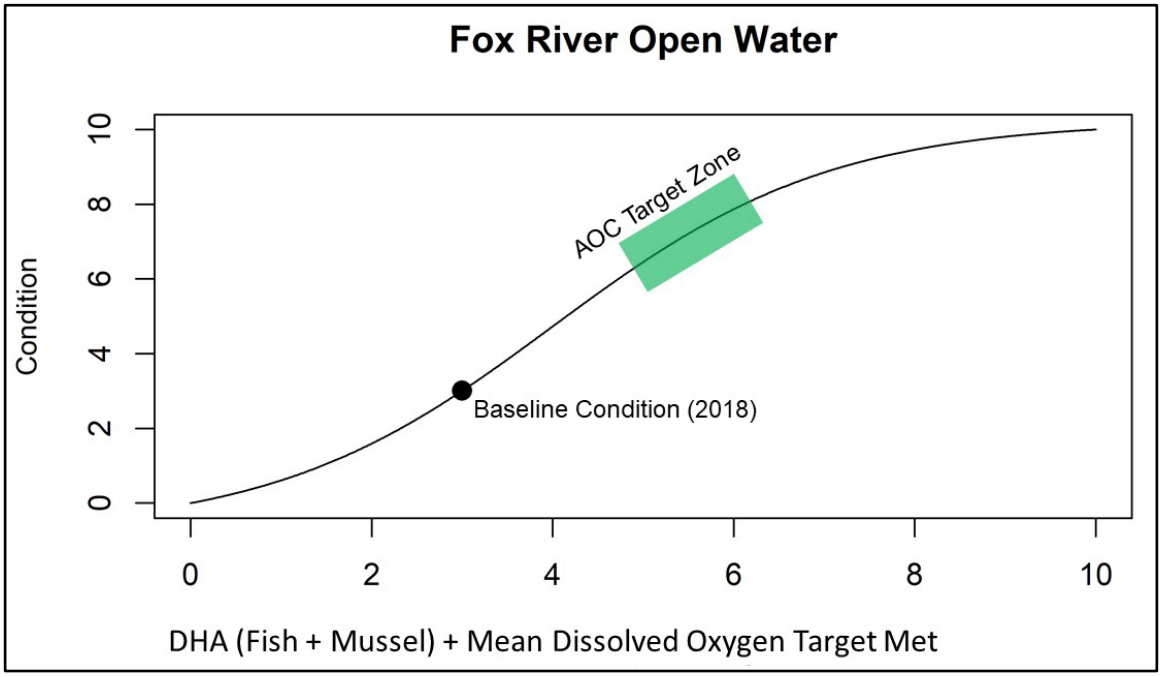


Figure 3.31. Fox River Open Water assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the number of Designated Habitat Areas (DHAs) which will be implemented to benefit fish and mussel species utilizing the Fox River. Baseline condition (black dot) was determined via expert opinion in 2018, as the number of currently functioning DHAs meeting the habitat needs of fish and mussel species in this area. The y-axis represents this habitat group's converted condition ranging from poor (0) to ideal condition (10). Progression along the curve will occur quantitatively as additional DHAs are implemented which also meet their dissolved oxygen (DO) target. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Experts conferred on 27 November 2019 that this approach is reasonable, measurable, and achievable in that it credits the success of implemented projects which will directly benefit both this habitat group and key fish/mussel population groups which also reside here. Partners and experts also placed high importance on evaluating water quality

for this habitat group. By including mean summer dissolved oxygen targets, we can be further assured that the implemented projects are meeting both the biotic and abiotic requirements necessary for sustained function of this habitat.

Assessment Method: The Fox River Open Water priority habitat will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining and managing their site(s) as a Fish and Mussel DHA(s). Water quality will be monitored by a contractor starting in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4).

Green Bay Open Water

Assessment Description: This habitat group will be evaluated by counting the number of implemented Fish and Mussel Designated Habitat Areas (DHAs) located within the AOC boundary starting at the confluence of the Fox River and lower Green Bay. In addition to being implemented, each DHA will also have an associated mean dissolved oxygen (DO) target for the DHA to be counted. Green Bay Open Water benthic zones experience regular, daily DO fluctuations ranging from 0 - >15mg/L (Chris Houghton preliminary data). As a result, observing the threshold of ≥5.0 mg/L (as used in the Fox River, and Tributaries Open Water Habitat groups) may be unachievable across all Green Bay Open Water DHAs, particularly in shallow nearshore areas. Individual DHA DO thresholds and monitoring plan will be determined on a case-by-case basis in consultation with the TAC and will take into consideration spawning periods for targeted fish and native mussel habitat requirements. We must note that our current data for prescribing this new threshold are based only on benthic DO measurements. Further monitoring may reveal that DO higher in the water column still meets the 5.0 mg/L threshold even during these mixing regimes. A condition score of 10 can be reached when 15 additional DHAs have been implemented which also meet their dissolved oxygen target (Figure 3.32).

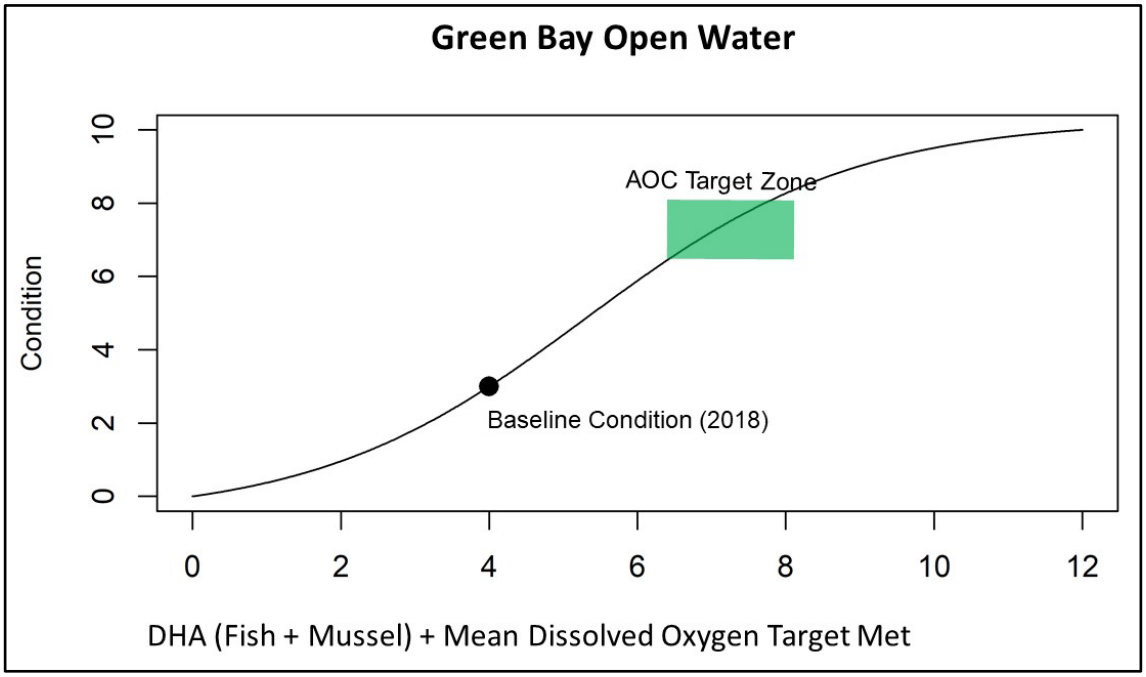


Figure 3.32. Green Bay Open Water assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the number of Designated Habitat Areas (DHAs) which will be implemented to benefit fish and mussel species utilizing these open water habitats. Baseline condition (black dot) was determined via expert opinion in 2018, as the number of currently functioning DHAs meeting the habitat needs of fish and mussel species in this area. The y-axis represents this habitat group's converted condition ranging from poor (0) to ideal condition (10). Progression along the curve will occur quantitatively as additional DHAs are implemented which also meet their dissolved oxygen (DO) target. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: On 27 November 2019, experts discussed and agreed that this approach is reasonable, measurable, and achievable in that credits the success of implemented projects which will directly benefit both this habitat group and key fish/mussel population groups which also reside here. Partners and experts also placed high importance on evaluating water quality for this habitat group. By including mean summer dissolved oxygen targets, we can be further assured that the implemented projects are meeting both the biotic and abiotic requirements necessary for sustained function of this habitat.

Assessment Method: The Green Bay Open Water priority habitat will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining and managing their site(s) as a Fish and Mussel DHA(s). Water quality will be monitored by a contractor starting in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4).

Tributary Open Water

Assessment Description: This habitat group will be evaluated by counting the number of implemented Fish and Mussel Designated Habitat Areas (DHAs) located within the LGBFR AOC boundary (up to 1 km inland) on a tributary beginning where the natural shoreline ends (or based on expert opinion of where "tributary" habitat begins). In addition to being implemented, each DHA will also have an associated mean dissolved oxygen (DO) target which must be met in >90% of measurements based on continuous monitoring for the DHA to be counted. This target will be measured at the depth where habitat augmentation is occuring (typically the benthic zone), and will be based on the Wisconsin Department of Natural Resources' warm water rivers and lake aquatic life use thresholds (≥5.0 mg/L DO). Waters with more than 10% of value under this threshold are listed as impaired in Wisconsin. Monitoring plans for DHAs will be determined on a case-by-case basis by the TAC. Please reference the WDNR 2020 WisCalm Guidance Document for more information. A condition score of 10 can be reached when 4 additional DHAs have been implemented, which also meet their dissolved oxygen target (Figure 3.33).

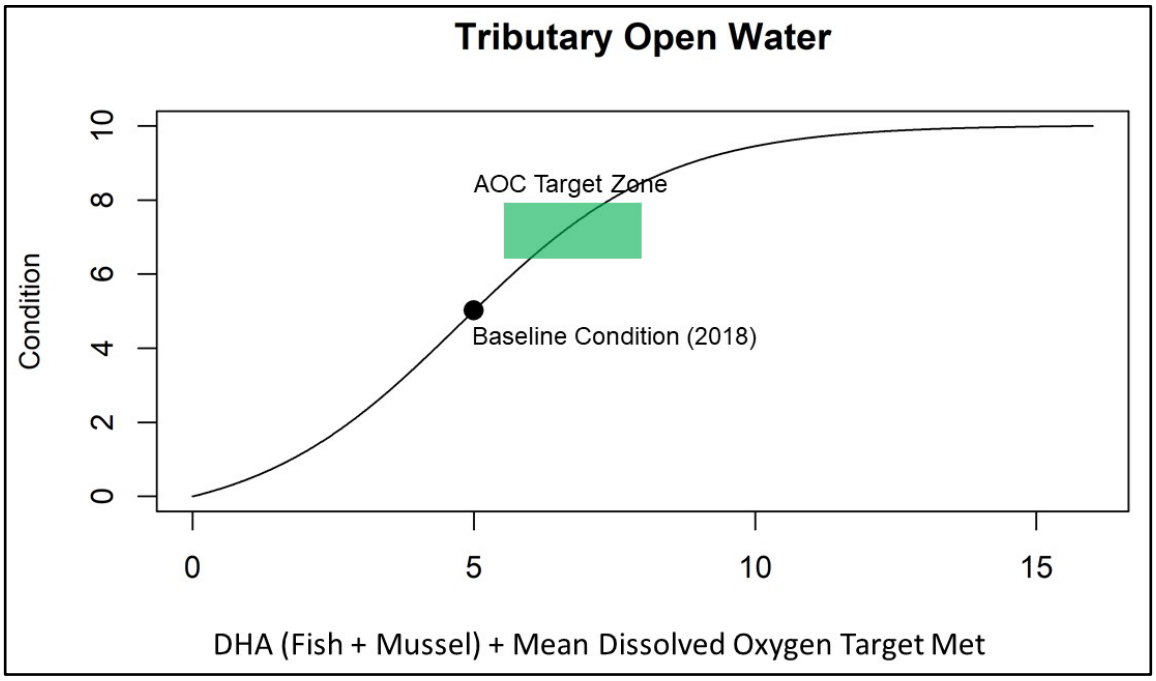


Figure 3.33. Tributary Open Water assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the number of Designated Habitat Areas (DHAs) which will be implemented to benefit fish and mussel species utilizing these open water habitats. Baseline condition (black dot) was determined via expert opinion in 2018, as the number of currently functioning DHAs meeting the habitat needs of fish and mussel species in these areas. The y-axis represents this habitat group's converted condition ranging from poor (0) to ideal condition (10). Progression along the curve will occur quantitatively as additional DHAs are implemented which also meet their dissolved oxygen (DO) target. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: On 27 November 2019, experts discussed and agreed that this approach is reasonable, measurable, and achievable in that credits the success of implemented projects which will directly benefit both this habitat group and key fish/mussel population groups which also reside here. Partners and experts also placed high importance on evaluating water quality for this habitat group. By including mean summer dissolved oxygen targets, we can be further assured that the implemented projects are meeting both the biotic and abiotic requirements necessary for sustained function of this habitat.

Assessment Method: The Tributary Open Water priority habitat will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining and managing their site(s) as a Fish and Mussel DHA(s). Water quality will be monitored by a contractor starting in 2028 after restoration and enhancement projects are complete and will continue for 3 years (see Chapter 4).

Surrogate Grassland Restored

Assessment Description: This habitat will be evaluated by tallying the number of upland Coastal Terrestrial Macroinvertebrate DHAs and multiplying that value by the current total area of available Surrogate Grassland (restored) throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0

(poor) to 10 (ideal; Figure 3.34). Currently, there are approximately 23 acres of variable quality Surrogate Grassland (restored) habitat in the LGBFR AOC, though there is significant potential to increase the area of this important and functionally relevant habitat in several sites in the LGBFR AOC.

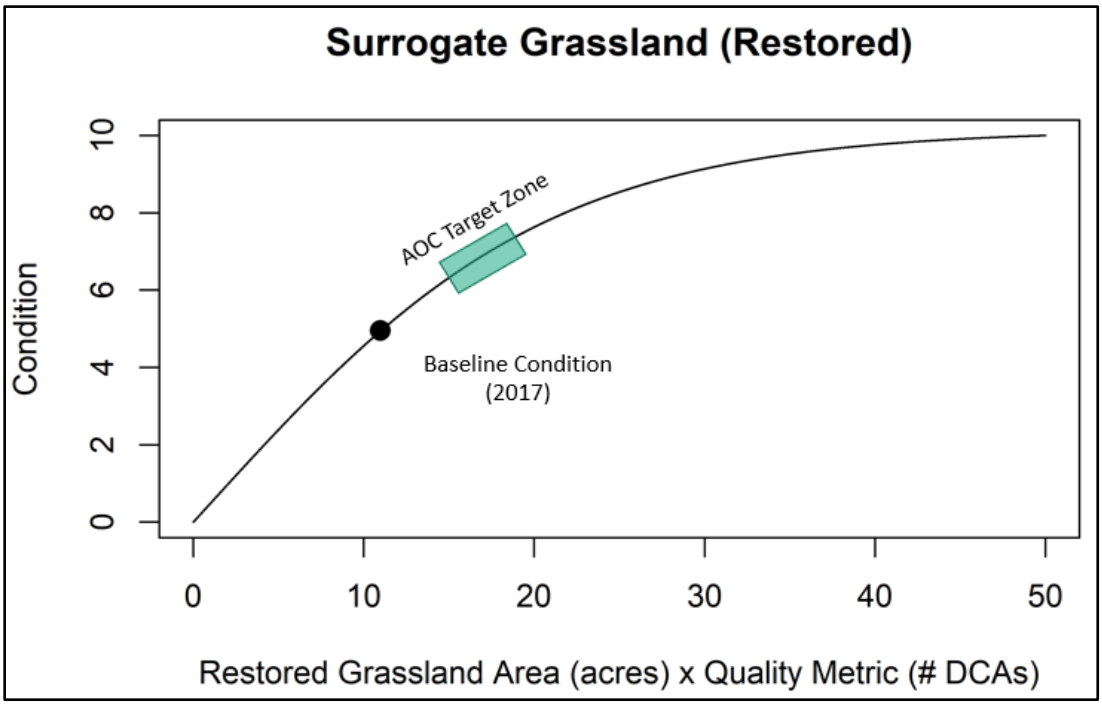


Figure 3.34. Surrogate Grassland (restored) assessment for the Lower Green Bay & Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available restored grassland in acres multiplied by a quality index and is scaled from 0 (no quality restored grassland) to 50 (ideal condition or quality restored grassland). The baseline Surrogate Grassland (restored) index was calculated as 23 acres × 0.5 (moderate quality) and is equal to 11.5 on the x-axis. Baseline quality was initially determined through expert opinion of vegetative diversity in existing restored grasslands; going forward restored grassland quality will be determined by the number of Coastal Terrestrial Macroinvertebrate DHAs encompassing grassland habitat. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Surrogate Grassland (restored) index of 11.5 is equal to a condition of 5 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Like other upland habitats, Surrogate Grassland (restored) is not directly connected to the pelagic zone of the bay of Green Bay and Fox River (i.e., the official LGBFR AOC boundary). Therefore, the WDNR and metrics team decided it was best to invest more time and funding into directly assessing the quality of water-based and wetland habitats that are more closely connected to the LGBFR AOC. Rather than conducting a separate quality assessment for this habitat, increasing the number of upland CTM DHAs will directly protect and provide quality Surrogate Grassland (restored) habitat since many CTMs rely heavily on this priority habitat type.

Assessment Method: The Surrogate Grassland (restored) priority habitat will be evaluated by the WDNR LGBFR AOC Coordinator, and individual landowners are responsible for maintaining

and managing their site(s) as an upland CTM DHA(s) (see Chapter 4). To calculate the area of Surrogate Grassland (restored), the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be reviewed to revise any expanded boundaries of currently available grassland, and updated using satellite imagery to include new habitat polygons. Once that shapefile is edited, then one can use ArcGIS to calculate habitat areas.

Open Water (inland)

Assessment Description: This priority habitat will be evaluated using an Open Water Inland Metric (OW):

$$OW = (0.00 \times acre_{verylow}) + (0.25 \times acre_{low}) + (0.50 \times acre_{moderate}) + (0.75 \times acre_{modhigh}) + (1.0 \times acre_{high})$$

where OW is the summation of the number of acres of inland open water that are in different quality categories. Descriptions of these five quality categories are described below. Metric OW ranges between 0 and 75 and is converted into a condition score (C) ranging from 0 to 10 (Figure 3.35). Currently there are approximately 140 acres of inland open water habitat in the AOC (overall "low quality"). There is limited opportunity to increase the acreage of this habitat type, but significant opportunity to improve the quality of existing inland open water habitat. Therefore, Open Water (inland) habitat quality will be assessed based on the following qualitative categories:

1. *Very Low Quality (0.00)* (=verylow in metric OW formula above): Inland open water that has no shoreline, submerged aquatic, or floating vegetation and no evidence of utilization by fish or wildlife.

2. *Low Quality (0.25)* (=low in metric OW formula above): Some low quality or non-native vegetation present on shoreline, little to no native submerged aquatic or excessive floating vegetation and some evidence of tolerant fish or wildlife (e.g., isopods/chironomids/leeches, black bullheads/central mudminnows, etc.).

3. *Moderate Quality (0.50)* (=moderate in metric OW formula above): Some higher quality shoreline and submerged aquatic vegetation present, or dominance by floating plant species. Evidence of higher quality fish or wildlife utilization (e.g., waterfowl, snails/amphipods/blackfly larvae, shiner spp./centrarchids/percids/esocids, etc.).

4. *Moderately High Quality (0.75)* (=modhigh in metric OW formula above): Some higher quality shoreline and submerged aquatic vegetation present, but still non-native species present. High quality fish or wildlife utilization present (e.g., anurans, caddisflies/odonates, wading birds, shiner spp./centrarchids/percids/esocids, etc.).

5. *High Quality (1.00)* (=high in metric OW formula above): Predominantly higher quality native shoreline and submerged aquatic vegetation species present. Abundant evidence of higher quality utilization of fish and wildlife species (e.g., anurans, high quality macroinvertebrates, fish, etc.).

Example: If 5 acres of Open Water (inland) are determined to be very low quality, 20 acres are low quality, 60 acres moderate quality, 40 acres moderate high quality, and 15 acres high quality, then metric B = (0.00 × 5 acres) + (0.25 × 20 acres) + (0.50 × 60 acres) + (0.75 × 40 acres) + (1.00 × 15 acres) = 0 + 5 + 30 + 30 + 15 = 80 (x-axis). The converted condition (y-axis) is 7.75.

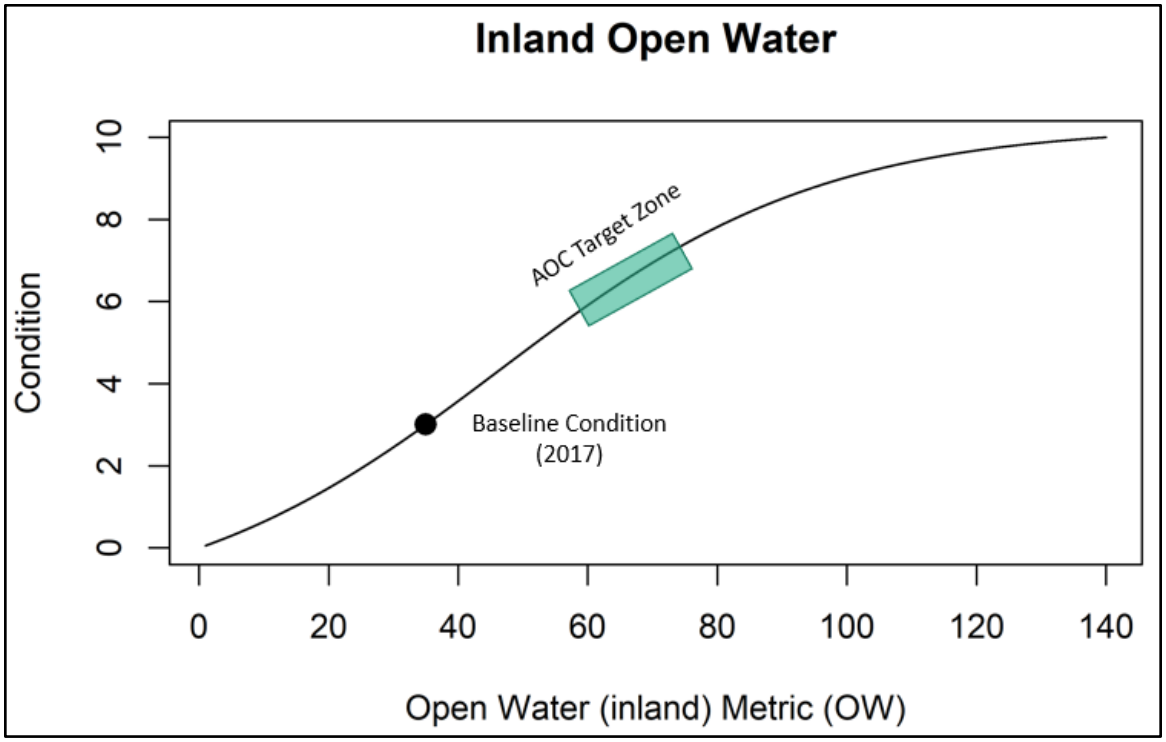


Figure 3.35. The metric for assessing Open Water (inland) habitat in the Lower Green Bay and Fox River Area of Concern, Open Water (inland) Metric (OW), is a summation of acres of inland open water habitat that are multiplied by different quality weights based on qualitative assessment. The baseline inland open water metric (OW) = (0.00 × 0 $acre_{verylow}$) + (0.25 × 140 $acre_{low}$) + (0.50 × 0 $acre_{moderate}$) + (0.75 × 0 $acre_{modhigh}$) + (1.00 × 0 $acre_{high}$) is equal to 35 on the x-axis. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and a baseline (OW) of 35 is equal to a condition of 3 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: The AOC metrics team discussed on several occasions in 2019 what the best method of assessing this habitat would be given the limited opportunity to increase the habitat area and difficulty standardizing a quality assessment for different types of inland open waters within 1 km of the AOC boundary (retention ponds, ephemeral ponds, northern pike spawning areas, etc.). It was determined on 15 January 2020 that a qualitative assessment of habitat quality would be most appropriate for evaluating this habitat's condition. The metrics team developed and described various quality categories that make up the Open Water (inland) metric (OW).

Assessment Method: The Open Water (inland) priority habitat will be evaluated by calculating the acreage of inland open water habitat using the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a, b) and multiplying acreages of individual open water inland habitats evaluated by the appropriate quality categories.

Shrub Carr

Assessment Description: This habitat will be evaluated by calculating the Tiered Aquatic Life Use (TALU) Category established in the WDNR Provisional Wetland Floristic Quality Benchmarks for Wetland Monitoring and Assessment in Wisconsin for the Southeast Wisconsin Till Plains Ecoregion. Assessment of TALU scores and categories of the shrub carr zone during field surveys (see "Monitoring Plan and Resulting Dataset" below) will be extrapolated and multiplied by 0.1 to obtain a quality multiplier between 0-1. This quality score will then be multiplied by the total area of available shrub carr habitat throughout the LGBFR AOC (in acres) (Figure 3.36). The final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.36). With the way this conversion curve is designed, if the total existing shrub carr habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available Shrub Carr in the LGBFR AOC is of high quality. Currently, there are approximately 244 acres of variable quality Shrub Carr habitat in the LGBFR AOC, and while there is limited potential to increase the area of habitat in the LGBFR AOC within the time constraints of the program, there are locations in which the quality of existing habitat could be improved.

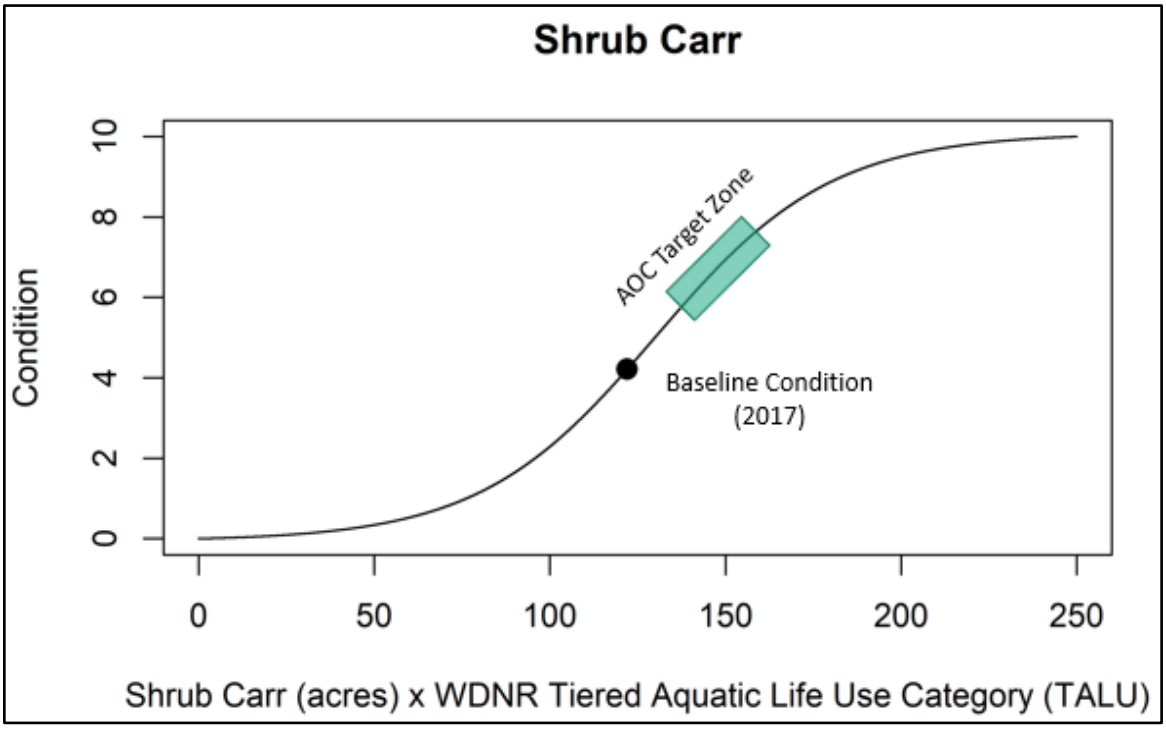


Figure 3.36. Shrub Carr assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Shrub Carr in acres multiplied by a quality index and is scaled from 0 (no quality shrub carr) to 250 (ideal condition or quality shrub carr). The baseline Shrub Carr index was calculated as 244 acres × 0.5 (moderate quality) and is equal to 122 on the x-axis. Baseline quality was initially determined through expert opinion; going forward Shrub Carr quality will be determined by the Tiered Aquatic Life Use (TALU) categories established by WDNR. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Shrub Carr index of 144 is equal to a condition of 4 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Kupsky held a conference call on 21 October 2019 with Aaron Marti (WDNR) to discuss the application of the WDNR wetland floristic quality assessment (FQA) benchmarks for various inland wetland habitats (including Shrub Carr) in the LGBFR AOC. The FQA benchmarks use cover-weighted Mean Coefficient of Conservatism scores for wetland communities in the Wisconsin Omernik Level III Southeast Wisconsin Till Plains Ecoregion based on TALU disturbance categories. These disturbance categories are based on Overall Disturbance Categories from the Disturbance Factors Checklist and range from Tier 5 (Very Poor; Most Disturbed) to Tier 1 (Excellent; Least Disturbed). Marti supported the application of using these benchmarks to describe the quality of LGBFR AOC Shrub Carr habitat and other inland wetland habitat monitoring efforts.

Assessment Method: Contracted monitoring of Shrub Carr will begin in 2028-2030 for a single year after restoration and enhancement projects are complete (see Chapter 4).

Hardwood Swamp

Assessment Description: This habitat will be evaluated by calculating the Tiered Aquatic Life Use (TALU) Category established in the WDNR Provisional Wetland Floristic Quality Benchmarks for Wetland Monitoring and Assessment in Wisconsin for the Southeast Wisconsin Till Plains Ecoregion. Assessment of TALU scores and categories of the hardwood swamp zone during field surveys (see "Monitoring Plan and Resulting Dataset" below) will be extrapolated and multiplied by 0.1 to obtain a quality multiplier between 0-1. This quality score will then be multiplied by the total area of available hardwood swamp habitat throughout the LGBFR AOC (in acres) (Figure 3.37). With the way this conversion curve is designed, if the total existing Hardwood Swamp habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available Hardwood Swamp in the LGBFR AOC is of high quality. Currently, there are approximately 1,910 acres of variable quality Hardwood Swamp habitat in the LGBFR AOC, and while there is limited potential to increase the area of habitat in the LGBFR AOC within the time constraints of the program, there are several locations in which the quality of existing habitat could be improved.

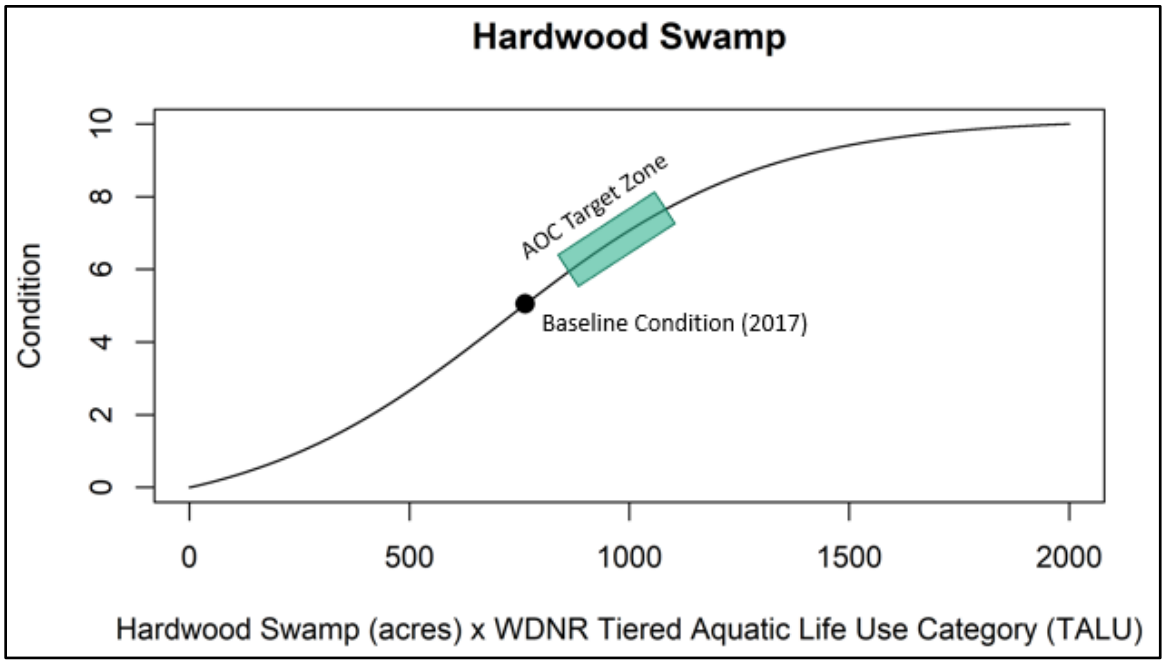


Figure 3.37. Hardwood Swamp assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Hardwood Swamp in acres multiplied by a quality index and is scaled from 0 (no quality Hardwood Swamp) to 2,000 (ideal condition or quality Hardwood Swamp). The baseline Hardwood Swamp index was calculated as 1,910 acres × 0.4 (low to moderate quality) and is equal to 764 on the x-axis. Baseline quality was initially determined through expert opinion; going forward Hardwood Swamp quality will be determined by the Tiered Aquatic Life Use categories established by WDNR. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Hardwood Swamp index of 764 is equal to a condition of 5 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Kupsky held a conference call on 21 October 2019 with Aaron Marti (WDNR) to discuss the application of the WDNR floristic quality assessment (FQA) benchmarks currently under development for various inland wetland habitats (including Hardwood Swamp) in the LGBFR AOC. The FQA benchmarks use cover-weighted Mean Coefficient of Conservatism scores for wetland communities in the Wisconsin Omernik Level III Southeast Wisconsin Till Plains Ecoregion based on TALU disturbance categories. These disturbance categories are based on Overall Disturbance Categories from the Disturbance Factors Checklist and range from Tier 5 (Very Poor; Most Disturbed) to Tier 1 (Excellent; Least Disturbed). Marti supported the application of using these benchmarks to describe the quality of LGBFR AOC hardwood swamp habitat and other inland wetland habitat monitoring efforts.

Assessment Method: Contracted monitoring will begin in 2028-2030 for a single year after restoration and enhancement projects are complete (see Chapter 4).

Emergent Marsh (inland)

Assessment Description: This habitat will be evaluated by calculating the Tiered Aquatic Life Use (TALU) Category established in the WDNR Provisional Wetland Floristic Quality Benchmarks for Wetland Monitoring and Assessment in Wisconsin for the Southeast Wisconsin Till Plains

Ecoregion. Assessment of TALU scores and categories of the inland emergent marsh zone during field surveys (see "Monitoring Plan and Resulting Dataset" below) will be extrapolated and multiplied by 0.1 to obtain a quality multiplier between 0-1. This quality score will then be multiplied by the total area of available inland emergent marsh habitat throughout the LGBFR AOC (in acres) (Figure 3.38). With the way this conversion curve is designed, if the total existing Inland Emergent Marsh habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available inland emergent marsh habitat in the LGBFR AOC is of high quality. Currently, there are approximately 327 acres of variable quality emergent marsh (inland) habitat in the LGBFR AOC, and while there is limited potential to increase the area of habitat in the LGBFR AOC within the time constraints of the program, there are several locations in which the quality of existing habitat could be improved.

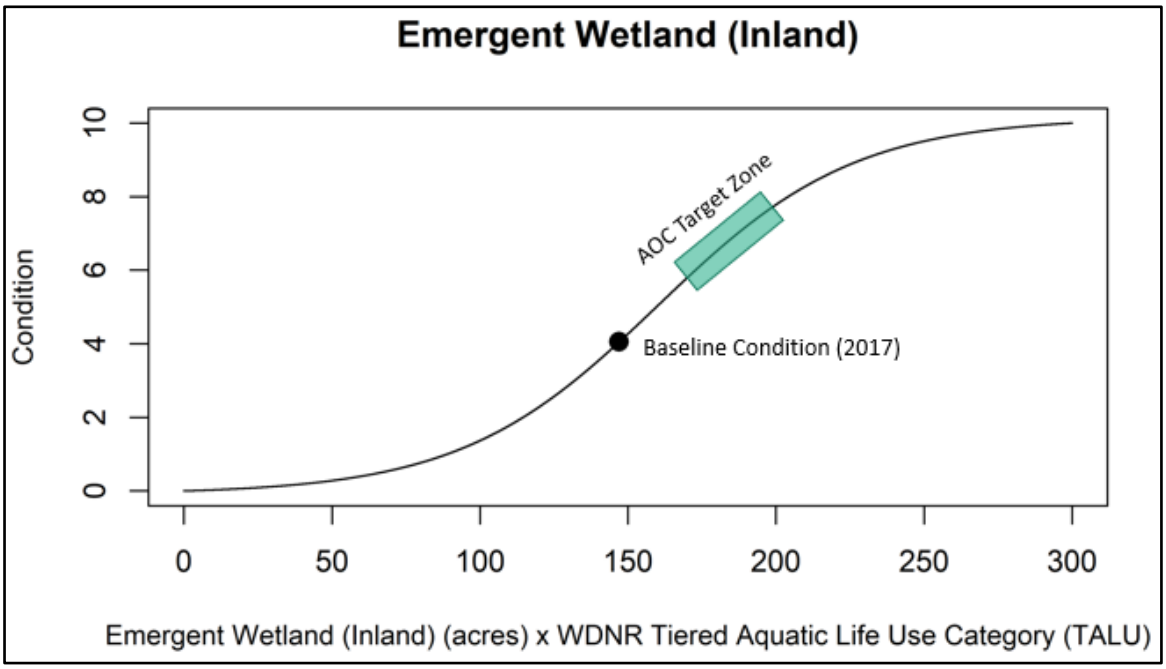


Figure 3.38. Emergent Marsh (inland) assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Emergent Marsh (inland) in acres multiplied by a quality index and is scaled from 0 (no quality marsh) to 300 (ideal condition or quality marsh). The baseline Emergent Marsh (inland) index was calculated as 327 acres × 0.45 (low to moderate quality) and is equal to 147.15 on the x-axis. Baseline quality was initially determined through expert opinion; going forward Emergent Marsh (inland) quality will be determined by the Tiered Aquatic Life Use (TALU) categories established by WDNR. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Emergent Marsh (inland) index of 147.15 is equal to a condition of 4 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Kupsky held a conference call on 21 October 2019 with Aaron Marti (WDNR) to discuss the application of the WDNR floristic quality assessment (FQA) benchmarks currently under development for various inland wetland habitats (including Inland Emergent Marshes) in the LGBFR AOC. The FQA benchmarks use cover-weighted Mean Coefficient of Conservatism scores for wetland communities in the WIsconsin Omernik Level III Southeast Wisconsin Till Plains Ecoregion based on TALU disturbance categories. These disturbance

categories are based on Overall Disturbance Categories from the Disturbance Factors Checklist and range from Tier 5 (Very Poor; Most Disturbed) to Tier 1 (Excellent; Least Disturbed). Marti supported the application of using these benchmarks to describe the quality of LGBFR AOC Inland Emergent Marsh habitat and other inland wetland habitat monitoring efforts.

Assessment Method: Contracted monitoring will begin in 2028-2030 for a single year after restoration and enhancement projects are complete (see Chapter 4).

Emergent Marsh (roadside)

Assessment Description: This habitat will be evaluated by calculating the Tiered Aquatic Life Use (TALU) Category established in the WDNR Provisional Wetland Floristic Quality Benchmarks for Wetland Monitoring and Assessment in Wisconsin for the Southeast Wisconsin Till Plains Ecoregion. Assessment of TALU scores and categories of the emergent marsh zone during field surveys (see "Monitoring Plan and Resulting Dataset" below) will be extrapolated and multiplied by 0.1 to obtain a quality multiplier between 0-1. This quality score will then be multiplied by the total area of available emergent marsh (roadside) habitat throughout the LGBFR AOC (in acres) (Figure 3.39). With the way this conversion curve is designed, if the total existing emergent marsh (roadside) habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available emergent marsh (roadside) habitat in the LGBFR AOC is of high quality. Currently, there are approximately 50 acres of very low quality Emergent Marsh (roadside) habitat in the LGBFR AOC with no desire to expand this habitat type by conservation professionals. However, there is significant potential to improve upon currently available habitat, particularly along the southern coastline of Green Bay.

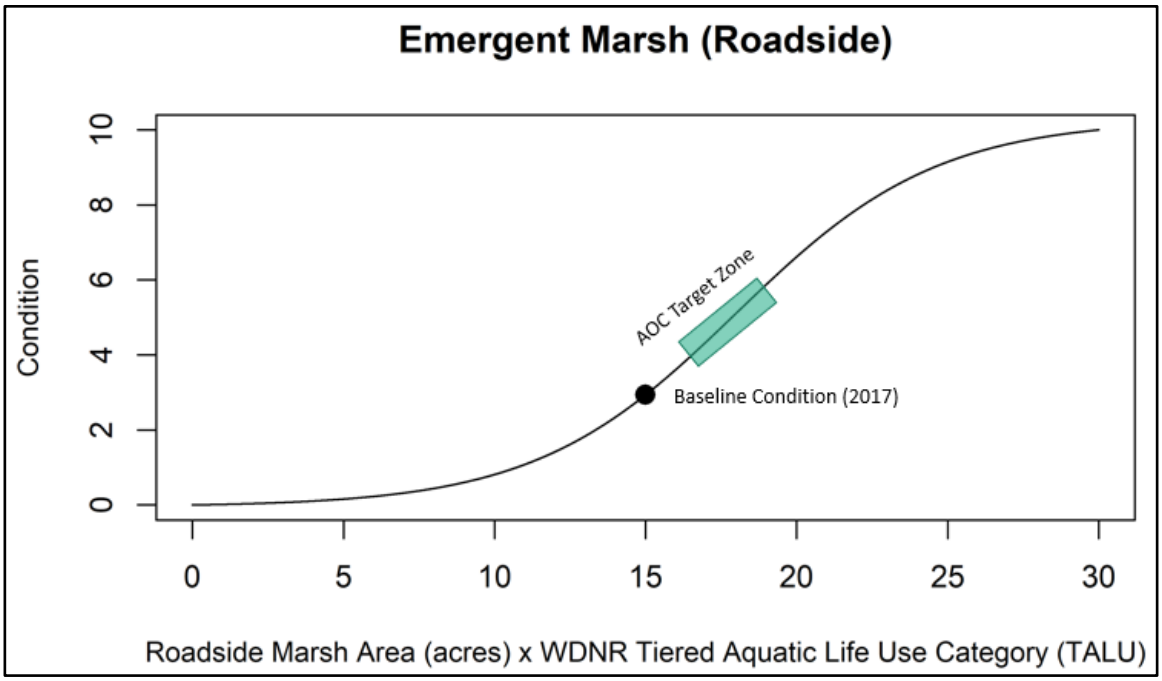


Figure 3.39. Emergent Marsh (roadside) assessment for the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Emergent Marsh (roadside) in acres multiplied by a quality index and is scaled from 0 (no quality marsh) to 30 (ideal condition or quality marsh). The baseline Emergent Marsh (roadside) index was calculated as 50 acres × 0.3 (very low to low quality) and is equal to 15 on the x-axis. Baseline quality was initially determined through expert opinion; going forward Emergent Marsh (roadside) quality will be determined by the Tiered Aquatic Life Use categories established by WDNR. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Emergent Marsh (roadside) index of 15 is equal to a condition of 3 on the y-axis. The AOC Target Zone ranges from 4.0 to 6.0 as there is limited fish and wildlife value of this habitat type.

Assessment Rationale: Kupsky held a conference call on 21 October 2019 with Aaron Marti (WDNR) to discuss the application of the WDNR floristic quality assessment (FQA) benchmarks currently under development for various inland wetland habitats (including roadside emergent marshes) in the LGBFR AOC. The FQA benchmarks use cover-weighted Mean Coefficient of Conservatism scores for wetland communities in the WIsconsin Omernik Level III Southeast Wisconsin Till Plains Ecoregion based on TALU disturbance categories. These disturbance categories are based on Overall Disturbance Categories from the Disturbance Factors Checklist and range from Tier 5 (Very Poor; Most Disturbed) to Tier 1 (Excellent; Least Disturbed). Marti supported the application of using these benchmarks to describe the quality of LGBFR AOC roadside emergent marsh habitat and other inland wetland habitat monitoring efforts.

Assessment Method: Contracted monitoring will begin in 2028-2030 for a single year after restoration and enhancement projects are complete (see Chapter 4).

Southern Dry Mesic Forest

Assessment Description: This habitat will be evaluated by estimating % invasive species cover in the Southern Dry Mesic Forest zone and multiplying that value by the current total area of available Southern Dry Mesic Forest habitat throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.40). With the way this conversion curve is designed, if the total existing forest habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available forest habitat in the LGBFR AOC is of high quality. Currently, there are approximately 57 acres of high quality Southern Dry Mesic Forest habitat in the LGBFR AOC, the majority of which are found on the UW-Green Bay campus. As such, there is limited potential to expand the area or improve the current quality of this habitat type in the LGBFR AOC under this particular program, though longer term initiatives should consider the restoration of this important and historically relevant habitat type.

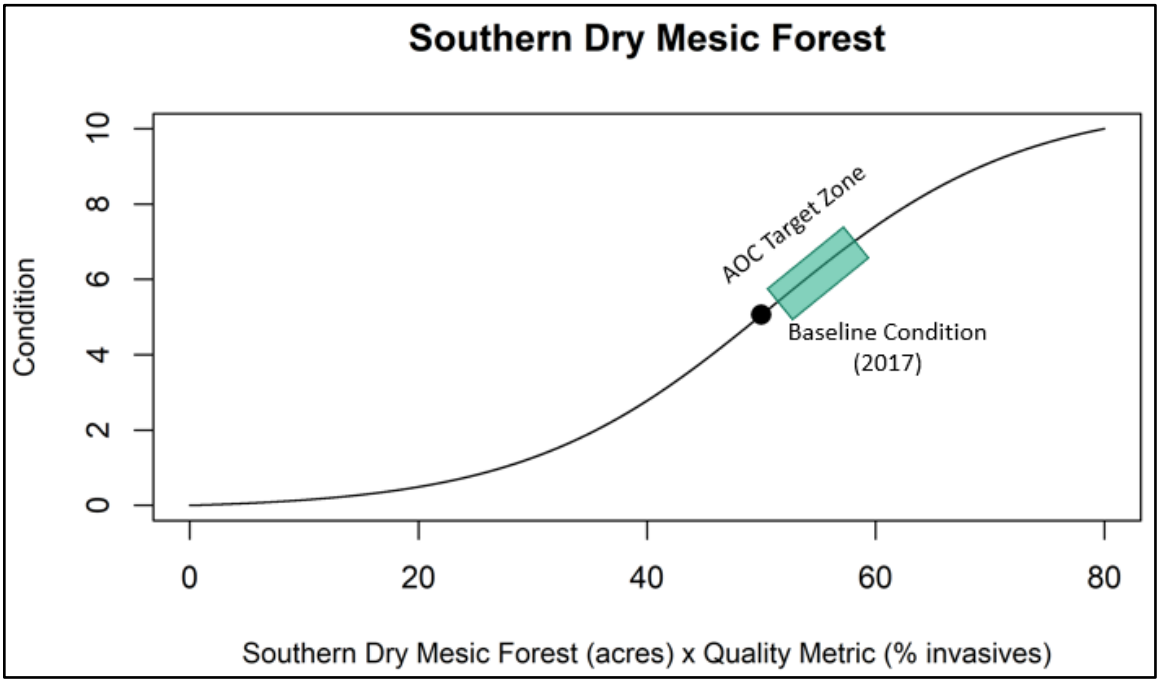


Figure 3.40. Southern Dry Mesic Forest assessment in the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Southern Dry Mesic Forest in acres multiplied by a quality index and is scaled from 0 (no quality forest) to 80 (ideal condition or quality forest). The baseline Southern Dry Mesic Forest index was calculated as 57 acres × 0.9 (high quality) and is equal to a 51 on the x-axis. Baseline quality was initially determined through expert opinion; going forward Southern Dry Mesic Forest quality will be determined by estimating the percent cover of invasive species and converting to a value between 0 and 1. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Southern Dry Mesic Forest index of 51 is equal to a condition of 5 on the y-axis. The AOC Target Zone ranges from 5.5 to 7.0.

Assessment Rationale: Like other upland habitats, Southern Dry Mesic Forest is not directly connected to the pelagic zone of the bay of Green Bay and Fox River (i.e., the official LGBFR AOC boundary). Therefore, the WDNR and metrics team decided it was best to invest more time

and funding into directly assessing the quality of water-based and wetland habitats that are more closely connected to the LGBFR AOC, which is why an estimate of percent invasive species cover is being used as a quality indicator for this habitat type.

Assessment Method: The WDNR will begin monitoring Southern Dry Mesic Forest for a single year in 2028-2030 after restoration and enhancement projects are complete (see Chapter 4). To calculate the area (ac) of Southern Dry Mesic Forest, the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons as needed. Once that shapefile is edited, then one can use ArcGIS to calculate the number of acres.

Northern Mesic Forest

Assessment Description: This habitat will be evaluated by estimating % invasive species cover in the Northern Mesic Forest zone and multiplying that value by the current total area of available Northern Mesic Forest habitat throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.41). With the way this conversion curve is designed, if the total existing forest habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available forest habitat in the LGBFR AOC is of high quality. Currently, there are approximately 120 acres of variable quality Northern Mesic Forest habitat in the LGBFR AOC. While there is limited potential to expand the area or improve the current quality of this habitat type in the LGBFR AOC under this particular program, though longer term initiatives should consider the restoration of this important and historically relevant habitat type.

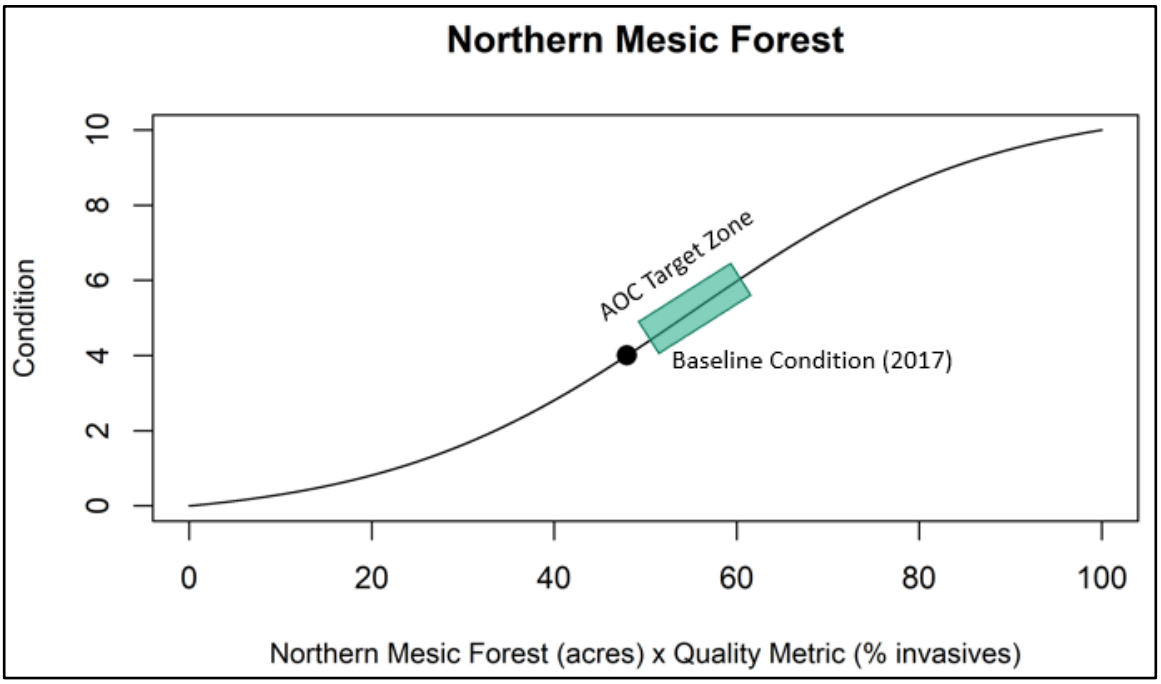


Figure 3.41. Northern Mesic Forest assessment in the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Northern Mesic Forest in acres multiplied by a quality index and is scaled from 0 (no quality forest) to 100 (ideal condition or quality forest). The baseline Northern Mesic Forest index was calculated as 120 acres × 0.4 (low to moderate quality) and is equal to a 48 on the x-axis. Baseline quality was initially determined through expert opinion; going forward Northern Mesic Forest quality will be determined by estimating the percent cover of invasive species and converting to a value between 0 and 1. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Northern Mesic Forest index of 48 is equal to a condition of 4 on the yy-axis. The AOC Target Zone ranges from 4.5 to 6.0.

Assessment Rationale: Like other upland habitats, Northern Mesic Forest is not directly connected to the pelagic zone of the bay of Green Bay and Fox River (i.e., the official LGBFR AOC boundary). Therefore, the WDNR and metrics team decided it was best to invest more time and funding into directly assessing the quality of water-based and wetland habitats that are more closely connected to the LGBFR AOC, which is why an estimate of percent invasive species cover is being used as a quality indicator for this habitat type.

Assessment Method: The WDNR will begin monitoring Northern Mesic Forest for a single year in 2028-2030 after restoration and enhancement projects are complete (see Chapter 4). To calculate the area (ac) of Northern Mesic Forest, the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons as needed. Once that shapefile is edited, then one can use ArcGIS to calculate the number of acres.

Other Forest

Assessment Description: This habitat will be evaluated by estimating % invasive species cover in the Other Forest zone and multiplying that value by the current total area of available Other

Forest habitat throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.42). With the way this conversion curve is designed, if the total existing forest habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available forest habitat in the LGBFR AOC is of high quality. Currently, there are approximately 432 acres of variable quality Other Forest habitat in the LGBFR AOC. While there is limited potential or desire by conservation professionals to expand the area of this habitat type, there are several opportunities to improve the quality of currently available habitat.

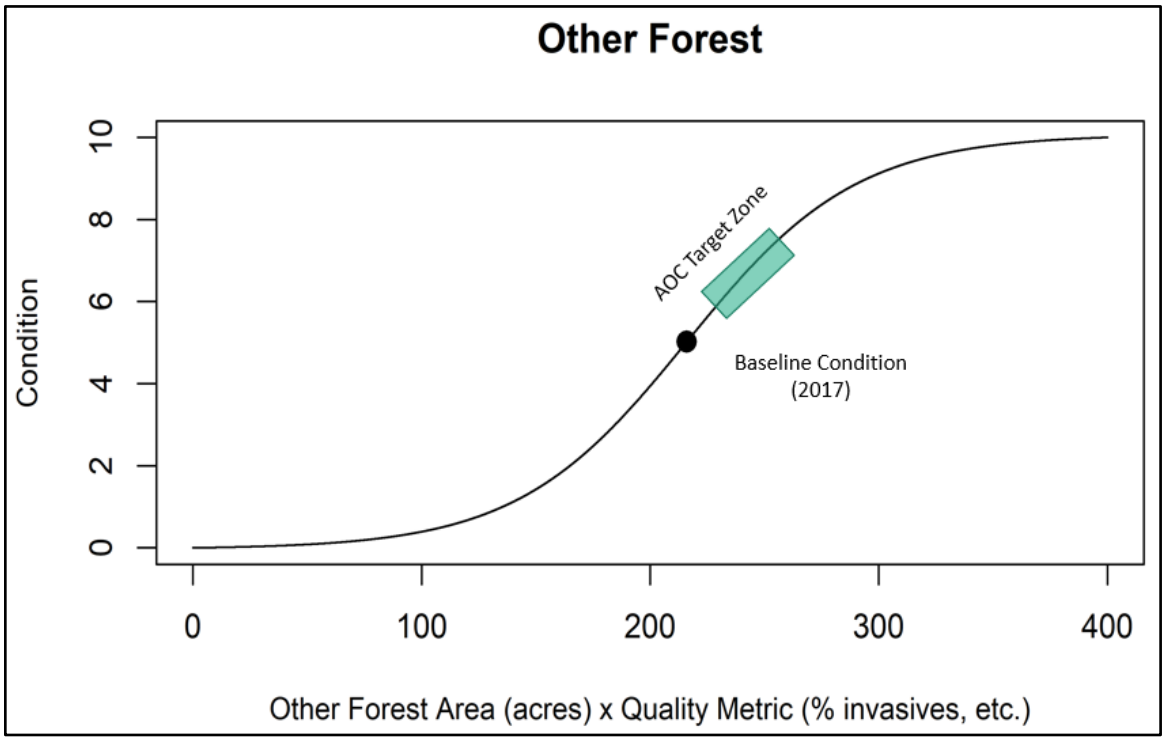


Figure 3.42. Other Forest habitat assessment in the Lower Green Bay and Fox River Area of Concern. The x-axis represents the mathematical product of the area of currently available Other Forest in acres multiplied by a quality index and is scaled from 0 (no quality forest) to 400 (ideal condition or quality forest). The baseline Other Forest index was calculated as 432 acres × 0.4 (low to moderate quality) and is equal to a 216 on the x-axis. Baseline quality was initially determined through expert opinion; going forward Other Forest quality will be determined by estimating the percent cover of invasive species and converting to a value between 0 and 1. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Other Forest index of 216 is equal to a condition of 5 on the y-axis. The AOC Target Zone ranges from 6.0 to 7.5.

Assessment Rationale: Like other upland habitats, Other Forest is not directly connected to the pelagic zone of the bay of Green Bay and Fox River (i.e., the official LGBFR AOC boundary). Therefore, the WDNR and metrics team decided it was best to invest more time and funding into directly assessing the quality of water-based and wetland habitats that are more closely connected to the LGBFR AOC, which is why an estimate of percent invasive species cover is being used as a quality indicator for this habitat type.

Assessment Method: The WDNR will begin monitoring the Other Forest priority habitat for a single year in 2028-2030 after restoration and enhancement projects are complete (see Chapter 4). To calculate the area (ac) of Other Forest, the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons as needed. Once that shapefile is edited, then one can use ArcGIS to calculate the number of acres.

Surrogate Grassland (old field)

Assessment Description: This habitat will be evaluated by estimating % invasive species cover in Surrogate Grassland (old field) habitats and multiplying that value by the current total area of available Surrogate Grassland (old field) habitat throughout the LGBFR AOC (in acres). This final mathematical product along the x-axis is then converted into a condition score ranging from 0 (poor) to 10 (ideal; Figure 3.43). With the way this conversion curve is designed, if the total existing old field habitat in the LGBFR AOC is of moderate quality, then the condition score will be the same if half of that available old field habitat in the LGBFR AOC is of high quality. Currently, there are approximately 347 acres of variable quality Surrogate Grassland (old field) habitat in the LGBFR AOC. While there is limited potential or desire by conservation professionals to expand the area of this habitat type, there are several opportunities to improve the quality of currently available habitat. There are also some limited opportunities to convert low quality old field habitat into a higher quality Surrogate Grassland (restored) habitat, though the TAC is invested in maintaining higher quality tracts of old field in the LGBFR AOC as-is.

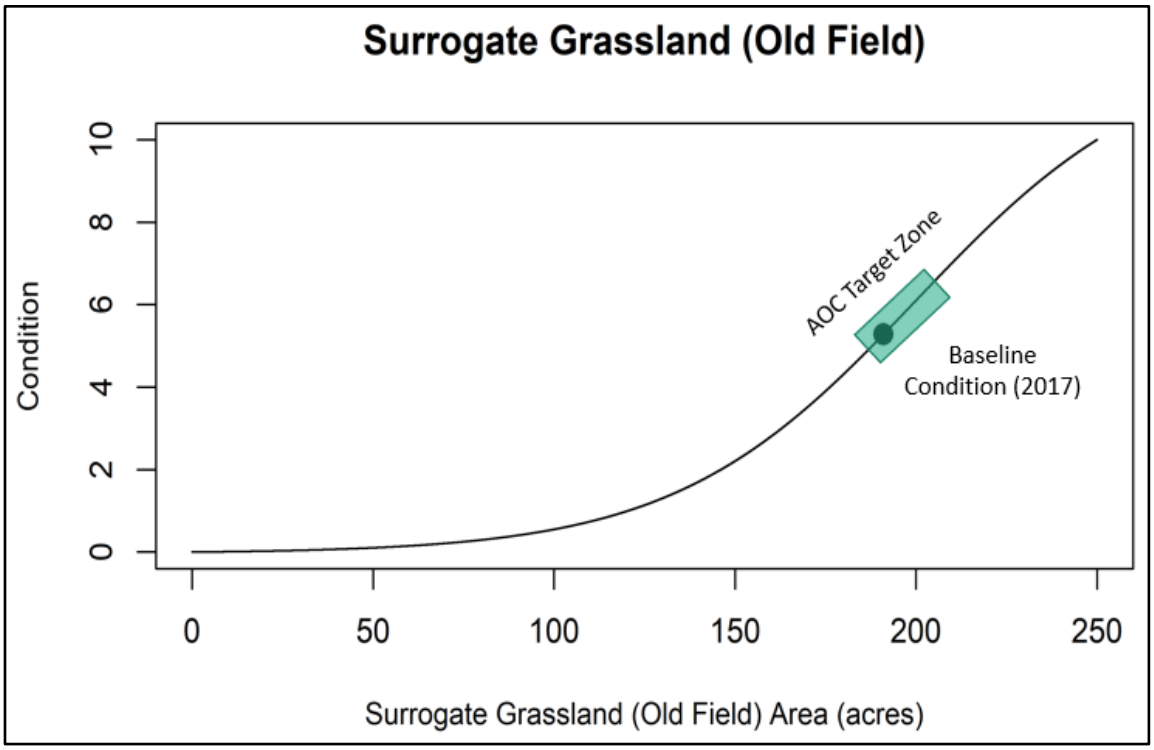


Figure 3.43. Surrogate Grassland (old field) habitat assessment in the Lower Green Bay and Fox River Area of Concern. The x-axis represents the area of currently available Surrogate Grassland (old field) in acres and is scaled from 0 (no old field acreage) to 250 (ideal acreage). The baseline Surrogate Grassland (old field) index was calculated as 191 acres and is equal to 191 on the x-axis. The y-axis is this habitat's converted condition ranging from poor condition (0) to good/ideal condition (10), and the baseline Surrogate Grassland (old field) index of 191 is equal to a condition of 5 on the y-axis. The AOC Target Zone ranges from 5.0 to 6.5.

Assessment Rationale: Like other upland habitats, Surrogate Grassland (old field) is not directly connected to the pelagic zone of the bay of Green Bay and Fox River (i.e., the official LGBFR AOC boundary). Therefore, the WDNR and metrics team decided it was best to invest more time and funding into assessing the quality of water-based and wetland habitats that are more closely connected to the LGBFR AOC, which is why no quality assessment will be conducted for Surrogate Grassland (old field). While some management actions are likely to convert low-quality old field habitat into a higher quality Surrogate Grassland (restored) habitat, the TAC recommended that higher quality old fields not be converted as this is an important habitat type for some wildlife. As such, the AOC Target Zone is already considered met for this habitat type, though it will remain important to track the acreage of this habitat to ensure that it is not being lost.

Assessment Method: The WDNR will begin monitoring Surrogate Grassland (old field) for a single year in 2028-2030 after restoration and enhancement projects are complete (see Chapter 4). To calculate the area (ac) of Surrogate Grassland (old field), the 2015 LGBFR AOC plant community shapefile generated by Howe et al. (2018a,b) should be edited using satellite imagery to revise the boundaries of current habitat polygons as needed. Once that shapefile is edited, then one can use ArcGIS to calculate the number of acres.

Chapter 4: Tracking Progress toward Beneficial Use Impairment (BUI) Removal

Purpose

The purpose of this chapter is to describe and build upon the framework developed by UW-Green Bay staff that includes a timeline and means in which BUI progress will be evaluated for the 18 priority habitats and 22 priority populations individually as well as the comprehensive BUI condition scores needed to evaluate progress toward removing the "Degradation of Fish and Wildlife Populations" and "Loss of Fish and Wildlife Habitat" BUIs.

How to Track Progress

As described in Chapter 1, UW-Green Bay staff led an investigation from 2015-2017 into the current condition of fish and wildlife populations and habitats within 1 km of the EPA-approved LGBFR AOC boundary. From this initial investigation, baseline condition scores were determined for all priority habitats and populations based on expert opinion, a quantitative BUI assessment framework was developed, and recommended removal targets were proposed for both BUIs (see Figure 1.2 in Chapter 1 for the Assessment Process).

During 2018-2019, WDNR and UW-Green Bay staff worked with the Fish and Wildlife Habitats and Populations Technical Advisory Committee (TAC) to craft BUI removal target language based on the quantitative BUI assessment framework, which state:

"Loss of Fish and Wildlife Habitat"

The cumulative fish and wildlife habitat condition score reaches a 6.0 averaged over a verification monitoring period taking place after all management actions have been completed. This cumulative score will be calculated as outlined in the "Evaluating Progress Toward Removing the Degradation of Fish and Wildlife Populations and Loss of Fish and Wildlife Habitat Beneficial Use Impairments" Plan.

"Degradation of Fish and Wildlife Populations"

The cumulative fish and wildlife population condition score reaches a 6.5 averaged over a verification monitoring period taking place after all management actions have been completed. This cumulative score will be calculated as outlined in the "Evaluating Progress Toward Removing the Degradation of Fish and Wildlife Populations and Loss of Fish and Wildlife Habitat Beneficial Use Impairments" Plan.

Additionally, from 2018-2019 the TAC developed a list of restoration and enhancement projects (e.g., management actions) that, when implemented, are anticipated to realize the removal targets for both BUIs. This list will be submitted to the USEPA Great Lakes National Program Office (GLNPO) in mid-2020, with restoration projects implemented approximately 2020-2024. Each project is expected to have an approximately three-year maintenance period

extending from approximately 2025 to 2027, which will not only help ensure project success, but also allow time for fish and wildlife to respond to habitat improvements before evaluating individual priority habitats and populations/population groups. The cumulative BUI condition scores will be evaluated from approximately 2028 until 2030, with condition scores calculated and considered each year as appropriate (Tables 4.1 and 4.2). This will allow the TAC to determine if each of the priority habitat and population/population group metrics are achievable and make any necessary adjustments during the verification monitoring period via a concurrence-based approach (Figure 4.1).

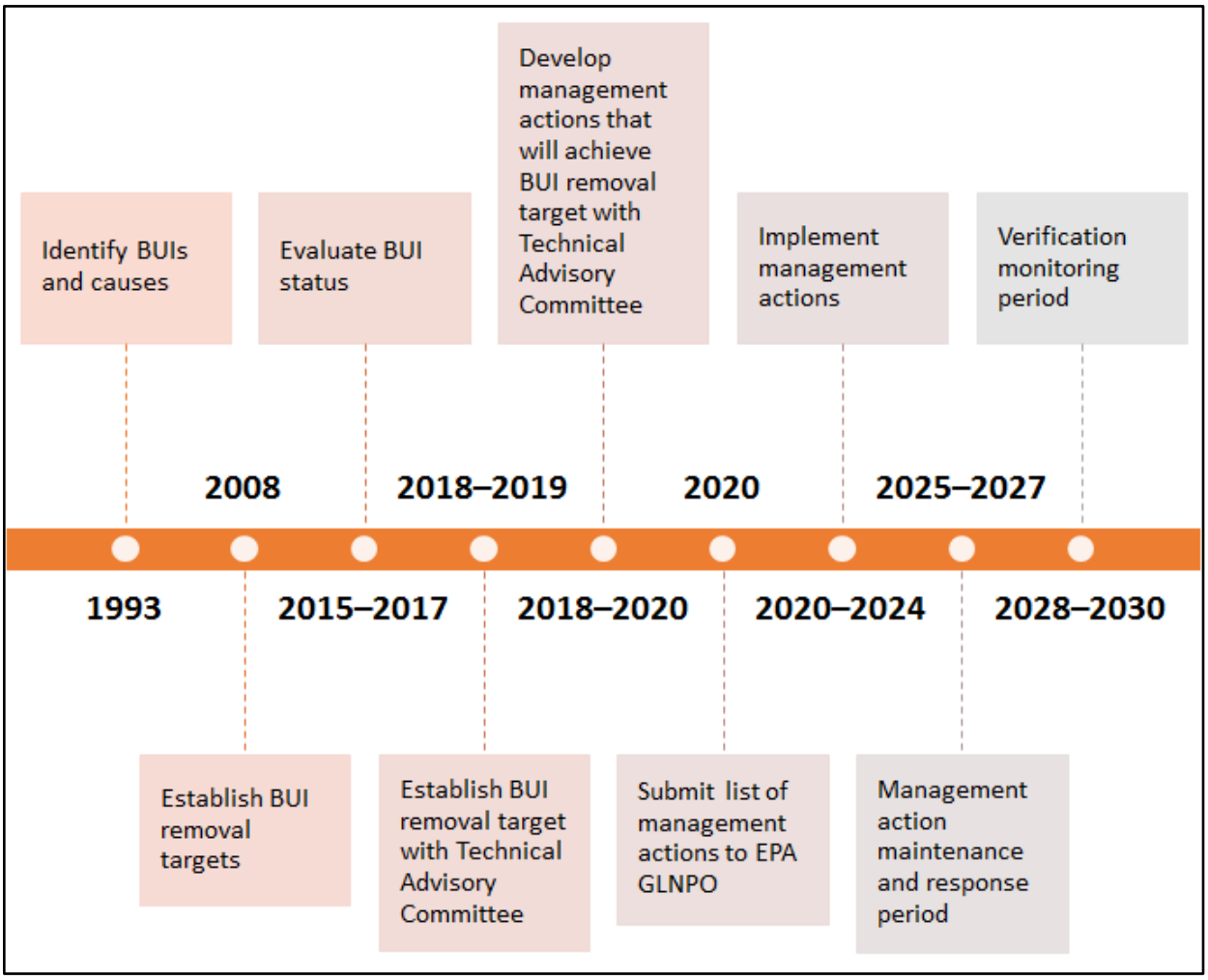


Figure 4.1. Beneficial Use Impairment (BUI) removal process for the LGBFR AOC Degradation of Fish and Wildlife Populations and Loss of Fish and Wildlife Habitat BUIs.

Populations will be monitored for verification purposes after all management actions are completed (Table 4.1). For populations that are not being evaluated through existing monitoring programs but have exceeded the AOC Target Zone after the first year of evaluation, the TAC will be consulted on whether or not monitoring should take place in subsequent years.

Table 4.1. Verification monitoring for the 22 priority populations after all management actions have been completed and their associated metric, number of years of data to be collected between 2028 and 2030 (0-3 years), and how the group will be monitored (e.g., existing monitoring program, contracted [noted with an asterisk]) in the AOC.

Population	Metric	# Years Data Collected (2028 - 2030)	Data Source
Coastal Terrestrial Macroinvertebrates	DHA	0	LGBFR AOC Coordinator DHA Tracking Spreadsheet
Shorebirds (migratory)	DHA	0	LGBFR AOC Coordinator DHA Tracking Spreadsheet
Landbirds (migratory)	DHA	0	LGBFR AOC Coordinator DHA Tracking Spreadsheet
Bats	DHA	0	LGBFR AOC Coordinator DHA Tracking Spreadsheet
Wooded Wetland Birds (breeding)*	IEC	1-3	Contractor
Turtles*	Count-based	1-3	Contractor + WDNR road-crossing data
Coastal Wetland Mustelids*	Count-based	1-3	WDNR Trapper Survey Data
Muskrats*	Count-based	1-3	WDNR Trapper Survey Data
Shorebirds (breeding)*	Count-based	1-3	Contractor
Coastal Birds (breeding)*	Count-based	1-3	Contractor
Waterfowl (migratory)*	Count-based	1-3	Contractor
Stream Macroinvertebrates	Count-based	1-3	Contractor
Colonial Waterbirds	IEC	3	WDNR and U.S. Department of Agriculture Wildlife Services' nest counts
Marsh Breeding Birds	IEC	3	Great Lakes Coastal Wetland Monitoring Program
Anurans	IEC	3	Great Lakes Coastal Wetland Monitoring Program
Coastal Wetland Aquatic Macroinvertebrates	IEC	3	Great Lakes Coastal Wetland Monitoring Program
Wetland Terns (breeding)	Count-based	3	WDNR nest counts
Bald Eagles/Osprey (breeding)	Count-based	3	WDNR nest counts
Fox River Fish	DHA + Count-based	3	WDNR fisheries and USFWS Aquatic Invasive Species Program
Tributary Fish	DHA + Count-based	3	WDNR fisheries and USFWS Aquatic Invasive Species Program
Shoreline Fish	DHA + Count-based	3	WDNR fisheries and USFWS Aquatic Invasive Species Program

Freshwater Unionid Mussels*	DHA + Count-based	3	Contractor

Like the population groups, priority habitats will be monitored for verification purposes once all management actions are completed (Table 4.2). Upland habitats and habitats that are not significantly influenced by Lake Michigan water levels will only be evaluated in the first year of verification monitoring. Due to the dynamic nature of Great Lakes water levels, all habitats influenced by Lake Michigan water levels and in-water habitats will be evaluated for the full three years, regardless of whether they are exceeding the AOC Target Zone in any of the three monitoring years except Great Lakes Beach which is being evaluated based on linear stretches and management category.

Table 4.2. Verification monitoring for the 18 priority habitats after all management actions have been completed and their associated metric, number of years of data to be collected between 2028 and 2030 (1-3 years), and how the habitat will be monitored (e.g., existing monitoring program, contracted [noted with an asterisk]) in the Lower Green Bay and Fox River Area of Concern (LGBFR AOC).

Habitat	Metric	# Years Data Collected (2028 - 2030)	Data Source
Great Lakes Beach*	Great Lakes Beach Metric (B)	1	LGBFR AOC Coordinator Tracking Spreadsheet
Shrub Carr*	# Acres × WDNR Tiered Aquatic Life Use Category (TALU)	1	Contractor
Hardwood Swamp*	# Acres × WDNR Tiered Aquatic Life Use Category (TALU)	1	Contractor
Emergent Marsh (inland)*	# Acres × WDNR Tiered Aquatic Life Use Category (TALU)	1	Contractor
Open Water (inland)	Open Water (inland) Metric (OW)	1	LGBFR AOC Coordinator DHA Tracking Spreadsheet and Contractor for assessing quality category
Southern Dry Mesic Forest	# Acres × Invasive Species %	1	Contractor
Emergent Marsh (roadside)*	# Acres × WDNR Tiered Aquatic Life Use Category (TALU)	1	Contractor
Northern Mesic Forest	# Acres × Invasive Species %	1	Contractor
Other Forest	# Acres × Invasive Species %	1	Contractor
Surrogate Grassland (old field)	# Acres × Invasive Species %	1	Contractor
Surrogate Grassland (restored)	# Acres × Upland CTM DHAs	1	LGBFR AOC Coordinator DHA Tracking Spreadsheet
Wet Meadow	# Acres × Combined Standardized Score	3	Great Lakes Coastal Wetland Monitoring Program

Emergent Marsh (high energy coastal)	# Acres × Combined Standardized Score	3	Great Lakes Coastal Wetland Monitoring Program
Submergent Marsh	# Acres × Combined Standardized Score	3	Great Lakes Coastal Wetland Monitoring Program
Emergent Marsh (riparian)	# Acres × Combined Standardized Score	3	Great Lakes Coastal Wetland Monitoring Program
Fox River Open Water	# Fish and Mussel DHAs × Mean Summer Dissolved Oxygen	3	LGBFR AOC Coordinator DHA Tracking Spreadsheet and Contractor for Water Quality
Green Bay Open Water	# Fish and Mussel DHAs × Mean Summer Dissolved Oxygen	3	LGBFR AOC Coordinator DHA Tracking Spreadsheet and Contractor for Water Quality
Tributary Open Water	# Fish and Mussel DHAs × Mean Summer Dissolved Oxygen	3	LGBFR AOC Coordinator DHA Tracking Spreadsheet and Contractor for Water Quality

If after the three-year verification monitoring period, the comprehensive BUI condition scores reach an average of 6.0 for the "Loss of Fish and Wildlife Habitat" BUI and a 6.5 for the "Degradation of Fish and Wildlife Populations" BUI, the LGBFR AOC Coordinator will draft a BUI Removal Recommendation to submit to the USEPA GLNPO. If the comprehensive BUI condition scores for one or both BUIs do not reach the target values, the following decision tree provides possibilities and strategies that the TAC and WDNR will evaluate to continue moving toward BUI removal (Figure 4.2).

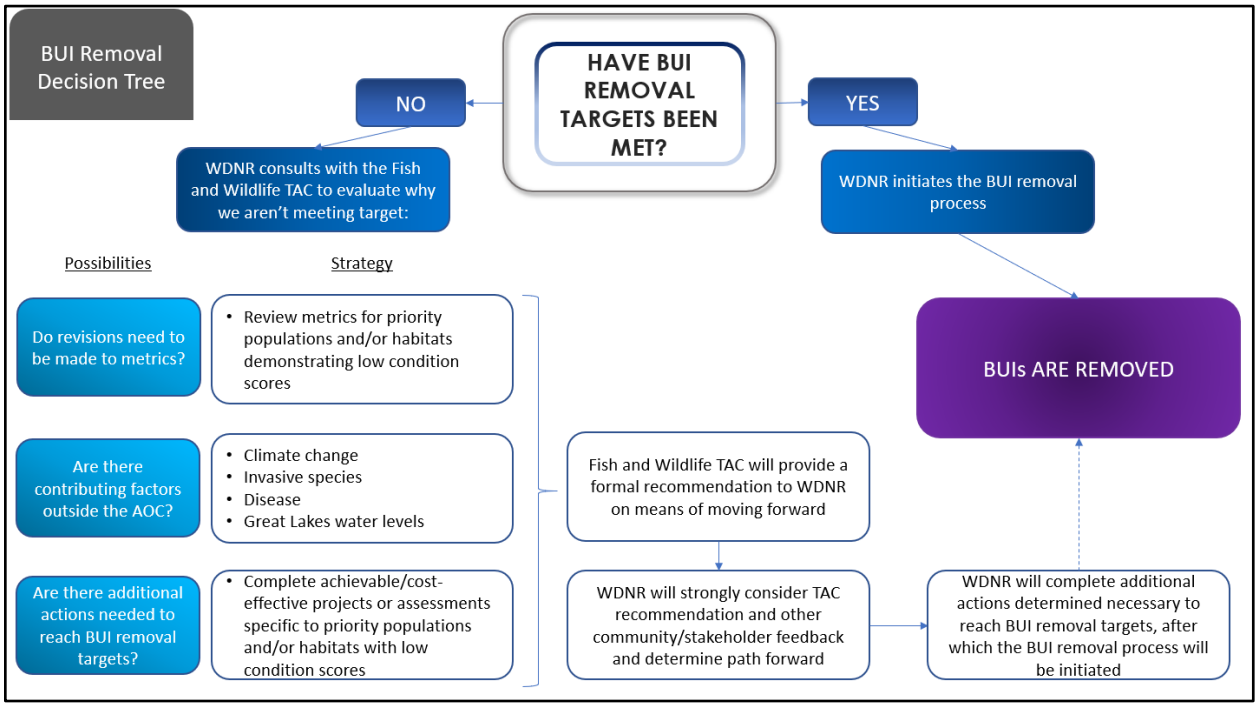


Figure 4.2. Decision tree illustrating how WDNR and TAC will consider alternatives if the verification period determines that BUI removal targets have not been met after all management actions have been completed.

Summary of Stakeholder Engagement in Revising the Loss of Fish and Wildlife Habitat and Degradation of Fish and Wildlife Populations BUIs

June 2015 - December 2017: UW-Green Bay and WDNR Lower Green Bay & Fox River Area of Concern Habitat Restoration Plan and Path Toward Delisting Project

UW-Green Bay project partners held 17 stakeholder meetings (see Table 4.3 below for meeting descriptions), three of which included presentations on overall project status updates. Fourteen meetings were interactive, in which we generated discussions with stakeholders and asked for specific feedback and information on various aspects of the project, including:

a) Compiling lists of current of historical AOC projects,
b) Gaining historical information on AOC fish and wildlife habitat and populations,
c) Identifying critical fish and wildlife habitats, populations, and areas of interest (i.e., "priority areas"),
d) Evaluating the current condition or status of priority habitats and priority species/species groups,
e) Reviewing AOC Fish and Wildlife Assessment Process and Tools, and
f) Reviewing proposed BUI removal targets for fish and wildlife habitat and populations.

Many of the stakeholders engaged throughout this process were active conservationists, environmentalists, scientists, biologists, natural resource managers, retirees, and engaged citizens who regularly work with fish and wildlife in the LGBFR AOC and whose expertise is vital to the removal of both BUIs and the LGBFR AOC as a whole.

Table 4.3. Descriptions of 17 stakeholder meetings held by UW-Green Bay in 2015-2017.

Date	Location	Type	Audience	Purpose
23 Jun 2015	UW-Green Bay	Interactive	Local fish and wildlife experts	Introduction to the project; compile existing information on fish and wildlife from attendees
17 Dec 2015	WDNR	Presentation	AOC technical stakeholders	Status update on the project
06 Jan 2016	UW-Green Bay	Interactive	Fish experts	Get feedback on identifying priority fish species and potential projects
13 Jan 2016	UW-Green Bay	Interactive	Local expert Thomas Erdman	Gain historical information on the LGB&FR AOC and identify potential projects

19 Jan 2016	UW-Green Bay	Interactive	Local expert Thomas Erdman	Gain historical information on the LGB&FR AOC and identify potential projects
22 Jan 2016	UW-Green Bay	Interactive	Local expert Thomas Erdman	Gain historical information on the LGB&FR AOC and identify potential projects
19 Apr 2016	UW-Green Bay	Interactive	Green Bay Conservation Partners	Introduction to the project; compile existing information on fish and wildlife from attendees
30 Jun 2016	WDNR	Presentation	AOC technical stakeholders	Status update on the project
16 Dec 2016	UW-Green Bay	Interactive	Local fish and wildlife experts	Status update on the project; review draft lists of AOC priority areas and fish and wildlife species/species groups
27 Jan 2017	WDNR	Presentation	AOC technical stakeholders	Status update on the project; review draft assessment tools
25 Apr 2017	UW-Green Bay	Interactive	Green Bay Conservation Partners	Get feedback on the AOC Fish and Wildlife Habitat Assessment Tool and brainstorm potential habitat restoration projects
24 May 2017	UW-Green Bay	Interactive	Local fish and wildlife experts	Review the AOC Fish and Wildlife Habitat and Populations Assessment Tools, discuss BUI removal targets, and brainstorm potential projects
15 Jun 2017	UW-Green Bay	Interactive	Local fish experts	Identify priority fish groups, evaluate their current condition, and brainstorm potential projects
03 Aug 2017	WDNR	Interactive	AOC technical stakeholders	Get feedback on the AOC Fish and Wildlife Habitat and Populations Assessment Tools and setting BUI removal targets
28 Sep 2017	UW-Milwaukee	Interactive	WDNR, USEPA, & USFWS staff	Annual state-federal meeting in which an overview of AOC fish and wildlife assessment process was presented and general discussion

01 Nov 2017	WDNR	Interactive	WDNR, USEPA, & Federal Partners	Overview of AOC fish and wildlife assessment process, discuss BUI removal targets and management action/project list
06 Dec 2017	UW-Green Bay	Interactive	Local fish and wildlife experts	Review the AOC Fish and Wildlife Habitat and Populations Assessment Tools, discuss BUI removal targets and potential projects

April 2018 - Present: UW-Green Bay and WDNR Development of Projects and Management Actions Necessary for Habitat & Populations BUI Removal in the Lower Green Bay & Fox River Area of Concern

UW-Green Bay and WDNR held 12 TAC, 14 Focus/Working Group, and 3 stakeholder meetings (see table below for meeting descriptions) of which interactive discussions and presentations on progress made toward the refinement of fish and wildlife habitat and population metrics and project ideas occurred.

Table 4.4. Descriptions of stakeholder meetings held by the Wisconsin Department of Natural Resources and UW-Green Bay in 2018-2020.

Date	Location	Audience	Purpose
12 April 2018	UW-Green Bay	TAC Members	Introduction to TAC members on the process for developing management action list, overview of assessment process and recommended BUI removal targets, general discussion and feedback.
25 April 2018	WDNR	AOC Stakeholders	RAP Update meeting presenting process for developing management action list, overview of assessment process and recommended BUI removal targets, general discussion and feedback.
11 June 2018	UW-Green Bay	TAC Members	TAC unanimously recommends WDNR draft new BUI removal targets for the Loss of Fish and Wildlife Habitat and Degradation of Fish and Wildlife Populations BUIs based on the BUI Assessment Tools. Discussed restoration ideas on AOC Islands.

06 August 2018	UW-Green Bay	TAC Members	Continued to discuss restoration ideas on AOC Islands and activities that would benefit priority habitats and populations at those locations.
19 September 2018	UW-Green Bay	TAC Members	Continued to discuss restoration ideas on AOC Islands and activities that would benefit priority habitats and populations at those locations.
27 September 2018	UW-Green Bay	Colonial Waterbirds Working Group	Discussed considerations for developing Colonial Waterbirds IEC metric with regional experts.
11 October 2018	UW-Green Bay	Wet Meadow and Grasslands Focus Group	Discussed considerations for developing Wet Meadow and Surrogate Grasslands metrics and ideas for project activities that would benefit these habitats and associated populations in the AOC with regional experts.
14 December 2018	WDNR	WDNR, USEPA, & Federal Partners	Annual state-federal meeting in which updates on fish and wildlife assessment process, draft target revision, and process to obtain final management action list for both BUIs presented and discussed.
26 October 2018	UW-Green Bay	Shoreline Fish Working Group	Discussed considerations for developing Shoreline Fish metric with regional experts.
29 October 2018	UW-Green Bay	Emergent and Submergent Marsh Focus Group	Discussed considerations for developing marsh metrics and ideas for project activities that would benefit these habitats and associated populations in the AOC with regional experts.
12 December 2018	UW-Green Bay	TAC Members	Updates to Assessment Tools and metric refinements, TAC unanimously recommends WDNR adopt a target condition score of 6.0 out of 10.0 for the Loss of Fish and Wildlife Habitat BUI, and 6.5 out of 10.0 for the Degradation of Fish and Wildlife Populations BUI. Group agrees that more discussion is needed on confidence intervals around those target scores and time period in which they must be observed to consider the target met.

5 February 2019	UW-Green Bay	Open Water and Fisheries Focus Group	Discussed considerations for developing Open Water and Shoreline, Tributary, and Fox River Fish metrics. Developed ideas for project activities that would benefit these habitats and populations in the AOC with regional experts.
11 February 2019	Weyers-Hilliard Brown County Library	AOC Stakeholders	RAP Update meeting presenting process for developing management action list, overview of assessment process and recommended BUI removal targets, general discussion and feedback.
14 February 2019	UW-Green Bay	Mammal Working Group	Discussed considerations for developing Mammal metrics with regional experts.
6 March 2019	UW-Green Bay	Turtles Working Group	Discussed considerations for developing Turtle metrics with regional experts.
27 March 2019	UW-Green Bay	Native Freshwater Mussels Focus and Working Group	Discussed considerations for developing Freshwater Mussel metrics and ideas for project areas/activities that would benefit this population with regional experts.
2 April 2019	UW-Green Bay	Coastal Forests and Inland Waters Focus Group	Discussed considerations for developing forest and inland water metrics and ideas for project areas/activities that would benefit these habitats and associated populations with regional experts.
2 April 2019	UW-Green Bay	Stream Macroinvertebrate Working Group	Discussed considerations for developing Stream Macroinvertebrate metrics with regional experts.
23 April 2019	UW-Green Bay	Great Lakes Beach Focus Group	Discussed considerations for developing Great Lakes Beach metrics and ideas for project areas/activities that would benefit this habitat and associated populations with regional experts.
29 April 2019	UW-Green Bay	Bird Working Group	Discussed considerations for developing Breeding Shorebirds, Bald Eagle/Osprey, Wetland Terns, Migratory Shorebirds, Migratory Landbirds, and Migratory Waterfowl metrics with regional experts.
20 May 2019	UW-Green Bay	Terrestrial Macroinvertebrate Working Group	Discussed considerations for developing Coastal Terrestrial Macroinvertebrate metrics with regional experts.

23 May 2019	UW-Green Bay	Colonial Waterbirds Working Group	Continued to discuss considerations for developing Colonial Waterbirds IEC metric with regional experts.
June – December 2019	UW-Green Bay	Metrics Team Meetings	UWGB, USFWS, and WDNR met on several occasions to synthesize outcomes from previous meetings and refine priority habitat and population metrics and to draft a metric and tracking BUI progress plan.
01 August 2019	UW-Green Bay	TAC Members	Discussed survey results for project areas and recommended activities generated from past TAC and Focus Group meetings for the east shore of the bay of Green Bay portion of the AOC. Identified 7 priority project areas located in this AOC to continue developing ideas and consideration for inclusion in the management action list.
25 September 2019	UW-Green Bay	TAC Members	TAC members presented and discussed project concepts for priority east shore project areas. Also discussed survey results for project areas and recommended ideas generated from past TAC and Focus Group meetings for the Fox River and southwest shoreline of the bay of Green Bay portion of the AOC.
22 October 2019	Southwest Brown County Library	TAC Members	TAC members presented and discussed project concepts for priority Fox River and southwest shoreline project areas. Also discussed project areas and ideas for the west shore of the bay of Green Bay portion of the AOC and metrics for Designated Habitat Area and Designated Habitat Area/Count-based Hybrid based fish and wildlife populations.
6 November 2019	WDNR	WDNR, USEPA, & Federal Partners	Annual state-federal meeting in which fish and wildlife assessment process, draft target revision, and process for obtaining final management action list for both BUIs presented and discussed.

18 November 2019	WDNR	TAC Members	TAC members presented and discussed project concepts for priority west shore of Green Bay project areas. A total of 26 priority project areas for the AOC were initially ranked by TAC members by overall project importance. TAC also discussed non-condition score metrics and how to incorporate those considerations into overall project scoring. Metric refinements were discussed overall.
12 December 2019	WDNR	TAC Members	WDNR, UWGB, and USFWS presented overall structure of the metrics and BUI progress evaluation plan to the TAC and discussed. Continued discussion about formally recommending BUI removal target language to WDNR. Presented priority project ranking results and revisions to project concepts/areas. TAC reached consensus on the removal of the Malchow/Olson project due to difficulty in acquiring private land under AOC program, but stressed that still an important overall priority area for AOC for other programs and initiatives to focus effort on. TAC members individually scored priority areas, habitat activities, impacts to priority populations, cost, feasibility, and cobenefits for each project.
30 January 2020	WDNR	TAC Members	WDNR, UW-Green Bay, and USFWS reviewed chapters of metric and BUI progress evaluation plan to the TAC and discussed. TAC unanimously recommended WDNR adopt the revised BUI target language for both BUIs. WDNR proposed a final draft MAL with 18 project areas based on several months of priority project ranking and discussion. TAC gained consensus on recommending this list of 18 projects be included in the management action list.
31 March 2020	WDNR Online	TAC Members	TAC members recommended WDNR adopt the "Evaluating Progress Toward Removing Fish and Wildlife Beneficial Use Impairments in the Lower Green Bay & Fox River Area of Concern" plan and continued to refine and develop the 18 projects recommended for inclusion in the management action list.
XX April 2020		AOC Stakeholders	WDNR will present the revised BUI removal target language and 18 project concepts the TAC has recommended for inclusion in the management action list to AOC stakeholders for feedback.

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Appendices

Appendix 1. Conversion Curve Parameters for Priority Habitats and Populations

Table A.1. Priority habitat conversion curve parameters for formulas used to convert field measurements to a standard condition score ranging from 0-10, where the relationship between the field metric and condition may be linear or nonlinear. Two types of nonlinear equations may be used to describe the conversion 1) logistic curve: $y = e^{P2*(x-P1)} / (1+e^{P2*(x-P1)})$ and 2) exponential curve: $y = x^{E1}$; P1, P2, and E1 are fitted parameters describing the shape of the curves. The value y is subsequently standardized to a 0-10 scale and plotted over an interval from 0 to max_x. Note that a linear relationship can be described by the exponential function where E1 = 1. Max_x is the maximum value of the field-measured metric. Max_y is the maximum value of the converted condition score.

Priority Habitat	Curve Type	max_x	E1	P1	P2	max_y	Metric Current Value
Great Lakes Beach	logistic	25		8	0.35	10	5
Wet Meadow	exponential	100	0.53			10	50
Emergent Marsh (high energy coastal)	logistic	1000		750	0.004	10	559
Submergent Marsh	logistic	350		80	0.02	10	96
Emergent Marsh (riparian)	logistic	200		110	0.03	10	83
Fox River Open Water	logistic	10		4	0.65	10	3
Green Bay Open Water	logistic	12		5.3	0.55	10	4
Shrub Carr	logistic	250		130	0.04	10	122
Tributary Open Water	logistic	16		4.75	0.55	10	5
Hardwood Swamp	logistic	2000		720	0.0034	10	764
Emergent Marsh (inland)	logistic	300		160	0.03	10	147
Open Water (inland)	logistic	140		46.4	0.04	10	35

Southern Dry Mesic Forest	logistic	80		51	0.092	10	50
Emergent Marsh (roadside)	logistic	30		18	0.3	10	15
Northern Mesic Forest	logistic	100		55	0.06	10	48
Other Forest	logistic	400		216	0.027	10	216
Surrogate Grassland (old field)	logistic	250		200	0.03	10	188
Surrogate Grassland Restored	logistic	50		1	0.1	10	11

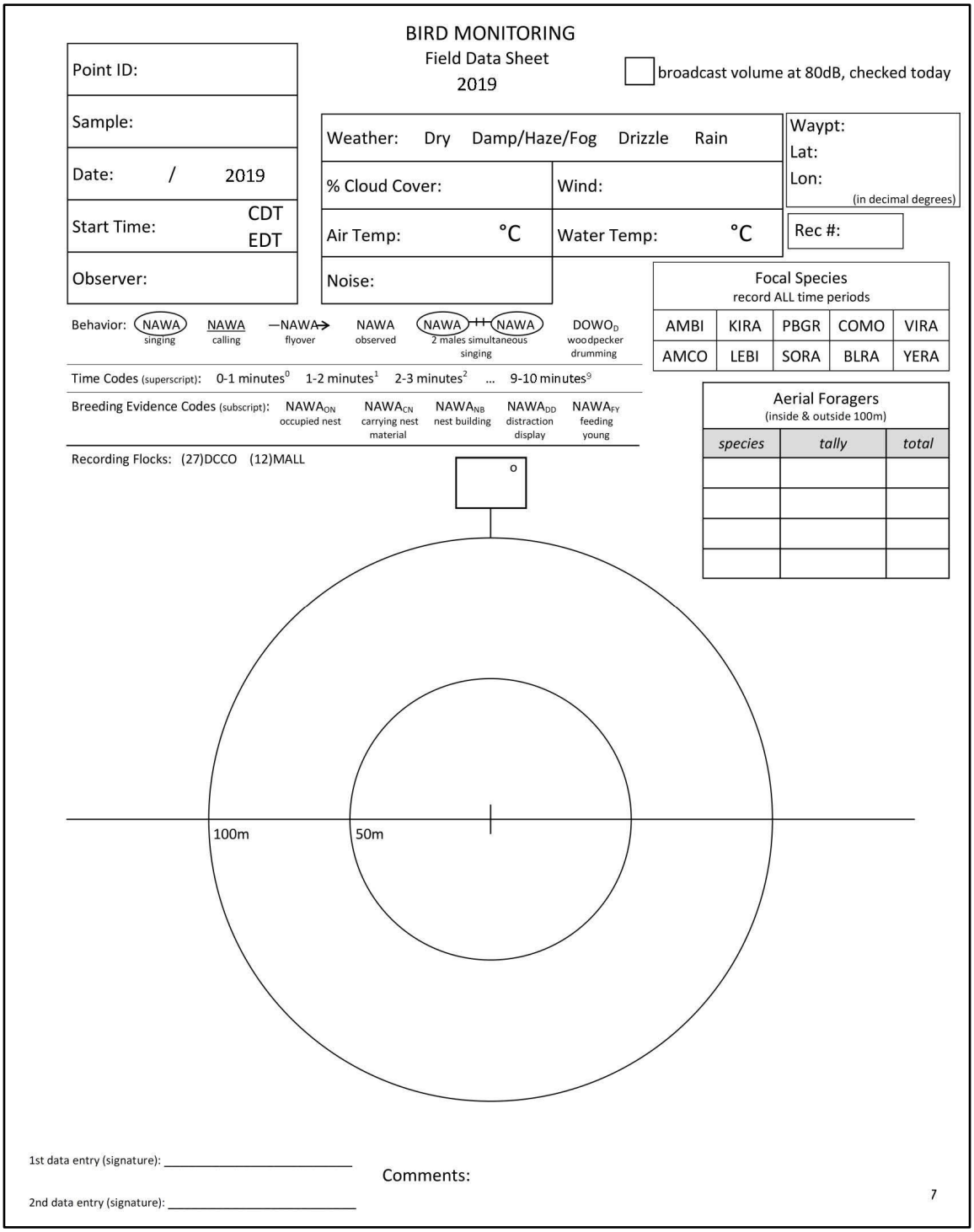
Table A.2. Priority population conversion curve parameters for formulas used to convert field measurements to a standard condition score ranging from 0-10, where the relationship between the field metric and condition may be linear or nonlinear. Two types of nonlinear equations may be used to describe the conversion 1) logistic curve: $y = e^{P2*(x-P1)} / (1+e^{P2*(x-P1)})$ and 2) exponential curve: $y = x^{E1}$; P1, P2, and E1 are fitted parameters describing the shape of the curves. The value y is subsequently standardized to a 0-10 scale and plotted over an interval from 0 to max_x. Note that a linear relationship can be described by the exponential function where E1 = 1. Max_x is the maximum value of the field-measured metric. Max_y is the maximum value of the converted condition score.

Priority Fish & Wildlife Populations	**Curve Type**	**max_ x**	**E1**	**P1**	**P2**	**max_ y**	**metric current value**
Colonial Waterbirds (breeding season)	linear	10	1			10	5
Coastal Wetland Mustelids	nonlinear (2)	10		1, 0.8	0.5, 0.848	8,10	2
Tributary Fish	nonlinear (3)	8		2.63, 0.6,0.1	0.75, 0.75,1.1	7,9,10	4
Coastal Birds (breeding season)	nonlinear	16		9.28	0.35	10	6
Fox River Fish	exponential (3)	10	0.28			7,9,10	3
Freshwater Unionid Mussels	nonlinear (3)	10		2.35, 0.5, 0.7,	0.66, 0.5, 0.9	7.5,9, 10	1

Shoreline Fish	exponential (3)	14	0.53			7,9,10	3.5
Wetland Terns	nonlinear (2)	10		0.4	0.5	9,10	1+1
Muskrat	nonlinear	1		0.01	6	10	0.234
Shorebirds (breeding)	nonlinear	16		8.3	0.45	10	8
Anurans	linear	10	1	1	0.001	10	7
Bald Eagle/Osprey (breeding)	nonlinear (2)	10		3	0.363	8,8+2	5
Marsh Breeding Birds	linear	10	1			10	6
Coastal Terrestrial Macroinvertebrates	exponential	20	0.52	0.2	277	10	2
Shorebirds (migratory)	linear	5	1			10	2.5
Waterfowl (migratory)	linear	10	1			10	6
Bats	linear	10	1			10	4
Coastal Wetland Aquatic Macroinvertebrates	linear	10	1			10	3
Stream Macroinvertebrates	nonlinear	2.5		1.9	5	10	1.89
Turtles	nonlinear	20		14	0.25	10	13
Wooded Wetland Birds (breeding season)	linear	10	1			10	6
Landbirds (migratory)	nonlinear	10		3.42	0.6	10	5

Appendix 2. Great Lakes Coastal Wetland Monitoring Program's Marshbird Monitoring Data Sheet

Downloadable protocol and sample data sheet are available online found here: https://www.greatlakeswetlands.org/Sampling-protocols



BIRD MONITORING
Field Data Sheet
2019

☐ broadcast volume at 80dB, checked today

Point ID:	
Sample:	
Date: / 2019	
Start Time:	CDT EDT
Observer:	

Weather: Dry Damp/Haze/Fog Drizzle Rain		Waypt: Lat: Lon: (in decimal degrees)
% Cloud Cover:	Wind:	
Air Temp: °C	Water Temp: °C	Rec #:
Noise:		

Behavior: NAWA singing; NAWA calling; NAWA flyover; NAWA observed; NAWA NAWA 2 males simultaneous singing; $DOWO_D$ woodpecker drumming

Time Codes (superscript): 0-1 minutes^0 1-2 minutes^1 2-3 minutes^2 ... 9-10 minutes^9

Breeding Evidence Codes (subscript): $NAWA_{ON}$ occupied nest; $NAWA_{CN}$ carrying nest material; $NAWA_{NB}$ nest building; $NAWA_{DD}$ distraction display; $NAWA_{FY}$ feeding young

Recording Flocks: (27)DCCO (12)MALL

Focal Species
record ALL time periods

AMBI	KIRA	PBGR	COMO	VIRA
AMCO	LEBI	SORA	BLRA	YERA

Aerial Foragers
(inside & outside 100m)

species	*tally*	*total*

o

100m 50m

1st data entry (signature): _____

2nd data entry (signature): _____

Comments:

7

Appendix 3. Wooded Wetland Birds (Breeding) Protocol and Data Sheet

Knutson et al. (2008) Protocol:

LANDBIRD MONITORING PROTOCOL FOR THE U.S. FISH AND WILDLIFE SERVICE, MIDWEST AND NORTHEAST REGIONS

STANDARD OPERATING PROCEDURE (SOP) #5

CONDUCTING THE BIRD POINT COUNT

VERSION 1.0 (JUNE 2008)

Melinda Knutson, U.S. Fish and Wildlife Service (melinda_knutson@fws.gov)

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REVISION HISTORY LOG

VERSION #	DATE	AUTHOR	CHANGES MADE	REASON FOR CHANGE
1.0	June 2008	Knutson, et al.		

This SOP provides step by step instructions for conducting 10-minute point counts for surveying landbirds. This SOP also describes the procedure for collecting data and completing the "Field Data Form—Point Count" and "Field Data Form—Circular Plot" (included in Appendixes B, C, and D). This SOP was modified from the Passerine Monitoring Protocol for the Central Alaska Network (2004). The protocol is designed for one person (observer and recorder) or a two-person survey crew.

PROCEDURES:

1. Before Surveys Begin:

    1.1. The Survey Coordinator (SC) is responsible for planning the survey.

    1.2. If the plot, route, or grid has been sampled in the past, examine the point sequence and times of surveys. The sequence and times should remain consistent with the original sampling sequence.

    1.3. The SC will discuss the sequence of points and route with field staff. Always plan to survey the maximum number of points possible each day and take advantage of good survey conditions.

    1.4. Ensure the GPS unit is loaded with the appropriate coordinates. This should be done before entering the field. See SOP #4, Using GPS to Navigate and Mark Waypoints.

    1.5. Review safety considerations with field staff, including extreme heat and cold, presence of disease-carrying insects, poisonous plants, operation of vehicles in off-road conditions, etc. Field staff should be equipped with food, water, rain gear, appropriate footwear, and a first aid kit, at a minimum.

    1.6. Organize equipment. See SOP #1, Before the Field Season.

2. Weather and Time Considerations:

    2.1. Consider weather conditions before leaving. When survey conditions are questionable, the primary consideration is the observer's safety, followed by the ability to hear birds. High winds, heavy rain, or snow may prevent or delay surveys for several hours or even days. The surveys should be postponed if the weather is unacceptable for surveys. It may be necessary to assess survey conditions from the actual survey points, not from the departure point.

    2.2. Discuss options for continuing surveys when weather is questionable. It may be necessary to go to the first survey points to determine if survey conditions are

acceptable. The crew leader is responsible for deciding if conditions are unacceptable for surveys. Some form of communication among crews and with the office (cell or satellite phones, walkie-talkies) is recommended.

2.3. Record your float plan or field itinerary according to station protocols. At a minimum, record who is in the field crew, where you will be sampling that day, when you left, when you expect to return, and who is responsible for checking that you have returned. Record your field and home contact information (phone number or pager) for use if you don't return.

2.4. Whenever possible, complete the entire plot, route, or grid before moving on to the next. Sample all accessible points on an entire plot, route, or grid before moving on.

2.5. Complete all surveys between 0.5 hr. before sunrise and 6 hr. after sunrise. Survey as many points as the time and weather allow each day. Arriving at a survey point on time often requires leaving your base 1.5 hr. before sunrise or earlier, depending on the time it takes to reach the first survey point. Be prepared with several extra data sheets, equipment batteries, (and markers, if applicable).

3. Conducting the Point Count and Recording Data:

3.1. Each day before beginning the survey, use your range finder to check your visual estimates of distances. If you can, use the range finder during the surveys to accurately estimate the correct distance band for each observation. If this is not feasible, daily calibrations before beginning surveys will help improve accuracy.

3.2. Navigate to the survey point using a handheld GPS unit. See SOP #4, Using GPS Units to Navigate and Mark Waypoints.

3.3. Complete a new datasheet for each survey point. The observer prepares a clipboard with the Circular Plot Data Sheet, along with a digital timer, binoculars, laser rangefinder, and compass.

3.4. Record all individual birds the *first* time they are observed and use a digital timer to record the minute associated with each bird observation. Small digital timers can be clipped to the clipboard. The observer records the time period when each bird is first observed on the data sheet next to the species code. The first time period (0-1 min.) is coded '0'; the observer records the minute displayed on the digital timer (0, 1, 2, ….9). Record all birds as accurately as possible within each time period. This will require some practice during the training period (SOP #3, Hiring and Training Observers). For

example, recording all the loud birds first will result in biased population estimates. In habitats with many birds, it will be difficult to record all the birds observed in the first minute; do the best you can. Recording the first observation of individual birds among different time periods is the basis for estimating detection probabilities.

3.5. Assign each individual bird to the distance band (0-25, 26-50, 51-100, ≥ 101-m) where it was first observed. Use a laser rangefinder to check the accuracy of visual estimates of distances as needed or at least daily. Record all distances as the horizontal distance interval from the observer to the bird. Pay particular attention to accurately estimating the distance band for birds closest to the point. Any birds that flush upon approaching the point, or birds that seem to be attracted by the presence of the surveyors, should be noted in the comments.

3.6. In summary, for each individual bird, the observer records the species code, or the observation number on the circular data sheet, in the distance band where it was *first* observed. Record the type of observation (audio, visual, flyover), and the minute either on the chart or on the list to the right of the chart. At the end of the day, bird detections should be legibly transcribed to the list form, either to the right of the circle chart or on Appendix C; the list is easier to use for data entry.

3.7. On the data sheet, the species is identified by its 4-letter AOU code, listed on the prepared Bird Species List (Example: Appendix A), for instance, "WCSP" for White-crowned Sparrow. A list of species codes associated with the study area (Example: Appendix A) should be printed, laminated, and carried in the field.

3.8. If you are using a 2-person crew, the observer will stand at the survey point and announce all detections to the recorder in a clear yet quiet voice, including species, detection type, distance and direction (for example "White-crowned Sparrow, audio, 125 meters, north"). The observer then marks the detection on the Circular-Plot Data Form to keep track of detections. The recorder is responsible for informing the observer when the 10-minute period has ended.

3.9. Record environmental data on the data sheet. The recorder may record environmental data (including temperature, weather, noise, vegetation etc.) while the observer prepares to conduct the point count, or after the point has been completed.

3.10. Complete a datasheet for each point, even if no birds are detected. If no birds were detected at a point, complete the ancillary data fields and note, "no birds were detected" in the comments to document that the point was surveyed.

3.11. If you have not already permanently marked your survey points, mark them now before moving on to the next survey point (SOP #4, Using GPS to Locate and Mark Sampling Points).

3.11.1. Vegetation/habitat variables should be recorded after the point count. See SOP #6 Vegetation Monitoring.

3.11.1.1. The minimum requirement for vegetation monitoring is to record the primary and secondary land cover class associated with the bird monitoring point, using the National Land Cover Database (NLCD) 2001 classes (SOP #6, Vegetation Monitoring). This information will be permanently linked to the bird data at each point, by visit, in the National Point Count Database.

3.11.1.2. All other vegetation/habitat monitoring is optional.

3.12. Complete all fields on the datasheet before departing for the next point. After a point count is completed, check that all fields have been completed on the datasheet. Any additional comments, particularly regarding factors that might affect the quality of the data should be recorded in the notes section.

3.13. Ensure that no equipment is left behind. It is useful to attach brightly-colored flagging or spray paint items like thermometers, binoculars, GPS units, and any other equipment that may accidentally be left behind or dropped between points.

3.14. Record ancillary observations of other fauna including mammals, fish, amphibian, and invertebrates in the additional notes or notes sections on the data sheets. Identify to species if possible. Note other fauna-related objects including beaver dams, beaver lodges, insect hatches, etc.

3.15. Navigate to the next point. Use the GPS to attain a bearing to the next point and hike to the next point at a reasonable pace. The pace between points should be fast enough to get a maximum number of points in days of good weather, but repeatable by other field crews in future surveys. Do not race to points. A good survey day may range from completing as few as 7 points to as many as 14 points in a day, depending on weather, topography, vegetation, and a variety of other factors.

3.16. Proof all data and update daily field notes after returning to base. Bird detections should be legibly transcribed from the circular charts to the list, either at the right of the circle chart or on Appendix C; the list is easier to use for data entry.

3.17. Enter data into the Bird Point Count (BPC) database http://www.pwrc.usgs.gov/point/ . If you are entering data from a new monitoring plan, the SC should contact the Bird Point Count Regional Data Coordinator. Each FWS Region has a BPC Data Coordinator who will issue the appropriate permissions to the Station Responsible Party. Here is the list of regional data coordinators: (http://www.pwrc.usgs.gov/point/main/mainPage.cfm?formName=113). See SOP #7, After the Field Season.

4. Field Descriptions for Point Count field data form:

4.1. Protocol Version number: Record the version number of the protocol at the top of the data sheet.

4.2. Study Name: Record the name of your monitoring effort; this name is used in the database to label all the point counts associated with this effort.

4.3. Grid/Plot/Route: Record the unique plot, route or grid name.

4.4. Point: Record the point number.

4.5. Date (mm/dd/yyyy): Record the month (2 digits), day (2 digits), and year (4 digits) in the format shown.

4.6. Start (hhmm): Record the time when the 10-minute point count begins: use military time and fill in all four digits. For instance, 0630 (6:30 am).

4.7. End (hhmm): Record the time when the 10 minute point count ends; use military time and fill in all four digits. For instance, 0640 (6:40 am).

4.8. Temperature (ºC): Record the ambient air temperature at the end of the count in degrees Celsius, rounded to the nearest degree. The thermometer should be placed above the ground and allowed to adjust to ambient air temperature.

4.9. Wind Speed (WS): Record the wind code (Table 5.1) as it applies to the wind speed during the 10-minute point count. The average wind speed is recorded, rounded to the closest single number, not the maximum (gusts). Acceptable conditions for counting birds include a wind code of 0-3. For more information, see the U.S. Fish and Wildlife Service's data standard on wind speed: http://www.fws.gov/stand/standards/de_windspeed.html

4.10. Wind Direction (WD): Record the direction from which the wind is blowing (N, S, E, W, NE, NW, SE, SW, VRB=variable) during the 10-minute point count. Wind direction may be considered variable if, during the 2-minute evaluation period, the wind speed is 6 knots (7 mph, Beaufort code <2) or less. In addition, the wind direction shall be considered variable if, during the 2-minute evaluation period, it varies by 60 degrees or more when the average wind speed is greater than 6 knots (7 mph, Beaufort code >2), For more information, see the U.S. Fish and Wildlife Service's data standard on wind direction: http://www.fws.gov/stand/standards/de_winddirection.html

4.11. Sky Condition (Sky): Record the sky conditions (Table 5.2). Acceptable conditions for counting birds include a sky code of 0-2.

4.12. Background Noise: Record the background noise code (Table 5.3) that best describes the noise conditions during the survey. Elevated noise at the survey site can decrease the observer's ability to detect birds. Surveys should not take place when environmental noise levels exceed 50 dB (code ≥ 3), unless the elevated noise is a permanent attribute of the site (adjacent to industrial site). A sound level meter (decibel meter) can be used to measure sound levels accurately (optional); prices range from $60-250. See Appendix E for common noises and sound levels in decibels.

4.13. Observer/Recorder (Obs/Rec): Record the 3-letter initials of the observer and recorder. Names and contact information for all observers and recorders are stored in the database.

4.14. GPS Lat/Long: Record the location (GPS coordinates) of the survey points using the UTM or Geographic (Latitude/Longitude) coordinate system referenced to either the horizontal datum of NAD83 or WGS84. Create data sheets with the sampling points and GPS coordinates pre-printed; recorders generally make mistakes recording numbers with many digits in the field. For more information, see the U.S. Fish and Wildlife Service's data standard on latitude and longitude: http://www.fws.gov/stand/standards/de_latlon.html

4.15. Detection Type: Record the type of detection associated with each bird (Table 5.4). Flyovers include birds flying above the forest canopy, not stopping in the count circle. Birds flying below the forest canopy are counted as visual detections; if they do not appear to stop in the count circle, put them in the 101 distance category. We will assume that low fliers belong to the breeding birds in the count circle. In grasslands, any birds that fly through the count circle below the height of an average tree in the region and do not stop are counted as members of the count circle (101 distance

category). Those that fly higher than the average tree and do not stop are counted as flyovers. Again, we'll assume that low fliers are members of the breeding bird community and high fliers are not.

4.16. Distance Category: For each bird detection, record the distance category between the observer and the bird (Table 5.5).

4.17. Photos taken? Circle YES if photos taken at the survey point according to SOP#6, Vegetation Monitoring. Circle NO if no photos were taken. If a photo was taken of some other item of interest, record the subject and the reason for taking the photo on the data sheet.

TABLE 5.1 CODES USED TO RECORD WIND SPEED DURING BIRD COUNTS (BEAUFORT SCALE)1.

Wind Code	Wind Speed (miles/hr)	Description
0	< 1	Calm; smoke rises vertically
1	1-3	Light air; wind direction shown by smoke drift
2	4-7	Light breeze; wind felt on face
3	8-12	Gentle breeze; leaves in constant motion, light flag extended
4	13-18	Moderate breeze; raises dust; small branches move
5	19-24	Fresh breeze; small trees sway, crested wavelets on inland waters
6	25 or more	Strong breeze; large branches in motion

[1] Acceptable conditions for counting birds include a wind code of 0-3.

TABLE 5.2 CODES USED TO RECORD SKY CONDITIONS DURING BIRD COUNTS[1].

Sky Code	Description
0	Clear or a few clouds
1	Partly cloudy (scattered)
2	Cloudy (broken) or overcast
4	Fog or Smoke
5	Drizzle
7	Snow
8	Showers

[1] Acceptable conditions for counting birds include a sky code of 0-2.

TABLE 5.3 CODES USED TO RECORD LEVELS OF BACKGROUND NOISE DURING BIRD COUNTS[1].

BACKGROUND NOISE CODE	DESCRIPTION
0	No background noise (BN) during most of the survey (< 40 decibels [dB])
1	Faint BN during at least half of the survey (~40-45 dB)
2	Moderate BN; difficulty hearing birds > 100 m away (~45-50 dB)
3	Loud BN; difficulty hearing birds > 50 m away (~50-60 dB)
4	Intense BN; difficulty hearing birds > 25 m away (>60 dB)

[1]Acceptable conditions for counting birds include a noise code of 0-2.

TABLE 5.4 CODES USED TO RECORD DETECTION TYPE DURING BIRD COUNTS.

DETECTION	DESCRIPTION
V	Visual detection
A	Auditory detection (singing, chipping, calling, rapping)
B	Both visual and auditory detection
F	Flyover (bird flying above the canopy; not landing in count circle)

TABLE 5.5 CODES USED TO RECORD DISTANCE CATEGORIES USED FOR BIRD COUNTS.

CATEGORY	DISTANCE
25	0-25 m
50	26-50 m
100	51-100 m
101	> 100 m

APPENDICES:

APPENDIX A: BIRD SPECIES LIST (EXAMPLE)

APPENDIX B: FIELD DATA FORM—POINT COUNT, BACK SIDE

APPENDIX C: FIELD DATA FORM—POINT COUNT, FRONT SIDE

APPENDIX D: FIELD DATA FORM—CIRCULAR PLOT

APPENDIX E. COMMON NOISE LEVELS

APPENDIX A (EXAMPLE). BIRD SPECIES WITH AOU CODES

This bird list will be customized by the Survey Coordinator prior to initiating surveys. An example of a partial list of avian species present or expected in the Central Alaska Network parks, Alaska is shown below.

AOU SPECIES CODE	COMMON NAME	GENUS SPECIES	TSN
GWFG	Greater White-fronted Goose	*Anser albifrons*	175020
CAGO	Canada Goose	*Branta canadensis*	174999
TRUS	Trumpeter Swan	*Cygnus buccinator*	174992
GADW	Gadwall	*Anas strepera*	175073
AMWI	American Wigeon	*Anas americana*	175094
MALL	Mallard	*Anas platyrhynchos*	175063
CITE	Cinnamon Teal	*Anas cyanoptera*	175089
NOSH	Northern Shoveler	*Anas clypeata*	175096
NOPI	Northern Pintail	*Anas acuta*	175074
AGWT	American Green Winged Teal	*Anas crecca*	175081
CANV	Canvasback	*Aythya valisineria*	175129
REDH	Redhead	*Aythya americana*	175125
RNDU	Ring-necked Duck	*Aythya collaris*	175128
GRSC	Greater Scaup	*Aythya marila*	175130
LESC	Lesser Scaup	*Aythya affinis*	175134
SCSP	Scaup Sp.	*Aythya sp.*	
HARD	Harlequin Duck	*Histrionicus histrionicus*	175149
SUSC	Surf Scoter	*Melanitta perspicillata*	175170
BLSC	Black Scoter	*Melanitta nigra*	175171
WWSC	White-winged Scoter	*Melanitta fusca*	175163

APPENDIX B. FIELD DATA FORM—POINT COUNT, BACK SIDE, RAPID VEGETATION ASSESSMENT (FORESTS, OPTIONAL)

TREE DENSITY (> 2.5 CM DBH)	
1	None
2	<5 in 10m radius
3	6 to 20
4	21 to 40
5	>40

SHRUB DENSITY (< 2.5 CM DBH)	
1	<10 in 10m radius
2	11 to 100
3	101 to 500
4	501 to 1000
5	>1000

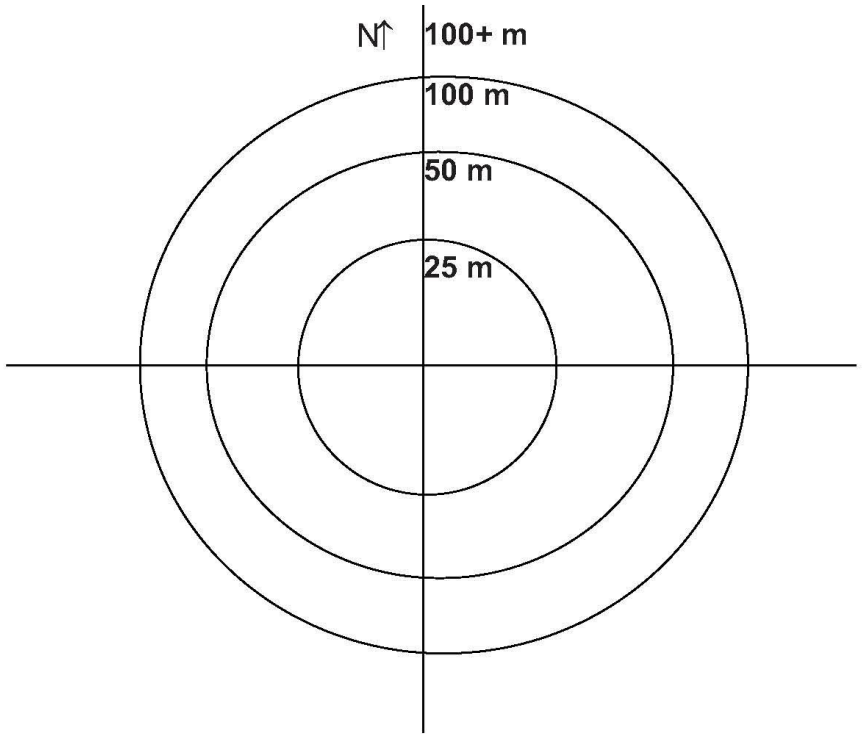
SPECIAL FEATURES			
1	Beaver flooding	7	Natural opening in site
2	Large downed logs	8	Rock outcrop
3	Small openings	9	Residual hardwood trees
4	Snags	10	Residual conifer trees
5	Wetland pocket in site	11	Residual patches
6	Woodland pond in site	12	Roads, buildings

VEGETATION STRUCTURE		COMMENTS
Canopy height (m)		
Tree Density (1 = few to 5 = dense) - 10 m radius		
Shrub Density (1 = few to 5 = dense) - 10 m radius		
High canopy cover (%)		
High canopy % deciduous (0% = all conifer)		
Subcanopy cover (lower layer of trees: %)		
Subcanopy % deciduous (0% = all conifer)		
Understory cover (3 ft to 12 ft: %)		
Understory % deciduous (0% = all conifer)		
Ground cover (3 ft to ground: %)		
Tree species (up to 5)		
Shrub species (up to 5)		
Special features (codes)		

APPENDIX C. FIELD DATA FORM – POINT COUNT, FRONT SIDE

Study Name:	*2007 BIRD SURVEYS*	*GREEN ACRES NWR*			*DETECTIONS*				
Horiz. Datum	*WGS84*	*NAD83*		Obs	Species	Type	Distance	Min. (0,1,2,..9)	Comments
Plot/rt/grid		Obs:	Rec:	1					
Point		Start:	End:	2					
Date		GPS lat (northing)		3					
Noise		GPS long (easting)		4					
Temp C		Aspect/slope		5					
WS		Other		6					
WD		Photos taken?	Y N	7					
Sky				8					
				9					
Noise Code		Detection Type		10					
0	None	V	Visual	11					
1	Faint	A	Auditory	12					
2	Moderate	B	Both	13					
3	Loud	F	Flyover	14					
4	Intense			15					
				16					
Wind Speed		Distance Band		17					
0	Calm	25	0-25 m	18					
1	Light air	50	26-50 m	19					
2	Light breeze	100	51-100 m	20					
3	Gentle breeze	101	> 100 m	21					
4	Moderate breeze			22					
5	Fresh breeze			23					
				24					
Sky Condition		NLCD 2001	(required)	25					
0	Clear	#1		26					
1	Partly cloudy	#2		27					
2	Cloudy	Ecol. System-Alliance	(optional)	28					
4	Fog or Smoke	#1		29					
5	Drizzle	#2		30					
7	Snow			31					
8	Showers	Comments:		32					
				33					
Wind Dir.		Notes:		34					
N, S, E, W,				35					
NW, SW,				36					
NE, SE, VBL				37					
		IN OFFICE	Date & initials	38					
		Data proofed:		39					
		Data entered:		40					

APPENDIX D. FIELD DATA FORM—CIRCULAR PLOT Date: Grid: XXXX Pt.:



Obs	Species	Type	Distance	Min.
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				

APPENDIX E. COMMON NOISE LEVELS.
(SOURCE: NOISE LEVELS IN OUR ENVIRONMENT FACT SHEET; HTTP://WWW.LHH.ORG/NOISE/FACTS/EVIRONMENT.HTML)

Points of Reference measured in dBA or decibels

0 the softest sound a person can hear with normal hearing
10 normal breathing
20 whispering at 5 feet
30 soft whisper
50 rainfall
60 normal conversation
110 shouting in ear
120 thunder

HOME	WORK	RECREATION
50 refrigerator	40 quiet office, library	40 quiet residential area
50 - 60 electric toothbrush	50 large office	70 freeway traffic
50 - 75 washing machine	65 - 95 power lawn mower	85 heavy traffic, noisy restaurant
50 - 75 air conditioner	80 manual machine, tools	90 truck, shouted conversation
50 - 80 electric shaver	85 handsaw	95 - 110 motorcycle
55 coffee percolator	90 tractor	100 snowmobile
55 - 70 dishwasher	90 - 115 subway	100 school dance, boom box
60 sewing machine	95 electric drill	110 disco
60 - 85 vacuum cleaner	100 factory machinery	110 busy video arcade
60 - 95 hair dryer	100 woodworking class	110 symphony concert
65 - 80 alarm clock	105 snow blower	110 car horn
70 TV audio	110 power saw	110 -120 rock concert
70 - 80 coffee grinder	110 leafblower	112 personal cassette player on high
70 - 95 garbage disposal	120 chain saw, hammer on nail	117 football game (stadium)
75 - 85 flush toilet	120 pneumatic drills, heavy machine	120 band concert
80 pop-up toaster	120 jet plane (at ramp)	125 auto stereo (factory installed)
80 doorbell	120 ambulance siren	130 stock car races
80 ringing telephone	125 chain saw	143 bicycle horn
80 whistling kettle	130 jackhammer, power drill	150 firecracker
80 - 90 food mixer or processor	130 air raid	156 capgun
80 - 90 blender	130 percussion section at symphony	157 balloon pop
80 - 95 garbage disposal	140 airplane taking off	162 fireworks (at 3 feet)
110 baby crying	150 jet engine taking off	163 rifle
110 squeaky toy held close to the ear	150 artillery fire at 500 feet	166 handgun
135 noisy squeeze toys	180 rocket launching from pad	170 shotgun

Sample datasheet created by UW-Green Bay for the Knutson et al. (2008) protocol

Lower Green Bay and Fox River Area of Concern Bird Survey

Point ID | Waypoint ID | Observer

Month | Day | Year 20___ | Time | Latitude 4__._____ | Longitude -8__._____ | Temp. (C) | Wind | Sky

Temp. (C): 0 = none; 1 = 1 - 3 mph; 2 = 4 - 7 mph; 3 = 8 -12 mph; 4 = > 12 mph

Wind: 0 = < 10% clouds; 1 = partly cloudy; 2 = mostly cloudy; 3 = overcast; 4 = raining

Audio Recorder _____

	Species Code	Detection Code	Distance	Minute	#	Comments (M or F, etc.)
1				0		
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

Distance = distance when individual first detected

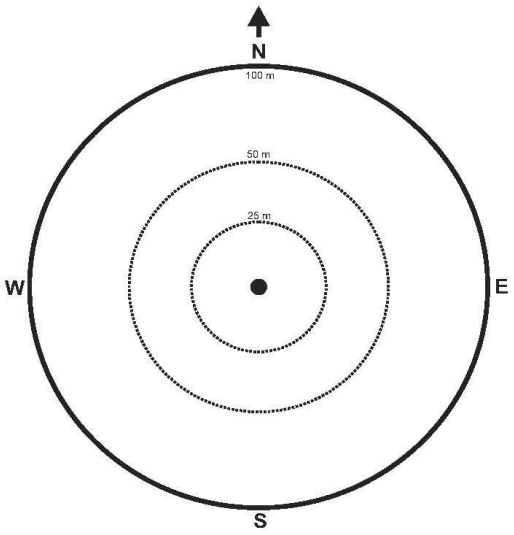
Minute = minute (0-9) when individual first detected # = estimated number of individuals

Detection Code

A = Audio (heard)
V = Visual (seen)
B = Both
F = Fly over

Distance

0 = 0 - 25 m
1 = 25 - 50 m
2 = 50 -100 m
3 = > 100 m



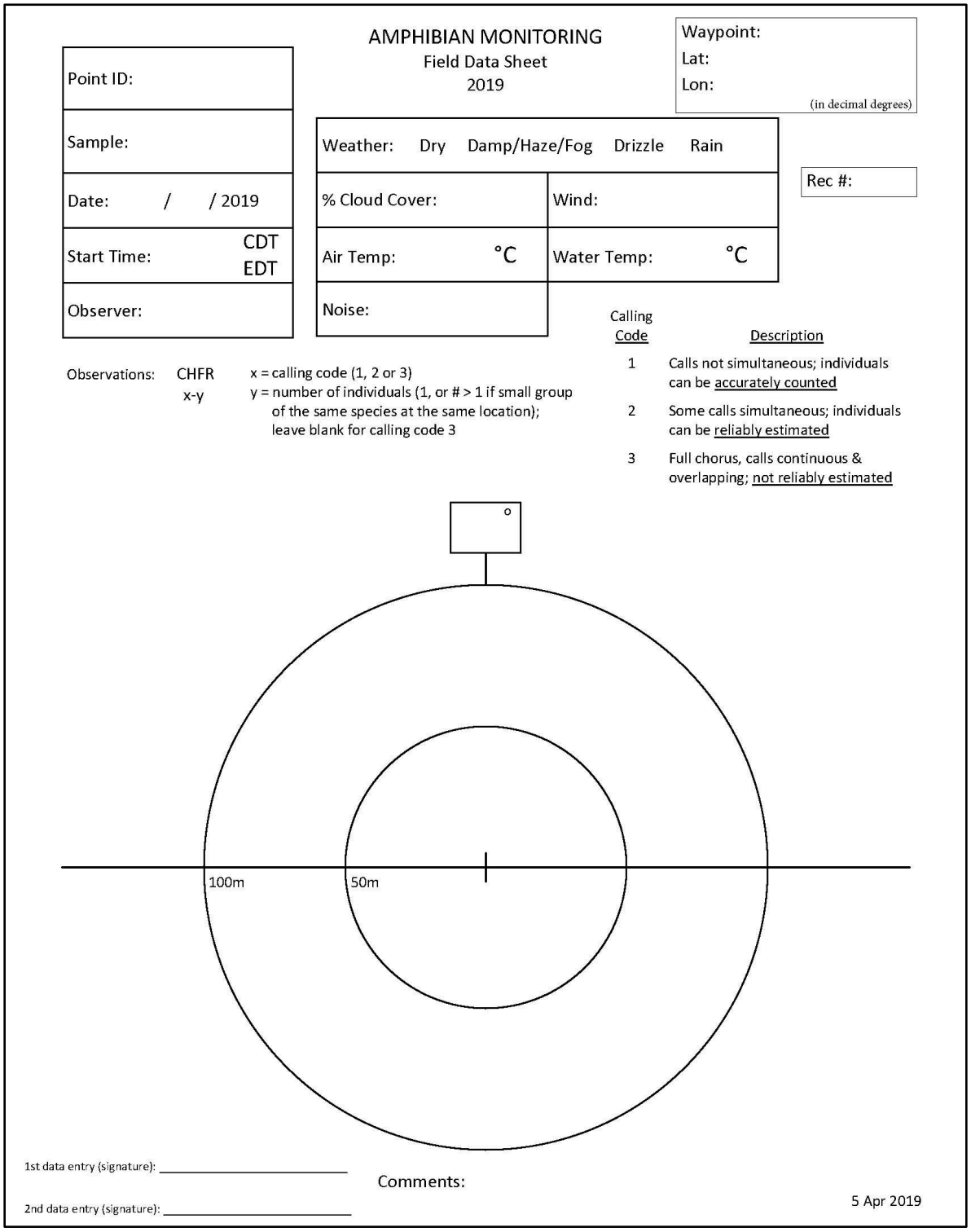
Notes:

1st data enterer/date _____

2nd data enterer/date _____

Appendix 4. Great Lakes Coastal Wetland Monitoring Program's Breeding Anuran Monitoring

Downloadable protocol and sample data sheet are available online found here: https://www.greatlakeswetlands.org/Sampling-protocols



AMPHIBIAN MONITORING
Field Data Sheet
2019

Waypoint:
Lat:
Lon:
(in decimal degrees)

Point ID:	
Sample:	
Date: / / 2019	
Start Time: CDT EDT	
Observer:	

Weather: Dry Damp/Haze/Fog Drizzle Rain		
% Cloud Cover:	Wind:	
Air Temp: °C	Water Temp: °C	
Noise:		

Rec #:

Observations: CHFR
x-y
x = calling code (1, 2 or 3)
y = number of individuals (1, or # > 1 if small group of the same species at the same location); leave blank for calling code 3

Calling Code	Description
1	Calls not simultaneous; individuals can be accurately counted
2	Some calls simultaneous; individuals can be reliably estimated
3	Full chorus, calls continuous & overlapping; not reliably estimated

1st data entry (signature): _____

2nd data entry (signature): _____

Comments:

5 Apr 2019

Appendix 5. Migratory Waterfowl Protocol and Data Sheet

Protocol from Howe et al. (2018b):

1. Sample each of the 10 permanent, ground-based sampling locations approximately twice a week throughout each season, so long as there is open water.
    a. Do not survey when visible area of water from survey location is >90% ice-covered.
    b. Check ice coverage at all points, especially in the beginning and end of winter, because ice shifts unpredictably.
    c. Randomize order of surveys to eliminate biases due to time of day.
        i. West shore and east shore points can be surveyed together for logistical reasons, but randomize order of points therein. Avoid conditions likely to decrease detectability associated with time of day, especially surveying toward a low sun angle in clear or partly cloudy conditions.

2. Surveys may be conducted during the following dates by season:
    a. Fall: 15 August - 30 November
    b. Winter: 1 December - 28 February
    c. Spring: 1 March - 31 May

    Seasonal dates are defined by the Wisconsin Society for Ornithology (https://wsobirds.org/report-sightings).

3. Surveys should be conducted during relatively good weather conditions with good visibility (not during thick fog or if waves affect line of sight), but not during heavy rain or very high wind.

4. Surveys may be conducted at any time during daylight hours.

5. Record the following basic information about the count:
    a. Site name
    b. Date
    c. Start time (using the 24-hr clock; 13:00 h = 1:00 pm)
    d. Length of survey (in minutes)
    e. Observer
    f. # of boats
    g. Boat disturbance: use one of the following codes:
        i. 0 = no effect
        ii. 1 = little effect
        iii. 2 = some effect
        iv. 3 = strong effect
    h. Notes (e.g., noise, access)
    i. Temperature (in °C)
    j. Wind: record wind direction (e.g., NW) and one of the following wind speed codes:
        i. 0 = none
        ii. 1 = 1-3 mph (1.6-4.8 kph)

iii. 2 = 4-7 mph (6.4-11.3 kph)
iv. 3 = 8-12 mph (12.9-19.3 kph)
v. 4 = 12-18 mph (19.3-29.0 kph)
vi. 5 = 18-25 mph (29.0-40.2 kph)
vii. 6 = >25 mph (>40.2 kph)
viii. Note that wind speed was not collected with an instrument but rather estimated by observer.

k. Cloud cover (estimate to the nearest 10%)
l. Precipitation: use one of the following codes:
    i. LR = light rain or drizzle
    ii. R = rain
    iii. H = hail
    iv. FR = freezing rain
    v. F = flurries
    vi. S = snow
m. Wave height (estimate in feet)
n. Visibility
    i. 1 = clear (>3 km)
    ii. 2 = light fog/haze/rain (<2 km)
    iii. 3 = heavy fog/rain (<1 km)
    iv. 4 = heat waves/distortion

6. Conducting the survey:
    a. Conduct an unlimited-distance point count by counting the number of individuals of each waterfowl (e.g., ducks, geese, mergansers) and waterbird species (e.g., gulls, terns, shorebirds, etc.) that are actively using open water and shoreline, regardless of how far away an individual is. Or, estimate to nearest 100, 1,000, 5,000, or 10,000. Record these counts or estimates in the six columns left of the solid black vertical line on the data form next to the appropriate species or species group (e.g., grebe sp.).
    b. When an individual or group of waterfowl cannot be identified, which is common due to distance, lighting, or waves, record as the species or family group that the individual or group can most safely be identified to. Options range from “scaup sp.” to “waterfowl sp.”
    c. Draw waterfowl rafts on the back of the data form for the appropriate point count location by drawing a polygon shape that represents the raft and recording the species and estimated number of individuals.
        i. Also draw ice coverage on map and other notable occurrences affecting waterfowl identification or congregation including severe glare or hunters.
    d. Record the species (or species group) and count the number of individuals of waterfowl that fly by the area being surveyed but that do not stay and actively use the water. These observations are called “Fly-ins” or “Fly-bys” and are recorded in the two columns to the right of the solid black vertical line on the data form.

    i. “Fly-ins/Flybys” are generally not recorded on the map on the back of the data form. However, notable groups can be recorded with an arrow starting on one side of the bird code label and ending on the other, indicating the direction of flight.

e. Each point count is 15 minutes in length at a minimum. If all waterfowl can be accurately recorded and counted in 15 minutes, then the count ends at 15 minutes. If there is a large number of waterfowl to record and the observer needs more than 15 minutes, then the observer stays to accurately count all waterfowl for however long it takes to count them.
f. An observer should use a handheld tally counter (e.g., Sparco Hand Tally Counter) to quickly count or estimate large waterfowl rafts.
g. High-quality optics are required for these unlimited-distance point counts. In 2017, an observer used a Swarovski 80 HD spotting scope and Swarovski 8 x 42 EL binoculars. A rangefinder is recommended for estimating distances.

Sample Data Sheets:

On the front side of every data sheet (shown below) is a tabular page that allows the counter to record all species seen or heard during the count and the total number of individuals. On the back side of each data sheet is a map of each point count location so that the counter may record waterfowl rafts within visual range (shown below tabular data form).

UW-Green Bay's Lower Green Bay & Fox River Area of Concern Migratory Waterfowl Survey

Site Name	Date	Start Time	Length (min)
	_____/_____/ 2017	_____:_____ h	

Observer	# of Boats	Boat Disturbance	Notes (e.g., noise, access)

Temp (°C)	Wind	Cloud Cover (nearest 10%)	Precipitation	Wave Height (ft)	Visibility
	Code: _____ Direction: _____				

Species	#	Species	#	Species	#	Fly-in/Flyby	#
SNGO		RUDU		Gull sp.			
CANG		BUFF		Tern sp.			
CACG		COGO		*Sterna* sp.			
TUSW		HOGR		Shorebird sp.			
AWPE		PBGR		Scaup sp.			
DCCO		RNGR		*Aythya* sp.			
WODU		COLO		Merganser sp.			
GADW		RTLO		Diving sp.			
NOPI		AMCO		Dabbler sp.			
AMWI		HOME		Duck sp.			
ABDU		COME		Swan sp.			
MALL		RBME		Loon sp.			
BWTE		LTDU		Grebe sp.			
GWTE		RBGU		Scoter sp.			
NSHO		HERG		GBHE			
REDH		GBBG		GREG			
RNDU		BOGU					
CANV		CATE					
GRSC		COTE					
LESC		FOTE					
SUSC		KILL					
WWSC		SPSA					
BLSC		SAND					

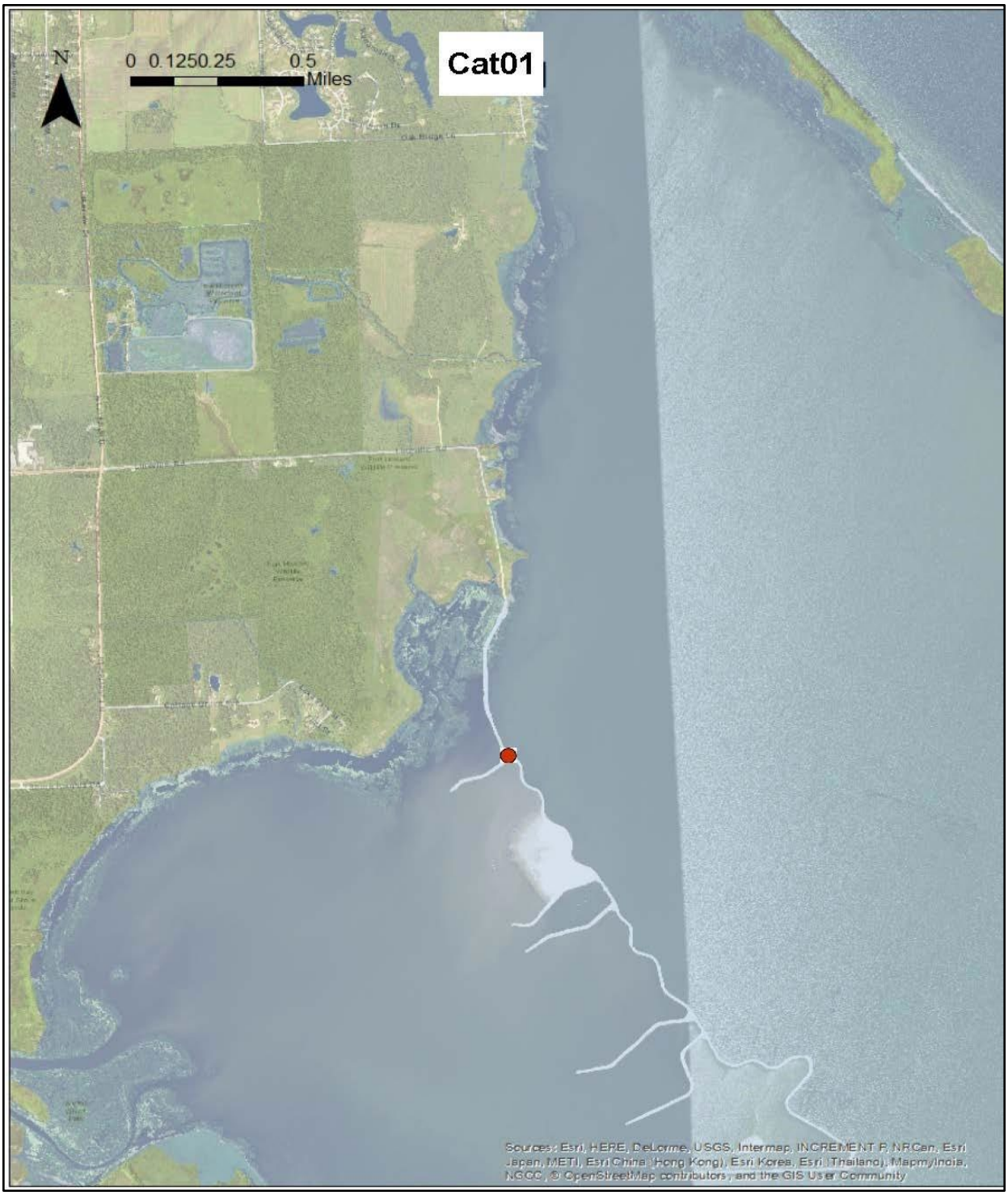
Boat Disturbance to Waterfowl:
0 = no effect
1 = little effect
2 = some effect
3 = strong effect

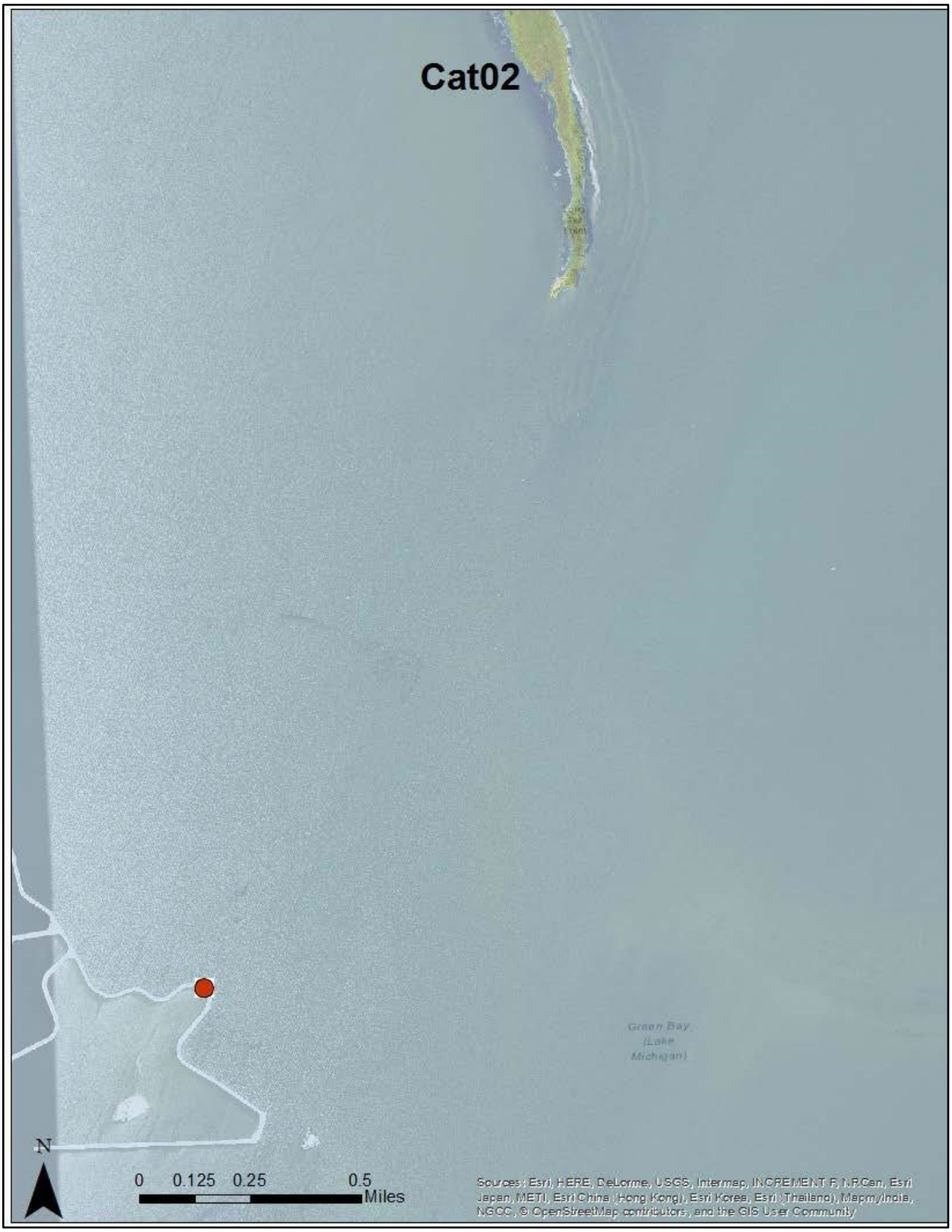
Wind:
0 = none
1 = 1-3 mph
2 = 4-7 mph
3 = 8-12 mph
4 = 12-18 mph
5 = 18-25 mph
6 = >25 mph

Precipitation:
LR = light rain or drizzle
R = rain
H = hail
FR = freezing rain
F = flurries
S = snow

Visibility:
1 = clear (> 3 km)
2 = light fog/haze/rain (< 2 km)
3 = heavy fog/rain (< 1km)
4 = heat waves/distortion

version 28 February 2017

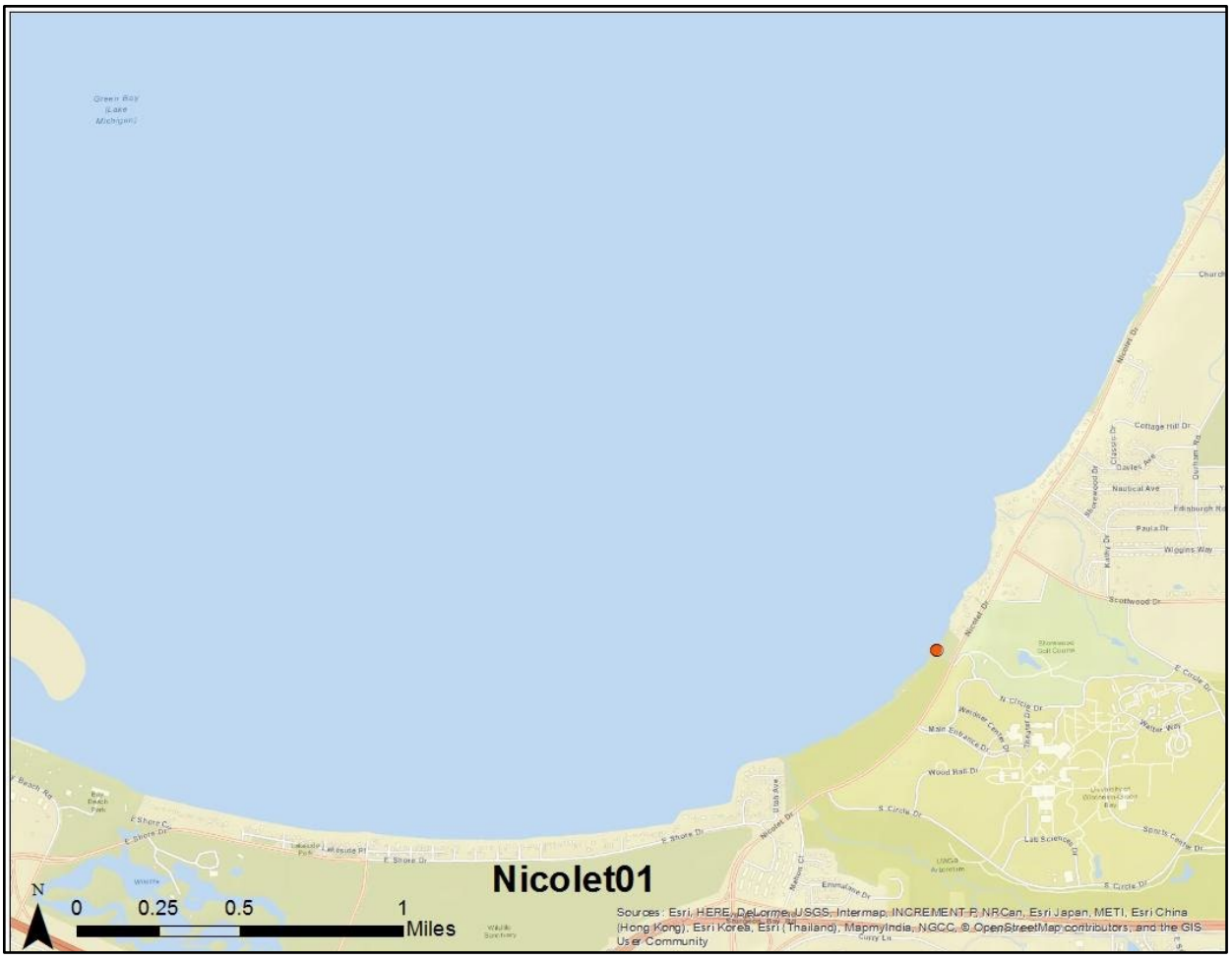

N
0 0.1250.25 0.5
Miles
Cat01
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri Thailand, MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community


Cat02
Green Bay
(Lake
Michigan)
N
0 0.125 0.25 0.5
Miles
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri, Thailand, MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community


Fox01
N
0 0.125 0.25 0.5
Miles
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri Thailand, MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community


Fox02
N
0 0.05 0.1 0.2
Miles
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri Thailand, MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community


Longtail01
0 0.125 0.25 0.5
Miles
N


Nicolet01
N
0
0.25
0.5
1
Miles
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community


Nicolet02
0
0.25
0.5
1
Miles
N
Nicolet Dr
Van Lanen Rd
Church Rd
Glen Oaks Pass
Glenn Abbey Dr
Spyglass Hill Dr
Blackwolf Run
Bayshore Dr
Cottage Hill Dr
Davies Ave
Fagerville Way
Edinburgh Rd
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community


Nicolet Dr
Grove Rd
Agamaite Rd
Lloyd Rd
Web St
Point Ln
Leanna Ln
CR-K
PointSable01
N
0 0.125 0.25 0.5
Miles
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Appendix 6. Wisconsin Breeding Bird Atlas II Project: Protocol, Codes and Data Sheet

Downloadable protocol found here: https://wsobirds.org/images/atlas/WBBA_II_Handbook.pdf, which also includes listings and descriptions of breeding codes on pages 9-13.

Sample Data Sheet:

FIELD CHECKLIST

Wisconsin Breeding Bird Atlas II

DATE: _____/_____/_____

OBSERVER: _____

ATLAS BLOCK NAME: _____

Checklist	Start Time	End Time	Survey Miles	Nocturnal?
1				
2				

Travel Effort between Home and Block:

Miles: _____

Hours: _____

Property Specific Checklist? #1 ☐ #2 ☐

CHECKLIST #1 -- LOCATION WITHIN BLOCK _____

Species	Count	Highest Breeding Code	Note #	Species	Count	Highest Breeding Code	Note #

No code for observed only

F Observed—flyover (see handbook for code usage)

H Possible—in appropriate habitat

S Possible—singing male in suitable habitat (single obs.)

S7 Probable—singing male present 7+ days

M Probable—multiple singing males (7 +)

P Probable—pair in suitable habitat

T Probable—territorial defense

C Probable—courtship display or copulation

N Probable—visiting probable nest

A Probable—agitated behavior/call notes

B Probable—wren/ woodpecker nest building

PE Confirmed—brood patch, other physiological evidence

CN Confirmed—carrying nesting material

NB Confirmed—nest building (non woodpecker/wren)

DD Confirmed—distraction display

UN Confirmed—used nest or eggshells (exercise caution)

ON Confirmed—occupied nest

FL Confirmed—recently fledged young

CF Confirmed—carrying food for young

FY Confirmed—feeding dependent young

FS Confirmed—carrying fecal sac

NE Confirmed—nest with eggs (exercise caution)

NY Confirmed—nest with young (seen or heard)

wsobirds.org/atlas

ATLAS BLOCK NAME: _____ DATE: ____/____/____

CHECKLIST #2 -- LOCATION WITHIN BLOCK _____

Species	Count	Highest Breeding Code	Note #	Species	Count	Highest Breeding Code	Note #

INCIDENTAL BLOCK RECORDS (not associated with above checklists)

	Species	Count	High Br. Code	Specific Location
1				
2				
3				
4				

NOTES (*please match note #'s above to numbered notes below*)

wsobirds.org/atlas

Appendix 7. Potential Sites for Designated Habitat Areas

Table A7.1. Site list for Designated Habitat Areas (DHA) for Coastal Terrestrial Macroinvertebrates (CTM), including the site location, associated target CTM habitat type, target CTM population group to be benefited, and site status in terms of whether a site is already a current DHA, a potential DHA proposed under an AOC management action (MA), or potential DHA not proposed under an AOC management action.

Location	Habitat Type	CTM Group Benefited	Status
UW-Green Bay Arboretum: Keith White Prairie	Upland	Butterflies, Bees	Current DHA; needs confirmation of DHA requirements
Cat Island	Great Lakes Beach	Tiger beetles, seaside grasshopper	Current DHA; needs confirmation of DHA requirements
Pt. Sable	Great Lakes Beach	Tiger beetles, seaside grasshopper	Potential Pt. Sable MA
Longtail Point	Great Lakes Beach	Tiger beetles, seaside grasshopper	Potential Longtail Point MA
UW-Green Bay Arboretum: Green Bay Shoreline	Great Lakes Beach	Tiger beetles, seaside grasshopper	Potential UW-Green Bay/Mahon Creek MA
Pt. Sable	Marsh and Sedge Meadow	Butterflies/Bees	Potential Pt. Sable MA
Duck Creek Mouth	Marsh and Sedge Meadow	Butterflies/Bees	Potential WDNR West Shores MA
Ken Euers Nature Preserve	Marsh and Sedge Meadow	Butterflies/Bees	Potential Ken Euers MA
Voyageur Park	Upland	Butterflies/Bees	Potential De Pere Dam MA
Ashwaubomay Memorial Park	Upland	Butterflies/Bees	Potential Ashwaubenon Creek MA
Jones Point/Allouez Retention Pond	Upland	Butterflies/Bees	Potential Heritage Hill MA
Dutchman Creek Corridor	Upland	Butterflies/Bees	Potential Dutchman Creek MA
Renard Island	Upland	Butterflies/Bees	Potential Renard Island MA
Bay Beach Wildlife Sanctuary	Upland	Butterflies/Bees	Potential Bay Beach Wildlife Sanctuary MA
Pt. Sable	Upland	Butterflies/Bees	Potential Pt. Sable MA
Ken Euers Nature Preserve	Upland	Butterflies/Bees	Potential Ken Euers MA
Duck Creek/Weitor Wharf	Upland	Butterflies/Bees	Potential Duck Creek/Weitor Wharf MA
Barkhausen Waterfowl Preserve	Marsh and Sedge Meadow	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
Malchow-Olson Tract	Marsh and Sedge Meadow	Butterflies/Bees	Identified as potential site, not included in AOC MA

			project list
East River Corridor	Marsh and Sedge Meadow	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
Expera Plant Property	Upland	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
WDNR Woodlot Properties	Upland	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
UW-Green Bay Oak Savanna and Golf Course	Upland	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
Sisters of St. Francis	Upland	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
WPS Closed Landfill Site	Upland	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
Barkhausen Waterfowl Preserve: Fort Howard	Upland	Butterflies/Bees	Identified as potential site, not included in AOC MA project list
UW-Green Bay Arboretum: Bay Shore Woods	Upland	Butterflies/Bees	Identified as potential site, not included in AOC MA project list

Table A7.2. Site list for Designated Habitat Areas (DHA) for Shorebirds (migratory), including the site location and status in terms of whether a site is already a current DHA, a potential DHA proposed under an AOC management action (MA), or potential DHA not proposed under an AOC management action.

Location	Status
Pt. Sable	Current DHA; needs confirmation of DHA requirements
Cat Island Wave Barrier	Current DHA; needs confirmation of DHA requirements
UW-Green Bay Arboretum: Green Bay Shoreline	Potential UW-Green Bay/Mahon Creek MA
Longtail Point	Potential Longtail Point MA
Ken Euers Nature Preserve	Potential Ken Euers MA
Bay Beach Wildlife Sanctuary	Potential Bay Beach Wildlife Sanctuary MA
Duck Creek/Weitor Wharf	Potential Duck Creek/Weitor Wharf MA
WDNR West Shores	Potential WDNR West Shores MA
Barkhausen Waterfowl Preserve	Identified as potential site, not included in AOC MA project list

Table A7.3. Site list for Designated Habitat Areas (DHA) for Landbirds (migratory), including the site location and status in terms of whether a site is already a current DHA, a potential DHA proposed under an AOC management action (MA), or potential DHA not proposed under an AOC management action.

Location	Status
Pt. Sable	Current DHA; needs confirmation of DHA requirements
UW-Green Bay Arboretum	Current DHA; needs confirmation of DHA requirements
Bay Beach Wildlife Sanctuary	Current DHA; needs confirmation of DHA requirements
Ken Euers Nature Preserve	Current DHA; needs confirmation of DHA requirements
Barkhausen Waterfowl Preserve	Current DHA; needs confirmation of DHA requirements
Upper Duck Creek North	Potential Duck Creek/Weitor Wharf MA
Renard Island	Potential Renard Island MA
Longtail Point	Potential Longtail Point MA
Ashwaubomay Memorial River Park	Potential Ashwaubenon Creek MA
Malchow-Olson Tract	Identified as potential site, not included in AOC MA project list
Fox River Trail	Identified as potential site, not included in AOC MA project list

Table A7.4. Site list for Designated Habitat Areas (DHA) for Bats, including the site location and status in terms of whether a site is already a current DHA, a potential DHA proposed under an AOC management action (MA), or potential DHA not proposed under an AOC management action.

Location	Status
UW-Green Bay Arboretum: Bayshore Woods	Current DHA; needs confirmation of DHA requirements
Pt. Sable	Current DHA; needs confirmation of DHA requirements
Barkhausen Waterfowl Preserve	Current DHA; needs confirmation of DHA requirements
Upper Duck Creek North Woods	Current DHA; needs confirmation of DHA requirements
Bay Beach Wildlife Sanctuary	Current DHA; needs confirmation of DHA requirements
Peters Marsh/Fort Howard	Current DHA; needs confirmation of DHA requirements
Ashwaubenon Creek Corridor	Current DHA; needs confirmation of DHA requirements
Voyageur Park	Potential De Pere Dam MA
Longtail Point	Potential Longtail Point MA
Wequiock Creek Nature Preserve	Identified as potential site, not included in AOC MA project list
Fox River Trail	Identified as potential site, not included in AOC MA project list

Table A7.5. List of Designated Habitat Areas (DHAs) for the Tributary Fish population group. Each DHA includes a point value contributed to the x-axis for the Tributary Fish group curve if adult monitoring criteria are met at that DHA. Each DHA also includes a list of adult, juvenile/young of year (yoy), and rare/sensitive target fish species and their respective monitoring criteria including proposed sampling seasons, gears, and data collectors. For an understanding of how juvenile/yoy or rare/sensitive monitoring criteria are scored, please see the provided example in the Tributary Fish section of Chapter 3. Note: "Centrarchids" excludes green sunfish in this case.

Designated Habitat Areas (DHAs)	Points contributed to Trib Fish Population Group Curve X-axis if adult criteria met	Adult Monitoring Target Species --- Juvenile/YOY Monitoring Target Species	Adult Monitoring Species Criteria (Season - Gear Type - Data Collector) --- Juvenile/YOY Monitoring Species Criteria (Season - Gear Type - Data Collector)	Rare/Sensitive Monitoring Target Species --- Monitoring Criteria (Season - Gear Type)
Dutchman Creek	1	Centrarchids AND Yellow Perch --- Centrarchids AND Yellow Perch	At least one adult of both species are observed (Summer - E-fishing - WDNR Baseline Survey) --- At least one Juvenile/YOY of both species are observed (Summer - E-fishing - WDNR Baseline Survey)	Any of multiple rare/sensitive species listed for the Lower Fox River and Lower Green Bay outlined in a site-specific monitoring plan (sans Musky, Smallmouth Bass or Rock Bass) --- At least one of these spp. are observed (Any season - Any gear)
Pt. Sable/Wequiock Creek	0.5	Yellow Perch --- Yellow Perch	At least one adult Yellow Perch is observed (Spring - Backpack/Boat E-fishing/Fykes - UWGB) --- At least one individual Juvenile/YOY yellow perch is observed (Spring - Backpack/Boat E-fishing/Fykes - UWGB)	" "
Duck Creek/Weitor Wharf	1	Centrarchids AND Northern Pike --- Centrarchids AND Northern Pike OR Musky (w/o fin clips)	At least one adult of both species are observed (Summer - E-fishing - WDNR Baseline Survey) --- At least one Juvenile/YOY Centrarchid spp. AND one Pike OR Musky are observed (Summer - E-fishing - WDNR Baseline Survey)	" "
Ashwaubenon Creek	1	Centrarchids AND Yellow Perch --- Centrarchids AND Yellow Perch	At least one adult of both species are observed (Summer - E-fishing - WDNR Baseline Survey) --- At least one Juvenile/YOY of both spp. are observed (Summer - E-fishing - WDNR Baseline Survey)	" "
UWGB/Mahon Creek	0.75	Redhorse Spp. OR Yellow Perch --- DNR Wadeable Baseline IBI Stream Survey	At least one adult of either species is observed (Spring - Fyke Net - WDNR Baseline Survey) --- IBI Score of "Fair" OR IBI score shows an increase of 20 from previous IBI survey (Summer - E-fishing - WDNR Wadeable Survey)	" "
Ken Euers	0.5	Northern Pike --- Northern Pike	At least one adult Northern Pike is observed (Spring - Visual Observation or Fyke Net - Brown County) --- At least one YOY Northern Pike is observed emigrating DHA (Spring - Fry Trap - Brown County)	" "
Peter's Marsh/Fort Howard	0.5	Northern Pike --- Northern Pike	At least one adult Northern Pike is observed (Spring - Visual Observation or Fyke Net - Brown County) --- At least one YOY Northern Pike is observed emigrating DHA (Spring - Fry Trap - Brown County)	" "
Heritage Hill	0.5	Northern Pike --- Northern Pike	At least one adult Northern Pike is observed (Spring - Visual Observation or Fyke Net - Brown County) --- At least one YOY Northern Pike is observed emigrating DHA (Spring - Fry Trap - Brown County)	" "

Table A7.6. List of Designated Habitat Areas (DHAs) for the Shoreline Fish population group. Each DHA includes a point value contributed to the x-axis for the Shoreline Fish group curve if adult monitoring criteria are met at that DHA. Each DHA also includes a list of adult, juvenile/young of year (yoy), and rare/sensitive target fish species and their respective monitoring criteria including proposed sampling seasons, gears, and data collectors. For an understanding of how juvenile/yoy or rare/sensitive monitoring criteria are scored, please see the provided example in the Shoreline Fish section of Chapter 3. Note: "Centrarchids" excludes green sunfish in this case and AIS = Aquatic Invasive Species.

Designated Habitat Areas (DHAs)	Points contributed to Shoreline Fish Population Group Curve X-axis if adult criteria met	Adult Monitoring Target Species --- Juvenile/YOY Monitoring Target Species	Adult Monitoring Species Criteria (Season - Gear Type - Data Collector) --- Juvenile/YOY Monitoring Species Criteria (Season - Gear Type - Data Collector)	Rare/Sensitive Monitoring Target Species --- Monitoring Criteria (Season - Gear Type)
Joilet Park	1	Smallmouth Bass --- Smallmouth Bass OR Walleye	At least one adult smallmouth bass is observed (Fall - Gillnets - USFWS AIS) --- At least one Juvenile/YOY of one either spp. are observed (Fall - E-fishing/Gillnets - USFWS AIS)	Any of multiple rare/sensitive species listed for the Lower Fox River and Lower Green Bay outlined in a site-specific monitoring plan (sans Musky, Smallmouth Bass or Rock Bass) --- At least one of these spp. are observed (Any season - Any gear)
Duck Creek Delta	1	Centrarchids AND Northern Pike --- Centrarchids AND Northern Pike OR Musky (w/o fin clips)	At least one adult of both species are observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY Centrarchid spp. AND one Pike OR Musky are observed (Fall - E-fishing - USFWS AIS)	" "
Dead Horse Bay	1	Smallmouth Bass --- Smallmouth Bass OR Walleye	At least one adult smallmouth bass is observed (Fall - Gillnets - USFWS AIS) --- At least one Juvenile/YOY of one either spp. are observed (Fall - E-fishing/Gillnets - USFWS AIS)	" "
Southwest Shoreline/Tank Farm Marsh	1	Centrarchids AND Northern Pike --- Centrarchids AND Northern Pike OR Musky (w/o fin clips)	At least one adult of both species are observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY Centrarchid spp. AND one Pike OR Musky are observed (Fall - E-fishing - USFWS AIS)	" "
Renard Island	0.75	Smallmouth Bass --- Smallmouth Bass	At least one adult smallmouth bass is observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY smallmouth bass is observed (Fall - E-fishing - USFWS AIS)	" "
Cat Island Chain	0.75	Centrarchids AND Walleye --- Centrarchids OR Walleye	At least one adult of both species are observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY of both species are observed (Fall - E-fishing - USFWS AIS)	" "
Peter's Marsh/Fort Howard	0.5	Centrarchids AND Northern Pike --- Centrarchids AND Northern Pike OR Musky (w/o fin clips)	At least one adult of both species are observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY Centrarchid spp. AND one Pike OR Musky are observed (Fall - E-fishing - USFWS AIS)	" "

Table A7.7. List of Designated Habitat Areas (DHAs) for the Fox River Fish population group. Each DHA includes a point value contributed to the x-axis for the Fox River Fish group curve if adult monitoring criteria are met at that DHA. Each DHA also includes a list of adult, juvenile/young of year (yoy), and rare/sensitive target fish species and their respective monitoring criteria including proposed sampling seasons, gears, and data collectors. For an understanding of how juvenile/yoy or rare/sensitive monitoring criteria are scored, please see the provided example in the Fox River Fish section of Chapter 3. Note: "Centrarchids" excludes green sunfish in this case; AC/DC Deltas = Ashwaubenon Creek/Duck Creek Deltas.

Designated Habitat Areas (DHAs)	Points contributed to Fox River Population Group Curve X-axis if adult criteria met	Adult Monitoring Target Species --- Juvenile/YOY Monitoring Target Species	Adult Monitoring Species Criteria (Season - Gear Type - Data Collector) --- Juvenile/YOY Monitoring Species Criteria (Season - Gear Type - Data Collector)	Rare/Sensitive Monitoring Target Species --- Monitoring Criteria (Season - Gear Type)
AC/DC Deltas	1	Channel OR Flathead Catfish --- Channel OR Flathead Catfish OR Centrarchids	At least one adult of either species is observed (Fall - E-fishing/mini fykes - USFWS AIS) --- At least one Juvenile/YOY of any of these species are observed (Fall - E-fishing/mini fykes - USFWS AIS)	Any of multiple rare/sensitive species listed for the Lower Fox River and Lower Green Bay outlined in a site-specific monitoring plan (sans Musky, Smallmouth Bass or Rock Bass) --- At least one of these spp. are observed (Any season - Any gear)
De Pere Dam (Brown Co Fairgrounds)	0.5	Centrarchids --- Centrarchids OR Walleye OR Musky (w/o fin clips)	At least one adult Centrarchids spp. is observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY of any of these species are observed (Fall - E-fishing - USFWS AIS)	" "
De Pere Dam (East shoreline)	1	Lake Sturgeon AND Lake Whitefish --- Lake Sturgeon AND Lake Whitefish	At least one adult Lake Sturgeon is observed (Spring - Dip Net - Interagency coordination needed) AND At least one adult Lake Whitefish is observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY Lake Sturgeon is observed (Spring - Larval Drift Net - Interagency coordination needed) AND At least one Larval/YOY Lake Whitefish is observed (Fall - Neuston Net Tows - Interagency coordination needed)	" "
De Pere Dam (West shoreline)	1	Centrarchids --- Centrarchids OR Walleye OR Musky (w/o fin clips)	At least one adult Centrarchids spp. is observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY of any of these species are observed (Fall - E-fishing - USFWS AIS)	" "
Heritage Hill	1	Centrarchids --- Centrarchids OR Walleye OR Musky (w/o fin clips)	At least one adult Centrarchids spp. is observed (Fall - E-fishing - USFWS AIS) --- At least one Juvenile/YOY of either species are observed (Fall - E-fishing - USFWS AIS)	" "

Table A7.8. List of Designated Habitat Areas (DHAs) for the Freshwater Unionid Mussel population group. Each DHA includes a point value contributed to the x-axis for the Freshwater Unionid Mussel curve if baseline monitoring criteria are met for the DHA. Each DHA also includes specified mussel groups that must be observed to meet both baseline and secondary monitoring criteria as well as a proposed data source and collector. For an understanding of how secondary monitoring criteria are scored, please see the provided example in the Freshwater Unionid Mussel section of Chapter 3.

Designated Habitat Areas (DHAs)	**Points contributed to Mussel Population Group Curve X-axis if baseline criteria met**	**Baseline Monitoring Criteria (Data Source - Collector)**	**Secondary Monitoring Criteria (Data Source - Collector)**
Renard Island	1	At least one adult opportunistic AND one adult keystone/stable mussel spp. observed (Mussel Surveys - WDNR/Contractor)	At least one rare mussel spp. observed OR natural recruitment of at least one rare or keystone/stable spp. observed (Mussel Surveys - WDNR/Contractor)
Ashwaubenon Creek	1	" "	" "
Dutchman Creek	1	" "	" "
DuckCreek/Weitor Warf	1	" "	" "
Wequiock Creek	0.5	" "	" "
Joilet Park	0.5	" "	" "
De Pere Dam (East shoreline)	0.5	" "	" "
Dead Horse Bay	0.5	" "	" "