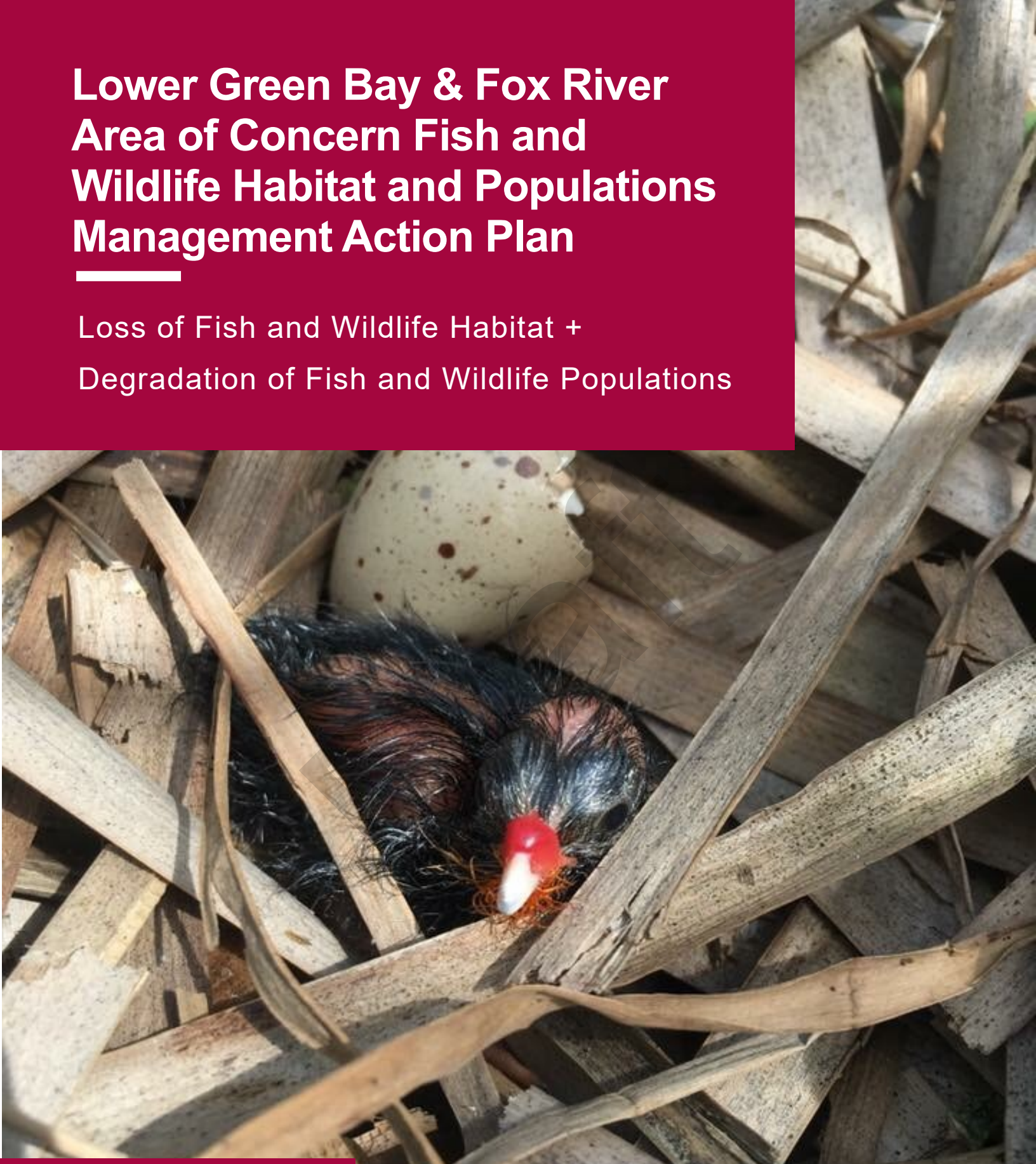
Lower Green Bay & Fox River Area of Concern Fish and Wildlife Habitat and Populations Management Action Plan

Loss of Fish and Wildlife Habitat +

Degradation of Fish and Wildlife Populations



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December 2023

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Table of Contents

Acknowledgements and Citation

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Written and Compiled by:

Brie Kupsky, Green Bay Program Coordinator

Jessica Brandt, AOC Project Manager

Mandy Mellinger, AOC Project Manager

With Input and Contributions from:

The Lower Green Bay & Fox River Fish and Wildlife Technical Advisory Committee (see Appendix 1 for list of members)

Kendra Axness, DNR

Rebecca Fedak, DNR

Brooke Lotto, DNR

Madeline Magee, DNR

Julie Majerus, DNR

Rae-Ann Eifert, DNR

Cover Photo: Newly hatched sora found in Peters Marsh, photo courtesy Brie Kupsky.

Dunlins flying near Cat Island Restoration Chain, with Bay of Green Bay and UW-Green Bay campus in the background. Photo courtesy Brie Kupsky.

Executive Summary

Plan Purpose

This plan outlines the management actions necessary to achieve the “Loss of Fish and Wildlife Habitat” and “Degradation of Fish and Wildlife Populations” beneficial use impairment (BUI) removal targets on the path to delisting the Lower Green Bay & Fox River Area of Concern (AOC). Development of this plan is the product of decades of research, collaboration, and engagement of AOC stakeholders.

The initial draft of eighteen management actions was presented to EPA Great Lakes National Program Office (GLNPO) in July 2020, and again in December 2020. Through EPAs review, it was determined by DNR and EPA that additional information on feasibility was needed for management action implementation at the De Pere Dam Riparian Wetland and Reef, Duck Creek Delta Wetland Restoration, and Longtail Point Beach Restoration and Reef projects.

To complete this work, EPA GLNPO entered into an Inter-Agency Agreement (IA) with the US Army Corps of Engineers (USACE) to complete feasibility studies (e.g., Technical Memorandum (TM)) in partnership with DNR, whereby existing conditions at the three project areas were documented and additional site information collected, conceptual design criteria were developed through stakeholder consultation, and design criteria vetted through desktop analyses.

In XXXX 2023, this plan was resubmitted to EPA GLNPO for review with additional updates including the categorization of management actions into three broader project regions throughout the AOC, the combining a subset of projects into larger project areas, and the completion of one management action by project partners (e.g. Ken Euers Nature Area).

The plan was officially approved by EPA on XXXXX XX, XXXX.

Plan Organization

The introductory sections of this document are intended to act as an executive summary that provides background on why this plan was needed, information about the full plan implementation, and important considerations that will be made throughout design and implementation of each project included in the plan.

Subsequent sections are organized into chapters that align with three priority areas across the AOC (Eastern Lower Bay, Lower Fox River, and Western Lower Bay). Each of the three region chapters begins with a narrative on key/unique priority habitats/populations and target species represented within that region, and how implementation of the body of respective projects within the priority area will result in landscape-level improvements and improved habitat corridors.

Following the chapter narrative, each of the 12 management action project narratives include the following information:

- Brief site description and location
- Project scope/concept and priority habitats and populations benefited
- Anticipated progress of project toward overall fish and wildlife BUI removal criteria
- Project manager, sponsor, and list of potential partners
- Timeline, estimated costs for necessary project phases (planning, design, construction, and monitoring), cost-sharing opportunities, and relevant historic and/or present contributions to fish and wildlife habitat and populations improvement made through other programs and initiatives.
- Specific stakeholder engagement, environmental justice, and/or climate resiliency considerations that are well defined as of completion of this document.

Plan Background

The Lower Green Bay & Fox River AOC encompasses the last seven miles of the Fox River, stemming from the De Pere Dam to the mouth of the river, and a 21 mi^2 area of the lower bay of Green Bay. It is one of the most ecologically important regions in the Great Lakes and supports a diverse community of fish and wildlife.[1,2]

This area remains an ecologically important region within the Great Lakes; however, fish, wildlife, and habitat have been impacted by anthropogenic activities in myriad ways, including direct habitat conversion and loss, severely degraded water quality, toxic substances, encroachment by invasive species, and other stressors. As a result, following designation of the AOC in 1987 confirmation of the Loss of Fish and Wildlife and Degradation of Fish and Wildlife Populations BUIs was initiated through the 1993 RAP Update. Initial BUI removal targets were developed in consultation with the Fish, Wildlife and Habitat Technical Advisory Committee (TAC) (previously "Biota Committee") in 2009 (Table 1), though subsequent RAP Updates identified the need for these removal targets to follow SMART (specific, measurable, achievable, realistic, and timebound) target development.

Table 1. The initial 2009 removal targets for the Fish and Wildlife BUIs.

BUI	Target	Status
Loss of Fish and Wildlife Habitat	The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native fish species (including walleye, northern pike, yellow perch, lake sturgeon, Great Lakes spotted muskellunge, and centrarchids) in abundances sufficient to provide ecological function in the fish community	Action needed
	Populations of traditionally harvested fish species are capable of supporting some level of exploitation	Action needed
	The AOC contains healthy, self-sustaining, naturally reproducing, and diverse populations of native furbearers (including mink, muskrats, and otter), amphibians (including spring peepers, leopard frogs, American toads, eastern gray tree frogs, green frogs, bullfrogs, and salamanders), reptiles (including snapping and painted turtles), terns (common and Forster's), migratory diving ducks, dabbling ducks, marsh nesting birds and island-dependent colonial nesting birds in abundances sufficient to provide ecological function	Action needed
	Populations of traditionally harvested wildlife species are capable of supporting some level of exploitation	Action needed
	Invasive species (lamprey, carp, gobies, white perch, and others) expansion is minimized and controlled as needed to protect native species within the AOC and upstream	Action needed

[1] Howe, R.W., E.E. Gnass Giese, A.T. Wolf. 2018. Quantitative restoration targets for fish and wildlife habitats and populations in the Lower Green Bay and Fox River AOC. Journal of Great Lakes Research, 44: 883.

[2] Gnass Giese, E.E., B. Kupsky, R.W. Howe, A.L. Stevens, A.T. Wolf. 2020. Evaluating progress toward removing fish and wildlife habitat and populations BUIs in the Lower Green Bay & Fox River Area of Concern.

	Contaminant levels in forage fish populations do not impair the reproductive success of fish-eating birds and wildlife (including predatory fish) and meet the criteria established in Annex 1 of the Great Lakes Water Quality Agreement, specifically "the concentration of total polychlorinated biphenyls (PCB) in fish tissues (whole fish, calculated on a wet weight basis), should not exceed 0.1 micrograms per gram for the protection of birds and animals which consume fish	Action needed
	The AOC supports fish and wildlife populations at levels consistent with extant fish and wildlife management plan objectives. Specifically, the following objectives should be met unless extant management plans have updated criteria. (Specific objectives are listed below)	Action needed
Degradation of Fish and Wildlife Populations	Fish and wildlife management goals are achievable as a result of the physical, chemical, and biological integrity of the AOC waters, including wetlands	Action needed
	A balance of diverse habitat types existing within the AOC that supports all life stage requirements of fish and wildlife populations including: - Multiple wetland types (for example: submerged aquatic vegetation, emergent vegetation, sedge meadows, forested & shrub) that adequately represent historic wetland types - Quality fish spawning habitats - Islands for colonial nesting birds, amphibians, and furbearers - Intact migration corridors (both shoreline and water) - Unconsolidated beaches (for shorebirds) - Habitat for State or Federally listed species (special concern, threatened, or endangered)	Action needed
	The hydrologic connectivity between wetlands and the AOC is maintained and restored sufficiently to support fish spawning and allow for fish passage	In progress
	The Green Bay portion of the AOC contains water clarity and other conditions suitable for support of a diverse biological community, including a robust and sustainable area of submerged aquatic vegetation in shallow water areas	Action needed
	The AOC contains a diversity of plants, an abundance of submersed aquatic vegetation, and sufficient invertebrates to provide adequate food supplies to support a diverse assemblage of migratory diving ducks (both mussel and vegetation feeding), fish, and other wildlife (including aquatic invertebrates, amphibians, and reptiles)	Action needed
	The AOC meets water quality standards and/or water quality targets of a State and US EPA approved TMDL	Action needed
	The AOC meetings Wisconsin water quality criteria for dissolved oxygen and water temperature that are protective of fish and wildlife populations	Action needed
	No waterbodies within the AOC are listed as impaired due to physical or water chemistry conditions in the most recent Wisconsin Impaired Waters List (303(d) List)	Action needed

Through the 2012 RAP Update, the TAC and DNR recommended an AOC-wide assessment to determine baseline condition of key habitats and fish and wildlife populations relative to current conditions, to recommend specific and achievable BUI removal targets, and to develop a project ranking protocol.

In response, a project led by UW-Green Bay (UWGB) researchers, The Nature Conservancy (TNC), and DNR was initiated in 2014 and completed in early 2018. The results of this project included **a final project portfolio** that describes 18 priority habitats and 22 priority populations and their baseline condition through a combination of stakeholder engagement, field assessments, and historical/contemporary cataloguing efforts. Additionally, a BUI assessment framework was developed that provided a flexible and objective quantitative mechanism for tracking progress toward the overall status of both BUIs based on the condition of priority habitats and populations. Recommended revised BUI removal criteria based on this assessment framework and broad goals and restoration recommendations for achieving the removal criteria were also included in the final project portfolio. Furthermore, TNC led a parallel analysis of restoration needs and opportunities outlined in **a final project report** that included a watershed assessment, fish connectivity assessment, and East River and Duck Creek habitat assessment to support projects intended to improve water quality and wildlife habitat within the broader Lower Fox River basin.

In 2018, DNR again partnered with UWGB researchers to work with the TAC to further refine priority habitat and population metrics within the BUI assessment framework and gain concurrence on recommended revised BUI removal criteria.

The BUI assessment process and refined metrics for the 22 priority fish and wildlife populations and 18 priority habitats are outlined in Chapters 1-3 of the **AOC Priority Fish and Wildlife Habitat and Populations Metrics and Monitoring Plan** located on the UWGB AOC website. Chapter 4 describes how progress will be tracked after implementation of management actions and includes the revised BUI removal targets that the TAC recommended through a consensus-based process (Table 2). These revised targets were published for public comment through the **2019 RAP Update** process and officially adopted as the new BUI removal targets in June of 2020.

Table 2. Revised removal targets for Fish and Wildlife BUIs.

BUI	Target	Status
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	Action Needed

Degradation of Fish and Wildlife Populations	The cumulative fish and wildlife populations 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	Action Needed

A 2019 TAC meeting to present potential project concepts for the East Shore of Green Bay.

Plan Scope and Connection to BUI Removal Criteria

The baseline Loss of Fish and Wildlife Habitat and Degradation of Fish and Wildlife Populations BUI condition scores as of 2020 (as calculated by the habitat BUI assessment tool) is a 3.60 and 4.65, respectively, out of 10. For more information about how the baseline scores were derived, please refer to the **Habitat Restoration Plan and Path Toward Delisting** and **AOC Priority Fish and Wildlife Habitat and Populations Metrics and Monitoring Plan** on the UWGB AOC Resources website. This means that the BUI condition scores must be raised at least **2.40** points to achieve the Loss of Fish and Wildlife Habitat and **1.85** points to achieve Degradation of Fish and Wildlife Populations updated BUI removal targets.

To determine what management actions could achieve these BUI removal targets, the TAC, UWGB, and DNR continued to collaborate through a consensus-based process from 2018 – 2020. One of the first tasks was to review where the priority populations and habitats occurred throughout the AOC. This effort determined that within the AOC boundaries, three main priority areas at the landscape-level provide distinctive habitat types for fish and wildlife: Lower East Green Bay, Fox River, and Lower West Green Bay (Figure 1 and Table 3).

Top left photo: The Cofrin Arboretum along Lower East Green Bay (photo credit UWGB); Top right photo: Walleye fishing at the De Pere Dam in the Lower Fox River (photo credit Anindo Choudhury); Bottom center photo: Cat Island Restoration Chain and Duck Creek Delta (photo credit Steve Seilo)

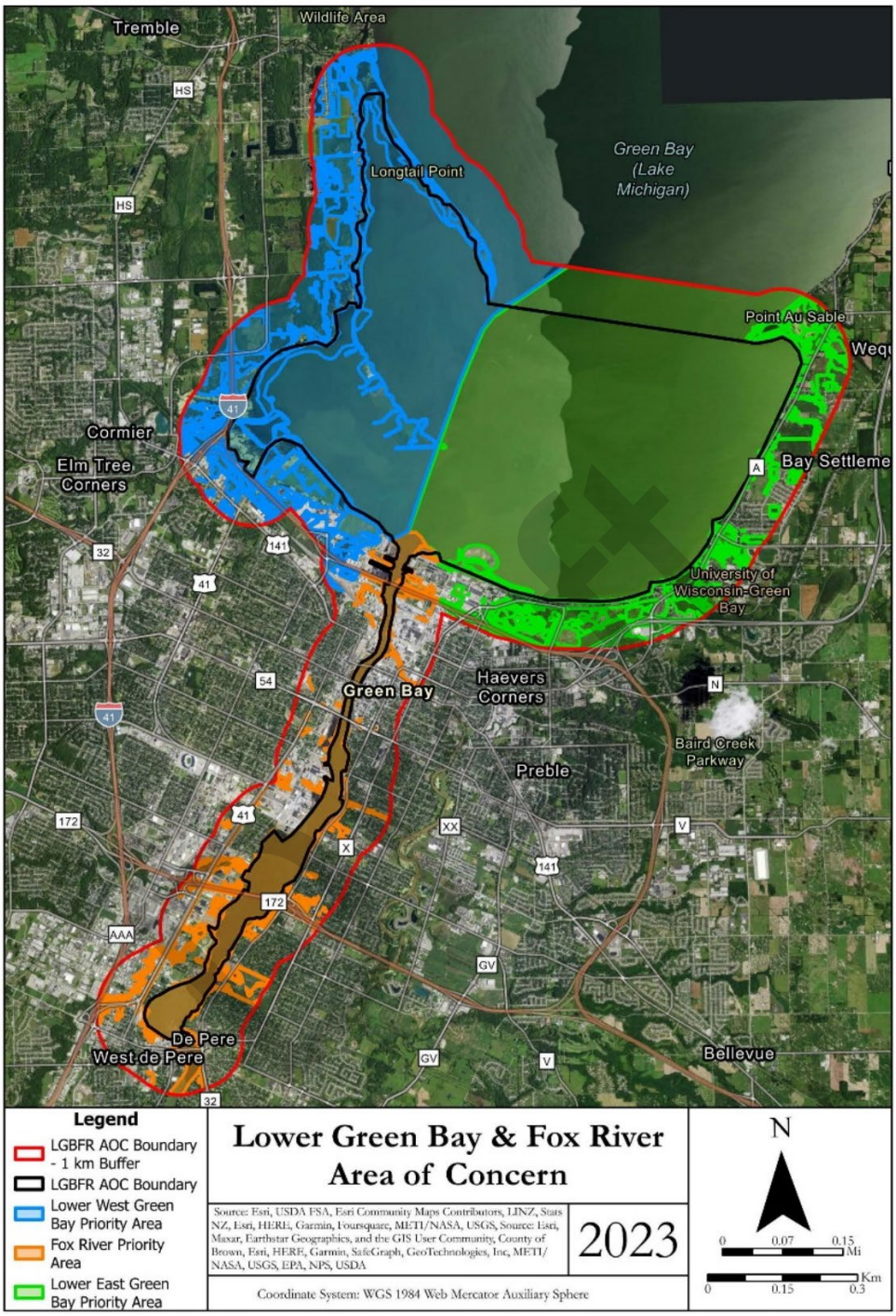


Figure 1. The Lower Green Bay & Fox River AOC boundary and priority habitats within fish and wildlife priority areas Lower East Green Bay (green), Lower Fox River (orange), and Lower West Green Bay (blue)

*Table 3. Priority habitat acreages across each priority area (Lower East Green Bay, Lower Fox River, and Lower West Green Bay) and total within the Lower Green Bay and Fox River AOC. Acreages and percentages in bold show which priority area the habitat type is the most dominant across the AOC. **Submergent Marsh reflects the total acres that could potentially be colonized by Submergent Marsh habitat. The TAC reviewed this acreage and determined that 193 acres is a more accurate estimate of baseline Submergent Marsh acreage.*

Priority Habitat	Total Acres in AOC	Lower East GB		Lower Fox River		Lower West GB	
		Acreage	Percent	Acreage	Percent	Acreage	Percent
Great Lakes Beach	110.60	**68.07**	**61.55**	0.43	0.39	41.28	37.32
Wet Meadow	1.78	0.24	13.48	0.00	0.00	**1.54**	**86.52**
Coastal Emergent Marsh	860.86	20.41	2.37	0.14	0.02	**840.31**	**97.61**
Submergent Marsh**	614.05	61.12	9.95	24.38	3.97	**528.55**	**86.08**
Riparian Emergent Marsh	205.57	**97.62**	**47.49**	36.74	17.87	71.22	34.65
Fox River Open Water	1385.94	0.00	0.00	**1385.94**	**100.00**	0.00	0.00
Green Bay Open Water	15591.33	**9755.59**	**62.57**	0.00	0.00	5835.74	37.43
Shrub Carr	240.76	0.00	0.00	2.17	0.90	**238.59**	**99.10**
Tributary Open Water	87.39	34.96	40.00	**51.96**	**59.46**	0.47	0.54
Hardwood Swamp	1893.32	560.17	29.59	194.69	10.28	**1138.46**	**60.13**
Inland Emergent Marsh	322.87	85.38	26.44	29.42	9.11	**208.07**	**64.44**
Inland Open Water	140.56	54.44	38.73	12.63	8.99	**73.49**	**52.28**
Southern Dry Mesic Forest	56.50	15.65	27.70	**22.57**	**39.95**	18.28	32.35
Roadside Emergent Marsh	51.29	9.40	18.33	3.38	6.59	**38.51**	**75.08**
Northern Mesic Forest	119.36	**63.62**	**53.30**	28.00	23.46	27.74	23.24
Other Forest	444.26	**207.46**	**46.70**	84.37	18.99	152.43	34.31
Old Field Grassland	345.62	**177.65**	**51.40**	104.43	30.22	63.53	18.38
Restored Grassland	23.11	**22.09**	**95.59**	1.01	4.37	0.00	0.00

Through review of priority habitats and populations within each of the priority areas, the TAC identified potential projects and developed general concepts for each of those projects. In early 2020, the TAC confirmed 18 project areas to include on the draft MAL, though these 18 project areas were consolidated into 12 discrete projects to better determine feasibility and overall cost of the full scope of project concepts in late 2021 (Figure 2).

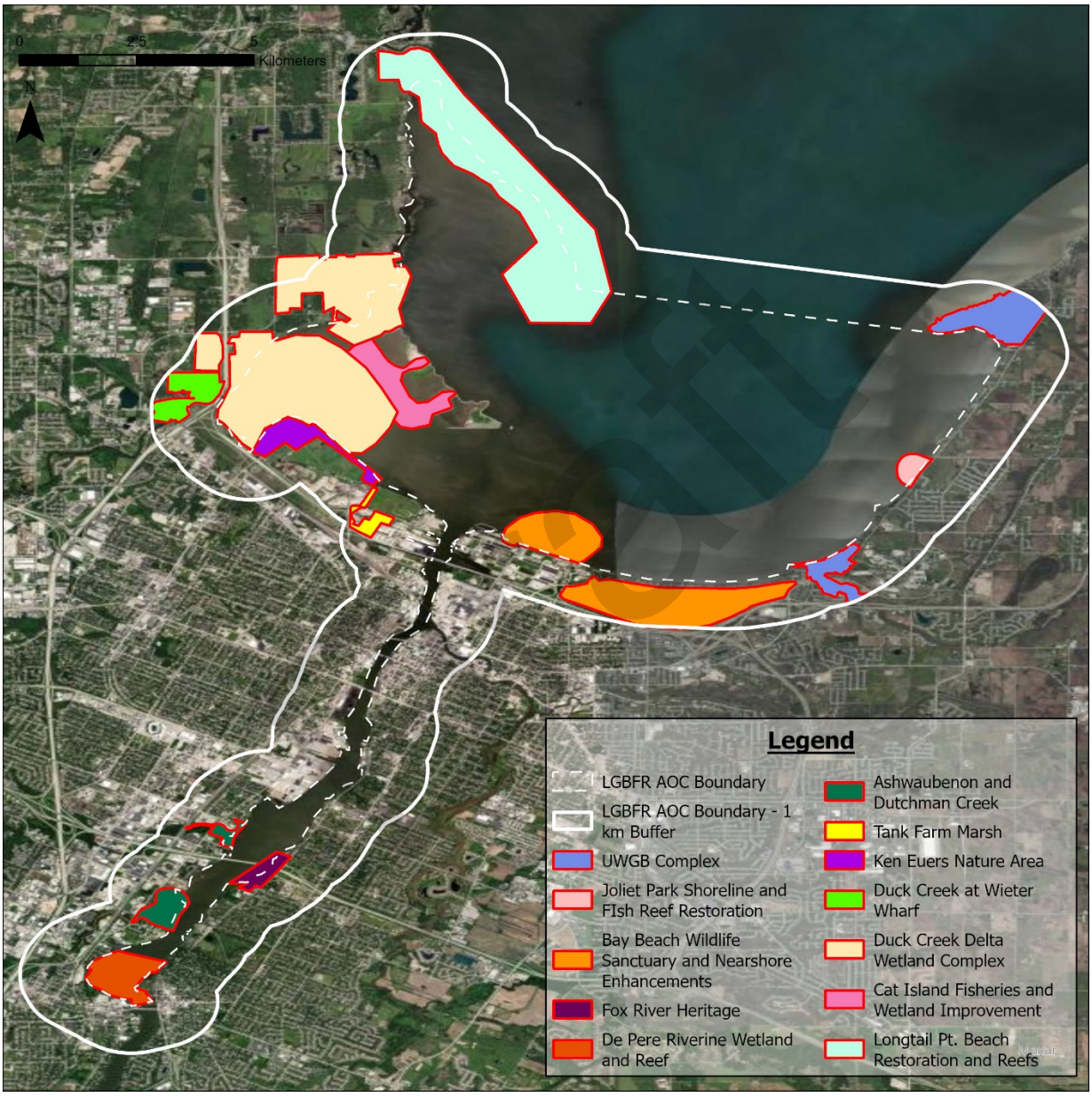


Figure 2. Lower Green Bay & Fox River AOC fish and wildlife habitat and populations management action locations across the three AOC priority areas.

Finally, each project area concept was scored to estimate its impact on priority habitat and populations condition scores (Table 4). As expected, the habitat improvement scores exceed the anticipated population score improvements, as fish and wildlife populations can be impacted by many other indirect factors and take longer to respond to improvements in habitat conditions. However, it should be noted that the habitat condition improvement scores reflect a "best achievable scenario" for implementation that require additional vetting through a design and permitting phase. For this reason, a small contingency in the scope of work for each project was included in the MAL. With support from the Fund for Lake Michigan, DNR is currently working with St. Norbert College to develop an R Shiny tool that will allow more streamlined tracking of priority habitat and population condition scores that will be available for broader stakeholder use in 2024.

Table 4. Project areas, anticipated improvement to priority habitat and populations condition scores, and overall BUI condition score targets after implementation of management actions. The three projects that USACE is completing feasibility studies for are marked with an asterisk; if these projects were not to move forward, it would result in a Habitat Condition Score of 5.46 and Population Condition Score of 5.99.

Project	Estimated Improvement to Habitat Condition Score	Estimated Improvement to Population Condition Score
1. UWGB Complex	0.60	0.28
2. Joliet Park Shoreline and Fish Reef Enhancements	0.10	0.07
3. Bay Beach Wildlife Sanctuary and Nearshore Enhancements	0.34	0.29
4. Fox River Heritage	0.16	0.12
5. De Pere Dam Riparian Wetland and Reef	0.25*	0.16*
6. Ashwaubenon and Dutchman Creek	0.28	0.25
7. Tank Farm Marsh	0.08	0.06
8. Ken Euers Nature Preserve	-	-
9. Duck Creek at Wietor Wharf	0.26	0.16
10. Duck Creek Delta Wetland Restoration	0.76*	0.36*
11. Cat Island Fisheries and Wetland Improvement	0.05	0.11
12. Longtail Point Beach Restoration and Reefs	0.44*	0.17*
Total Estimated Improvement	3.31	2.03
Baseline BUI Condition Scores	3.60	4.65
Updated BUI Condition Scores	**6.91**	**6.68**
BUI Removal Target	**6.00**	**6.50**

To better understand how these estimated scores compare to real-world improvements in priority habitat and populations condition based on the **AOC Priority Fish and Wildlife Habitat and Populations Metrics and Monitoring Plan** assessment methodology, Ken Euers Nature Preserve was included in the MAL even though the project and associated management actions were already completed through partner initiatives. DNR will work with USEPA GLNPO and the

partners who led the Ken Euers project to implement the AOC Monitoring and Metrics methodology and make any necessary changes to the methodology or score estimates beginning in 2024.

When implemented, Table 5 shows habitat improvements that could also be counted towards other GLRI Focus Area Measures of Progress and/or other DNR and partner initiatives:

Table 5. Total miles of shoreline, acres of habitat, and high-quality fish and mussel areas created in the AOC, or existing habitat improved upon.

Priority Habitat	Acres/Miles of Habitat Added	Acres/Miles of Habitat Improved
Great Lakes Beach	-	6.2 miles
Wet Meadow	114 acres	-
Coastal Emergent Marsh	201 acres	236 acres
Submergent Marsh	158 acres	133 acres
Riparian Emergent Marsh	40 acres	136 acres
Fox River Open Water	5 high quality fish and mussel habitat areas	-
Green Bay Open Water	7 high quality fish and mussel habitat areas	-
Tributary Open Water	8 high quality fish and mussel habitat areas	-
Shrub Carr	-	141 acres
Hardwood Swamp	-	823 acres
Inland Emergent Marsh	-	96 acres
Inland Open Water	-	36 acres
Southern Dry Mesic Forest	-	16 acres
Roadside Emergent Marsh	-	-
Northern Mesic Forest	-	3 acres
Other Forest	-	153 acres
Old Field Grassland	-	113 acres
Restored Grassland	14 acres	-

Plan Cost and Anticipated Timeline

The 12 projects presented total an estimated $82,550,000 to plan, design, construct, and maintain/monitor for a period of three years after implementation (Table 6). While the primary funding source will be Focus Area 1 of the Great Lakes Restoration Initiative (GLRI), DNR and EPA GLNPO continue to closely collaborate with the Fox River Natural Resource Damage Assessment (NRDA) Trustees to evaluate cost share opportunities as the plan is implemented. Several other potential funding sources have been identified and will be pursued to the best ability of the Agency and Partner Leads.

*Table 6. Project areas, associated total cost for design, implementation, and maintenance/monitoring, and anticipated funding sources. *Existing and planned investments from sources other than GLRI total approximately $5,620,000, making the anticipated GLRI investment for projects 1-9 and 11 approximately $17,230,000. **Total GLRI investment for all projects is anticipated to be $77,230,000.*

Project	Target Project Budget	Anticipated Funding Sources
#1: UWGB Complex	$3,000,000	GLRI
#2: Joliet Park Shoreline and Fish Reef Restoration	$2,000,000	GLRI
#3: Bay Beach Wildlife Sanctuary and Nearshore Enhancements	$3,500,000	GLRI
#4: Fox River Heritage	$3,000,000	GLRI
#6: Ashwaubenon and Dutchman Creek	$3,000,000	NRDA/Other Funding Sources
#7: Tank Farm Marsh	$3,000,000	GLRI + NRDA
#8: Ken Euers Nature Preserve	$50,000	GLRI + NRDA
#9: Duck Creek at Wietor Wharf	$2,500,000	NRDA/Other Funding Sources
#11: Cat Island Fisheries and Wetland Improvement	$2,600,000	GLRI + NRDA
Project Subset Sub-total	**$22,850,000***	**GLRI, NRDA, and Other Funding Sources**
Duck Creek Delta Wetland Restoration	<$20,000,000	GLRI
Longtail Point Beach Restoration and Reefs	<$20,000,000	GLRI
De Pere Dam Riparian Wetland and Reef	<$20,000,000	GLRI
Project Subset Sub-total	**<$60,000,000**	**GLRI**
Implementation of All Projects on Management Action List Total	**<$82,850,000****	**GLRI, NRDA, and Other Funding Sources**

The timeline for implementing this plan is heavily dictated by USEPA and DNRs commitment to complete all remaining management actions in the Lower Green Bay & Fox River AOC by 2030 (Table 7). While this timeline is aggressive, partners responsible for implementing the plan will

be actively tracking and adapting as needed and communicating changes to the timeline to AOC stakeholders as described in the next section of this document.

Table 7. List of project areas and timeline for completing feasibility (yellow), design (orange), implementation (green), and maintenance/monitoring (purple) phases, assuming GLNPO approval of MAL by December 2023.

Project	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Project Total
1. UWGB Complex				$400,000	$2,600,000						**$3,000,000**
2. Joliet Park Shoreline and Fish Reef Restoration			$230,000	$1,770,000							**$2,000,000**
3. Bay Beach Wildlife Sanctuary and Nearshore Enhancements				$500,000	$3,000,000						**$3,500,000**
4. Fox River Heritage			$300,000	$2,700,000							**$3,000,000**
5. De Pere Dam Riparian Wetland and Reef	$250,000			$600,000		<$19,150,000					**$20,000,000**
6. Ashwaubenon and Dutchman Creek			$150,000	$2,850,000							**$3,000,000**
7. Tank Farm Marsh	$175,000			$2,825,000							**$3,000,000**
8. Ken Euers Nature Preserve				$50,000							**$50,000**
9. Duck Creek at Wietor Wharf					$300,000	$2,200,000					**$2,500,000**
10. Duck Creek Delta Wetland Restoration	$250,000			$600,000	<$19,150,000						**$20,000,000**
11. Cat Island Fisheries and Wetland Improvement	$100,000		$100,000	$2,600,000							**$2,600,000**
12. Longtail Point Beach Restoration and Reefs	$250,000		$75,000	$600,000		<$19,075,000					**$20,000,000**
Total	**$1,025,000**		**$855,000**	**$15,195,000**	**$25,050,000**	**$40,425,000**					**$82,850,000**

Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

To date, stakeholder engagement with conservation practitioners, implementation partners, and municipal leaders has been significant. Several public meetings and presentations to various groups have also occurred throughout the management action list development. However, DNR acknowledges the need to broaden the local stakeholder base to those who have not traditionally been at the table to realize as many environmental, social, and economic benefits that will result from plan implementation. Similarly, more engagement with formal and informal community groups will occur throughout project design and implementation to ensure that project designs can incorporate desired community amenities/needs where feasible.

Over the past year, the DNR Office of Great Waters (OGW) has also convened several different stakeholders and stakeholder groups to discuss a framework by which a coalition of regional partners could come together to address needs associated with plan implementation and community engagement. Through these meetings, several barriers to authentic and effective engagement were identified, including:

- Capacity and Financial Resources
    - Capacity of conservation partners to build a more representative and active coalition of partners is limited in terms of time.
    - Financial resources are needed to effectively coordinate a coalition.
    - Many of the same partners and community members are frequently tapped across multiple initiatives.
- Messaging and Outreach
    - There is confusion about how these conservation initiatives fit together because there is no centralized source of outreach and means of getting involved.
    - Conservation partners need a unified and consistent message for conservation work in the region.
- Engagement and Inclusivity
    - There is a clear need to engage new voices in meaningful ways and invite those stakeholders to the table that can serve as representatives for the broader community.
    - There needs to be consideration for engaging not only those who are immediately adjacent to project locations, but also the diversity of individuals and groups that enjoy the resource.
    - More effort is needed to present information less technically to better engage a more diverse array of stakeholders to invest in the work.
- Time

- Many environmental initiatives are on short/near-term timelines directed either through policy or funding opportunities. As a result, there is pressure to move work forward without accounting for the time it takes to build relationships to develop a coalition of partners that can likewise gain trust from the communities they serve.

In evaluating the feedback received through stakeholder meetings and lessons learned from similar efforts to establish a coalition of partners in the Milwaukee Estuary AOC, DNR OGW is working with municipal and community leaders to establish a "Leadership Council" who will direct the work of several sub-teams that can identify synergies and integration opportunities in conservation implementation and better connect with the community on collective efforts.

The architecture of this coalition and governance structure is still in development and will require the buy-in from various stakeholders that are participating in these groups, but may follow the model below:

Leadership Council

Representation and Decision Making: Local community and municipal leaders will use a consensus-based decision-making process to develop social and economic goals and outcomes. State and federal agency representatives will act as advisors to the Leadership Council.

Role(s): This group will assist in project implementation and establish goals and outcomes for strategic integration of community priorities into AOC project implementation and other relevant local conservation initiatives. Some examples include working through permitting considerations across multiple projects, identifying opportunities for education, training and local workforce recruitment and retention, communication and outreach through established networks, improved and expanded recreational opportunities, collaborative long-term maintenance strategies and funding pathways, environmental justice initiatives, bringing forward additional project ideas, etc. This group will also direct the efforts of sub-teams listed below that will bring specific expertise on various topical areas, including:

Implementation Sub-Team

Representation: Local staff that coordinates/directs the implementation of AOC and other relevant local conservation initiatives throughout the Green Bay basin.

Role(s): This group will clearly outline and update implementation plans and communicate those to the Leadership Council and troubleshoot issues associated with project design, implementation, monitoring and/or maintenance needs.

Communications and Outreach Team

Representation: Communications staff from respective partners/organizations included on the Leadership Council and Implementation Team.

Role(s): This group will guide development of consistent branding and messaging to be shared through established networks of Leadership Council representatives and through the Green Bay Conservation Partners (GBCP) website and listserv.

Education, Training and Workforce Development Team

Representation: Staff from school districts, workforce development organizations, workforce/procurement staff from coalition partners, and employers that have a clear stake in AOC implementation and other local conservation initiatives throughout the Green Bay basin.

Role(s): This group will identify opportunities to provide K-12 education, job training, and workforce development to encourage stability and growth of jobs that have a nexus to AOC project implementation and other local conservation initiatives.

Citizens Advisory Committee (Clean Bay Backers)

Representation and Decision-Making: ~10 member committee that would go through a solicitation process with the Leadership Council and representatives of sub-teams. Selected committee members would be compensated for their time and lived experience as independent contractors, coordinated by New North, Inc. and initially supported through The Fund for Lake Michigan. The committee would then collaboratively determine their preferred decision-making structure.

Role(s): Provide both “communication in” to the Leadership Council and Implementation Team about community priorities, recommend representation on project design and implementation teams, and communicate potential impacts to areas immediately adjacent to project boundaries and/or broader community. Working with Communications and Outreach Team, assist with “communication out” to various community groups and members as trusted partners about AOC project implementation and other local conservation initiatives throughout the Green Bay basin. Recommend opportunities for improved recreation and access to Leadership Council and Implementation Team. Work with Leadership Council and Education, Training and Workforce Development Team to identify opportunities for community members to get involved.

Through this effort to establish, advise, and participate in various groups described above, DNR and partners will work to provide meaningful contribution and engagement of partners not traditionally/historically included in AOC planning and implementation efforts. While many of these groups are not anticipated to begin working together until mid to late 2024, DNR will be working in the interim identify a more holistic list of AOC and Green Bay basin stakeholders that will be reviewed by the Leadership Council and Citizens Advisory Committee in 2024.

Environmental Justice

According to Executive Order 14096 (88 FR25251, April 26, 2023) on Revitalizing our Nation's Commitment to Environmental Justice for All, environmental justice (EJ):

> *"…means the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment so that people:*
>
> *i. Are fully protected from disproportionate and adverse human health and environmental changes (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and*
> *ii. Have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices."*

At the heart of the DNR's mission is ensuring the right of all people to use and enjoy a healthy, sustainable environmental and full range of outdoor opportunities, and bringing together people of diverse perspectives to carry out the public will. In keeping with the department's mission and Governor Tony Evers' Executive Order #59 (Relating to Diversity, Equity, and Inclusion in State Government – 2019), DNR continues to make progress on addressing EJ.

The DNR OGW is currently developing strategies for identifying stakeholders that both live within/near the Lower Green Bay & Fox River AOC, as well as those who interact with AOC resources. We anticipate sharing this information with the Leadership Council, Citizens Advisory Committee, and other community partners to identify possible opportunities to expand engagement, promote representation, and encourage stewardship.

Grounding our work in the principle that local communities should be the primary source for solutions, we also expect these partners will help identify potential positive and negative impacts of projects included in this plan and troubleshoot to mitigate burdens that might be incurred. This Management Action Plan (MAP) identifies some EJ considerations for specific projects in the project narratives here. As further considerations are identified through work with stakeholder partners, they will be documented in future GLRI proposals, project design reports, and other relevant materials.

Climate Resiliency and Adaptation Considerations

The Wisconsin Initiative on Climate Change Impacts (WICCI) Great Lakes Working Group reports increased precipitation, increasing variability in extreme rainfall events, and increasing

air temperatures as driving physical, biological, and chemical changes in the Great Lakes region.[3] These impacts have and will continue to initiate impacts on water quality, habitats, species, and climate change interactions in Lake Michigan and Lake Superior, particularly in highly vulnerable coastal and nearshore ecosystems.[4]

As a result, the US Fish and Wildlife Service (USFWS), US Forest Service (USFS) and Northern Institute of Applied Climate Science (NIACS) convened natural resource managers and experts to develop a "menu" of climate adaptation strategies and approaches for Great Lakes coastal ecosystems that was completed in 2022.

This menu includes the following strategies and approaches that will be referenced throughout each projects planning, design, implementation, and maintenance phase. A list of these strategies and approaches is presented in Table 8; more defined climate resiliency and adaptation strategies will be included in future respective GLRI project proposals.

Table 8. Menu of strategies and approaches for Coastal Ecosystems as described in "Strategies for Adapting Great Lakes Coastal Ecosystems to Climate Change" with projects that are anticipated to utilize these strategies and approaches based on the current project scope.

Strategy 1: Maintain and enhance fundamental hydrologic processes and sediment dynamics.	
Approach 1.1	Maintain and restore natural sediment transport processes.
Approach 1.2	Maintain and restore hydrological connectivity between hydrological features.
Approach 1.3	Maintain and enhance infiltration and water storage capacity of soils.
Strategy 2: Maintain and enhance water quality.	
Approach 2.1	Moderate water temperature increases.
Approach 2.2	Reduce sediment deposition.
Approach 2.3	Reduce loading and export of nutrients and other pollutants.
Strategy 3: Maintain, restore, and manage coastal vegetation	
Approach 3.1	Maintain the integrity of unique plant communities, coastal wetlands and estuaries, and their integral landforms.
Approach 3.2	Minimize non-climate physical damage to coastal ecosystems and habitats.
Approach 3.3	Establish living shorelines by maintaining and restoring coastal vegetation.
Approach 3.4	Maintain and enhance species and structural diversity in coastal ecosystems.
Approach 3.5	Prevent invasive plant and animal species establishment and minimize their impacts where they occur.
Approach 3.6	Maintain and establish refugia for plants and animals.
Approach 3.7	Maintain and increase connectivity of coastal wetlands.
Strategy 4: Alter coastal ecosystems to accommodate changing hydrology, storm events, and shoreline erosion.	
Approach 4.1	Manage coastal ecosystems to accommodate increased frequency and duration of low water levels.

[3] Magee, M. et al. 2021. Climate Change and Wisconsin's Great Lakes Ecosystem: Great Lakes Working Group Report. WICCI Working Group Report, 76 pp.

[4] Schmitt, K. et al. 2022. Strategies for Adapting Great Lakes Coastal Ecosystems to Climate Change. White Paper. Houghton, MI: US Department of Agriculture, Northern Forests Climate Hub. 61 pp. https://doi.org/10.32747/2022.7816961.ch

Approach 4.2	Manage coastal ecosystems to accommodate increased frequency and duration of high water levels.
Approach 4.3	Promote features that reduce the impacts of wind and wave energy or damage from coastal erosion.
Approach 4.4	Manage sediment to respond to fluctuating water levels.
Approach 4.5	Reduce or manage surface water runoff.
Approach 4.6	Maintain and create conditions for inland and waterward movement of plants and animals.
Approach 4.7	Manage impounded wetlands to accommodate changes in hydrologic variability.
Strategy 5: Facilitate transformation of coastal ecosystems by adjusting plant species composition.	
Approach 5.1	Favor or restore native species and genotypes with wide moisture and temperature tolerances.
Approach 5.2	Increase genetic diversity of seed and plant mixes.
Approach 5.3	Disfavor species that are distinctly maladapted.
Approach 5.4	Introduce species that are expected to be adapted to future conditions.
Approach 5.5	Move at-risk species to locations that are expected to provide more suitable habitat.
Strategy 6: Design and modify infrastructure to accommodate future conditions.	
Approach 6.1	Reinforce infrastructure to meet expected conditions.
Approach 6.2	Design infrastructure with low-impact or ecologically friendly features.
Approach 6.3	Adjust the placement, design, and planned lifespan of infrastructure.
Approach 6.4	Remove infrastructure and readjust systems.

Photos from the shoreline of the Bay Beach Amusement Park (photo credit City of Green Bay and @Nature.Connections).

Chapter 1 – Lower East Green Bay

Lower East Green Bay History, Special Features, Priority Fish and Wildlife Habitats and Populations, Recreational Access, and Restoration Goals

The Lower East Green Bay priority area encompasses about 11,244 acres of AOC priority habitats within the LGBFR AOC east of the Fox River navigational channel to Point au Sable (Figure 3). The East Shore's unique features, rich history, and ecological importance sets the tone for why the implementation of recommended management actions is critical to improving the condition of AOC priority fish and wildlife habitats and populations.

Historically, native peoples of Bodwéwadmi (Potawatomi), Omāeqnomenew-ahkew (Menominee), and Hoocąk (Ho-Chunk) descent were the primary inhabitants of the Green Bay area for over 10,000 years until Frenchman Jean Nicolet first arrived in the early 1630's.[5,6] The Menominee, the oldest continuous residents of Wisconsin, were likely the predominant tribe in the area and were known to have a settlement less than 0.5 km of Point au Sable. The Menominee are an Algonkian-speaking people and have referred to themselves as *Mamaceqtaw*, meaning "the people". However, other tribes referred to them as Menominee, derived from the Algonkian word for wild rice, *manomin*, which was historically abundant in the area and was a staple food source.[7]

A predominant distinction that makes the East Shore of the Green Bay unique from the West Shore is its geology. The result of weathering, erosion, and uplift of lime mud deposited over 430 million years ago forms what is now known as the Niagara Escarpment. Extending through the middle of the Point du Sable Frontal Lobe Lower Green Bay watershed, the Niagara Escarpment possesses dramatic topographical characteristics such as rocky outcroppings and steep terrain. By nature, conditions on the East Shore have not been as suitable for wetland formation as they have been on the opposite side of the Green Bay on the West Shore.[8]

Another example of an important feature of the East Shore is the Point Sable Bar and Frying Pan Shoal. This sandbar extends from Point au Sable on the East Shore to Longtail Point on the West Shore.[9] During low water years, willows and cottonwoods grew were able to grow on

[5] Native American Digital. Native-Land.ca | Our home on native land

[6] Jean Nicolet: French Explorer. By The Editors of Encyclopaedia Britannica. Available: https://www.britannica.com/biography/Jean-Nicolet (accessed on 24 Oct 2016).

[7] Milwaukee Public Museum. Menominee History. Menominee History | Milwaukee Public Museum (mpm.edu)

[8] Webster B., P. Baumgart, M. Hoff, J. Noordyk, E. Gnass Giese, L. Terrien, R. Howe, and A. Wolf. 2021. East Shore Lower Green Bay Watershed Plan: Wequiock Creek, Mahon Creek, and Bay Shore Watersheds. Nine key element watershed plan submitted to the Wisconsin Department of Natural Resources and the U.S. Environmental Protection Agency.

[9] NOAA Navigational Chart: http://www.charts.noaa.gov/BookletChart/14910_BookletChart.pdf

the exposed sandbar. In fact, the sandbar would be so exposed that Native Americans often used it to travel to the opposite side of the bay during the low water years.[10]

Historically, habitat along the East Shore largely consisted of wild rice and wild celery beds, extensive emergent marsh, sedge meadows, shrub carr, swamps, wet conifer forests, and upland forests dominated by a variety of oak species (Figure 3).[11]

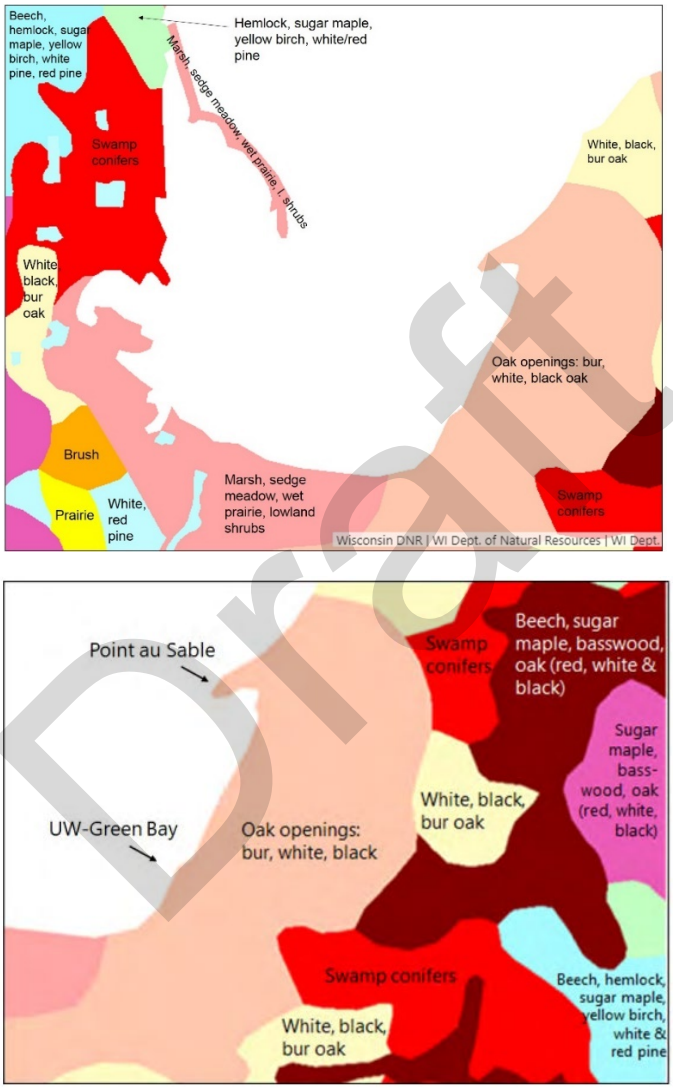


Figure 3. Habitat map depicting the original, historical vegetation from the Public Land Survey System surveys completed in the 1840's of the lower Green Bay (courtesy UWGB).

[10] Personal communication with Thomas Erdman

[11] Howe, R.W., E.E. Gnass Giese, A.T. Wolf. 2018. Quantitative restoration targets for fish and wildlife habitats and populations in the Lower Green Bay and Fox River AOC. Journal of Great Lakes Research, 44: 883-894.

Today, 17 priority habitats are represented along the East Shore, with several that have the highest acreage extent within the Lower East Green Bay priority area, including Riparian Emergent Marsh, Great Lakes Beach, Great Lakes Open Water, Northern Mesic Forest, Other Forest, and Old Field and Restored Surrogate Grasslands (Table 9 and Figure 4).

Table 9. Priority habitat acreages across the Lower East Green Bay priority area. Acreages and percentages in bold show which priority habitats are most dominant in this priority area.

Priority Habitat	Priority Habitat Acreage	East Shore Priority Area Habitat Acreage	Percent of Total Priority Habitat Acres in East Shore Priority Area
Coastal Emergent Marsh	860.86	20.41	2.37
Inland Emergent Marsh	322.87	85.38	26.44
Riparian Emergent Marsh	205.57	**97.62**	**47.49**
Roadside Emergent Marsh	51.29	9.40	18.33
Fox River Open Water	1385.94	0.00	0.00
Great Lakes Beach	110.60	**68.07**	**61.55**
Great Lakes Open Water	15591.33	**9755.59**	**62.57**
Hardwood Swamp	1893.32	560.17	29.59
Northern Mesic Forest	119.36	**63.62**	**53.30**
Open Water Inland	140.56	54.44	38.73
Other Forest	444.26	**207.46**	**46.70**
Shrub Carr	240.76	0.00	0.00
Southern Dry Mesic Forest	56.50	15.65	27.70
Wet Meadow	1.78	0.24	13.48
Submergent Marsh	614.05	61.12	9.95
Old Field Grassland	345.62	**177.65**	**51.40**
Restored Grassland	23.11	**22.09**	**95.59**
Tributary Open Water	87.39	34.96	40.00
Total Priority Habitat Acreage	22,495.17	11,233.87	49.94

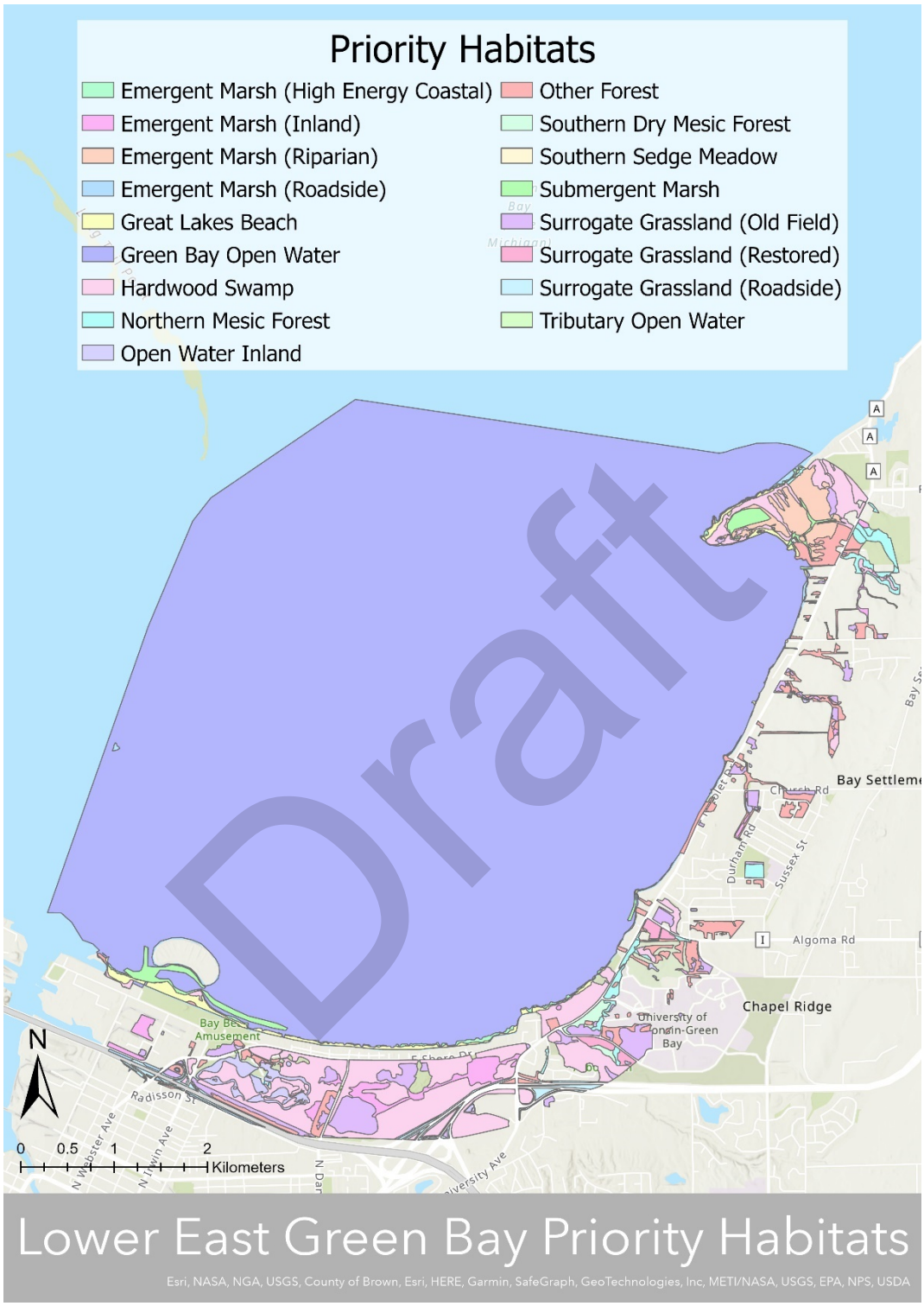


Figure 4. Lower East Green Bay priority habitat map.

Open Water Habitats

Green Bay Open Water remains the most significant habitat by acreage in this priority area. Impacts to this priority area are primarily degradation of water quality and substrates through nutrient, sediment, and historical toxic substance discharges from the Fox River to Green Bay. The East Shore is particularly impacted by these issues as the currents extending from the mouth of the Fox River into Green Bay move in a counterclockwise direction up the eastern shoreline of the AOC.

High concentrations of total phosphorous, total suspended solids, nitrates/nitrites, and chlorophyll *a* are regularly reported within the open waters of this priority area.[12] As a result, the area experiences excessive turbidity, habitat degradation, and harmful algae blooms throughout the summer into late fall, which are harmful to both aquatic organisms and humans.[13] Poor water quality in the Lower Green Bay has contributed to the decline of multiple fish species as well as mass die-offs of bird species from avian botulism and contaminated food sources.[14,15]

However, the Lower Fox River PCB Cleanup project, Lower Fox River TMDL, and several habitat restoration efforts along the East Shore of Green Bay have resulted in improved sediment and water quality over the last three decades. Over 80 species of fish have been reported in the pelagic area of the lower bay, and over 100 bird species use the open water and nearshore habitat, with large groups of ducks, waterfowl and waterbirds congregating in large groups during migration along the East Shore.[16]

Additionally, a 2018 – 2019 survey of native mussels in the AOC found the highest total density of mussels near Renard Island, with some evidence of natural recruitment through the presence of juvenile mussels. Benthic species such as native mussels have also historically and contemporarily been found in the pelagic and nearshore areas of east Green Bay. A 2018-2019 survey of the native mussel community in the AOC identified 15 species historically present as compared to evidence of 10 species that may remain today (either observed as living or dead shell) in locations surveyed in Wequiock Creek and Green Bay.[17] It should be noted that this study only observed 8 living native mussel species throughout all locations surveyed in the AOC, and 67% of those observations were dominated by the tolerant species *Pyganodon gradis* and *Quadrula quadrula*. Interestingly, the highest total density of native mussels and evidence of natural recruitment through the presence of juvenile mussels was observed near Renard Island. While this area has benthic substrates that typically support native mussels such as cobble and gravel habitat, native mussels don't appear to be as impacted by dreissenid mussel fouling near Renard Island as they are in other hard substrate areas in the east Green Bay priority area. One reason for this may be that round gobies are found in large abundances near

[12] NEW Water Aquatic Monitoring Program (AMP) data.
[13] Miller et al., 2023. Lower Green Bay Area of Concern Cyanobacterial Harmful Algal Bloom Study 2016 -2020.
[14] Qualls et al. 2013: State of the Bay 2013: http://www.seagrant.wisc.edu/Home/Topics/HabitatsandEcosystems/Details.aspx?PostID=1840
[15] Qualls et al. (2013) cited Kraft, C. 1982. Green Bay's Yellow Perch Fishery. Wisconsin Sea Grant Publication. WIS. SG.82-725
[16] Howe et al., 2018. Lower Green Bay & Fox River AOC Restoration Plan and Path Toward Delisting.
[17] Weinzinger and Kitchel, 2020. Investing Native Mussel Communities Within Nearshore Habitats

Renard Island and may help reduce dreissenid mussel abundances. Another hypothesis is that the velocity of the water draining from the Fox River is quite high on the northern end of Renard Island and may help reduce settling of dreissenid mussel veligers on good native mussel habitat. In general, key management strategies for native mussel re-colonization in the AOC include stream habitat restoration, water quality improvements, and propagation of areas with suitable benthic substrates, hotspots of host fish, appropriate water quality and food resources.

The Eastern Lower Green Bay priority area has two substantial tributaries (Wequiock and Mahon Creek) and several smaller unnamed/named tributaries contributing to **Tributary Open Water** habitat for fish, macroinvertebrates and other priority populations. Though Wequiock and Mahon Creek are not considered impaired, they are impacted by agricultural runoff and rapid urbanization in headwater areas.[18] Stream macroinvertebrate surveys conducted in 2019 found all four tributaries evaluated along the east shore to be in "fair" to "good" condition (Figure 5). However, Mahon Creek is particularly in need of streambank stabilization as soft sediment deposition is occurring over higher quality substrates.[19] As such, improvement of riparian and benthic habitat in Mahon and Wequiock Creek is likely to improve priority populations of Native Unionid Mussels, Stream Macroinvertebrates, and Tributary Fish among others.

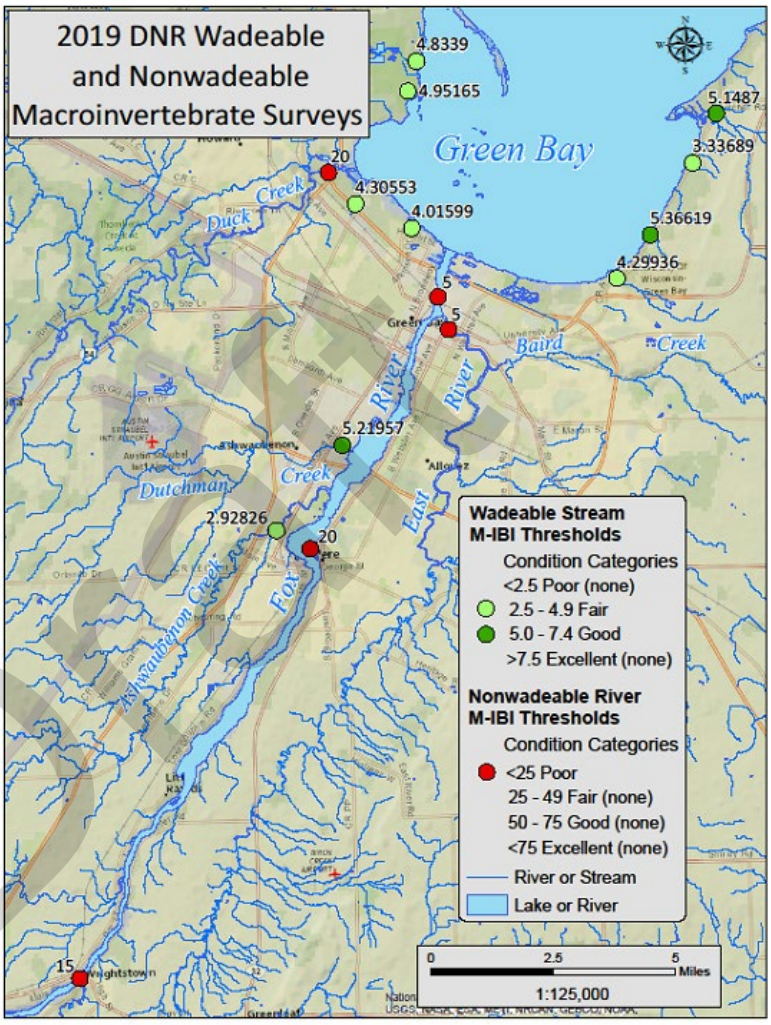


Figure 5. Wadeable macroinvertebrate index of biological integrity (M-IBI) and nonwadeable river M-IBI thresholds for several tributaries in the AOC and its watershed basin.

[18] UWGB, UW Seagrant. 2021. East Shore Lower Green Bay Watershed Plan. 141 pp.
[19] McReynolds, A. 2020. Concordance among fish and macroinvertebrates, environmental filters, and restoration in small tributaries. UWGB Master's Thesis, 95 pp.

Additionally, a recent benthic community and habitat suitability assessment documented improvements in species richness and diversity in benthic communities in the AOC in 2019-2020 when compared to 1978 (Figure 6), though the benthic species present still reflect a eutrophic to highly eutrophic system.[20] Water quality and habitat restoration efforts in the east Green Bay priority area are therefore likely to improve not only the Loss of Fish and Wildlife and Degradation of Fish and Wildlife Populations BUIs, but also the Degradation of Benthos BUI.

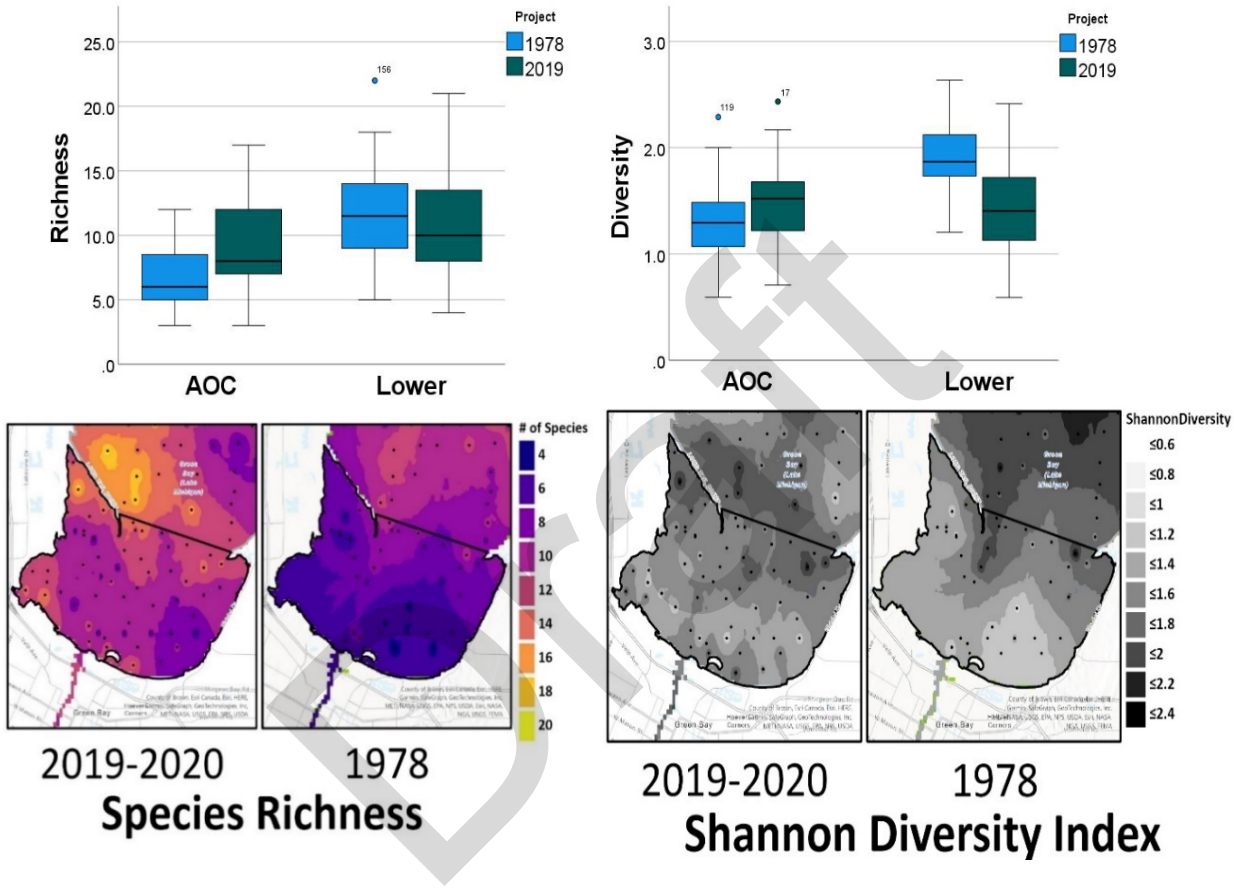


Figure 6. Species richness and Shannon diversity index values for benthic invertebrate collected within lower Green Bay during 2019-2020, compared to 1978 (Markert 1982). Richness values are number of identified taxa per site and diversity the Shannon Diversity index of each site. Boxplots indicate median, quartiles, and range of data (whiskers) with outliers individually labeled. Predictive "heat maps" are inverse distace weighted interpolation results.

[20] Houghton, C. 2022. Benthic Macroinvertebrate Community Assessment of Lower Green Bay. Final Report for GLRI Grant # GL00E02456.

The primary assessment methodology for open water habitats in the AOC is designating important/high-quality habitat areas for spawning, rearing, and feeding for fish and native mussel priority populations (i.e., DHAs). The TAC evaluated **Green Bay Open Water** and **Tributary Open Water** habitats along the east shore to designate as DHAs using USFWS AIS, DNR Fisheries, and DNR Natural Heritage Conservation program data. The group determined that the following DHAs currently occur within the Lower East Green Bay priority area (Table 10):

Table 10. Green Bay Open Water and Tributary Open Water DHAs in the Lower East Green Bay priority area:

DHA	Priority Population Utilization	Points Contributed to Habitat Condition Score
UWGB to Point au Sable Shoreline	Shoreline Fish	0.5
Renard Island	Shoreline Fish Native Freshwater Mussels	0.5
Wequiock Creek	Tributary Fish	0.5
Mahon Creek	Tributary Fish	0.5

Nearshore Habitats

Great Lakes Beach is an important but limited habitat type along the East Shore and across the AOC in general. The primary assessment methodology for this priority habitat is calculating a Beach Metric, which considers what kind of management is completed along a linear stretch of beach (i.e., no management, recreational management, conservation management, or conservation management with recreational restrictions). Most of the Great Lakes Beach habitat occurs near the Bay Beach Amusement Park to UWGB Arboretum shoreline and at Point au Sable, with only the Point au Sable portion managed specifically for fish and wildlife conservation. Keeping Great Lakes Beaches free of invasive species is the biggest management challenge in the AOC. Both zebra and quagga mussels are invasive to the region and common in the open waters along the East Shore, with piles of shells frequently inundating Great Lakes Beach habitat. Common reed (*Phragmites australis*), or *Phragmites,* has also overwhelmed Great Lakes Beach habitat, particularly when Great Lakes water levels are low.

Another important priority habitat that is impacted by fluctuating Great Lakes water levels and encroachment by invasive species includes **Riparian Emergent Marsh, Coastal Emergent Marsh, Submergent Marsh** and **Wet Meadow**. The primary assessment methodology for marsh and wet meadow priority habitats considers both total acreage and floristic quality. Most of the Lower East Shore habitat acreage occurs at Point au Sable along the Wequiock Creek corridor and Point au Sable lagoon, though some small tracts of Coastal Emergent Marsh and Submergent Marsh also exist along the Bay Beach shoreline. Historically, these wetland habitats were much more prevalent along the nearshore areas of the Fox and East Rivers

(Figure 4), but urbanization of the southeastern shoreline has reduced the extent of these habitats significantly. As a result, opportunities for restoration through expansion of these habitat types and improvements to the floristic quality of existing wetland habitat extent largely exist at Pt. au Sable and to a smaller degree, along the shoreline of Bay Beach.

Furthermore, the oak forests that once dominated the East Shore have been largely replaced with agricultural lands, though a large forest corridor remains between the Bay Beach Wildlife Sanctuary and UWGB Cofrin Memorial Arboretum. Remaining forest types include **Hardwood Swamp, Northern Mesic Forest, Other Forest**, and **Southern Dry Mesic Forest** and are impacted by invasive species such as European buckthorn (*Rhamnus cathartica*), Glossy buckthorn (*Frangula alnus*), and Showy bush honeysuckle (*Lonicera x bella*). The primary assessment methodology for forest habitat considers both total acreage and floristic quality. While limited opportunities exist to expand forest habitat, substantial opportunity to improve floristic quality in the current extent of priority forest habitats exists near the Bay Beach Wildlife Sanctuary, UWGB Cofrin Memorial Arboretum and Point au Sable.

The following section contains project narratives for three management actions to be completed along the Lower East Green Bay priority area.

Lower East Green Bay Project Narratives and Recommended Management Actions

Project #1: UWBG Complex

Site Locations and Current Conditions

The UWGB Complex project is comprised of two different project areas – the Point au Sable Natural Area (Point au Sable) and the UWGB Cofrin Memorial Arboretum (Arboretum) (Figure 7). These two project areas are owned by the UW System Board of Regents and managed by the UWGB Cofrin Center for Biodiversity. Currently, research and invasive species management efforts by students and staff occur within both project areas; however, extensive additional work and capacity is needed to restore important habitat within these project areas.

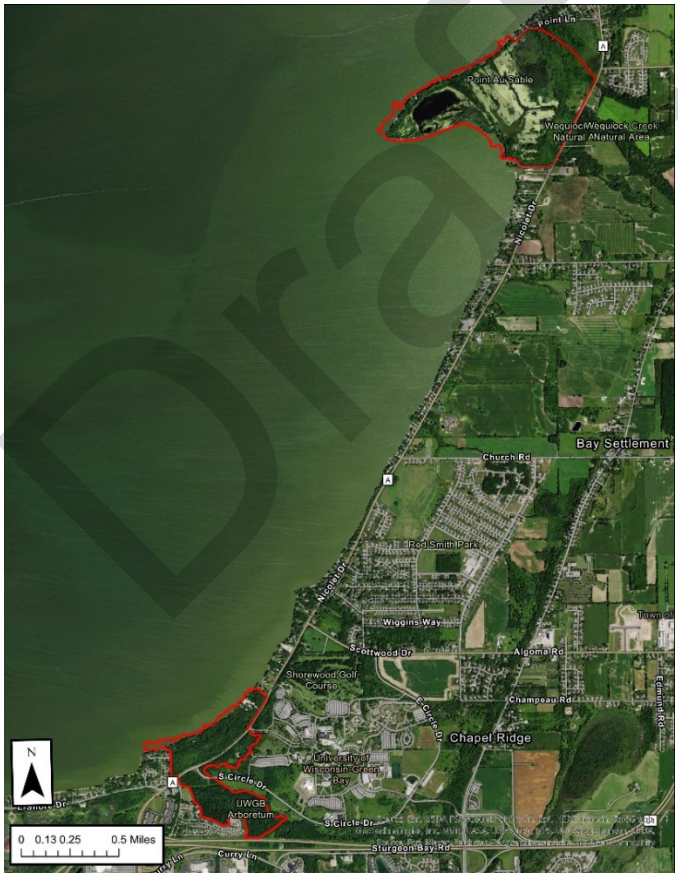


Figure 7. Map of the Point au Sable and Cofrin Memorial Arboretum project site locations in relation to each other. Both project areas are owned and managed by UWGB.

Point au Sable Natural Area[21]

Point au Sable Natural Area is an undeveloped peninsula located on the northeastern terminus of the LGBFR AOC boundary and contains several different priority habitats (Figure 8). It is largest and last remaining coastal wetland on the east shore of the bay portion of the AOC and is also one of the few unmodified estuarine wetlands in the AOC and the entire Lake Michigan ecosystem. Point au Sable, like other Great Lakes coastal wetlands, experiences regular fluctuations in Lake Michigan water levels, which results in drastic shifts in plant communities. During persistent high-water periods, the lagoon fills with water and contains emergent and submergent plants along the edges. During lower water periods, muds flats are exposed through the lagoon and marsh where invasive common reed (Phragmites australis) and hybrid cattail (Typha × glauca) have dominated the lagoon in low water conditions these last two decades.[22]

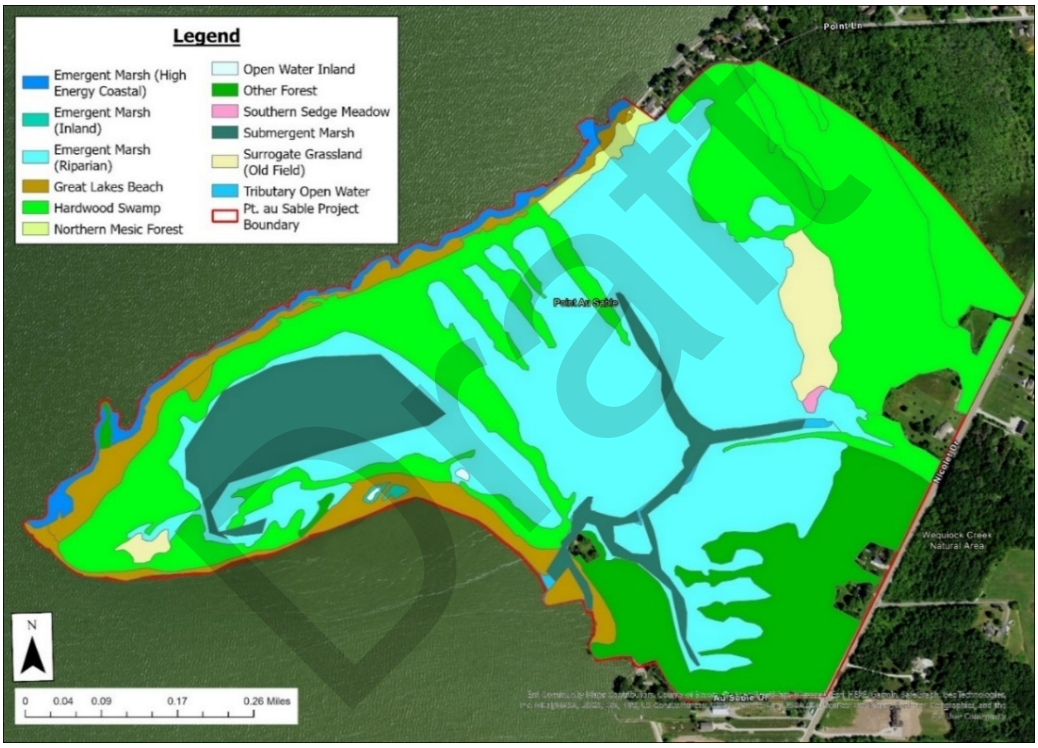


Figure 8. Priority habitats within the Point au Sable portion of the Point au Sable Natural Area and UWGB Arboretum project boundary.

[21] Point au Sable - Natural Areas - UW-Green Bay (uwgb.edu)

[22] Tulbure, M.G., C.A. Johnston, D.L. Auger. 2007. Rapid invasion of a Great Lakes coastal wetland by non native Phragmites australis and Typha. Journal of Great Lakes Research 33:269-279.

Point au Sable attracts thousands of waterfowl that stage in Green Bay before spring and fall migrations. Historically, there were so many waterfowl that the birds would "cover the sun and darken the sky".[23,24,25] Before strict game laws, market and sport hunters shot thousands of waterfowl during periods of high concentrations.[26] Estimates of no less than half a million waterfowl were harvested annually in lower Green Bay during the late 1800s and early 1900s.[27] Unfortunately, duck numbers have reduced significantly since that time due to the decline of ecosystem health in lower Green Bay from pollution and habitat loss. However, Point au Sable still supports rafts of thousands of ducks in the lower bay.[28] Most of the Point au Sable peninsula was privately owned as a duck hunting camp from the turn of the century until the 1990s when the main portion of the Point was donated by local business leader John Rose, Sr. to TNC of Wisconsin including the tip of the Point. These lands were subsequently transferred to UWGB, and several adjoining tracts were added more recently to what is today the Point au Sable Natural Area. UWGB manages the property with John Rose Sr's vision for the site to be held in perpetuity "for the birds." John Rose (the son of John Rose, Sr.) still owns small parcels of the Point but provides UWGB with access for research and land management purposes. Recently, an adjacent 76-acre property was acquired upstream along Wequiock Creek, further expanding the ecological integrity of this landscape.

Officially considered a "Migratory Bird Concentration Site" by the DNR, Point au Sable provides critical habitat for a variety of migratory birds and supports many breeding bird species as well. In fact, some of the highest densities of woodpeckers in North America have been reported at Point au Sable. Over 200 bird species have been recorded across all seasons, including two federal special concern species, five state endangered species, one state threatened species, thirty-five Wisconsin Wildlife Action Plan Species of Greatest Concern, forty-four state special concern species, eight International Union for Conservation of Nature (IUCN) of Nature-listed species as near threatened, large numbers of migratory waterfowl and songbirds, and at least 40 species known to breed at the project area. Some highlighted species include American white pelican (*Pelecanus erythrorhynchos*), Peregrine falcon (*Falco peregrinus*), Snowy egret (*Egretta thula),* and Least bittern (*Ixobrychus exilis*) as well as multiple warbler (Parulidae sp.), thrush (Turdidae sp.), and flycatcher (Tyrannidae sp.) species during migration. Proposed habitat enhancements will provide benefit for several of these migratory and breeding bird species.

Additionally, aquatic habitat enhancements within Wequiock Creek will benefit many fish and native mussel species. A total of 20 fisheries surveys were conducted in the project area from 2016 – 2018 by the USFWS' AIS early detection team, using a variety of gear types (boat electrofishing, gillnet, paired fyke net, beach seine). Combining the results of all gear types, a total of 1637 fish, representing 36 different species were sampled. These were dominated by Gizzard shad (37.8% of total fish caught), White perch (16.9%), Yellow perch (12.8%), Walleye

[23] Draper, L.C. 1903. Recollections of Green Bay in 1816-17. Wisconsin Historical Society, Madison, WI. 1:49-63.
[24] Martin, D. 1913. History of Brown County: past and present. S.J. Clark, Chicago. Vol. 1.
[25] Thwaites, R.G. (ed.) 1959. The Jesuit relations and allied documents. Pagent Book. New York. Vol. 54.
[26] Stiller, D. 1994. Stillers' Duck Camp: A Half Century of Waterfowling on Green Bay. Alt Publishing Co. 178 pp.
[27] Connett, E.V. (ed.) 1949. Waterfowling in the Mississippi Flyway. D. Van Nostrand Co., Inc., New York.
[28] Harris, V.A. 1998. Waterfowl use of lower Green Bay before (1977–78) and after (1994–97) zebra mussel invasion. Master's Thesis, University of Wisconsin-Green Bay, Green Bay, WI. 109 pp.

(6.7%), Emerald shiner (5.7%), Freshwater drum (3.8%), and Round goby (2.9%). Centrarchids represented 3.12% of total catch. Note, although Gizzard shad dominated the total catch, the majority (65.7%) of these came from only 2 electrofishing surveys in the fall of 2018. Additional surveys within Wequiock Creek and adjacent offshore areas of Green Bay have observed over forty species of fish. The mouth of Wequiock is much more ecologically diverse than the mouths of the other east shore tributaries.[29] Yellow perch (the target Tributary Fish species for this site) are often collected around the mouths and nearshore areas of Green Bay tributaries, especially near Wequiock Creek, indicating that this is a particularly important nursery and reproduction area for this species in the AOC. Historically, yellow perch have been an important fishery species for the lower Bay, but their populations have been decimated in the last decade due to many factors including habitat loss, predation, and fishing pressure. Studies suggest that Wequiock Creek is an important site for yellow perch in the lower Green Bay that could contribute to the recovery and persistence of the species. Research also suggests that Wequiock Creek provides important spawning habitat for yellow perch and may also be a source for quality food options and protection from unstable conditions and predators.[30] Lastly, a 2018 to 2019 study completed by DNR evaluated native mussel populations in various locations throughout the AOC, including Wequiock Creek. A total of 4 native mussel species were observed in Wequiock Creek in low abundances, emphasizing the need to pair fisheries habitat enhancements with preferred native mussel species enhancements.[31]

[29] Webster B., P. Baumgart, M. Hoff, J. Noordyk, E. Gnass Giese, L. Terrien, R. Howe, and A. Wolf. 2021. East Shore Lower Green Bay Watershed Plan: Wequiock Creek, Mahon Creek, and Bay Shore Watersheds. Nine key element watershed plan submitted to the Wisconsin Department of Natural Resources and the U.S. Environmental Protection Agency, p. 118.

[30] Koosmann, A.A., 2016. Small Tributaries of Upper and Lower Green Bay, Lake Michigan: A Case for Understanding Their Role in Shaping the Population Dynamics and Structure of Resident and Transient Native and Exotic Fish Communities. UWGB Master's Thesis, 57 pp.

[31] Weinzinger and Kitchel, 2020. Investigating Native Mussel Communities Within Nearshore Habitats. Report included in the Lower Green Bay & Fox River Remedial Action Plan 2019 Update, Appendix E, p. 52.

Point au Sable is a prime location for implementation of management actions as it encompasses 9 of the 18 priority habitats that will determine if removal criteria have been met for the Degradation of Fish and Wildlife Populations BUI. Two of the highest quality submergent marsh communities and one of the highest-quality hardwood swamps within the LGBFR AOC are contained within the project site. Point au Sable also contains Great Lakes beach and Wet Meadow habitats, priority habitats that are rare within the AOC.

Northern mesic forest east of Point Sable along Wequiock Creek corridor (photo credit Bob Howe).

UW-Green Bay Cofrin Memorial Arboretum[32]

The UWGB Cofrin Memorial Arboretum is a 290-acre conservancy encircling the UWGB campus along the eastern shore of the Green Bay that encompasses a range of nearshore and upland habitats (Figure 9). The Arboretum is managed to prioritize protection, research, enrichment, and development of native Wisconsin plant communities and areas of special ecological significance. The site also provides many benefits to the community including six miles of trails open for passive recreation (hiking, biking, cross-country skiing, birdwatching,

[32] UWGB Cofrin Center for Biodiversity Cofrin Memorial Arboretum webpage: https://www.uwgb.edu/cofrin-memorial-arboretum/

etc.). University and high school classes regularly use the Arboretum for lab exercises, field trips, research, and student projects.

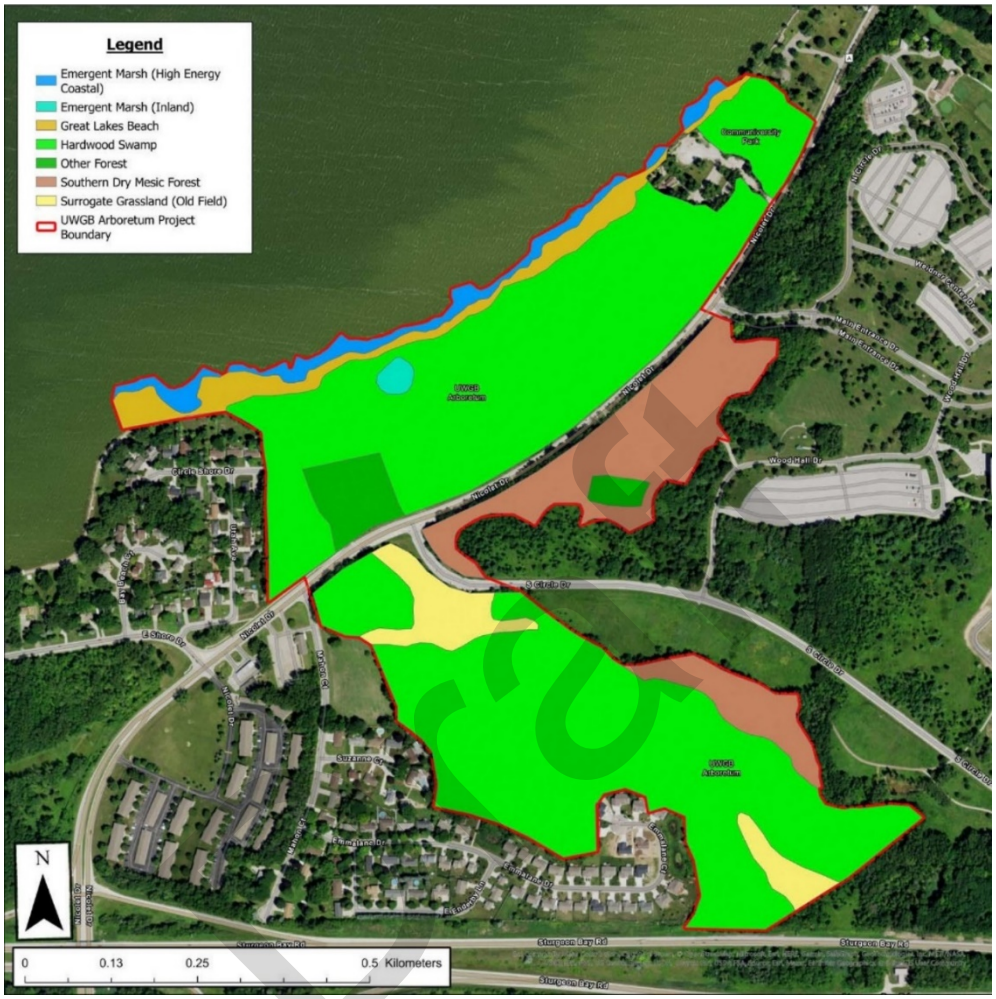


Figure 9. Priority habitats within the UWGB Arboretum portion of the Point au Sable Nature Preserve and UWGB Arboretum project boundary.

When the university first obtained the property from the state of Wisconsin, it was dominated by agricultural fields. However, the property also contained several important features including Mahon Creek and the Niagara Escarpment. Additionally, located on the shore property is the Lambeau Cottage built by Curly Lambeau, who helped establish, played for, and coach the Green Bay Packers football team. The cottage was built for recreational enjoyment of the team from 1941 to 1950. Today, the Lambeau Cottage is owned by the university for public entertainment purposes. After a recommendation from former Chancellor Edward Weidner in 1971, an endowment was established by the John Cofrin Family to pay for a six-mile hiking trail system, enhance the natural communities, and purchase additional adjacent property to develop

what is now known as the Cofrin Memorial Arboretum in order prevent future establishment on the property. The endowment also funds student research opportunities and ongoing management to preserve the ecological integrity and biodiversity of the arboretum lands. Numerous ecological restoration projects have occurred within the Arboretum during the past 50 years.

Restored grassland at the Keith White Prairie (photo credit Kathryn Corio).

An estimated 45 mammal species, 200 resident and migratory bird species, and significant populations of native amphibians, reptiles, amphibians, and insects utilize the Arboretum for food and shelter. The physical proximity to the Bay Beach Wildlife Sanctuary and Joliet Park contributes to a corridor for ease of wildlife movement in lower Green Bay.

The Cofrin Memorial Arboretum is another prime location for implementation of management actions as it encompasses 11 of the 18 priority habitats that will determine if removal criteria have been met for the Degradation of Fish and Wildlife Populations BUI. Furthermore, the Arboretum contains Great Lakes Beach habitat, a priority habitat that is rare within the LGBFR AOC.

Aside from Point au Sable and the Cofrin Memorial Arboretum being ecologically important sites, both sites are culturally significant sites to First Nations people. Indigenous people have long used the lower Bay and Fox River for trading, hunting, and settlements. Point au Sable and neighboring areas are located within the ancestral homelands of the Ho-Chunk and Menominee

people, which are referenced in their creation stories, and hold importance to Potawatomi and Oneida people. According to Indigenous oral histories and other historical documents, areas specifically within and adjacent to Point au Sable were used heavily by First Nations people, including the Menominee, Potawatomi, and Ho-Chunk people for settlements. Additionally, First Nations' campsites and burial mounds were found within the present-day campus property in the 1840s and archaeological surveys performed within the Arboretum in the 1970s identified artifacts significant to the early Late Woodland period.[33,34]

Project Scope and Priority Habitats and Populations Benefited

Priority Habitats

Proposed habitat improvements within the Point au Sable Natural Area and UWGB Arboretum project are anticipated to provide direct benefits to 11 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 11 shows priority habitats have been mapped within the Pt. au Sable and UWGB Arboretum project boundary and how baseline and post-implementation BUI condition scores were derived.

Table 11. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundary	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Coastal Emergent Marsh	7.98 x 0.65	**5.19**	7.98 x 0.75	**5.99**
Submergent Marsh	23.44 x 0.50	**11.72**	23.44 x 0.65	**15.24**
Riparian Marsh	97.62 x 0.50	**48.81**	62.62 x 0.65	**40.70**
Inland Emergent Marsh	0.84 x 0.40	**0.38**	0.84 x 0.65	**0.54**
Wet Meadow	1.80 x 1.00	**1.80**	35.2 x 0.65 + 1.80	**24.68**

[33] Dorney, J.R. 1975. The vegetation pattern around Green Bay in the 1840s as related to geology, soils and land use by [redacted] with a detailed look at the Townships of Scott, Green Bay and Suamico. Senior Distinction Project. University of Wisconsin-Green Bay, Green Bay, Wisconsin. 142 pp.
[34] Mason C.I. "Archaeological Survey of Proposed Bicycle Path," 1975. UW-Green Bay Facilities Management Records (UWGB Series 36, Box 12, Folder 10). UW-Green Bay Archives, University of Wisconsin Green Bay, Green Bay, WI.

Hardwood Swamp	167.84 x 0.40	**67.14**	167.84 x 0.65	**109.10**
Northern Mesic Forest	1.66 x 0.40	**0.66**	1.66 x 0.65	**1.08**
Southern Dry Mesic Forest	15.65 x 0.8	**12.52**	15.65 x 0.9	**14.09**
Other Forest	32.80 x 0.5	**16.40**	32.80 x 0.65	**21.32**
Old Field Grassland	11.37	**11.37**	11.37	**11.37**
Quantity (acres or km) x Management Based Metrics				
Great Lakes Beach	3.4km X 0.25B	**0.85**	3.4km x 1.0B	**3.40**
Inland Open Water	0.15 x 0.5B	**0.08**	0.15 x 0.75B	**0.12**
Designated Habitat Area Based Metrics				
Tributary Open Water	0.50 + 0.50 Tributary Fish	**1.00 Tributary Fish**	0.50 + 0.75 Tributary Fish 0.5 Mussels	**2.75**

Much of the project scope will focus on vegetation management activities to improve floristic quality in existing habitat acreages/lengths (e.g., removal of invasive species, addition of higher quality native species). These activities will improve the BUI condition score for all Quantity x Quality and Quantity x Management based priority habitat metrics. Additionally, increase in high-quality Wet Meadow habitat from 0.24 to 35.2 acres at Point au Sable is a primary goal, as only three other project locations have the capacity to influence the BUI condition score for this priority habitat. To accomplish this, UWGB land managers have proposed converting some low-quality riparian marsh to expand higher quality wet meadow habitat, resulting in a net decrease in the Riparian Emergent Marsh BUI condition score for this project.

Another primary goal for this project is to improve riparian habitat along Wequiock and Mahon Creeks. Both Wequiock and Mahon Creek were determined through consultation with local experts and available data to provide important, but degraded habitat within the 1km AOC buffer. A total of 0.5 DHA Tributary Open Water points was established as a baseline for existing Tributary Fish habitat in both Wequiock and Mahon Creek. In Wequiock Creek, an additional 0.5 DHA points of Tributary Fish and Native Freshwater Mussel habitat will be added after implementation of invasive submerged aquatic species removal, woody habitat additions, and substrate improvements for a total DHA score of 1.50. Improvements to Mahon Creek would include the reduction of overland flow, stabilization of eroding banks, fixing a breach in the main channel, woody habitat additions, addressing potential fish passage issues, and substrate improvements, resulting in an additional 0.75 DHA points, for a total of DHA score of 1.25. This could result in a total Tributary Open Water DHA score of 2.75 when the project is fully implemented, though additional verification monitoring will be required to demonstrate utilization by target species.

Priority Populations

Proposed habitat improvements are anticipated to benefit at least 18 of the 22 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 12 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 12. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	**Metric Type**	**Metric Assessment Methodology**	**Data Source**
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	UWGB
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Breeding Coastal Birds	Count-Based	Number of sites breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	UWGB
Breeding Shorebirds	Count-Based	Number of sites breeding documented for Killdeer + Spotted Sandpiper + Rare Species (Piping Plover, Wilson's Phalarope, American Avocet, etc.) to generate Breeding Shorebird (Sb) Metric	UWGB
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Stream Macroinvertebrates	Count-Based	Citizen Biotic Monitoring Index in Mahon and Wequiock Creeks	DNR + Citizen Science
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood,	UWGB + Citizen Science

		Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	
Wetland Terns	Count-Based	Number of nesting colonies at least 1 km apart from each other	DNR + UWGB
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Freshwater Unionid Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Tributary Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	UWGB

As described in the Metrics and Monitoring Plan, some DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 13 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 13. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	**Current DHA Points**	**New DHA Points**	**Post-Implementation Total DHA Points**
Bats	2.0	0.0	**2.0**
Coastal Terrestrial Macroinvertebrates	1.0 Upland	2.0 Great Lakes Beach 1.0 Marsh/Sedge Meadow 1.0 Upland	**4.0**
Migratory Landbirds	2.0	0.0	**1.0**
Migratory Shorebirds	1.0	1.0	**2.0**

Anticipated Progress Toward Overall Fish and Wildlife BUI Removal Criteria

Taken in whole, the UWGB Complex project represents an 18% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat BUI and a 13% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

DNR will provide grant oversight and request GLRI funding to subaward to UWGB Cofrin Center for Biodiversity to solicit requests for proposals to design, implementation, and maintenance/monitoring services for this project.

DNR, UWGB and the selected contractor will collaborate as a Project Management Team, and will solicit technical expertise from a number of partners, who may include but are not limited to: USFWS, UW Seagrant, Audubon Great Lakes, Ducks Unlimited (DU), TNC, Northeast Wisconsin Land Trust, Menominee Nation, Ho-Chunk Nation, Potawatomi Nation, Oneida Nation, etc.

In addition to soliciting technical expertise, the Project Management Team will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase. The Project Management Team intends to involve landowners adjacent to Point au Sable during the planning and design phase.

Project Timeline and Estimated Cost

An initial GLRI proposal to support planning and design for this project will be developed in 2023 and submitted in FFY2024; a second proposal will be developed in 2024 to secure funding for both the implementation and maintenance phases beginning in 2025 (Table 14). The total estimated cost for this project is $3,000,000 with cost estimates generated in consultation with GEI Consultants.

Table 14. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2024	2025	2026	2027	2028	2029	2030
Planning/Design	$400,000						
Implementation		$2,600,000					
Maintenance							

This GLRI request will build on many years of restoration efforts at Pt. au Sable and the UWGB Arboretum, including:

- Point au Sable acquisition funded by the National Resource Damage Assessment (NRDA)
- Cofrin Family Endowment supporting conservation, maintenance, improvement, and research within the Cofrin Memorial Arboretum
- Cofrin Student Research Grant projects have taken place at both sites over the last 2+ decades with student work focused on birds, fish, plants, and invertebrates

- Nine-key element plan for Wequiock and Mahon Creeks, referred to as the East Shore Lower Green Bay Watershed Plan
- National Fish and Wildlife Foundation (SOGL) grants to fund Phase I and II restorations at Point au Sable Nature Preserve ($280,360)
- Long-term bird monitoring at Point au Sable
- Removal of the Nicolet Drive fish passage barrier in 2019
- Computerized water-level monitoring stations implemented in Point au Sable lagoon and the Wequiock Creek outlet
- Adjacent Wequiock Creek Natural Area restoration (under planning)
- Ongoing archaeological surveys performed by Dr. David Overstreet

Project Maintenance

The Point au Sable Nature Preserve and UWGB Cofrin Memorial Arboretum are both UWGB managed properties, therefore, they are committed to managing and maintaining AOC-initiated restoration activities at the project sites in the long-term.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

Since both sites are owned by the University, educational opportunities are already offered to students and the community. The team will explore opportunities to expand educational opportunities through this project in partnership with the University including workshops, signage/installments, tours, presentations, and more. There also may be opportunity to utilize grant money to involve University classes and/or even employ student staff to help with management activities within the project sites.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the Point au Sable Nature Preserve and UWGB Arboretum project is not within a census tract that is identified as disadvantaged.

As mentioned above, Point au Sable and neighboring areas are located within the ancestral homelands of the Ho-Chunk and Menominee people, which are referenced in their creation stories, and hold importance to Potawatomi and Oneida people. Historically, Indigenous people from multiple Tribes used Point au Sable and the Arboretum for a variety of purposes, such as hunting, campsites, and settlements as stated above.[35] The Project Team aims to recognize the cultural significance of these project areas and ensure they are preserved for future generations. The UWGB Project Team will reach out to Menominee, Ho-Chunk, Oneida, and Potawatomi Nations and gauge their interest in partnering on this project. Specifically, in partnership with Tribal representatives, the Team aims to explore ways to honor Tribal cultural significance and/or opportunities for outreach and education specific to the Indigenous history of the sites.

Climate Change

The project team will review Adaptation Strategies and Approaches specified in The Coastal Adaptation Menu to promote resiliency of management actions under a changing climate.

During the project design phase, updated rain forecast and design storm information from WICCI and the Wisconsin Rainfall Project will be used to design storm criteria to ensure long-term resiliency of in water and nearshore habitat restoration and guide long-term operation and maintenance plans.

[35] Dorney, J.R. 1975. The vegetation pattern around Green Bay in the 1840s as related to geology, soils and land use by [redacted] with a detailed look at the Townships of Scott, Green Bay and Suamico. Senior Distinction Project. University of Wisconsin-Green Bay, Green Bay, Wisconsin. 142 pp.

Project #2: Joliet Park Shoreline and Fish Reef Restoration

Site Location and Current Conditions

The Joliet Park project area encompasses 5-acres of public land located on Nicolet Drive along the eastern shore of the Green Bay, extending north from Cottage Hill Drive and south from Church Road (Figure 10). The park represents one of the few public spaces on the eastern shore of the bay and includes about 300 meters of some of the only walkable shoreline on the East Shore. The lack of development along the Joliet Park shoreline makes this area unique amongst the rest of the east shore which is primarily developed for residential purposes. Joliet Park is managed as a passive greenway, meaning it remains primarily in its natural state therefore providing ample habitat for wildlife, making the site popular among duck hunters and anglers.

Figure 10. Priority habitats within the Joliet Park project boundary.

The nearshore area adjacent to Joliet Park currently provides important fishery habitat, particularly for walleye. Historically, gravel aggregate extended approximately 55' from the shoreline, with another 30' of 2" – 6" limestone aggregate placed in late 1999/early 2000 along the shoreline for walleye spawning habitat in partnership with Walleyes for Tomorrow (Figure 11). Though the existing reef currently provides some opportunity for angling walleye during the ice fishing season, it likely needs to be repaired and may need to be extended to improve accessibility during low-water levels.

Figure 11. Aerial imagery of Joliet Park and the nearshore area shows the walleye reef shortly after construction (April 2000, 176.14 m monthly average water level – left image) and more recently (May 2020, 177.38 monthly average water level – right image). The left and right image reflect a change of over 1.2 m/4 ft in water levels. Imagery retrieved from the Brown County "Brown Dog" Geographic Information System (GIS).

Results from a study conducted from 2018 - 2020 assessing Benthic Community and Habitat Suitability in partnership with UWGB identified hard substrates nearshore around 6 – 7 ft contours transitioning to primarily sandy substrates offshore of Joliet Park (Figure 12).[36] These results indicate the need increase hard substrate availability offshore beyond these contours to create more suitable habitat accessible to shoreline fish during low water periods.

[36] Houghton, C. 2022. Benthic Macroinvertebrate Community Assessment of Lower Green Bay. Final Report for GLRI Grant # GL00E02456.

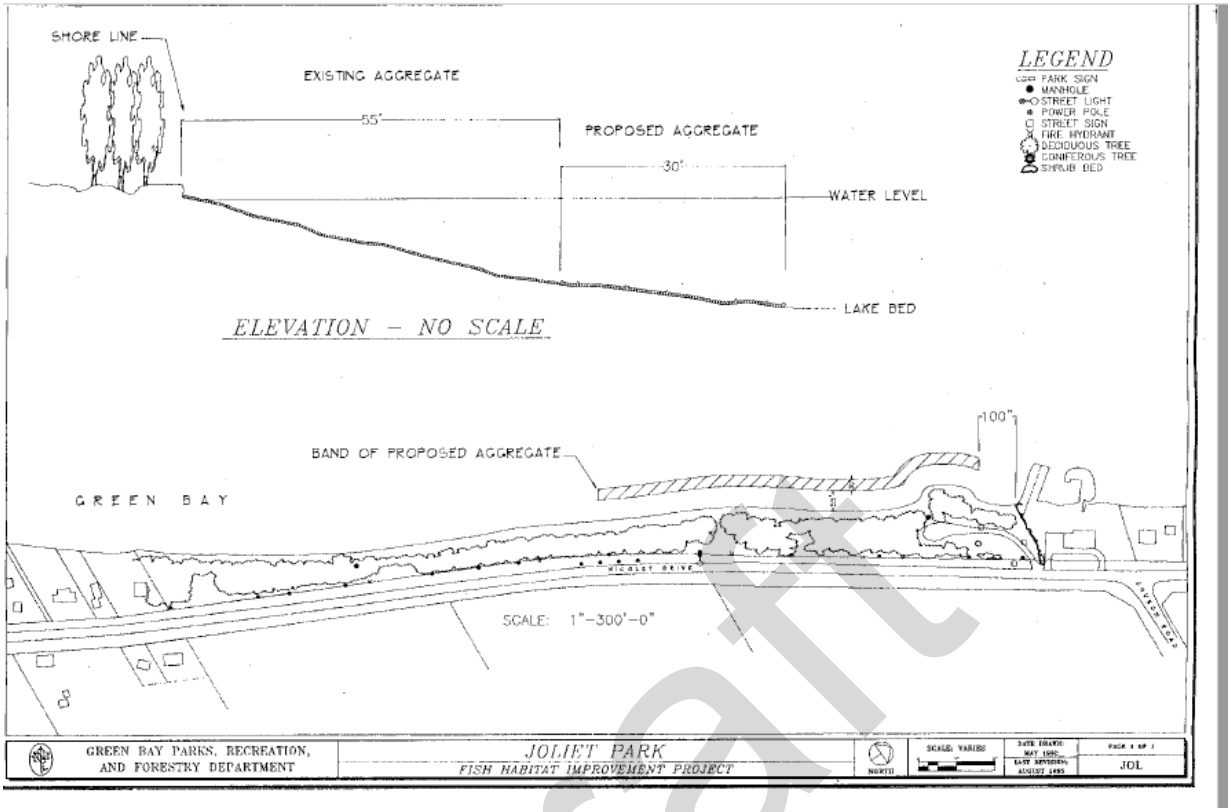


Figure 12. Figure included in permit application to DNR to complete the walleye spawning reef improvement project in late 1999/early 2000. Limestone aggregate (2" – 6" diameter was spread in a band on the ice approximately 30 ft wide x 1000 ft long x 1 ft deep. The reef was originally placed to extend out to the 580' water depth contour.

While the spawning reef was constructed to attract primarily walleye, several fisheries surveys conducted from 2016 – 2018 by the USFWS' AIS early detection team identified a total of 1448 fish representing 21 different species utilizing this shoreline. These were dominated by gizzard shad (41% of total fish caught), white perch (32%) and yellow perch (10%) followed by freshwater drum (6%), walleye (3%), and white bass (2%).

Out of the 14 surveys, no smallmouth bass were detected, though few fishery surveys observe this species throughout the lower bay portion of the AOC. As a result, smallmouth bass habitat improvements were identified by the TAC as a goal for several fishery management actions in the lower Green Bay, including at Joliet Park. Another species of interest for potential habitat improvements near Joliet Park include Lake Whitefish, as populations are rebounding but very little is known about successful spawning locations in the lower bay.

In addition to being an important fish spawning location, a recent freshwater unionid mussel study identified 15 historically present species in the AOC portion of the lower bay, though 10

total species (both living and dead shell) and 8 living species were observed in 2018 and 2019.[37] While historic records identified several species on the east shore of Green Bay, the coarser substrates typic of this area tend to support zebra mussel proliferation and high dead shell abundances of freshwater unionid mussels were observed. Evidence of dreissenid mussel colonization can be seen on shorelines throughout the east shore, where large piles of dead dreissenid mussel shells accumulate and can restrict beach access. However, stable abundances of freshwater unionid mussels were found to occur in primarily soft but stable sediments throughout the AOC during this study. This may be the result of freshwater unionid mussels being about to burrow into those substrates and physically remove attached dreissenid mussels. As a result, Joliet Park is a recommended location to attempt altering small patches of substrates amongst host fish habitat that can support freshwater unionid mussels and attempt propagation efforts.

Though most of the project scope focuses on in-water features to improve open water habitat in the Green Bay (e.g., Green Bay Open Water) for fish and native mussels, the nearshore area of Joliet Park supports an early successional forest (e.g., Other Forest). However, invasive species such as Amur honeysuckle (*Lonicera macckii*), Motherwort (*Leonurus cardiaca*), Garlic mustard (*Alliaria petiolata*), Common buckthorn (*Rhamnus cathartica*) and Glossy buckthorn (*Frangula alnus*) have encroached on much of this habitat and may be contributing to erosion as these understory species shade can shade out native species that stabilize the shoreline.

Lastly, while Joliet Park has historically been managed as a passive greenway and provides a unique public recreational opportunity along the East Shore of Green Bay, improvement of the parking area, walking trails, and shoreline access is needed.

Project Scope and Priority Habitats and Populations Benefited

Priority Habitats

Proposed habitat improvements within the Joliet Park project are anticipated to provide direct benefits to 2 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 15 shows priority habitats have been mapped within the Joliet Park project boundary and how baseline and post-implementation BUI condition scores were derived.

[37] Weinzinger and Kitchel, 2020. Investigating Native Mussel Communities Within Nearshore Habitats. Report included in the Lower Green Bay & Fox River Remedial Action Plan 2019 Update, Appendix E, p. 52.

Table 15. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundary	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Other Forest	5.43 x 0.50	**2.71**	5.43 x 0.65	**3.53**
Designated Habitat Area Based Metrics				
Green Bay Open Water	0.50 Shoreline Fish	**0.50**	0.50 + 1.00 Native Freshwater Mussels + Shoreline Fish	**2.0**

Much of the project scope will focus on vegetation management activities to improve floristic quality in existing Other Forest priority habitat (e.g., removal of invasive species, addition of higher quality native species).

The shoreline from UWGB to Pt. au Sable were determined through consultation with local experts and available data to provide important fish spawning habitat, particularly near Joliet Park. A total of 0.5 DHA points was established as a baseline for Joliet Park, with the potential to increase by 1.0 DHA points for Shoreline Fish and 0.5 DHA points for Native Freshwater Mussels through substrate improvements for a total DHA score of 2.0 for Joliet Park.

Priority Populations

Proposed habitat improvements are anticipated to benefit at least 4 of the 22 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 16 lists these priority populations, the primary metric type, assessment

methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 16. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	Metric Type	Metric Assessment Methodology	Data Source
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Freshwater Unionid Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Shoreline Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult (Smallmouth Bass), Juvenile/YOY (Smallmouth Bass or Walleye) and Rare/Sensitive target species present	DNR

Anticipated Progress Toward Overall Fish and Wildlife BUI Removal Criteria

If implemented, the Joliet Park project represents a 3.1% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 3.5% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

DNR will request GLRI funding to subaward to the City of Green Bay Parks Department to solicit requests for proposals to design, implementation, and maintenance/monitoring services for this project.

DNR, the City of Green Bay Parks Department, and the selected contractor will collaborate as a Project Management Team, and will solicit technical expertise from a number of partners, including but not limited to: Green Bay Conservation Corps, UWGB, USFWS, Walleyes for Tomorrow, Titletown Muskies, DU, etc.

In addition to soliciting technical expertise, the Project Management Team will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase. This will include groups such as Nicolet Drive Neighborhood Association, Green Bay School District, Green Bay Duck Hunters Association, etc.

Project Timeline and Estimated Costs

An initial proposal to support planning and design for this project will be developed in 2022 to secure funding in 2023; a second proposal will be developed and submitted in late 2024 to secure funding for both the implementation and maintenance phases beginning in 2025 (Table 17). Anticipated cost for planning/design is $200,000, with an estimated $2,000,000 needed for the implementation and maintenance phases.

Table 17. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2023	2024	2025	2026	2027	2028
Planning/Design	$230,000					
Implementation		$1,770,000				
Maintenance						

This work will build on previous investments at Joliet Park, including:

- Walleyes for Tomorrow funded the installation of a 1,000 x 30 ft spawning reef in the nearshore area adjacent to Joliet Park
- Green Bay Conservation Corps mapped hazards, invasive species, and potential trail routes throughout Joliet Park
- Invasive species removal efforts lead by Green Bay Conservation Corps

Project Maintenance

Post-project invasive species removal activities will be coordinated by the City of Green Bay Parks Department in partnership with the Green Bay Conservation Corps within the 5-acres park footprint. In-water features are not anticipated to require maintenance activities.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

Joliet Park is within walking distance from the UWGB campus and Red Smith K-8 School (both within <1.5 miles of Joliet Park). Both schools are considerably ethnically diverse.[38] Not only will Joliet Park project efforts provide students of all backgrounds a space to study, relax, and connect with the resource – future project phases can provide environmental education

[38] https://wisedash.dpi.wi.gov/Dashboard/dashboard/22275

opportunities. Students will be encouraged to participate in public outreach and volunteer events coordinated in partnership with Green Bay Conservation Corps. Outreach events are an important approach to teaching the younger generation how to be environmental advocates, adding to the number of future problem-solvers and decision-makers.

Environmental Justice

According to the EJScreen and Justice40 (CEJST) tool, Joliet Park is not within a census tract that has been identified as disadvantaged. However, this project provides a unique opportunity to improve accessibility to the Green Bay shoreline and minimize environmental hazards, provide the community with a high-quality greenspace suitable for a variety of recreational uses, and expand upon environmental education opportunities within the Green Bay area.

Joliet Park provides the community with some of the only public, walkable shoreline areas present along the Lower East Shore of Green Bay. Project efforts to improve shoreline accessibility throughout the park would further promote equitable distribution of environmental benefits and protection from environmental hazards. To accomplish this, bank erosion will be mapped and resilient methods for stabilization will be incorporated into the project design. The anticipated outcome is to provide the public safe and easy access to the shoreline and throughout the park's walking trails. These project elements, along with proposed habitat improvements, also ensure that a high-quality greenspace is available to the broader community. Project efforts are anticipated to create a space that supports the physical and mental health of community members and provide better opportunities for them to connect with the environment.

Climate Change

During the project design phase, updated rain forecast and design storm information from WICCI and the Wisconsin Rainfall Project will be used to design storm criteria to ensure long-term resiliency of in water and nearshore habitat restoration and guide long-term operation and maintenance plans.

Climate change poses a threat to elements in the project scope including spawning reef accessibility during low-water levels, shoreline impacts from increased water levels and wave action (especially after the removal of invasive species), and vegetation tolerance with shifting annual and seasonal temperatures as well as increased wave action.

Project #3: Bay Beach Wildlife Sanctuary and Nearshore Enhancements

Site Location and Current Conditions

Bay Beach Wildlife Sanctuary

The Bay Beach Wildlife Sanctuary (BBWS) is a 500-acre urban wildlife refuge along the southeastern shoreline of the bay of Green Bay and is managed by the City of Green Bay Parks Department. In 1929, the City purchase 250 acres adjacent to the Bay Beach Amusement Park with the intention of creating a golf course, though concerned citizens developed a concept for a wildlife refuge with guidance from Aldo Leopold in 1935.

In response, the City Park Board granted 5 acres to use for waterfowl, and the first pond at the refuge was hand dug and stocked with injured waterfowl. From 1938 to 1941, the lagoon system was expanded to a 55-acre footprint, with more ponds and landscape islands incorporated along the shoreline. In 1941, the City Park Recreation and Forestry Department assumed the management of the refuge and named it the BBWS. In 1980, the BBWS acreage was doubled with the purchase of 300 additional acres, and Phase I and II Master Plans were completed with the support of Wisconsin Coastal Zone Grants.

Since then, a trail system and several indoor and outdoor animal exhibits and other infrastructure projects have been completed at the BBWS that support a nature-based recreational and educational resource for the community. These include the Outdoor Adventure for Kids (OAK) Learning Center nature-based 4-year-old kindergarten program, hands-on education programs for community groups and schools, public programs and camps, facility rentals, and self-guided opportunities. The BBWS also provides a Wildlife Rehabilitation Program for sick, injured, or orphaned animals and partners with the R-PAWS rehabilitation organization which trains volunteers to rehabilitate animals in their homes and release these animals when appropriate.

Today, the BBWS boasts a large inland nearshore lagoon system that supports hundreds of bird species, nearly 400 acres of hardwood swamp, several inland emergent marshes, and large tracts of old field habitat (Figure 13). The BBWS is considered a Wisconsin Important Bird Area (WIBA) and integral stopover and concentration site for migratory birds in both spring and fall, with 240 species recorded on eBird.[39] Additionally, the BBWS 28-year goose banding program is one of the longest running in the state.

As with many urban sanctuaries, invasion by exotic species is one of the most pressing management obstacles. However, the Friends of the Wildlife Sanctuary is a non-profit group initiated in 1978 that supports the BBWS interns, staff, and volunteers to remove invasive species every year among other efforts.

[39] https://ebird.org/hotspot/L159721

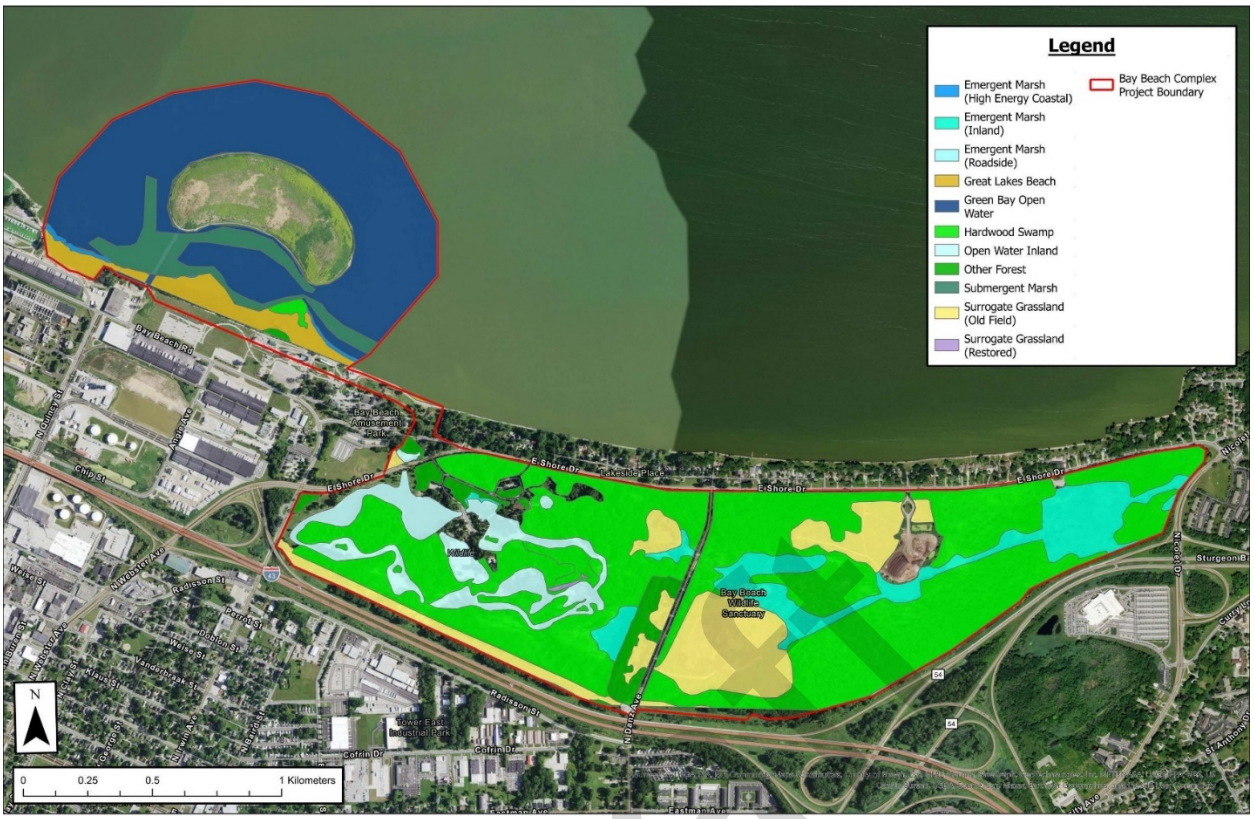


Figure 13. Priority habitats within the Bay Beach Complex project boundary.

Renard Island Nearshore Enhancements

Renard Island is a 55-acre manmade confined disposal facility (CDF) located near the southeastern shoreline of Green Bay and the mouth of the Fox River. In 1977, Brown County and the USACE implemented a memorandum of agreement to construct the CDF for PCB contaminated sediment dredged from the navigation channel in Green Bay and the Fox River on a legislative lakebed, granted by the State of Wisconsin to Brown County. From 1978 to 1997, approximately 2.7 million cubic yards of dredged sediments were placed on the island. The island remained uncapped until 2010 when Brown County received a GLRI Focus Area 1 grant to place several hundred thousand cubic yards of clean dredged material as a final cap, meeting the requirements of the DNR-approved Closure Plan. As part of the closure plan process, USACE built a causeway to access the island. In 2015, DNR approved the final cap and in 2017 USACE transferred ownership of the island and causeway to Brown County.

With the transfer of ownership from USACE, Brown County embarked on an effort to explore end-use options for the island. In 2017, Brown County received a Wisconsin Coastal Management Program grant with funds matched from McDonald Lumber, NEW Water, and Wisconsin Public Service (WPS) to complete a stakeholder driven Master Plan for Renard

Island's end use. After 18 months of public input and several design charette meetings, the final **Renard Island Strategic Master Plan** was adopted by the Brown County Board in 2019.

The final master plan includes five overarching themes, one of which is expanded habitat for fish and wildlife. Currently, the footprint of the island is largely comprised of low-quality herbaceous and shrub species, though the surrounding in-water areas provide some small, but high-quality habitat areas for fish, mussels, and colonial nesting birds. The Master Plan recommended wetland, beach, cobble enhancements, and vegetative buffers along the shorelines of the island, with prairie and oak savanna-type habitat on the island. To date, none of these recommendations have been implemented, as there is a need for coordination and funding to move these ideas forward.

Additionally, the Fox River NRDA supported a 30% design for a restoration project immediately to the west of the Renard Island footprint along the South Bay Marina shoreline that could provide significant fishery habitat enhancement at an existing walleye reef, creation of new fish and wildlife habitat, shoreline protection, and provide improved public access to Green Bay. Concerns around the impact that these rock reef enhancements would have on water quality and the need to model hydrodynamics in this area has paused progress on this project.

The TAC considered these concurrent strategic planning and design efforts in the development of this management action, and the intention for this portion of the project is to bring stakeholders together to develop a shared, broader vision for habitat restoration in this area. A major goal that cross cuts all planning and design efforts is to improve habitat for shoreline fish, including smallmouth bass which are the primary target species for this site. USFWS AIS early detection team identified 4001 fish representing 36 different species during surveys conducted from 2016 – 2018. These were dominated by spottail shiner (36%), yellow perch (20%), and gizzard shad (12%) followed by trout perch and emerald shiner (5%), round goby (4%), walleye (3%), common carp (3%) and bluegill (3%). Centrachids represented 8% of the total catch. Of note, 76% of yellow perch were observed during fall surveys, 72% of spottail shiners were observed in one paired mini fyke net in 2016, and smallmouth bass represented only 2% of the total catch and were evenly distributed across survey sites.

Another population that could significantly benefit from in-water habitat creation and enhancement are freshwater unionid mussels. Surveys in 2018 and 2019 in the AOC observed the highest diversity of native mussels near Renard Island, with some evidence of sustained natural recruitment.[40] Additionally, zebra mussels were found to be heavily grazed in this area, which may release native mussels from that significant stressor. As a result, a major goal for this management action is to expand and augment freshwater unionid mussel habitat near Renard Island and consider propagation of additional species historically found in the AOC. These efforts will be paired with host fish habitat enhancements in addition to the habitat enhancements targeted for smallmouth bass and other shoreline fish.

Project Scope and Priority Habitats and Populations Benefited

[40] Weinzinger and Kitchel, 2020. Investing Native Mussel Communities Within Nearshore Habitats.

Priority Habitats

Proposed habitat improvements within the BBWS and Nearshore Enhancements project are anticipated to provide direct benefits to 11 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 18 shows priority habitats have been mapped within the project boundaries and how baseline and post-implementation BUI condition scores were derived.

Table 18. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundaries	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Coastal Emergent Marsh	3.50 x 0.65	**2.28**	3.50 x 0.65	**2.63**
Submergent Marsh	35.35 x 0.50	**17.68**	35.35 x 0.65	**22.98**
Inland Emergent Marsh	57.06 x 0.45	**25.68**	57.06 x 0.65	**37.09**
Wet Meadow	0.00 x 0.50	**0.00**	20.00 x 0.65	**13.00**
Hardwood Swamp	323.38 x 0.40	**129.35**	323.38 x 0.65	**210.20**
Other Forest	28.49 x 0.50	**14.25**	28.49 x 0.65	**18.52**
Old Field Grassland	84.00	**84.00**	64.00	**64.00**
Restored Grassland	0.00 x 0.50	**0.00**	20.00 x 0.65	**13.00**
Quantity (acres or km) x Management Based Metrics				
Great Lakes Beach	1.00km X 0.25B	**0.25**	1.00km x 0.50B	**0.50**
Inland Open Water	20.00 x 0.50OW	**10.00**	20.00 x 0.75OW	**15.00**
Designated Habitat Area Based Metrics				
Green Bay Open Water	0.50 + 0.50 Shoreline Fish + Native Freshwater Mussels	**1.00**	0.75 + 1.00 Shoreline Fish + Native Freshwater Mussels	**2.75**

Much of the project scope will focus on vegetation management activities to improve floristic quality in existing habitat acreages/lengths (e.g., removal of invasive species, addition of higher quality native species). These activities will improve the BUI condition score for all Quantity x Quality and Quantity x Management based priority habitat metrics. Additionally, a primary goal

is to add higher quality Wet Meadow habitat by converting some low-quality Inland Emergent Marsh, and to add higher quality Restored Grassland by converting some low-quality Old Field Grassland.

A primary goal for the BBWS area is to improve shoreline and in-water habitat at the Manger Lagoon at BBWS. At present, much of the shoreline is riprapped and a goal is to create a more naturalized and accessible shoreline, as these lagoons are included in the Urban and Community Fishing Program which have a year-round season accessible to juveniles under 15 years of age and younger and disabled anglers. Manger Lagoon is currently considered to have "Moderate Quality" Open Water metric, indicative of some higher quality shoreline and submerged aquatic vegetation (SAV), and evidence of higher quality fish or wildlife utilization (e.g., waterfowl, snails/amphiponds/blackfly larvae, shiner spp./centrarchids/percids/escocids, etc.). The goal is to improve shoreline and in-water habitat to a "Moderately High Quality" Open Water metric, indicative of higher quality shoreline, SAV, and fish and wildlife utilization (e.g., anurans, caddisflies / odonates, wading birds, shiner spp. / centrarchids / percids / escocids, etc.).

At the Renard Island area, a primary goal is to improve the Great Lakes Beach Metric from "No Management", indicative of no regular or persistent conservation or recreational management activities, to "Recreational Management", where the beach is regularly maintained for recreational purposes that provide some conservation or wildlife value.

A total of 2.75 DHA points for Green Bay Open Water can be designated for this project (1.50 for Shoreline Fish and 1.25 for Freshwater Unionid Mussels), though additional verification monitoring will be required to demonstrate utilization by target species. The primary monitoring target for Shoreline Fish adult and juvenile/young of the year (YOY) species is Smallmouth Bass, though additional points will be awarded for observed utilization by Rare/Sensitive fish species. USFWS AIS data will be used to evaluate the Shoreline Fish BUI condition score. Any observed Opportunistic, Stable/Keystone, or Rare/Sensitive Freshwater Unionid Mussels will count toward the BUI condition score, but habitat enhancements and propagation efforts will focus on native mussels that use centrarchid species as host fish to complete their life cycle. DNR Natural Heritage Conservation program will work with OGW to provide recommended native mussel species propagation and provide post-implementation monitoring efforts.

Priority Populations

Proposed habitat improvements within the BBWS and Nearshore Enhancements project are anticipated to benefit 13 of the 18 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year for the IEC and Count-Based metrics, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 19 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 19. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	Metric Type	Metric Assessment Methodology	Data Source
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Coastal Wetland Aquatic Macroinvertebrates	IEC	CWMP Environmental Reference Gradient	CWMP
Colonial Waterbirds	IEC	Average IEC based on number of nests for 8 Colonial Waterbird species	USDA + DNR
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Breeding Coastal Birds	Count-Based	Number of sites breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	Contractor
Breeding Shorebirds	Count-Based	Number of sites breeding documented for Killdeer + Spotted Sandpiper + Rare Species (Piping Plover, Wilson's Phalarope, American Avocet, etc.) to generate Breeding Shorebird (Sb) Metric	Contractor
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	Contractor + DNR
Wetland Terns	Count-Based	Number of nesting colonies at least 1 km apart from each other	DNR
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR

Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Freshwater Native Mussels	DHA + Count-Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Shoreline Fish	DHA + Count-Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR

As described in the Metrics and Monitoring Plan, some DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 20 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 20. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	1.0	0.0	**1.0**
Coastal Terrestrial Macroinvertebrates	0.0	1.0 Upland	**1.0**
Migratory Landbirds	1.0	0.0	**1.0**
Migratory Shorebirds	1.0	1.0	**1.0**

Anticipated Progress Toward Overall Fish and Wildlife BUI Removal Criteria

When implemented, this project represents a 10.4% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 14.4% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

DNR will request GLRI funding to subaward to the City of Green Bay Parks Department to solicit requests for proposals to design, implementation, and maintenance/monitoring services for this project.

DNR, the City of Green Bay Parks Department, and the selected contractor will collaborate as a Project Management Team, and will solicit technical expertise from a number of partners, including but not limited to: Brown County, USFWS, UWGB, Friends of Bay Beach, South Bay Marina, NEW Water, DU, Wisconsin Coastal Management, etc.

In addition to soliciting technical expertise, the Project Management Team will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase. This will include groups such as adjacent Neighborhood Associations, Green Bay School District, Green Bay Duck Hunters Association, Walleyes for Tomorrow, Green Bay Sail and Paddle, etc.

Project Timeline and Estimated Costs

An initial proposal to support planning and design for this project will be developed in 2023 to secure funding in 2024; a second proposal will be developed and submitted in late 2024 to secure funding for both the implementation and maintenance phases beginning in 2025 (Table 21). Anticipated cost for planning/design is $500,000, with an estimated $3,000,000 needed for the implementation and maintenance phases.

Table 21. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2023	2024	2025	2026	2027	2028
Planning/Design		$500,000				
Implementation			$3,000,000			
Maintenance						

This work will build on previous investments at the BBWS and Renard Island area, including:

- Sanctuary Master Plan Phase I and II (Wisconsin Coastal Management Grant)
- Web of Life Accessible Trail and Waterfall (HUD Grant)
- Sanctuary Communication Plan (Wisconsin Coastal Management Grant)
- $1,700,000 in private donations raised by Friends for Bay Beach for a Nature Education Center
- Acquisition of 11 acres of land connecting BBWS to UWGB Arboretum supported by Stewardship Grant of $116,000 matched by Friends of Bay Beach and City of Green Bay
- Communities and Connections of the World Nature $165,159 grant from National Science Foundation

- Interactive Web of Life Trail Station $4,330 Wisconsin Environmental Education Board grant
- Observation and Rehabilitation structures have $250,000 bond issued by City of Green Bay

Project Maintenance

Post-project invasive species removal activities will be coordinated by the City of Green Bay Parks Department in partnership with the Green Bay Conservation Corps within the BBWS park footprint. In-water features are not anticipated to require maintenance activities.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

Stakeholder engagement is during the early the design phase will be essential for project success. BBWS serves an important role in the Greater Green Bay community as a resource that provides free or low-cost recreation, education, wildlife viewing, and waterfront access to the public. Greater Green Bay includes the City of Green Bay (the 3rd largest city in Wisconsin with a population of 107,395) along with the City of De Pere, 9 villages, and 12 towns. Bay Beach is already a popular among bird enthusiasts and anglers; the planned improvements have the potential to bolster participation in these activities. This type of stakeholder engagement with nature can create environmental stewardship among citizens through appreciating and protecting wildlife and waterways for future generations.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST), this project will take place within a census tract that is identified as disadvantaged, citing issues related to income, legacy pollution, and workforce development. However, it should be noted that this project is located within a significant community resource, and improvements will be much more far reaching within the local and regional community.

BBWS and the neighboring Bay Beach Amusement Park provide education and recreation to many underserved populations in Greater Green Bay. The Manger Lagoon at BBWS is part of the Urban and Community Fishing Program, with a year-round season accessible to youth (under 15 years of age) and disabled anglers. Habitat improvements to the lagoons will serve to enhance conditions for fish and wildlife populations and for anglers. The habitat restoration work proposed here will expanding the breadth of free and accessible opportunities to citizens and visitors alike.

The City of Green Bay is currently seeking other funding to complete a shoreline revitalization project at the adjacent Bay Beach Amusement Park that would further bolster public access to the waterfront, complementing the habitat work at BBWS and Renard Island. The project

includes the construction of new shoreline walk with amenities, a wildlife viewing platform, fish habitat improvement, wetland/waterway plantings, a swimming beach with bathhouse, stormwater management and a parking lot expansion. The wildlife viewing platform will provide coastal access to Green Bay for both wildlife viewing (especially to the wetland, natural area directly west of the platform) and ADA (Americans with Disabilities Act) fishing access that is not available anywhere else in the AOC boundaries within Green Bay. It is expected that the shoreline improvements will draw even more visitors to the park from near and far. These projects coupled with the AOC habitat work present an opportunity to meet a critical need for those who are underserved in the Green Bay community and do not currently have access to these types of amenities and resources.

Please see Appendix 4 for the full EJ Screen Community Report for this census tract.

Climate Change

The project team will review Adaptation Strategies and Approaches specified in The Coastal Adaptation Menu to promote resiliency of management actions under a changing climate.

During the project design phase, updated rain forecast and design storm information from WICCI and the Wisconsin Rainfall Project will be used to design storm criteria to ensure long-term resiliency of in water and nearshore habitat restoration and guide long-term operation and maintenance plans.

Chapter 2 – Lower Fox River

Lower Fox River History, Special Features, Priority Fish and Wildlife Habitats and Populations, Recreational Access, and Restoration Goals

The Lower Fox River of northeastern Wisconsin is the principal tributary of Green Bay. Originating at Lake Winnebago the Fox River flows north before passing through the city of Green Bay and emptying into the bay; overall, the Fox-Wolf drainage basin encompasses 6,349 square miles. The Lower Fox River is heavily impacted by temporal seiche effects and annual water level dynamics typical of Green Bay. Water levels in Green Bay are influenced by wind-driven seiche events that result in an average 9-inch water level fluctuation daily, through storm surges that can increase water level fluctuations by several feet, and by changes in annual Lake Michigan water levels driven by several regional factors (e.g., precipitation, ice cover, etc.). Habitat at the mouth of the Lower Fox River was historically comprised of extensive meadows and marshes with upland vegetation consisting of beech, maple, basswood, and oak (Figure 14).[41]

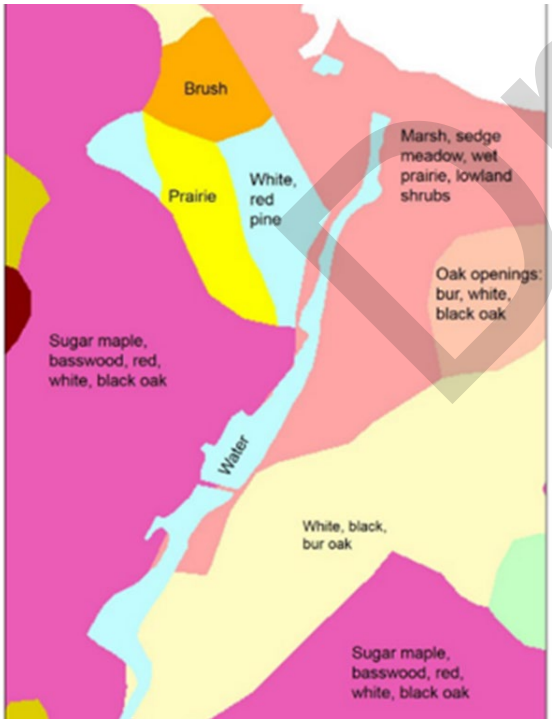
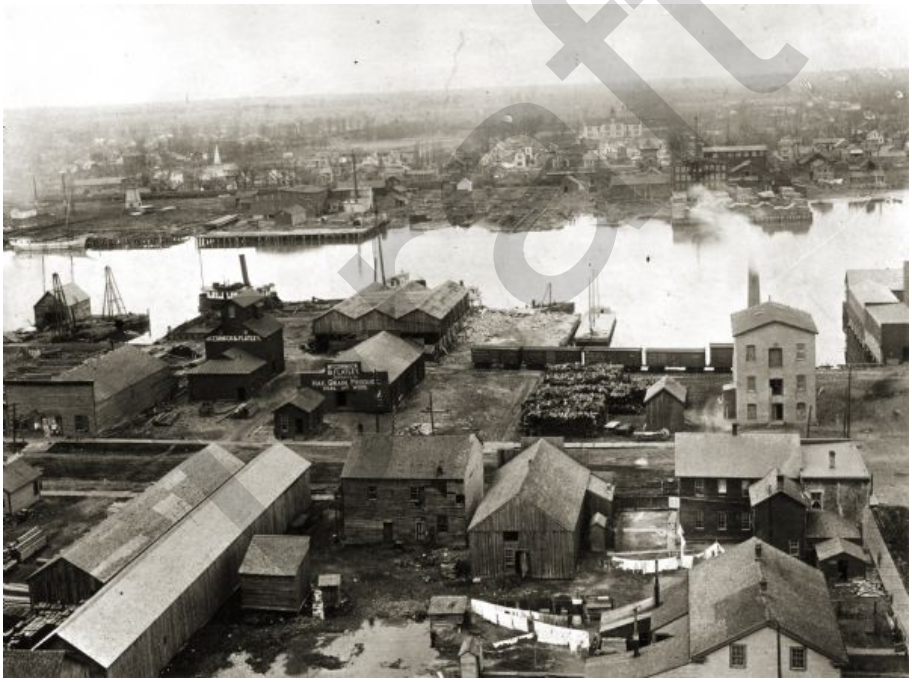


Figure 14. Habitat map based on the original, historical vegetation from the Public Land Survey System surveys completed in the 1840's of the lower Fox River.

[41] Howe, R.W., E.E. Gnass Giese, A.T. Wolf. 2018. Quantitative restoration targets for fish and wildlife habitats and populations in the Lower Green Bay and Fox River AOC. Journal of Great Lakes Research, 44: 883-894.

Prior to European settlement of northeastern Wisconsin, the Fox River supported several Indigenous Tribes with its rich fisheries, waterfowl, wild rice, forest, and water resources. European settlement of the Green Bay and Fox River area occurred in the 17th century, at which time the Fox River became part of an important water route connecting the Great Lakes to the Mississippi River. This water route supported the fur trade, commercial fishing, wheat mills, and timber harvesting throughout the 1700-1900s.[42] In the 1850s lock and dam systems were built along the Lower Fox River and riverfront industry boomed. When wheat production in Wisconsin decreased, agricultural operations shifted to dairy in the watershed, which remains the dominant agricultural industry. Over time, wheat mills were replaced with paper mills, and the Lower Fox River, from Lake Winnebago to its mouth, is said to have had the highest concentration of paper mills per river mile globally.[43] Urbanization and industrialization along the Fox River resulted in environmental damage by way of direct habitat conversion and historical point source discharges of hazardous materials; furthermore, agriculture in the Lower Fox River watershed generated non-point source runoff. The culmination of these stressors caused considerable loss of fish and wildlife habitat throughout the watershed.



Lower Fox River shoreline showing significant industrialization by 1889 (photo courtesy Wisconsin State Historical Society)

[42] Harris, H.J., R.B. Wenger, P.E. Sager, J.V. Klump. 2018. The Green Bay saga: Environmental change, scientific investigation, and watershed management. Journal of Great Lakes Research, 44: 829-836.
[43] Wisconsin Department of Natural Resources. 1992. Wisconsin water quality assessment report to Congress – 1992. DNR Publ. WR254-92, 220 p.

The passage of the Clean Water Act of 1972 and other flagship federal, state, and local regulations and efforts reduced discharge of pollutants into the Lower Fox River; thereby, improving water quality.[44] From 2002 to 2008, DNR and USEPA established Records of Decision (ROD) for segments of the Lower Fox River and Green Bay under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). This led to the Lower Fox River PCB Cleanup Project in which responsible parties were required to pay for the $1 billion cleanup efforts, with active cleanup operations in place from 2009 to 2020. Over eight million cubic yards of contaminated sediment was remediated.[45]

Today, a total of 17 AOC priority habitats exists within 1 km of the Fox River open water corridor, with Fox River Open Water and Southern Dry Mesic Forest having the greatest acreage extent in this priority area as compared to the other two AOC priority areas (Table 22 and Figure 15).

Table 22. Priority habitat acreages across the Lower Fox River priority area. Acreages and percentages in bold show which priority habitats are most dominant in this priority area.

Priority Habitat	Priority Habitat Acreage	Fox River Priority Area Habitat Acreage	Percent of Total Priority Habitat Acres in Fox River Priority Area
Coastal Emergent Marsh	860.86	0.14	0.02
Inland Emergent Marsh	322.87	29.42	9.11
Riparian Emergent Marsh	205.57	36.74	17.87
Roadside Emergent Marsh	51.29	3.38	6.59
Fox River Open Water	1,385.94	**1,385.94**	**100.00**
Great Lakes Beach	110.60	0.43	0.39
Great Lakes Open Water	15,591.33	0.00	0.00
Hardwood Swamp	1,893.32	194.69	10.28
Northern Mesic Forest	119.36	28.00	23.46
Open Water Inland	140.56	12.63	8.99
Other Forest	444.26	84.37	18.99
Shrub Carr	240.76	2.17	0.90
Southern Dry Mesic Forest	56.50	**22.57**	**39.95**
Wet Meadow	1.78	0.00	0.00
Submergent Marsh	614.05	24.38	3.97
Old Field Grassland	345.62	104.43	30.22
Restored Grassland	23.11	1.01	4.37
Tributary Open Water	87.39	45.02	37.85
Total Priority Habitat Acreage	22,495.17	1,975.32	8.78

[44] DNR, 2022. Degradation of Aesthetics BUI Removal Package. 148 pp. LGBFR Aesthetics BUI Removal Document (wisconsin.gov)

[45] DNR, 2021. Restrictions on Dredging Activities BUI Removal Package. 90 pp. GW_LGB_DredgingBUIRemoval2021.pdf (widen.net)

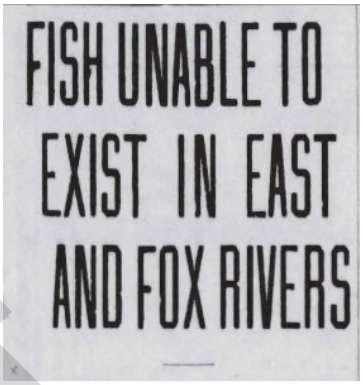
Figure 15. Lower Fox River priority habitat map.

Open Water Habitats

Fox River Open Water is the most significant habitat by acreage in this priority area. Impacts to this priority habitat primarily stem from a long history of degraded water quality through nutrient and sediment loading, as well as historical toxic substance discharges from industrial operations. [46,47]

A 1927 survey by the Wisconsin State Board of Health was reported in an article published by the Green Bay Press Gazette which explained the significant impact of pollution in the Lower Fox River on the fishery:[48]

"The river is rendered unfit for the breeding and feeding of fishes by the covering of the river bottom by silt and paper fibre and by the killing of vegetation, more or less, throughout the whole stretch of the river; but this is particularly noticeable just below Kaukauna, in the two miles of East River and in Fox River just below the point where it receives East River…Conditions in the lower East River and mouth of the Fox River were so foul as to preclude the living of any fishes, with the possible exception of carp…"


FISH UNABLE TO EXIST IN EAST AND FOX RIVERS

1927 headline in Green Bay Press Gazette

Spawning substrate degradation, removal, or inaccessibility, and coarse woody habitat removal also greatly impacted the fishery in the Lower Fox River, including target species such as Walleye, Lake Whitefish, and Sturgeon. A Great Lakes Fishery Commission (GLFC) Technical Report described the fluctuations in walleye stocks in the Great Lakes, including the early history of the walleye fishery in southern Green Bay (GLFC, 1979[49]). The report describes walleye stocks declining by the 1880's with a nearly complete collapse by the 1950's. This collapse was attributed to factors such as overfishing, sawmill wastes, pollutant discharges, dams interfering with spawning habitat and reproduction, and offshore habitat degradation. Particularly, pollutant discharges in the Fox River resulted in reduced dissolved oxygen conditions that could be observed spanning over 25 miles into Green Bay from the river mouth. These conditions also significant deteriorated the benthic community in the AOC, with *Hexagenia* populations extirpated by 1966 (Howmiller and Beeton, 1970).[50]

Following water quality improvements in the 1970s, DNR began stocking fry and fingerling fish to re-establish the walleye population in the Fox River. Beginning in 1973, 44 million fry and 58,000 fingerlings were stocked in the Fox River. The program was so successful in re-

[46] Prepared by The Cadmus Group on behalf of DNR, Oneida Tribe of Indians of Wisconsin, and USEPA, 2012. Total Maximum Daily Load and Watershed Management Plan for Total Phosphorus and Total Suspended Solids in the Lower Fox River Basin and Lower Green Bay. 177 pp.
[47] DNR, 2020. Lower Green Bay & Fox River AOC Beneficial Use Impairment Removal Recommendation: Restrictions on Dredging Activities. 90 pp.
[48] Green Bay Press Gazette Article published August 6, 1927. Retrieved July 1, 2020.
[49] Great Lakes Fishery Commission, Technical Report 31, 1979, 59 pp.
[50] Howmiller

establishing a naturally reproducing walleye population in southern Green Bay and the Lower Fox River that it was discontinued in 1984. In the 1990's, a spawning refuge was established just below the De Pere Dam to protect walleyes from fishing pressure and harvest on their spawning grounds and was recently extended to protect sturgeon spawning grounds as well (Figure 16). The refuge is closed to all boating and fishing from March 1 – May 31.

Today, southern Green Bay and the Lower Fox River boast a world-class walleye fishery, with consistent increases in catch and harvest data collected through creel surveys since 1986 (Figure 17).[51] Continuing to support and protect the walleye fishery in the AOC is a key consideration for management action implementation in the Fox River.

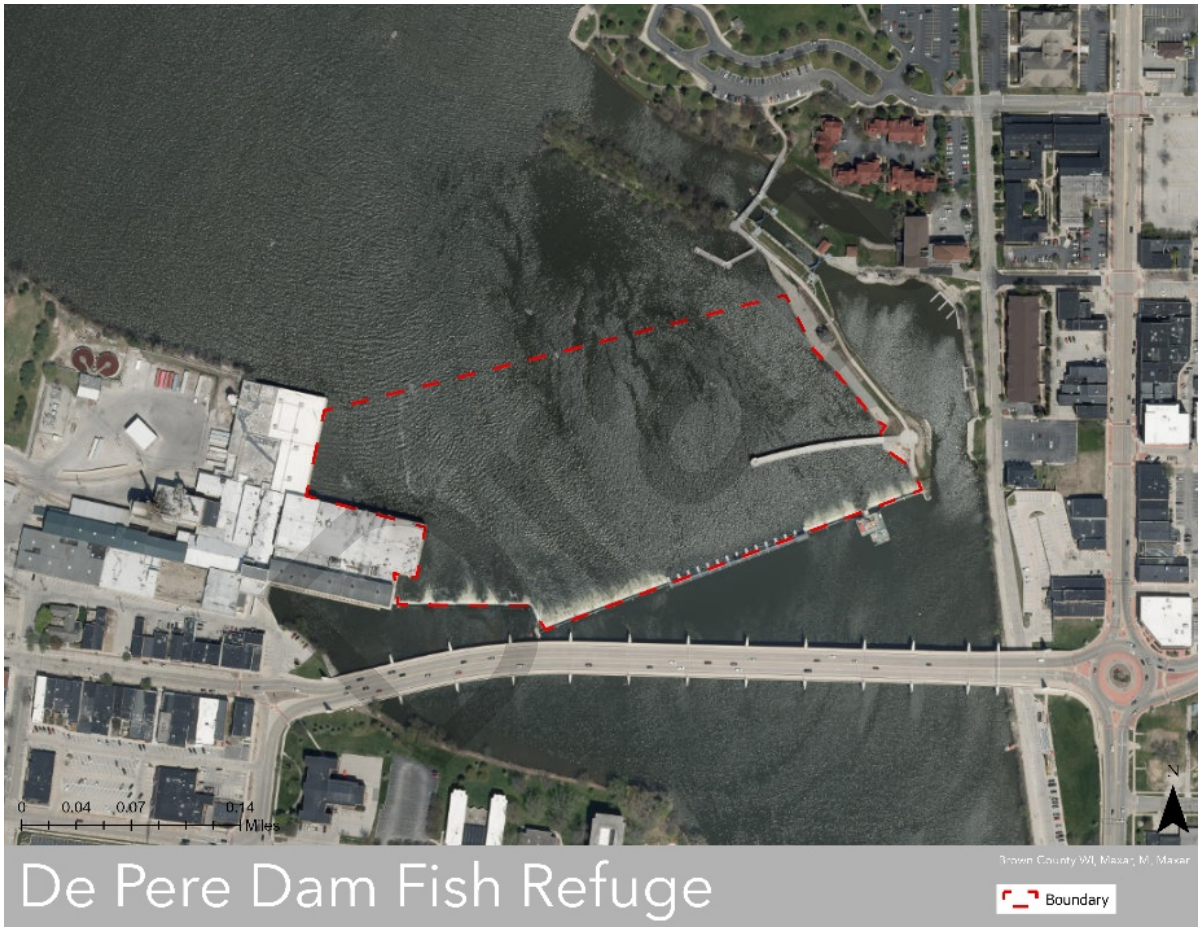


Figure 16. De Pere Fish Refuge

[51] DNR, 2021. Status of Walleye in southern Green Bay and the Fox River.

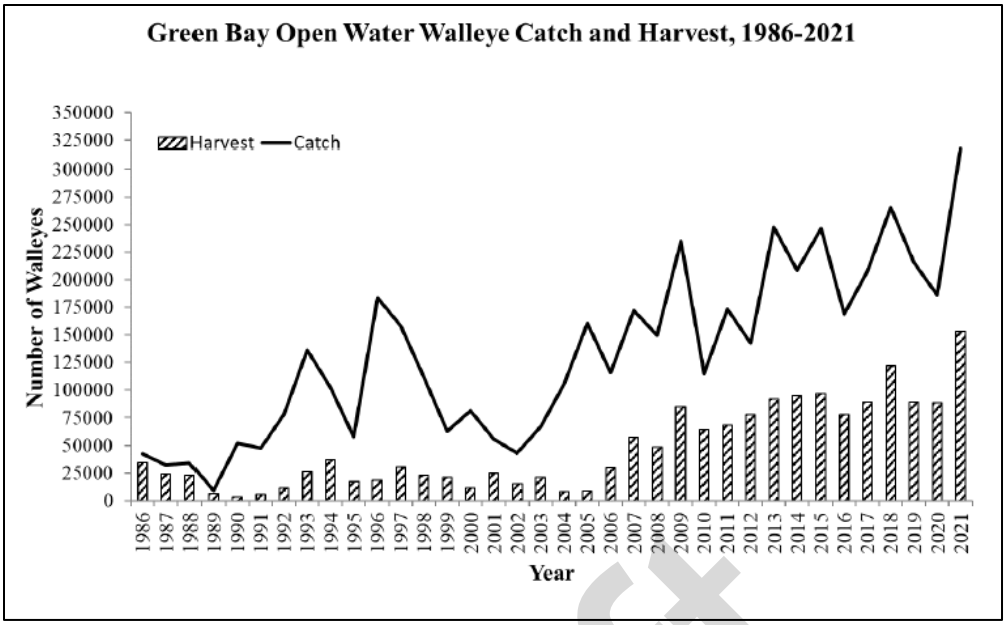


Figure 17. Top graph shows walleye catch and harvest data collected in southern Green Bay and the Lower Fox River from 1986 to 2021; bottom photo shows walleye anglers just downstream of the De Pere Dam and fish refuge in spring (photo credit Anindo Choudhury).

While walleye populations have been largely re-established and are naturally recruiting, recent studies by the UWGB Aquatic Ecology Lab (AEL) are attempting to better understand how habitat below the De Pere Dam is supporting lake whitefish spawning and rearing. Early accounts report that lake whitefish spawning occurred in protected reef structures in southern

Green Bay and major tributaries of western Green Bay.[52] Tributary spawning fish were extirpated by the 1870s due to degraded river habitat, and no observations of lake whitefish spawning in southern Green Bay have been made since the 1940s (Hoagman, 1973). However, increases in the presence of lake whitefish have generally been observed in southern Green Bay, with migratory adults also observed to be returning to west shore tributaries and the Lower Fox River more recently.[53] In 2017, Ransom and colleagues collected 30 whitefish eggs from 7 of 26 points; in 2018, 130 eggs were collected at 19 of 31 points (Figure 18), with whitefish larvae also observed in the Fox, Oconto, Peshtigo and Menominee Rivers in 2017 and 2018.

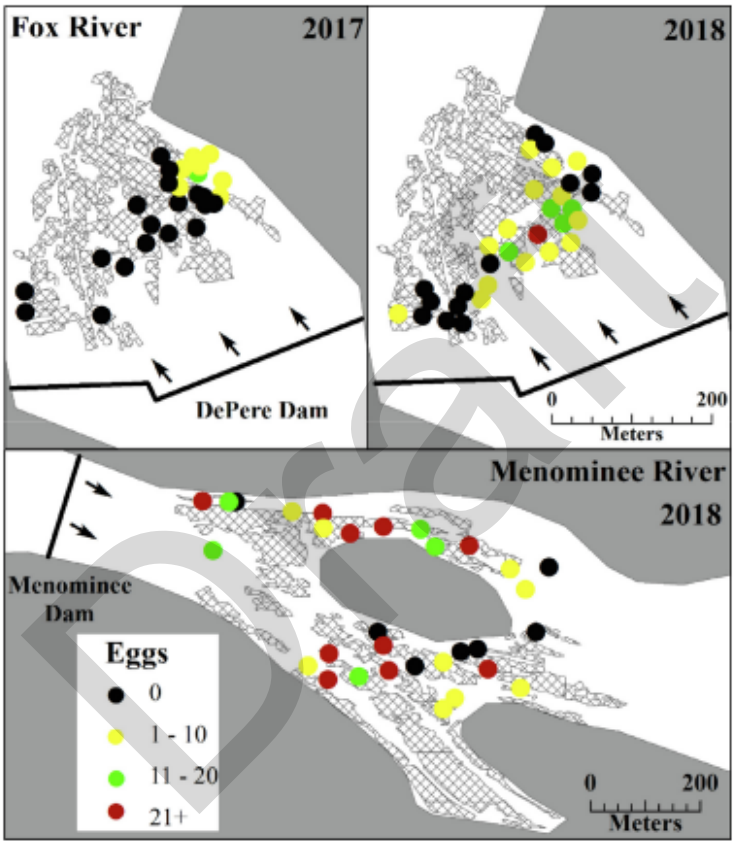


Figure 18. Figure shows lake whitefish egg densities observed in the Lower Fox River immediately below the De Pere Dam, as well as the Menominee River below the Menominee Dam.

[52] Smiley, C.W. 1882. Changes in the fisheries of the Great Lakes during the decade, 1870 – 1880. Transactions of the American Fisheries Society, 11: 28-37.
[53] Ransom, A.L., C.J. Houghton, S.D. Hanson, S.P. Hansen, L.R. Doerr, P.S. Forsythe. 2020. Recolonization of lake whitefish river spawning ecotypes and estimates of riverine larval production in Green Bay, Lake Michigan. Journal of Great Lakes Research, https://doi.org/10.1016/j.jglr.2020.11.011

Lake sturgeon populations in the Lower Fox River and southern Green Bay have experienced similar degradation patterns to that of walleye and lake whitefish. An early account by Father Claude Allouez in 1670 described sturgeon and other fish being harvested by Native Americans at the rapids that are now located at the De Pere Dam and reports throughout the 1800's describe sturgeon as an important part of the diet of European settlers.[54] As of 1883, local newspapers described plentiful sturgeon being caught above and below the De Pere Dam; accounts from 1889 – 1913 noted small numbers (1-12) of sturgeon being caught; by 1912, accounts described sturgeon to be a "curiosity", and in 1915 surgeon harvest was outlawed in Wisconsin following near extinction. Lake sturgeon were generally extirpated from the Lower Fox River until the 1980s, though Elliott and Gunderman reported 25 - 75 spawning adults returning to the De Pere Dam in a 2002-2006 assessment of lake sturgeon in the Green Bay Basin. [55,56]

A more recent study conducted by the UWGB AEL from 2017 – 2019 identified 130 adults present during the spawning run and confirmed that adults appear to primarily key in on shallow cobble habitat along the eastern shoreline as described in previous assessments. While this study found that enough adults and year classes are reflected in the current spawning population below the De Pere Dam to support reproductive success, larval catch appears to be low and potential recruitment limitations may continue to exist (e.g., habitat quality, dewatering, water quality, predation, etc.). As a result, an improvement and/or expansion of suitable spawning and rearing habitat for lake sturgeon is a high priority for the AOC, as is continued protections for existing walleye and whitefish spawning and rearing habitat below the De Pere Dam.

It should also be noted that while the Lower Fox River PCB Cleanup successfully removed over 6 million cubic yards of contaminated sediments through dredging and capped or sand covered over 800 acres of river bottom, this effort has significantly altered substrates, habitat, and water depths in the Lower Fox River. [57] A 2018 – 2019 survey of native mussels in the AOC found only 5 of the 16 native mussel species that have historically been observed in the Fox River, with 4 of those 5 species observed as dead shells only.[58]

The primary assessment methodology for open water habitats in the AOC is designating important/high-quality habitat areas for spawning, rearing, and feeding for fish and native mussel priority populations (i.e., DHAs). The TAC evaluated **Fox River Open Water** and **Tributary Open Water** habitats along the east shore to designate as DHAs using USFWS Aquatic Invasive Species (AIS), DNR Fisheries, and DNR Natural Heritage Conservation

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[54] Cochran, P.A. and R.F. Elliott. 2012. Newspapers as sources of historical information about lake sturgeon (*Acipenser fulvescens* Rafinesque, 1817). Archives of Natural History, 39.1: 136 – 146.

[55] Cochran, P.A. 1995. - Lake sturgeon (Acipenser fulvescens) in the lower Fox River, Wisconsin. Sturgeon Quarterly, 3: 8 – 9.

[56] Elliott, R.F. and B.J. Gunderman. 2008. Assessment of remnant lake sturgeon populations in the Green Bay Basin, 2002 – 2006. Great Lakes Fishery Trust report, project number 2001.113/2004.610.

[57] DNR, 2021. Lower Green Bay & Fox River AOC Beneficial Use Impairment Removal Recommendation: Restrictions on Dredging Activities. 90 pp.

[58] DNR, 2020. Investigating native mussel communities within nearshore habitats in the Lower Green Bay & Fox River. 30 pp.

program data. The group determined that the following DHAs currently occur within the Lower Fox River priority area (Table 23):

Table 23. Green Bay Open Water and Tributary Open Water DHAs in the Lower East Green Bay priority area:

DHA	Priority Population Utilization	Points Contributed to Habitat Condition Score
Ashwaubenon Creek	Native Freshwater Mussels Tributary Fish	0.5 0.5
De Pere Dam and Voyageur Park Shoreline	Fox River Fish	1.0
Dutchman Creek	Tributary Fish	0.5
East River	Tributary Fish	1.0

Nearshore Habitats

The loss of **Riparian Emergent Marsh** and **Submergent Marsh** habitat is one of the most notable impacts to the Lower Fox River and associated secondary order tributaries (Ashwaubenon Creek, Dutchman Creek, and East River). The stretch of Lower Fox River between the De Pere Dam and Mason Street Bridge was previously rich with emergent and submergent marsh vegetation, though it is nearly extirpated today (Figure 19). These marshes were heavily used by fish and nesting birds (e.g., Least Bittern, Blue-winged Teal, Marsh Wren, and rails), and they served as migratory bird stop overs.

Today, nearly all wetland habitat in the Fox River Open Water corridor has been extirpated, though small tracts remain near Ashwaubenon Creek and a slough near mouth of the Fox River. Existing marsh tracts generally support Sago Pondweed, Slender Waterweed, Leafy Pondweed, Coontail, Common Waterweed, Water Stargrass, with rare instances of Wild Celery, Longleaf Pondweed and Spatterdock.[59] Invasive species frequently observed include Phragmites and Eurasian Watermilfoil.

[59] Howe, R.W., E.E. Gnass Giese, A.T. Wolf. 2018. Quantitative restoration targets for fish and wildlife habitats and populations in the Lower Green Bay and Fox River AOC. Journal of Great Lakes Research, 44: 883-894.

Figure 19. The Lower Fox River in 1938 (left) shows much of the shoreline flanked by riparian wetlands, with a substantial complex near the De Pere Dam. As of 2020 (right), nearly all of the Riparian Emergent and Submergent Marsh habitat has been extirpated from Fox River Open Water habitat, though very small tracts exist near Ashwaubenon Creek and Dutchman Creek (Howe et al., 2018). Figures retrieved from Brown County Web Map

One species that may have been particularly impacted by the reduction of nearshore riparian habitat in the AOC is Great Lakes Muskellunge (*Esox masquinongy*). Management goals specific to muskellunge in the AOC included reintroduction through stocking to re-establish a naturally reproducing and self-sustaining population.[60] DNR began stocking muskellunge fingerlings in the Fox River in 1989, with 218,025 stocked in Green Bay and its tributaries to date. These efforts have restored a significant adult muskellunge fishery and angling destination to the AOC in recent years. However, researchers continue to observe extremely limited evidence of natural recruitment, which is insufficient to sustain the stocked muskellunge population in Green Bay and its tributaries. While eggs are collected from the AOC-portion of the Fox River and other Green Bay tributaries and fertilized/reared at state fish hatcheries, DNR surveys have found no naturally reproduced juveniles in the AOC-portion of Green Bay and very few in northern areas of Green Bay.[61] This indicates that there are continued stressors to

[60] DNR. 1988. Lower Green Bay & Fox River Area of Concern Remedial Action Plan.

[61] Kapuscinski, K.L., B.J. Belonger, S. Fajfer, & T.J. Lychwick. 2007. Populaiton Dynamics of muskellunge in Wisconsin waters of Green Bay, Lake Michigan, 1989-2005. The Muskellunge Symposium: A Memorial tribute to EJ Crossman: pp 27 – 36. Springer Netherlands.

natural reproduction of muskellunge, particularly in the AOC, and has initiated recent research projects to better understand what these limitations are.

Muskellunge telemetry, habitat mapping, and egg and larval surveys.[62,63] found that most tagged muskellunge were spawning in the Fox River, and they showed moderate/high site fidelity to original stocking locations. From 2017 - 2019, no larval fish were found in the AOC though 43 egg deposition sites were confirmed, and several spawning pairs were observed (Figure 20).

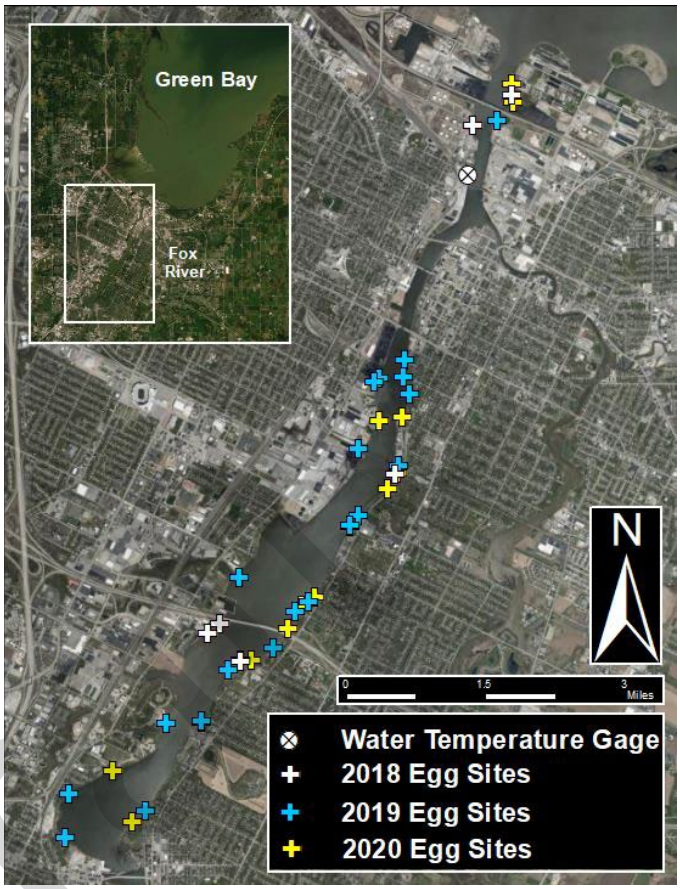


Figure 20. Figure retrieved from Krebs (2020) showing confirmed muskellunge egg deposition sites in the AOC-portion of the lower Fox River.

Habitat surveys identified that a variety of factors predicted the presence of muskellunge egg deposition, including water depth, dissolved oxygen concentrations at the substrate interface, percent gravel and organic matter substrates, distance from shore, and slope. Using this information, Krebs found that only 1.3% of the surface area of the AOC-portion of the Fox River is suitable for muskellunge spawning and egg deposition.

Interestingly, coarse woody habitat and aquatic vegetation are also frequently identified as suitable spawning and rearing habitat for muskellunge. The overall lack of suitable spawning and egg deposition habitat, as well as rearing habitat may account for why muskellunge are not being observed in early life stages in the AOC. Considering the results of this recent research and DNR muskellunge surveys, increasing available spawning and rearing habitat is a high priority for restoring naturally recruiting muskellunge populations in the AOC. This work is also expected to improve population metrics for other nearshore fish (e.g., centrarchids, northern pike, etc.) and wildlife species (e.g., mammals, waterbirds, macroinvertebrates, herptiles, etc.).

[62] Scheffer, R.J. 2019 Movement, habitat use, and reproductive success of muskellunge Exos masquinongy in Green Bay, Lake Michigan. Thesis, University of Wisconsin – Stevens Point.
[63] Krebs, J.E. 2020. Movements and spawning habitat of Muskellunge Esox masquinongy in Green Bay, Lake Michigan. Thesis, University of Wisconsin – Stevens Point.

While today much of the shoreline and upland area along the river have been industrialized/urbanized, nearly 40% of the **Southern Dry Mesic Forest** acreage is found near Ashwaubenon and Dutchman Creek, and significant tracts of **Hardwood Swamp**, **Northern Mesic Forest**, **Other Forest,** and **Old Field Grasslands** occur throughout the Lower Fox River shoreline. These upland and nearshore habitats support over 130 bird, 10 mammal, 3 herptile, 5 bats, and 8 dragonfly species historically observed along the Lower Fox River.

The following section contains project narratives for three management actions to be completed along the Lower Fox River priority area.

Lower Fox River Project Narratives and Recommended Management Actions

Project #4: Fox River Heritage

Site Description and Location

Heritage Hill State Park (HHSP) is a 501(c)(3) corporation and an example of a highly successful private and public partnership between the Wisconsin Department of Natural Resources (DNR) and Heritage Hill Corporation. The property is operated as an outdoor living history museum dedicated to the preservation of several buildings and artifacts that represent Northeastern Wisconsin heritage. The park was initially opened in 1977, after a large bequeathment made it possible to bring together several historical buildings in Green Bay. Today, HHSP is owned by the State of Wisconsin and administered by the Wisconsin DNR state parks program. It is leased to the Heritage Hill Foundation and boasts 56 acres of land along the banks of the Fox River.

The HHSP shoreline and adjacent in-water area serves as important nearshore habitat along the Fox River (Figure 21), though its condition has been degraded due to dredging of contaminated sediment, poor water quality, and encroachment by invasive species, among other stressors. Namely, the riparian wetland previously observed along the shoreline of HHSP has been lost, taking with it critical habitat for several fish and wildlife species, including Great Lakes muskellunge. While adult muskellunge are observed along the east shore of the AOC-portion of the Fox River today, this is largely the result of a decades-long effort to rehabilitate the population following extirpation throughout the AOC and broader Green Bay. DNR surveys have found no naturally reproduced juveniles in the AOC-portion of Green Bay and very few in northern areas of Green Bay (Kapuscinski et al., 2007), indicating continued stressors to natural reproduction of muskellunge, particularly in the AOC. Proposed habitat enhancements intend to restore aquatic connectivity, expand riparian marsh habitat, and install woody habitat structures and rocky

UW-Stevens Point sampling musky eggs along the Fox River shoreline (photo courtesy Dan Dembkowski).

substrates that will benefit many fish species including muskellunge, centrarchids, walleye, and northern pike which are the primary monitoring species.

The USFWS AIS Early Detection and Rapid Response team conducted three surveys near the project area in the fall of 2017 and 2018 that yielded a total of 193 fish representing 17 different species. These were dominated by yellow perch (69.4% of total catch), gizzard shad (19.6%), spottail shiner (6.7%), walleye (4.1%) round goby (3.1%), trout perch (3.1%), white bass (3.1%), common carp (2.6%), sand shiner (2.9%), centrarchids (2%). An important note is that 97% of the yellow perch surveyed during the AIS team efforts came from one beach seine, emphasizing the importance of nearshore habitat at this site. DNR electrofishing results from 2015 to 2018 within the project area found a total of 2161 fish representing 19 different species. These were dominated by gizzard shad (86.2% of total catch), followed by yellow perch (6.7%), emerald shiner (2.4%), centrarchids (1.3%), freshwater drum (1.2%) and walleye (0.5%). Additionally, a small tributary slough exists near the southern boundary of the project and was previously identified as a potential pike spawning habitat improvement project. The shoreline of HHSP is generally undeveloped and is one of the few remaining naturalized tracts of shoreline along the Fox River in the AOC, providing opportunity for improvements to several other AOC priority habitats and priority populations that will be considered throughout the design phase, including native mussels, macroinvertebrates, mammals, and several bird species.

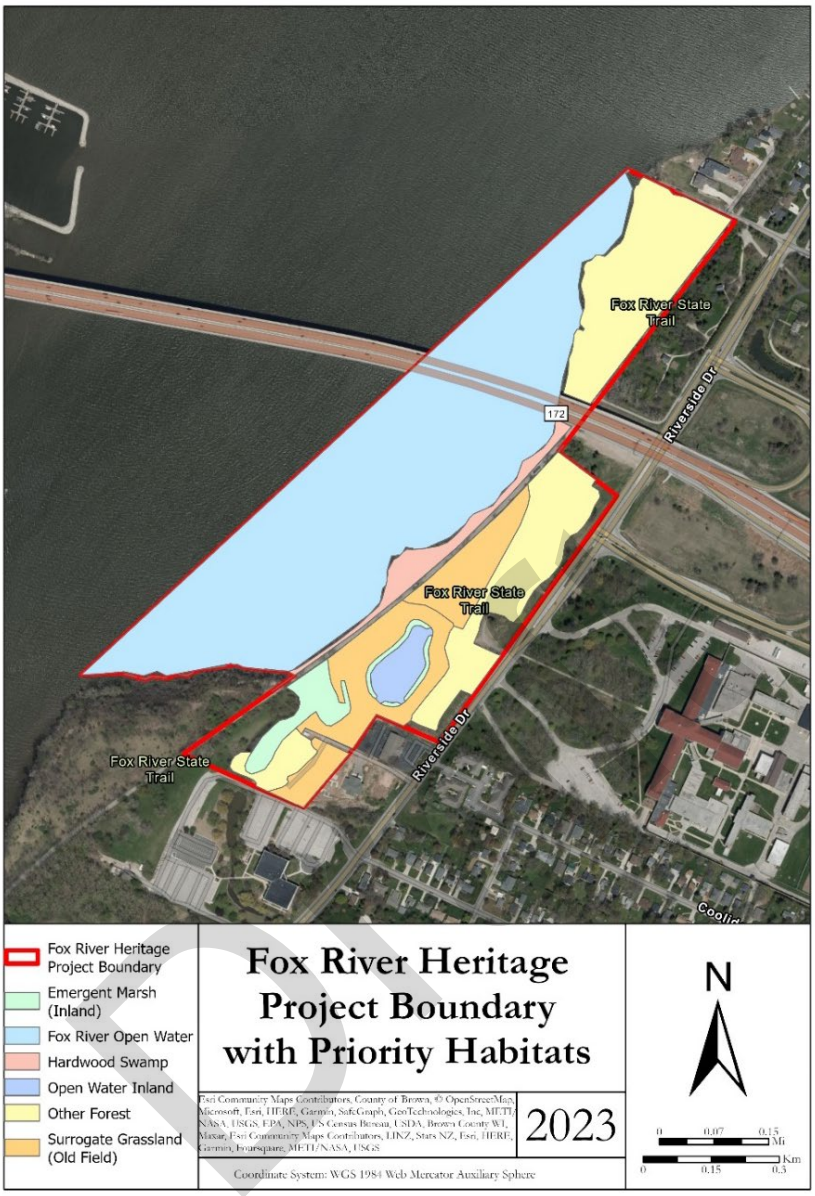


Figure 21. Priority habitats within the HHSP project boundary.

Project Scope and Priority Habitats/Populations Benefited

Priority Habitats

Proposed habitat improvements within the Fox River Heritage project are anticipated to provide direct benefits to 9 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 24 shows priority habitats that have been mapped within the Fox River Heritage project boundary and how baseline and post-implementation BUI condition scores were derived.

Table 24. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundaries	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Riparian Emergent Marsh	0.00 x 0.50	**0.00**	10.00 x 0.65	**6.50**
Submergent Marsh	0.00 x 0.50	**0.00**	10.00 x 0.65	**6.50**
Inland Emergent Marsh	1.87 x 0.45	**0.84**	1.87 x 0.65	**1.22**
Hardwood Swamp	10.99 x 0.40	**4.40**	10.99 x 0.65	**7.14**
Other Forest	14.72 x 0.5	**7.36**	14.72 x 0.65	**9.57**
Old Field Grassland	15.82	**15.82**	15.82	**15.82**
Quantity (acres or km) x Management Based Metrics				
Inland Open Water	1.11 x 0.50OW	**0.56**	1.11 x 0.75OW	**0.83**
Designated Habitat Area Based Metrics				
Fox River Open Water	0.00	**0.00**	1.00 Fox River Fish	**1.00**
Tributary Open Water	0.00	**0.00**	0.50 Tributary Fish	**0.50**

Some of the project scope will focus on vegetation management activities to improve floristic quality in existing habitat acreages/lengths (e.g., removal of invasive species, addition of higher quality native species). These activities will improve the BUI condition score for Quantity x Quality and Quantity x Management based priority habitat metrics. A primary goal is to add 10 acres each of Riparian Emergent and Submergent Marsh to form a complex of riparian, submergent, and additional woody and rocky substrates for fish and native mussels. Additionally, improving the quality of 2.5 acres of Hardwood Swamp and 10 acres of Other Forest (targeting migratory landbirds and bats) will contribute the overall project goal.

At present, HHSP has the longest stretch of natural Fox River shoreline below the De Pere Dam. North of the STH-172 bridge bisecting the property the shoreline has a sandy grade into the river, while south of the bridge the shoreline is riprapped. A primary goal for the project area is to improve and naturalize shoreline and reestablish in-water habitat within a 25-acre footprint of the Fox River. The open water area currently provides 0.0 DHA points for Fox River and Tributary Open Water due to lack of important habitat for Fox River Fish, Tributary Fish and

Freshwater Unionid Mussels. Substrate enhancement (targeting Muskellunge and Centrarchids), shoreline improvements, and native mussel propagation efforts will create a 1.0 DHA point for Fox River Open Water when the project is fully implemented. Furthermore, a potential opportunity to improve an existing tributary slough and establishing passage (targeting Northern Pike) could add 0.5 DHA for Tributary Open Water.

A storm water pond at HHSP is currently considered to have “Moderate Quality” Open Water metric, indicative of some higher quality shoreline and SAV, and evidence of higher quality fish or wildlife utilization (e.g., waterfowl, snails/amphiponds/blackfly larvae, shiner spp./centrarchids/percids/escocids, etc.). The goal is to improve this shoreline and in-water habitat to a “Moderately High Quality” Open Water metric, indicative of higher quality shoreline, SAV, and fish and wildlife utilization (e.g., anurans, caddisflies/odonates, wading birds, shiner spp./centrarchids/percids/escocids, etc.).

Priority Populations

Proposed habitat improvements within the Fox River Heritage project are anticipated to benefit 11 of the 18 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year for the IEC and Count-Based metrics, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 25 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 25. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	Metric Type	Metric Assessment Methodology	Data Source
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Colonial Waterbirds	IEC	Average IEC based on number of nests for 8 Colonial Waterbird species	USDA + DNR
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor

Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	Contractor + DNR
Breeding Coastal Birds	Count-Based	Number of sites with breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	Contractor
Stream Macroinvertebrates	Count-Based	Average Citizen Monitoring Biotic Index across six sites	DNR + Citizen Science
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Freshwater Native Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Fox River Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR + UWSP
Tributary Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR

As described above, DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 26 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 26. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	1.0	0.0	**1.0**
Coastal Terrestrial Macroinvertebrates	0.0	1.0 Upland	**1.0**
Migratory Landbirds	1.0	0.0	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

If implemented, the HHSP project represents a 4.7% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 5.9% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

DNR will request GLRI funding to solicit requests for proposals for design, implementation, and maintenance/monitoring services for this project.

DNR and the selected contractor will collaborate as a Project Management Team and will solicit technical expertise from a number of partners, including but not limited to: Heritage Hills Corporation, TNC, Village of Allouez, Brown County Land and Water Conservation Department, and Northeast Wisconsin Land Trust.

In addition to soliciting technical expertise, the Project Management Team will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase.

Timeline, estimated costs for applicable project phases, and cost-sharing opportunities

An initial proposal to support planning and design for this project will be developed in 2022 to secure funding in 2023; a second proposal will be developed and submitted in 2024 to secure funding for both the implementation and maintenance phases beginning in 2024 (Table 27). Given the need to complete planning and design for this project, implementation and maintenance costs are contingent upon the completion of the planning and design phase. The total estimated cost for this project is $3,000,000 with cost estimates generated in consultation with GEI Consultants.

Table 27. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2024	2025	2026	2027	2028	2029	2030

Planning/Design	$300,000						
Implementation		$2,700,000					
Maintenance							

Project Maintenance

The Wisconsin DNR would be responsible for management of the in-water features. Heritage Hill Foundation and the Wisconsin DNR would be expected to manage and maintain terrestrial restoration areas. Prairie plantings surrounding stormwater ponds would be managed and maintained by the Village of Allouez. The pike spawning marsh would be managed and maintained by the Brown County Land and Water Conservation Department.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

The Fox River Heritage Project provides a unique opportunity to educate the public about culturally important natural resources. This project aims to link habitat and population restoration work to the development of interpretive exhibits that emphasize the cultural significance of the Fox River, surrounding habitats, native plants, and wildlife. Current Park exhibits provide information dating back to the 1700s; therefore, the inclusion of exhibits focusing on the natural resources as they relate to the Indigenous Tribes of Northeast Wisconsin is an important extension of the work already being done by the Heritage Hill Corporation. There is tremendous potential for public education at this site given the large number of people accessing the Fox River Trail (FRT), along which exhibits will be placed.

During the design phase of the Fox River Heritage Project DNR, Heritage Hill Corporation, and partners will work with the consultant to create an outreach and engagement plan that ensures tribal and other community members are engaged in the development of diverse and resilient natural communities. Outreach plans will inform engagement and inclusion efforts and will include focused efforts on those already utilizing recreation opportunities in the area, such as the FRT and a nearby kayak/canoe launch. Feedback will be collected via public meetings and other activities conducted with interest groups and stakeholders.

Selected responses to the potential social/economic benefits associated with the Fox Heritage project include:

- “Opportunities for public education and exposure to the positive AOC 'story' could be woven easily into this project. Partnerships with the park, the Village of Allouez and others could be envisioned.”

- "Heritage Hill brings in folks from all around Wisconsin and beyond, so enhancing its ability to share not only the human history of the area but also the natural history of the area will only benefit the park and the community by being an additional draw."
- "Restoring any type of wetlands has such profound beneficial economic impacts that it is hard to quantify. Flood abatement, fish spawning which in turns benefits sportsmen and women, and outdoor recreation opportunities such as birding, wildlife viewing, kayaking, boating etc. will all be positively impacted."
- "Anything we can do to restore the native habitat to our area will enhance the quality of life, improve our economic prospects, and attract more people to our area."

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the Fox River Heritage project is not within a census tract that is identified as disadvantaged. However, the Fox River Heritage project provides a unique opportunity to improve public access to the Fox River shoreline, to increase recreational potential, and to expand the community's understanding of the cultural significance of the area's resources. Already HHSP, the FRT, and the nearby Kayaker's Point draws visitors from across the Greater Green Bay community.

The Menominee, Forest County Potawatomi, Ho-Chunk, and Oneida Nations have been invited to have representatives on the project management team. Participation as project management team members ensures the chance to provide input and feedback on all aspects of the project during the planning and design phases. For more information on the cultural interpretive elements anticipated at this project site see the section above on *Stakeholder Engagement* related to this project.

Please see Appendix 4 for the full EJ Screen Community Report for this census tract.

Climate Change

The project team will review Adaptation Strategies and Approaches specified in The Coastal Adaptation Menu to promote resiliency of management actions under a changing climate.

Resiliency will be factored into the project during the design phase. Specifically, this project will consider elements of stream bank stabilization to reduce the impacts of increased wave energy and fluctuating water levels. This may be achieved through the incorporation reefs/small islands of rock to break waves and protect shallow water habitat and development of emergent and submergent aquatic plant beds. These actions can create resiliency by increasing habitat size, species densities and heterogeneity through expansion and diversification of habitat niches and enhanced food-web complexity. This project will also include the management of invasive, non-native plant species in existing habitat, along with the planting of native species. The invasive species management will have a climate adaptation benefit by reducing exacerbating stressors

within the system. Native vegetation selected for planting will be persistent under the more extreme temperature and precipitation anticipated with changing climate conditions.

Project #5: De Pere Riverine Wetland and Reef

Site Description and Location

The De Pere Dam is located 7 miles upstream from the mouth of the Fox River and is one of a few sites in the Great Lakes where adult lake sturgeon spawn. Prior to the dam being installed, lake sturgeon had access to 40 miles of riverine habitat in the Lower Fox River. Spawning was historically recorded near the Kaukauna Rapids, approximately 18 miles from the river mouth, though spawning also likely occurred at other sites with suitable habitat. In the early 1800s, the Fox River was fragmented by a complex lock and dam system, with a total of 14 dams and 17 locks constructed between the Fox River mouth and Lake Winnebago. This infrastructure, while important for water management and passage on the Lower Fox River, has largely isolated the lake sturgeon populations in Lake Winnebago and Green Bay. Furthermore, the De Pere dam restricts much of the Green Bay lake sturgeon population to spawning grounds located directly below the dam on the eastern shoreline of the Lower Fox River. Once eggs hatch, only 7 miles of riverine habitat is available for recruitment and out migrating of larval and juvenile fish which will spend most of their life in Green Bay.

While some natural reproduction of lake sturgeon has been documented below the De Pere Dam, prolonged survival and recruitment from larvae to sexually mature adults has not yet been documented and there is some evidence that year class strength may be declining.[64,65,66,67] Recent research by the UWGB AEL found an estimated 2.4 acres of nearshore spawning habitat below De Pere dam be used by 137 lake sturgeon in 2018 and 150 individuals in 2019. However, eggs deposited in that area were observed to experience temporary or permanent desiccation due to daily dynamic water level fluctuations characteristic of Green Bay (also observed in other river systems in Great Lakes basin), potential predation by common carp, and some evidence of impacts from algae growth on suitable substrates.[68] This study also mapped a total of 9.7 acres of cobble and boulder habitat along the eastern shoreline below the De Pere Dam which spawning lake sturgeon do not appear to use but has been observed to provide important spawning habitat for walleye and lake whitefish. Despite the apparent suitable lake sturgeon spawning habitat, very little larval production was observed from 2017 to 2019, suggesting that conditions in the Lower Fox River may not support meaningful production to the Green Bay lake sturgeon population.

[64] Elliott, R.F. and B.J. Gunderman. 2008. Assessment of remnant lake sturgeon populations in the Green Bay Basin, 2002 – 2006. Great Lakes Fishery Trust report, project number 2001.113/2004.610.
[65] Donofrio, M.C. et al., 2017. Telemetry and genetic data characterize lake sturgeon (*Acipenser fulvescens* Rafinesque, 1817) breeding ecology and spawning site fidelity in Green Bay Rivers of Lake Michigan. Journal of Applied Ichthyology, 34: 302 – 313.
[66] Tucker, S.R. et al., 2021. Reproductive status of a remnant Lake sturgeon (Acipenser fulvescens) population: Spawning and larval drift in the lower Fox River, Wisconsin. River Research and Applications, 37: 1265 – 1278.
[67] Tsehaye, I. et al., 2016. Combining genetics with age/length data to estimate temporal changes in year-class strength of source populations contributing to mixtures. Fisheries Research, 173: 236 – 249.
[68] Auer, N.A. and E.A. Baker, 2002. Duration and drift of larval lake sturgeon in the Sturgeon River, Michigan. Journal of Applied Ichthyology, 18: 557 – 564.

Lake sturgeon sampling near the De Pere Dam, photo courtesy UWGB AEL.

In general, fisheries researchers and resource managers agree that expansion of suitable spawning and rearing reef habitat into more offshore areas of the Lower Fox River may increase the likelihood of meaningful production to the Green Bay lake sturgeon population. As a result, the TAC recommended implementation of one or more reefs below the De Pere Dam that could be implemented across a range of water level and flow conditions to support lake sturgeon, with ancillary benefits to other river-spawning species such as walleye and lake whitefish.

Additionally, the area just west of the De Pere dam was historically a large shallow riparian wetland complex, though this wetland habitat has been completely extirpated from the area (Figure 22). This is likely due to decades of degraded water quality from point and nonpoint source phosphorus and sediment runoff, as well as significant dredging of contaminated sediments stemming from the nearby Fort Howard paper mill during the Lower Fox River PCB Cleanup project. The dredging has deepened this area substantially, making natural re-establishment of the riparian wetland complex extremely unlikely without intervention. As a result, the TAC recommended that options for restoring some of the previous riparian wetland extent be evaluated through this project's design phase.

Figure 22. Top left photo shows 1938 air photo of riparian wetland below the De Pere Dam, top right is 1952, bottom left is 1978, and bottom right is 2023.

However, questions surrounding potential impacts to the existing high-quality walleye and lake whitefish habitat below the dam, floodplain impacts, and other feasibility considerations needed to be made before pursuing a full design phase for the project. As a result, EPA GLNPO and DNR partnered with USACE in 2021 to complete a pre-design investigation for the project, as USACE has considerable technical expertise, understanding of the Lower Fox River dynamics, and can provide the nexus to beneficially reused clean dredge materials that could be used to construct the wetland portion of the project. The results of the pre-design investigation are

documented in a TM to be finalized in late 2023 and appended to this document when available. Results of this effort indicate that it is possible to construct at least one offshore lake sturgeon reef and clean/appropriate sources of clean dredge material may exist within navigational harbors in Green Bay (e.g., Suamico, Oconto, Sturgeon Bay, etc.) to construct the wetland.

Next steps include beginning the design phase for the lake sturgeon reef portion of the project in early 2024, with construction scheduled in 2025. Additionally, characterization of sediments in the Oconto Harbor will occur in mid-2024 to determine if the harbor contains an appropriate source of material that can be beneficially reused to construct the wetland portion of the project. The riverine wetland design is not anticipated to begin until 2026 to gain stakeholder/riparian landowner concurrence and to design other high priority AOC projects (Duck Creek Delta and Longtail Point).

It should be noted that when implemented, this project has the potential to benefit many other fish species beyond lake sturgeon, including walleye, lake whitefish, centrarchids and musky which are the target species across the project area. Previous USFWS AIS fisheries surveys completed in the project area from 2016 – 2018 observed 35 fish species, including gizzard shad (44.3% of total catch), emerald shiner (13.4%), yellow perch (13.4%), walleye (11.7%), and long perch (2.2%). Centrarchids and lake whitefish represented 5.7% and 1.9% of the total catch, respectively. Additionally, results from the 2016 – 2019 DNR musky survey observed 27 species, including white bass (19.2%), longnose gar (13.5%) musky (10.7%), white perch (9.0%), walleye (7.9%), smallmouth bass (7.2%), common carp (6.1%), channel catfish (3.9%), freshwater drum (3.5%), and quillback (3.2%). Centrarchids represented 14.1% of the total catch. Given the number of species this area of the river currently supports and uniqueness of the project, DNR and partners will be requesting GLRI funding to complete additional pre and post restoration fish community assessments.

Project Scope and Priority Habitats/Populations Benefited

Priority Habitats

Proposed habitat improvements within the De Pere Dam project are anticipated to provide direct benefits to 7 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 28, below, shows priority habitats that have been mapped within the De Pere Dam project boundary and how baseline and post-implementation BUI condition scores were derived.

Table 28. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundaries	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Riparian Emergent Marsh	0.00 x 0.50	**0.00**	30.00 x 0.65	**19.50**
Submergent Marsh	0.00 x 0.50	**0.00**	30.00 x 0.65	**19.50**
Wet Meadow	0.00 x 0.60	**0.00**	6.00 x 0.65	**3.90**
Hardwood Swamp	15.00 x 0.40	**6.00**	15.00 x 0.65	**9.75**
Other Forest	1.25 x 0.50	**0.63**	1.25 x 0.65	**0.81**
Old Field Grassland	6.00	**6.00**	6.00	**6.00**
Designated Habitat Area Based Metrics				
Fox River Open Water	1.00 Fox River Fish	**1.00**	2.50 + 0.50 Fox River Fish + Native Freshwater Mussels	**4.00**

The primary goal is to implement at least one 1-acre offshore reef to extend lake sturgeon spawning habitat and to re-establish 30 acres each of Riparian Emergent and Submergent Marsh with additional woody and rocky substrates for fish and native mussels. An ancillary goal is to integrate up to 6 acres of Wet Meadow habitat along the shoreline, where feasible; if this cannot be achieved within the project budget, additional funding from other sources will be pursued. Additionally, improving the existing quality of 15 acres of Hardwood Swamp, just over 1 acre of Other Forest, and 6 acres of Old Field Grasslands (targeting migratory landbirds and bats) will contribute the overall project goal by managing invasive species and incorporating higher quality native species.

The open water area below the De Pere Dam already provides 1.0 DHA points for Fox River Open Water as a fish refuge. Reef implementation (targeting lake sturgeon, walleye and lake whitefish) and wetland re-establishment will add 3.00 points for Fox River Open Water (2.0 for Fox River Fish, 0.5 for Shoreline Fish, and 0.5 for Native Freshwater Mussels) when the project is fully implemented.

Priority Populations

Proposed habitat improvements within the De Pere Dam project are anticipated to benefit 16 of the 18 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the

habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year for the IEC and Count-Based metrics, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 29 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 29. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	**Metric Type**	**Metric Assessment Methodology**	**Data Source**
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Colonial Waterbirds	IEC	Average IEC based on number of nests for 8 Colonial Waterbird species	USDA + DNR
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	Contractor + DNR
Breeding Coastal Birds	Count-Based	Number of sites with breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	Contractor
Stream Macroinvertebrates	Count-Based	Average Citizen Monitoring Biotic Index across six sites	DNR + Citizen Science
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR

Freshwater Native Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Fox River Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR + UWGB
Shoreline Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR + UWGB

As described above, DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 30 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 30. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	0.0	1.0	**1.0**
Coastal Terrestrial Macroinvertebrates	0.0	1.0 Upland	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

When implemented, the De Pere Dam project represents a 7.5% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and an 8.0% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

EPA GLNPO and USACE entered into an Inter-Agency Agreement (IA) to support the pre-investigation design phase in partnership with DNR. Going forward, EPA GLNPO, USACE, DNR will continue to collaboratively manage the project, with USACE leading the project design and construction. DNR will work with local and regional partners to implement a restoration design and adaptively manage the site.

Many federal, state, and local partners will participate in informing the project design, including but not limited to the riparian landowners, City of De Pere, Brown County, Village of Ashwaubenon, Fox River Navigational System Authority, UWGB, UW-Stevens Point, USFWS, USGS and others.

In addition to soliciting technical expertise, DNR will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase.

Timeline, estimated costs for applicable project phases, and cost-sharing opportunities

An initial interagency agreement (IA) to support feasibility for this project was awarded in 2021 to USACE, with a second IA awarded in 2023 to move forward the design phase for the reef portion of the project and to complete sediment characterization in navigational harbors in Green Bay. Future IAs are expected to move forward to support various aspects of implementation phases from 2025 – 2027 (Table 31). DNR will submit a GLRI proposal in 2026 to secure funding needed for the restoration plan and maintenance phase. GLRI requests for this project will not exceed <$20,000,000. If additional funding is needed to complete various phases of the project, AOC partners will collaborate with DNR on requests to other funders.

Table 31. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Planning/Design	$250,000			$600,000						
Implementation						<$19,150,000				
Maintenance										

Project Maintenance

DNR, USACE and local partners will be responsible for cooperatively managing the in-water features; DNR will work with adjacent riparian landowners to conduct any vegetation maintenance needed.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

Given the complexity and scale of the project, stakeholder engagement is critical for project buy-in. While most conservation-focused stakeholders have had some engagement with the project concept to date through various public meetings, technical groups, events, and/or presentations, much more work is needed to engage the community and user groups who could be impacted by this project. DNR will rely heavily on the partnership with the Leadership Council and relevant sub-teams, the GBCP to assist with outreach and communications, and with a re-established Citizens Advisory Committee to identify potential benefits and burdens of the project.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the census tracts immediately adjacent to the De Pere Dam project boundaries are not identified as disadvantaged. However, the project represents a unique opportunity to restore a historically significant habitat that's been completely extirpated from the Fox River, and as such will provide tremendous opportunities for citizen science, education/training/workforce development, increasing the diversity of user groups and recreational interests in the area, and other community benefits. DNR will continue to scope and better define these benefits through partnership with the Leadership Council and Citizens Advisory Committee ahead of project design.

Climate Change

All of the proposed project elements are nature-based features that are designed to integrate into the river's hydrologic and hydraulic regime. USACE will continue to evaluate resiliency measures throughout the project's design phase.

Project #6: Ashwaubenon and Dutchman Creek

Site Description and Location

Ashwaubenon Creek and Dutchman Creek are small tributaries that feed into the Fox River from the west. Dutchman Creek is situated approximately 4.5 miles south from the mouth of the river and Ashwaubenon Creek is situated approximately 1-mile further south. Like all small tributaries that feed into the AOC, the environmental characteristics and biota of the mouth of both creeks is highly influenced by temporal seiche effects and annual water level dynamics typical of Green Bay. The watershed that drains into Dutchman Creek is approximately 30 square miles, with just under half of the watershed encompassing a predominantly rural/agricultural land use. Similarly, the watershed that drains into Ashwaubenon Creek is approximately 30 square miles, with 20 square miles encompassing a predominantly rural/agricultural land use and the remaining 10 square miles predominantly suburban/urban land use (Figure 23).[69]

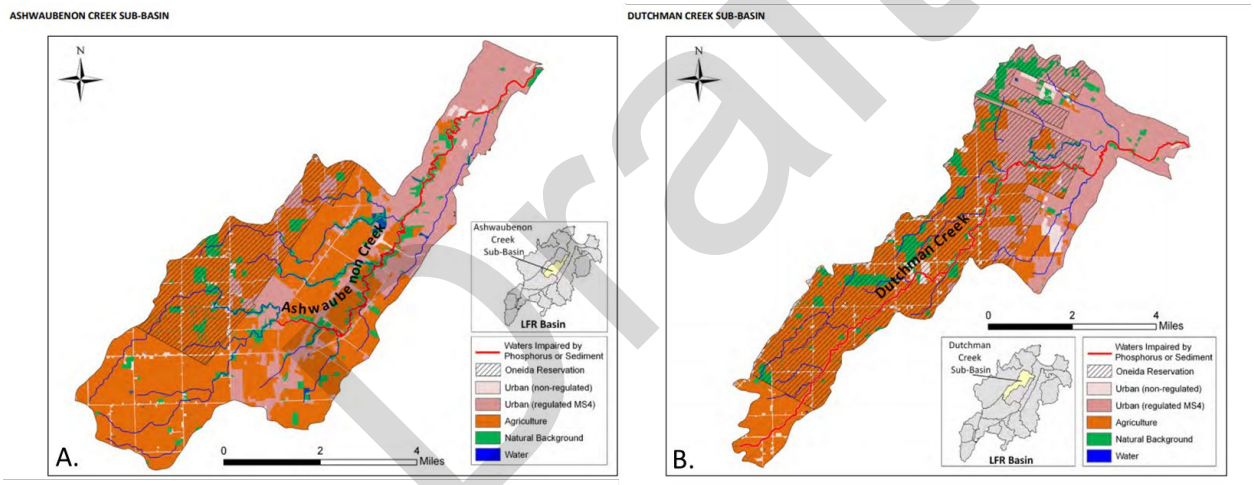


Figure 23. A. The Ashwaubenon Creek sub-basin of the Lower Fox River Basin. B. The Dutchman Creek sub-basin of the Lower Fox River Basin

Ashwaubenon and Dutchman Creek face similar environmental challenges, being located within 1km of the AOC boundary, including flashiness under storm events causing significant bank erosion and water turbidity, a general lack of submergent, emergent or riparian vegetation, low dissolved oxygen levels, and cyanobacterial algal blooms. Additional challenges within Ashwaubenon Creek are chronically high conductivity and runoff from both agricultural and

[69] Outagamie County Land Conservation Department, 2020. Ashwaubenon and Dutchman Creeks Nonpoint Source Watershed Implementation Plan. 154 pp.

urban nonpoint sources that may present some sediment toxicity. Furthermore, a low dissolved oxygen and degraded habitat impairment exists from the mouth of Ashwaubenon Creek to stream mile 14.15 out of the 14.2 miles of stream, with total phosphorus and total suspended solids listed as pollutants of concern in the most recent Wisconsin 2018 Water Quality Report to Congress. Likewise, low dissolved oxygen and degraded biological community impairments are present from the mouth of Dutchman Creek to stream mile 4.04 with total phosphorus listed as the pollutant of concern; a chronic aquatic toxicity impairment is present from the mouth of Dutchman Creek to stream mile 17.97 with ammonia listed as the pollutant of concern in the most recent Wisconsin 2018 Water Quality Report to Congress.

These issues are contributing to a degraded macroinvertebrate and fish community within Dutchman and Ashwaubenon Creek, and account for NEW Water's (Green Bay Metropolitan Sewerage District) efforts to pursue adaptive management in the Ashwaubenon Creek and Dutchman Creek watersheds. They are working to achieve point source compliance for the facility's new total phosphorus and total suspended solids limits. Such endeavors to improve water quality in these watersheds, along with several other partner efforts, are anticipated to provide improved environmental conditions. However, seiche-impacted dynamics in the lowest reach of Dutchman and Ashwaubenon Creek and their confluences with the Fox River have been observed to have poor flow, resulting in poor water quality and frequent algal blooms.

Cyanobacterial harmful algal bloom at the Ashwaubenon Creek boat launch in 2019 (photo credit Cheryl Bougie)

A primary goal is to benefit multiple fish and wildlife populations that were injured by PCB contamination, primarily by adding and improving habitat that was previously degraded or lost. Much of the project footprint was dredged as part of the Fox River Cleanup efforts to remove PCB contaminated sediments, likely resulting in the removal of coarse woody habitat and other substrates for fish and macroinvertebrates (Figure 24). Replacing some of this habitat in areas that were dredge or capped would be a key component of this project by providing benefit for multiple groups of native fishes including muskellunge, centrarchids, yellow perch and catfish which are the primary monitoring species.

The DNR conducted an electrofishing stream survey in the lower reaches of Ashwaubenon and Dutchman Creek in August of 2015. In Ashwaubenon Creek, a total of 178 fish representing 13 different species were sampled. These were dominated by creek chub (48.3% of total catch), white sucker (19.7%), johnny darter (10.7%) and black bullhead (10.1%) followed by round goby (3.9%), northern pike (2.3%), and yellow perch (1.7%). Although fish abundances here may be lower in August compared to other times of the year, the fact that only 3 total centrarchids and 3 yellow perch were sampled in this one survey emphasize the need for habitat improvements. In Dutchman Creek, a total of 446 fish representing 16 different species were sampled; These were dominated by round goby (36.8% of total catch), yellow perch (13.5%) and creek chub (12.3%) followed by emerald shiner (8.1%), johnny darter (7.9%), central mudminnow (7.9%) and white sucker (7.2%). Here only 8 total centrarchids (1 largemouth bass and 7 green sunfish) were sampled in this one survey emphasizing the need for additional habitat improvements.

Additionally, in May of 2016 – 2019, the DNR set 4 fyke nets from Voyageur Park to the Highway 172 bridge as part of its Fox River musky egg collection efforts. Combining the results of all fyke nets and years, a total of 1471 fish, representing 27 species were sampled. These were dominated by white bass (19.2%), longnose gar (13.5%) and musky (10.7%), followed by white perch (9%), walleye (7.9%), smallmouth bass (7.2%), common carp (6.1%), channel catfish (3.9%), freshwater drum (3.5%), and quillback (3.2%). Centrarchids represented 14.1% of the total catch. Although these surveys were not conducted within the actual project area, they are representative of the resident species that would be expected to occupy this area.

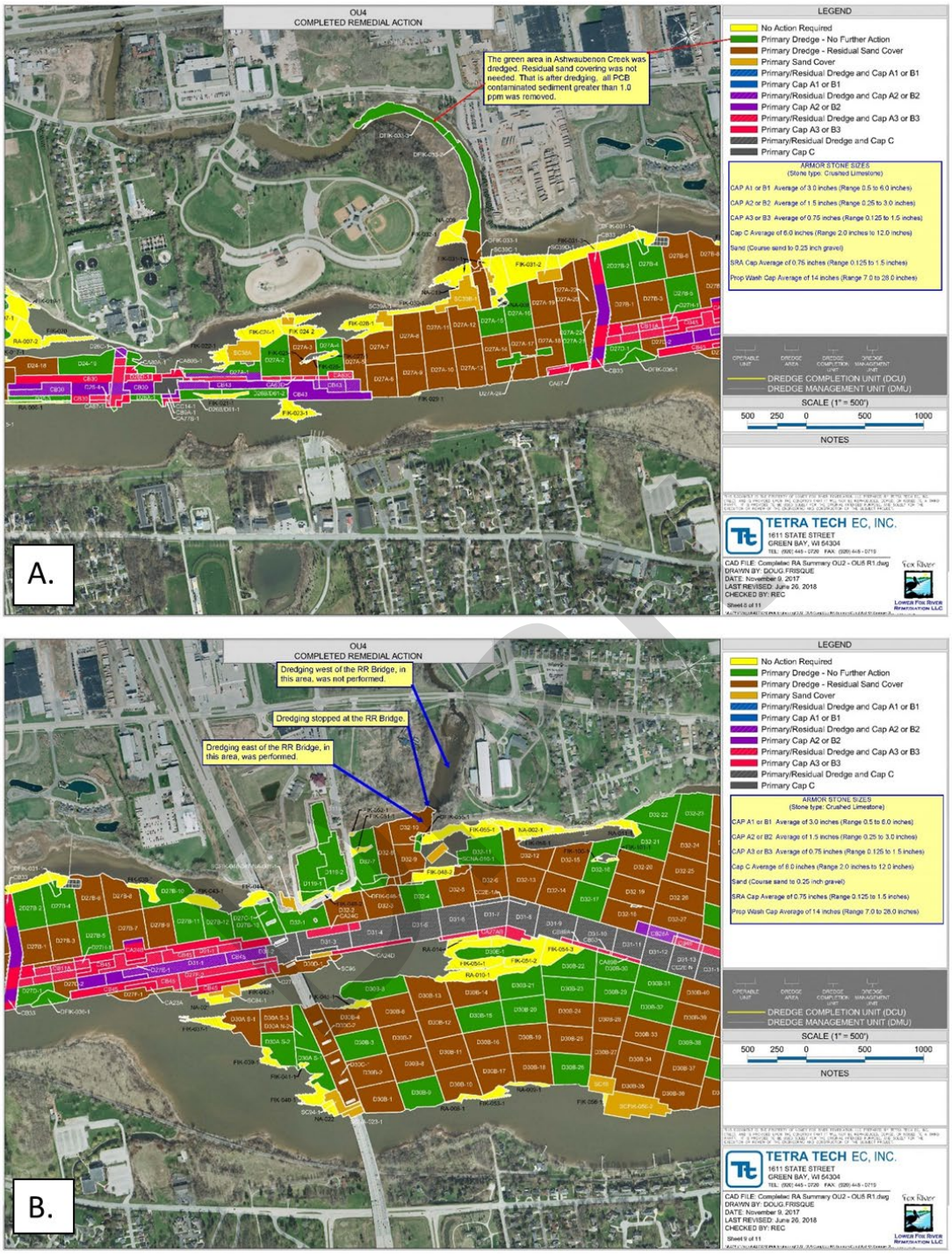


Figure 24. A. Map of remedial actions completed in the mouth of Ashwaubenon Creek and area adjacent to the Fox River as part of the Fox River Cleanup project. B. Map of remedial actions completed in the mouth of Dutchman Creek and area adjacent to the Fox River as part of the Fox River Cleanup project.

Another important element of this project will focus on the opportunity to restore native freshwater mussel species within the project footprint. A 2018 survey conducted in Ashwaubenon Creek by the DNR Natural Heritage Conservation program found a total of 5 native mussel species, though one species was observed as a dead shell only. Historical mussel records in the same footprint found evidence of only one native mussel species, suggesting that native mussels are potentially colonizing Ashwaubenon Creek more recently from 1 km of the Fox River. Furthermore, only one native mussel species was observed in Dutchman Creek in a 2018-2019 DNR study also emphasizing the need to pair habitat enhancements with native mussel species that would benefit from this project's target host fish.[70]

Notably, while native mussel densities were relatively low, Ashwaubenon Creek had relatively high replacement ratios and the highest percent of juvenile species observed compared to other sites evaluated in the AOC, suggesting to some natural recruitment within the creek is occurring. However, the most frequently observed species, *Pyganodon grandis* (giant floater) is considered an opportunistic native mussel species whose populations experience significant fluctuations from year to year and can tolerate poor water quality. As such, this species is not necessarily representative of areas that can support stable mussel populations, though a five-year old *Quadrula quadrula* (mapleleaf – a Wisconsin Special Concern and Protected native mussel species) and six-year old *Lasmigona complanata* (white heelsplitter) were also observed in Ashwaubenon Creek in 2018. These results suggest that current environmental conditions can support native keystone mussel species exhibiting more stable population dynamics and emphasizes the need to pair habitat enhancements for preferred mussel species with enhancements for host fish.

Additionally, a 2019 zebra mussel colonization survey completed by the DNR Water Quality program found low colonization relative to five other sites evaluated in the AOC (Figure 25). This suggests that the softer sediments of Ashwaubenon Creek are conducive to native mussel survival by allowing native mussels to bury themselves to slough off non-native zebra mussels. Taken in whole, both zebra mussel colonization and native mussel species surveys suggest that current environmental conditions can support at least some natural recruitment by opportunistic mussel species, though improvements in water quality and mussel habitat may provide opportunities for restoration of more stable native mussel species and tributary fish habitat.

[70] Weinzinger and Kitchel, 2020. Investing Native Mussel Communities Within Nearshore Habitats

Figure 25. Results from the 2019 zebra mussel colonization study. Ashwaubenon Creek was observed to have low zebra mussel colonization relative to five other sites evaluated.

Anticipated improvements are focused on increasing the quality and extent of natural/high quality tributary habitats that serve critical life history functions for multiple species of fish, native freshwater Unionid mussels, and stream macroinvertebrates but have been lost across the area because of dredging, filling, erosion, development, and invasive species. In-water restoration will encourage the development of multiple life stages of fishes – including spawning and nursery habitat, which is a crucial step towards restoring a diverse and self-sustaining fish community in the lower Fox River. These sites represent two of four anticipated projects in the Fox River that will work to create suitable muskellunge (and other fish) spawning and rearing areas; thereby, creating a corridor of habitat suitable under various environmental/climactic conditions. These fish populations serve important cultural and recreational purposes and are critical food sources to local wildlife including colonial nesting birds, water birds, piscivorous raptors, and furbearers among others. Therefore, by enhancing habitat and potentially bolstering fish populations, the impacts of legacy contaminants can be mitigated over time at multiple trophic scales. Additional habitat improvements will focus on invasive species treatments in Hardwood Swamp and Riparian Emergent Marsh areas. Finally, the design will

consider bioengineered bank stabilization along the shorelines to better infiltrate/filter storm water runoff from the adjacent shoreline properties to improve water quality and habitat value for stream macroinvertebrates and native fish.

Project Scope and Priority Habitats/Populations Benefited

Priority Habitats

Proposed habitat improvements within the Ashwaubenon and Dutchman Creek project are anticipated to provide direct benefits to 9 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

The table below shows priority habitats that have been mapped within the Ashwaubenon and Dutchman Creek project boundary and how baseline and post-implementation BUI condition scores were derived (Table 32).

Table 32. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundaries	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Riparian Emergent Marsh	3.23 x 0.50	**1.62**	3.50 x 0.65	**2.28**
Submergent Marsh	16.91 x 0.50	**8.45**	20.00 x 0.65	**13.00**
Inland Emergent Marsh	0.35 x 0.45	**0.16**	0.35 x 0.65	**0.23**
Hardwood Swamp	35.5 x 0.40	**14.20**	35.5 x 0.65	**23.08**
Old Field Grassland	2.47	**2.47**	1.47	**1.47**
Restored Grassland	0.00 x 0.50	**0.00**	1.00 x 0.65	**0.65**
Quantity (acres or km) x Management Based Metrics				
Inland Open Water	0.20 x 0.25OW	**0.05**	0.20 x 0.50OW	**0.10**
Designated Habitat Area Based Metrics				
Fox River Open Water	0.00	**0.00**	1.00 Fox River Fish	**1.00**
Tributary Open Water	1.00 + 0.50 Tributary Fish + Native Freshwater Mussels	**1.50**	2.00 + 2.00 Tributary Fish + Native Freshwater Mussels	**5.50**

Much of the project scope will focus on vegetation management activities to improve floristic quality in existing habitat acreages/lengths (e.g., removal of invasive species, addition of higher quality native species). These activities will improve the BUI condition score for all Quantity x Quality and Quantity x Management based priority habitat metrics. A primary goal is to add or improve Riparian Emergent and Submergent Marsh to form a complex of riparian, submergent, and additional woody and rocky substrates for fish and native mussels. Additionally, improving the quality of 35.5 acres of Hardwood Swamp and converting Old Field Grassland into Restored Grassland will contribute the overall project goal.

A crucial element of the project area is to protect and improve the shoreline and reestablish in-water habitat within the Fox River. The Tributary Open Water area currently provides 1.5 DHA point, while 0.0 DHA are provided for Fox River Open Water due to lack of important habitat for Fox River Fish and Freshwater Unionid Mussels. Substrate enhancement (targeting Muskellunge and Centrarchids), shoreline improvements, and native mussel propagation efforts will create a 5.0 DHA points for the Tributary Open Water (3.0 for Tributary Fish and 2.5 for Freshwater Unionid Mussels) and 1.0 DHA point for Fox River Open Water when the project is fully implemented.

A storm water pond at Ashwaubomay Park is currently considered to have “Low Quality” Open Water metric, indicative by 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.). The goal is to improve this shoreline and in-water habitat to a “Moderate Quality” Open Water metric, indicative of some higher quality shoreline and SAV, and evidence of higher quality fish or wildlife utilization (e.g., waterfowl, snails/amphiponds/blackfly larvae, shiner spp./centrarchids/percids/escocids, etc.).

Priority Populations

Proposed habitat improvements within the Ashwaubenon and Dutchman Creek project are anticipated to benefit 16 of the 18 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year for the IEC and Count-Based metrics, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 33 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 33. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	Metric Type	Metric Assessment Methodology	Data Source
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Breeding Coastal Birds	Count-Based	Number of sites with breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	Contractor
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	Contractor + DNR
Stream Macroinvertebrates	Count-Based	Average Citizen Monitoring Biotic Index across six sites	DNR + Citizen Science
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Native Freshwater Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Tributary Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR

A total of 4.0 DHA points for Tributary Open Water can be designated for this project (2.0 for Tributary Fish and 2.0 for Freshwater Unionid Mussels), though additional verification monitoring will be required to demonstrate utilization by target species. Additionally, 1.0 DHA points for Fox River Open Water can be designated for this project for Fox River Fish. The primary monitoring targets for Tributary adult and juvenile/YOY species are Centrarchids and

Yellow Perch, and the primary monitoring targets for Fox River adult and juvenile/YOY species are Muskellunge and Channel or Flathead Catfish. Additional points will be awarded for observed utilization by Rare/Sensitive fish species. Any observed Opportunistic, Stable/Keystone, or Rare/Sensitive Freshwater Unionid Mussels will count toward the BUI condition score, but habitat enhancements and propagation efforts will focus on native mussels that use centrarchid species as host fish to complete their life cycle. DNR Natural Heritage Conservation program will work with OGW to provide recommended native mussel species propagation and provide post-implementation monitoring efforts.

As described above, DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 34 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 34. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	1.0	0.0	**1.0**
Coastal Terrestrial Macroinvertebrates	0.0	2.0 Upland	**2.0**
Migratory Landbirds	0.0	1.0	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

If implemented, the Ashwaubenon and Dutchman Creek project represents an 8.3% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 12.3% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

The Village of Ashwaubenon, with support from DNR, will request NRDA funding for their selected consultant (Stantec) to design, implement, and maintain/monitor phases of this project.

DNR, the Village of Ashwaubenon, and Stantec will collaborate as a Project Management Team, and will solicit technical expertise from a number of partners, including but not limited to: NEW Water, USFWS, The National Railroad Museum, Brown County, and the City of Green Bay.

In addition to soliciting technical expertise, the Project Management Team will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase.

Project Timeline and Estimated Cost

An initial proposal to support planning and design for this project was developed and submitted in 2023 to secure funding to begin in 2023; this funding was requested through the Fox River NRDA. A second proposal will be developed and submitted in early 2024 to secure funding for both the implementation and maintenance phases beginning in 2024 (Table 35). Given the need to complete planning and design for this project, implementation and maintenance costs are contingent upon the completion of the planning and design phase. The total estimated cost for this project is $3,000,000 with cost estimates generated in consultation with GEI Consultants.

Table 35. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2023	2024	2025	2026	2027	2028	2029	2030
Planning/Design	$150,000							
Implementation		$2,850,000						
Maintenance								

Some early cost-sharing opportunities that were identified by the TAC and City of Green Bay are:

- Fox River NRDA
- Great Lakes Fishery Trust
- DNR River Protection and Planning Grant
- Fund for Lake Michigan
- Wisconsin Coastal Management Program

Additionally, existing, or historic investments have been made in the area surrounding Ashwaubenon and Dutchman Creeks including:

- 2016 improvements to 13.8 acres of hardwood swamp and southern mesic forest, installation of platforms for colonial rookery nesting birds, native herbaceous plantings in riparian and submergent marsh areas, and various fish habitat structures along the confluence of Ashwaubenon Creek and the Fox River (NRDA; $140,000)
- West De Pere High School and Green Bay East High School have actively monitored water quality characteristics in Ashwaubenon Creek since 2006\

- NEW Water (Green Bay's metropolitan sewerage district) has opted to pursue adaptive management in the Ashwaubenon Creek and Dutchman Creek watersheds to achieve point source compliance for the facility's new total phosphorus and total suspended solids limits
- Ashwaubenon High School teachers and students ran volunteer monitoring of water quality in Dutchman's Creek from 2011-2017
- Parkview Middle School teachers and students took over volunteer water quality monitoring in 2019

Project Maintenance

The Village of Ashwaubenon will maintain nearshore habitat improvements, and in-water coarse woody habitat/rocky substrates are not anticipated to require maintenance in Ashwaubenon Creek. Riparian landowners (City of Green Bay & Brown County) will maintain shoreline improvements at the Dutchman Creek project area. In-water coarse woody habitat and rocky substrates are not anticipated to require maintenance, but in the event that maintenance is required, DNR and other local partners will work together to complete it.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

Both the Ashwaubenon and Dutchman Creek project sites are located in places readily accessed by members of the community. The work associated with Ashwaubenon Creek will take place at Ashwaubomay Park. The 84-acre park includes sports fields, shelters, a swimming lake, picnic areas, walking trails, and a bridge with fishing piers. Beyond these amenities, there are many community events held at Ashwaubomay Park every year. Dutchman Creek bisects the National Railroad Museum, another site that is important to the community. More than 100,000 people visit the National Railroad Museum each year from around the country to view the exhibits, take train rides, and attend events. It is essential to partner with those already utilizing these sites and those who live in the surround neighborhoods to ensure that the proposed project will improve access to the Fox River shoreline, increase potential educational opportunities, and encourage stewardship of the enhanced natural resources.

Selected responses to the potential social/economic benefits associated with the Ashwaubenon and Dutchman Creek project include:

- "Great opportunity to enhance habitat in an area where public education can also be leveraged and community members can benefit from the wildlife and aesthetic improvements."
- "If their is fishing piers do we need to improve them for the handicapped like installing vertical railings no horizontal for easier access to the fish with a net when needed..."

- "This reach is visible to the general public and would also be a benefit to improvement of local tributaries as they are restored to a more natural confluence with the Fox River."

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the Ashwaubenon and Dutchman Creek project is within a census track that has been identified as disadvantaged, citing low income and low life expectancy. During design, this project will focus on including elements intended to improve access to the shoreline at both Ashwaubenon and Dutchman Creek sites.

Please see Appendix 4 for the full EJ Screen Community Report for this census tract.

Climate Change

In recognition of the substantial impact of climate change, the Ashwaubenon and Dutchman Creek Project will be designed to bolster the resiliency of this system. This project will include elements of stream bank stabilization along the Fox River shoreline stretches to reduce the impacts of increased wave energy and fluctuating water levels and increase quality of multiple priority habitats. Within Dutchman Creek the project focuses on stream bank erosion reduction by installing point bars to encourage sedimentation accumulation, decrease the velocity of flow, and direct water away from the stream banks. Inclusion of emergent and submergent aquatic plant beds will increase climate resiliency by increasing habitat size and heterogeneity. In turn there will be expansion and diversification of habitat niches and enhanced food-web complexity, promoting an increase in extant and new, colonizing riverine wetland associated species. The establishment of habitat structures will increase spawning, refuge habitat, and passage for muskellunge, centrarchids, and other fish species. These actions ultimately aim to bolster natural recruitment in fish populations, improving their persistence when faced with extreme conditions that reduce or prevent successful spawning or rearing during some years, Finally, this project will include the management of invasive, non-native plant species in existing habitat, along with the planting of native species. The invasive species management will have a climate adaptation benefit by reducing exacerbating stressors within the system. Native vegetation selected for planting will be persistent under the more extreme temperature and precipitation anticipated with changing climate conditions.

Chapter 3 – Lower West Green Bay

Lower West Green Bay History, Special Features, Priority Fish and Wildlife Habitats and Populations, Recreational Access, and Restoration Goals

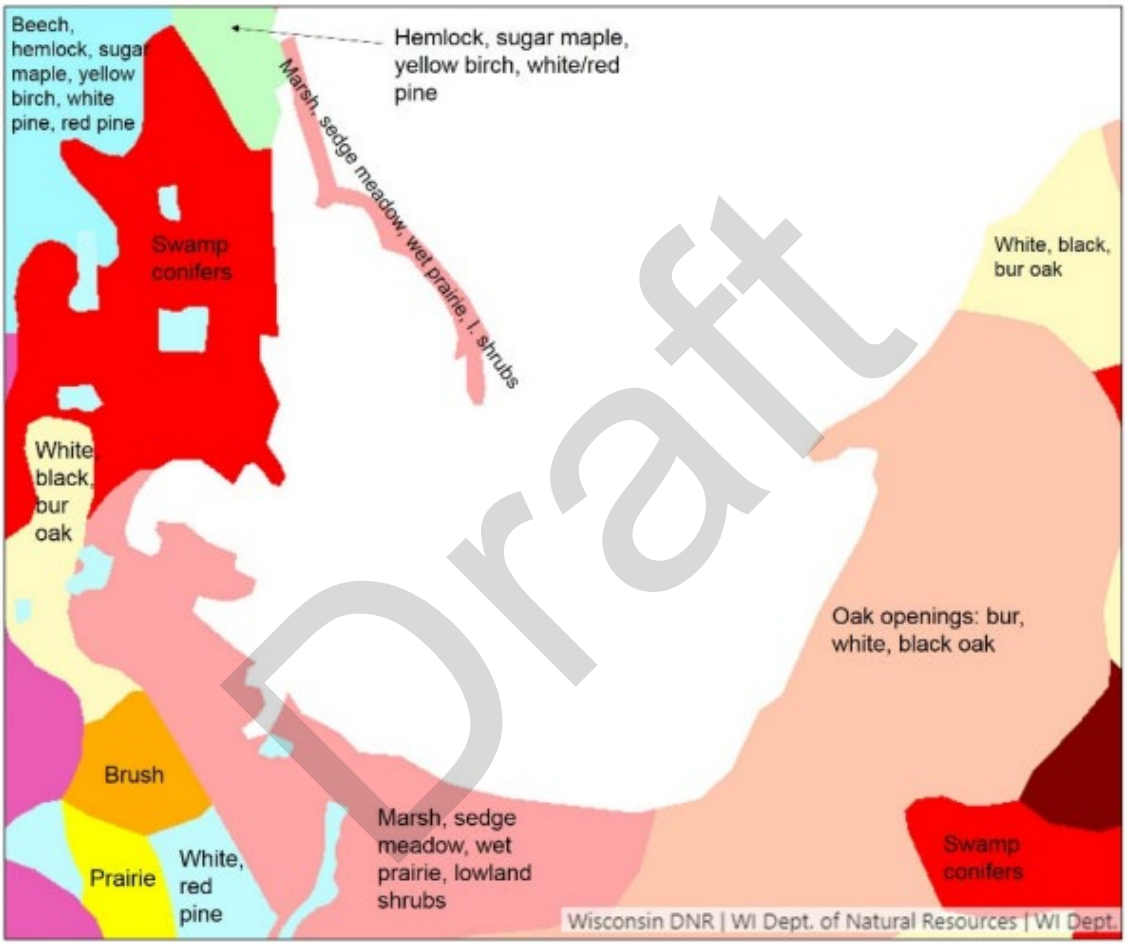
The Lower West Green Bay priority area is separated from Lower East Green Bay by the Green Bay Navigational Channel, though other factors make it unique. While Fox River water quality does influence Lower West Green Bay, the Fox River water current largely travels along the eastern shore to Sturgeon Bay.[71] A principal tributary to the Lower West Green Bay portion of the AOC is Duck Creek, which drains the 152 mi^2 Duck Creek subwatershed, the second largest HUC10 subwatershed in the Lower Fox River Basin.[72]

Land use in the watershed is predominately agricultural in the headwaters, though several areas have residential growth occurring in both MS4 and urban non-permitted areas. These land use changes have led to the conversion of approximately 70% of the original wetlands within the watershed, causing flashy stream characteristics and excessive sediment and nutrient loading into the Duck Creek tributary. Conservation practices to reduce sediment loss in the Duck Creek watershed have been ongoing since it was selected as a priority watershed in 1994, and more recently 9 Key Element implementation under the Total Maximum Daily Load (TMDL) program.[73,74]

Aerial image showing sediment plume discharging from Duck Creek after rain event in April 2012 (photo courtesy Steve Seilo)

[71] Klump, J.V., D.N. Edgington, P.E. Sager, D.M. Roberston. 1997. Canadian Journal of Fisheries and Aquatic Sciences. 54: 10 – 26.
[72] DNR Duck Creek Watershed Overview
[73]Outagamie County Land Conservation Department. 2016. Upper Duck Nonpoint Source Watershed Implementation Plan.
[74] Outagamie County Land Conservation Department. 2022. Middle and Lower Duck Creek Nonpoint Source Watershed Implementation Plan.

Habitat along the west shore historically included the largest coastal wetland complex in the Lake Michigan basin, with emergent and submergent marshes, sedge meadows, shrub carr, and floodplain swamp habitat (Figure 26).[75] It should be noted that these coastal habitats interact dynamically based on annual Great Lakes Water Levels and daily seiche fluctuations in Green Bay and can change the extent of coastal wetland habitat dramatically from year to year.



[75] Howe, R.W., E.E. Gnass Giese, A.T. Wolf. 2018. Quantitative restoration targets for fish and wildlife habitats and population in the Lower Green Bay & Fox River AOC. Journal of Great Lakes Research, 44: 883-894.

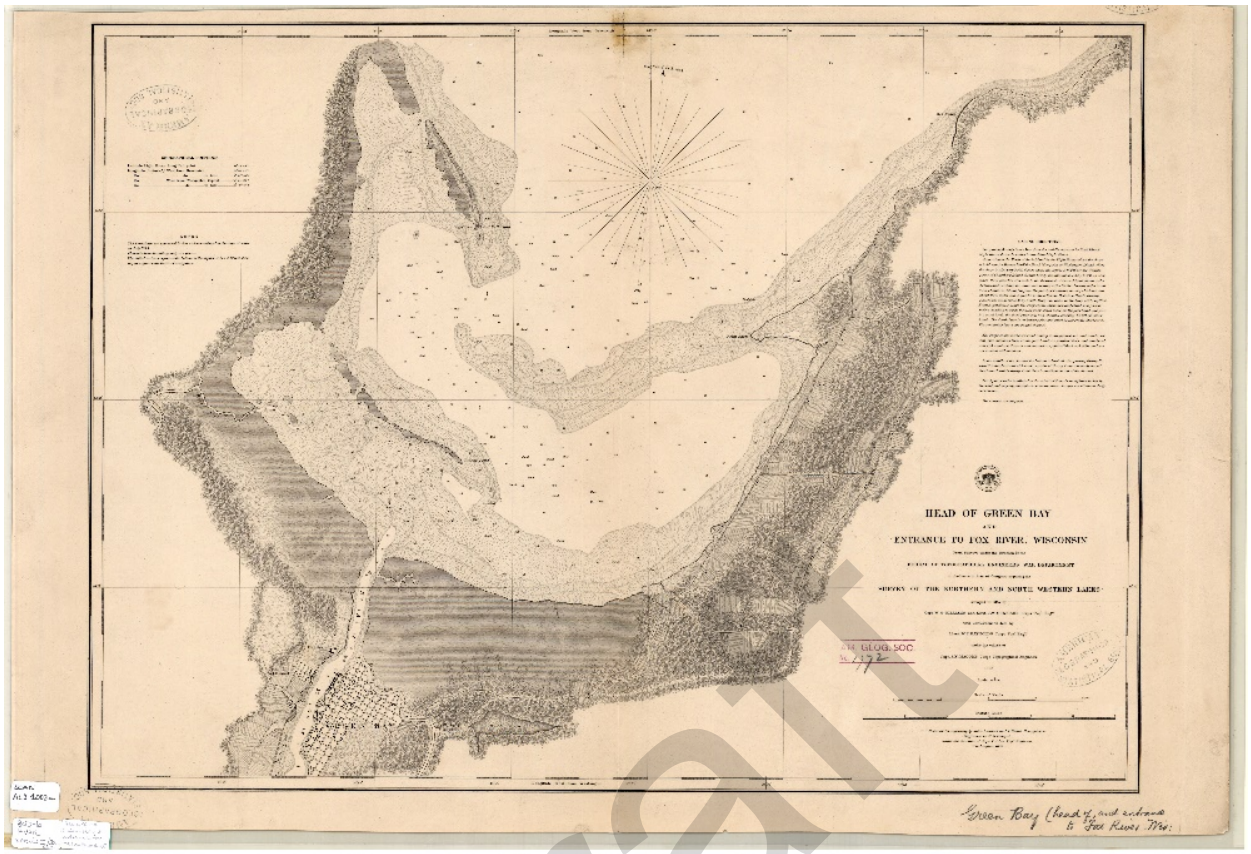


Figure 26. Top figure shows habitat map based on the original, historical vegetation from the Public Land Survey System surveys completed in the 1840's of Green Bay; bottom figure shows map of 1845 Head of Green Bay.

Father Marquette remarked on the habitat in his 1673 – 1675 Journal, stating:

> *"We left this bay [Green Bay] to enter the river [Fox River] that discharges into it; it is very beautiful at its Mouth and flows gently; it is full of bustards, Ducks, Teal and other birds, attracted thither by the wild oats [wild rice] of which they are very fond."*

Jenks' 1901 research on wild rice gatherers in the Great Lakes region also described the bay of Green Bay as "having thousands of acres of wild rice in the shallows of its waters" south of the Menominee River to the head of the Lower Bay, and waterfowl habitat surveys conducted in the 1940s by Zimmerman observed a prolific and diverse aquatic macrophyte community in Lower West Green Bay as well.[76,77]

[76] Jenks, A.E. 1901. The wild rice gatherers of the upper lakes; a study in American primitive economics. US Government Printing Office, Volume 19.
[77] Zimmerman, F.R. 1953. Waterfowl habitat surveys and food habitat studies, 1940 – 1943.

Photograph of a manmade ditch cut through Longtail Point by Zimmerman in 1941 (photo courtesy UWGB Digital Estuary Archive)

While the west shore of Lower Green Bay remains a globally important coastal wetland area, water quality degradation, habitat conversion, invasion by exotic species, and other natural and anthropogenic change has resulted in nearly 90% loss of coastal wetland habitat extent in Lower Green Bay from 1834 to 1975.[78,79] Some examples of direct habitat conversion include the filling and shoreline hardening of Atkinson's Marsh along the southwestern shoreline of Green Bay in the mid-1960s, an area once considered one of the highest-quality and largest coastal marsh complexes in the Midwest.[80] The filling of Atkinson's Marsh was implemented to create and expand an industrial park largely with dredge spoils from Green Bay and the Fox River for many decades, which has reduced the original marsh footprint to small, disjointed coastal and inland marsh remnants such as the Tank Farm Marsh area that persists today.

Additionally, a series of natural sandbar islands known as the "Cat Island Chain" was lost as a result of prolonged high-water levels in Lake Michigan in the 1970s, exacerbated by a succession of strong storm events and increased wave refraction from hardening of the southwest shoreline of Green Bay.[81] This island chain once buffered roughly 1500 acres of leeward coastal wetland habitat known as the Duck Creek Delta from extensive wave, wind, and ice scour characteristic of the open water portions of Green Bay. The loss of the Cat Island Chain strongly coincided with dramatic reductions in coastal wetland

[78] Howlett, G.F. 1974. The rooted vegetation of West Green Bay with reference to environmental change. SUNY – Syracuse Master's Thesis.
[79] Bosley, T.R. 1978. Loss of wetlands on the west shore of Green Bay. Transactions of the Wisconsin Academy of Sciences, Arts and Letters, 66: 235 – 245.
[80] Scharf, W.C. 1979. Nesting and migration areas of birds of the U.S. Great Lakes (30 April to 25 August 1976. USFWS Office of Biological Services. FWS/OBS-77/2. 113 pp.
[81] Frieswyk, C.B. and J.B. Zedler. 2007. Vegetation changes in Great Lakes coastal wetlands; Deviation from the historical cycle. Journal of Great Lakes Research, 33: 366 – 380.

extent and diversity in the Duck Creek Delta post-1970, and this habitat loss contributed, in part, to the designation of the AOC.[82]

As a result, AOC stakeholders worked diligently through the RAP process for decades to identify a means of restoring the lost sandbar island habitat and to re-establish protection to the leeward coastal wetland. This came to fruition in 2012, when GLRI funding supported the implementation the Cat Island Restoration Chain; a nearly 2.5-mile-long wave barrier constructed along the original footprint of the sandbar island chain. The primary goal of the project is to house clean dredge material from the Port of Green Bay shipping channel to eventually rebuild nearly 250 acres of terrestrial shorebird and waterfowl habitat over a 30-year period. An ancillary goal of the project is to re-establish protection to the leeward coastal wetland habitat from northeast storm events and ice scour.

Today, 17 priority habitats are represented along the West Shore, with several that have the highest acreage extent within the Lower West Green Bay priority area, including Coastal Emergent Marsh, Inland Emergent Marsh, Roadside Emergent Marsh, Hardwood Swamp, Inland Open Water, Shrub Carr, Wet Meadow, and Submergent Marsh habitat (Table 36 and Figure 27).

Table 36. Priority habitat acreages across the Lower West Green Bay priority area. Acreages and percentages in bold show which priority habitats are most dominant in this priority area.

Priority Habitat	Priority Habitat Acreage	West Shore Priority Area Habitat Acreage	Percent of Total Priority Habitat Acres in West Shore Priority Area
Coastal Emergent Marsh	860.86	**840.31**	**97.61**
Inland Emergent Marsh	322.87	**208.07**	**64.44**
Riparian Emergent Marsh	205.57	71.22	34.65
Roadside Emergent Marsh	51.29	**38.51**	**75.08**
Fox River Open Water	1,385.94	0.00	0.00
Great Lakes Beach	110.60	41.28	37.32
Great Lakes Open Water	15,591.33	5,835.74	37.43
Hardwood Swamp	1,893.32	**1,138.46**	**60.13**
Northern Mesic Forest	119.36	27.74	23.24
Open Water Inland	140.56	**73.49**	**52.28**
Other Forest	444.26	152.43	34.31
Shrub Carr	240.76	**238.59**	**99.10**
Southern Dry Mesic Forest	56.50	18.28	32.35
Wet Meadow	1.78	**1.54**	**86.52**
Submergent Marsh	614.05	**528.55**	**86.08**
Old Field Grassland	345.62	63.53	18.38
Restored Grassland	23.11	0.00	0.00
Tributary Open Water	87.39	0.47	0.54
Total Priority Habitat Acreage	22,495.17	9,728.21	43.25

[82] DNR. 1989. Lower Green Bay & Fox River Area of Concern Remedial Action Plan.

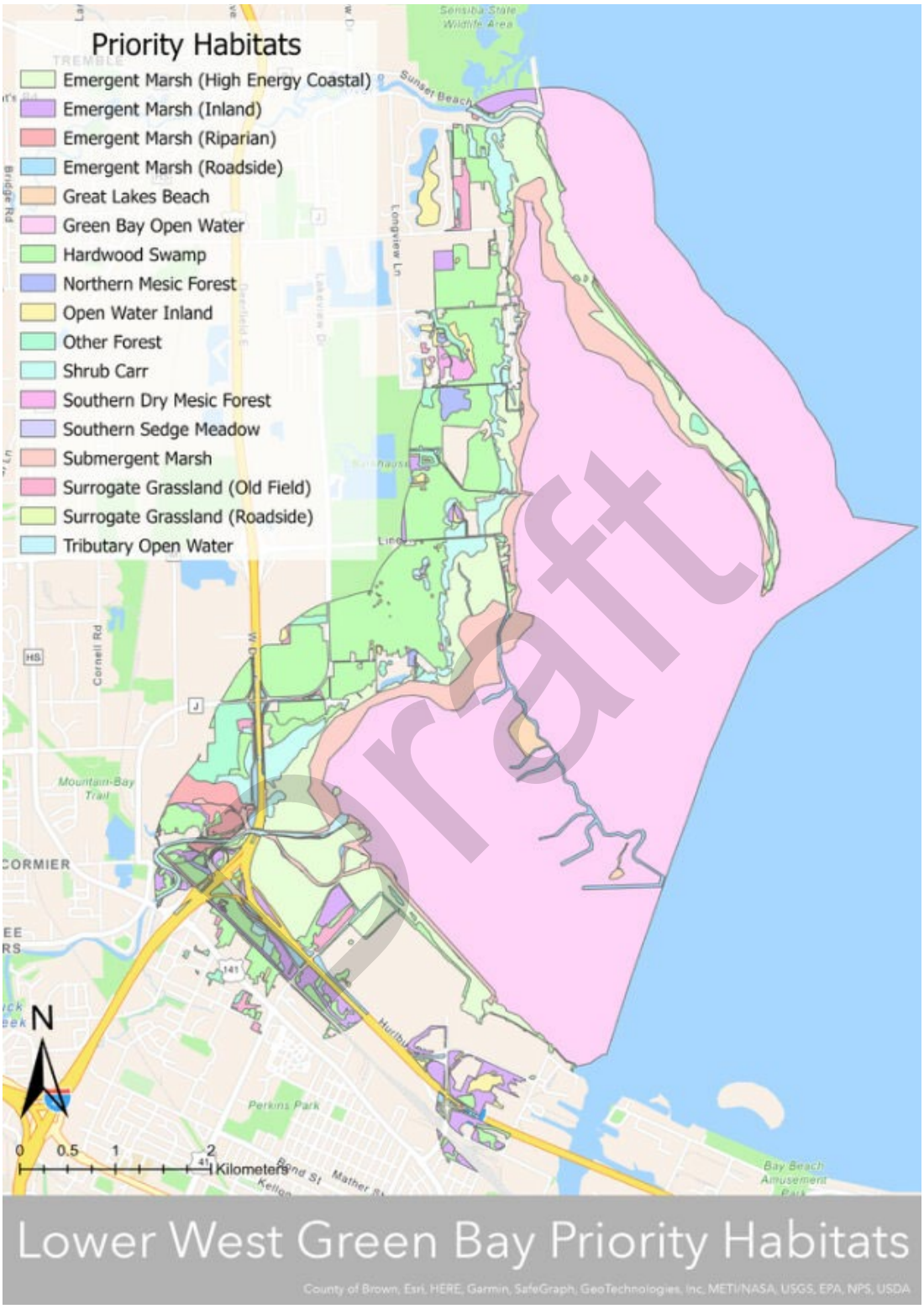


Figure 27. Lower West Green Bay priority habitat map.

Open Water Habitats

Green Bay Open Water is a significant habitat by acreage in this priority area. Impacts to this priority area are primarily degradation of water quality and substrates through nutrient, sediment, and historical toxic substance discharges from Duck Creek, Suamico River and/or the Fox River to Green Bay. The West Shore is somewhat less impacted by issues stemming from the Fox River as the currents extending from the mouth of the Fox River into Green Bay move in a counterclockwise direction up the eastern shoreline of the AOC. However, loss of wetlands in the Duck Creek watershed (the largest sub-watershed in the Lower Fox River Basin) has led to decades of extensive nutrient and sediment loading into the Duck Creek Delta.

High concentrations of total phosphorous, total suspended solids, nitrates/nitrites and chlorophyll *a* are regularly reported within the open waters of this priority area.[83] As a result, the area experiences excessive turbidity, habitat degradation, and harmful algae blooms throughout the summer into late fall, which are harmful to both aquatic organisms and humans.[84] Poor water quality in the Lower Green Bay has contributed to the decline of multiple fish species as well as mass die-offs of bird species from avian botulism and contaminated food sources.[85,86] However, the Lower Fox River PCB Cleanup project, Lower Fox River TMDL, Oneida Nation and other partner watershed restoration efforts in the Duck Creek sub-watershed, and several other habitat restoration efforts along the West Shore of Green Bay have resulted in improved sediment and water quality over the last three decades.

These efforts help support the over 80 species of fish that have been reported in the pelagic area of the lower bay. Over 100 bird species also use the open water and nearshore habitat in the lower Bay. Notably, large groups of waterfowl, waterbirds such as herons, and coastal birds such as swallows congregate to forage in several locations along the open waters of the west shore during migration and the breeding season. The largest number of migratory shorebird species in Wisconsin have been observed using Cat Island Wave Barrier and adjacent habitat as stopover areas. Hundreds of thousands of colonial waterbirds such as American White Pelican, Double-Crested Cormorants, and Gulls nest and forage on and near the Cat Island Wave Barrier and Lone Tree Island. Colonial tern species also nest on Cat Island Wave Barrier, artificial nesting platforms and created habitat islands Piping Plovers have also successful nested and reared young on the Cat Island Wave Barrier since 2016.

Benthic species such as native mussels have also historically and contemporarily been found in the pelagic and nearshore areas of west Green Bay. A 2018-2019 survey of the native mussel community in the AOC identified 18 species historically present as compared to evidence of 12 species that may remain today (either observed as living or dead shell) in locations surveyed in Duck Creek, the Suamico River and Green Bay.[87] It should be noted that this study only observed 8 living native mussel species throughout all locations surveyed in the AOC, and 67% of those observations were dominated by the tolerant species Giant Floater (*Pyganodon*

[83] NEW Water Aquatic Monitoring Program (AMP) data.
[84] Miller et al., 2023. Lower Green Bay Area of Concern Cyanobacterial Harmful Algal Bloom Study 2016 -2020.
[85] Qualls et al. 2013: State of the Bay 2013: http://www.seagrant.wisc.edu/Home/Topics/HabitatsandEcosystems/Details.aspx?PostID=1840
[86] Qualls et al. (2013) cited Kraft, C. 1982. Green Bay's Yellow Perch Fishery. Wisconsin Sea Grant Publication. WIS. SG.82-725
[87] Weinzinger and Kitchel, 2020. Investing Native Mussel Communities Within Nearshore Habitats

grandis) and Mapleleaf (*Quadrula quadrula)*. While the study found evidence of native mussel recolonization through natural recruitment in Duck Creek, one reason for this may be that softer substrates in Duck Creek allow native mussel species to burrow and resist fouling by invasive dreissenid mussels. In general, key management strategies for native mussel re-colonization in the AOC include stream habitat restoration, water quality improvements, and propagation of areas with suitable benthic substrates, hotspots of host fish, appropriate water quality and food resources.

The Western Lower Green Bay has one substantial tributary (Duck Creek) and several smaller unnamed/named tributaries contributing to **Tributary Open Water** habitat for macroinvertebrates and other priority populations. Stream macroinvertebrate surveys conducted in 2019 found Duck Creek to be in "poor" condition, and four additional drainage areas to be in "fair" condition (Figure 28). As such, improvement of riparian and benthic habitat in Duck Creek is likely to improve priority populations of Native Unionid Mussels, Stream Macroinvertebrates, and Tributary Fish among others.

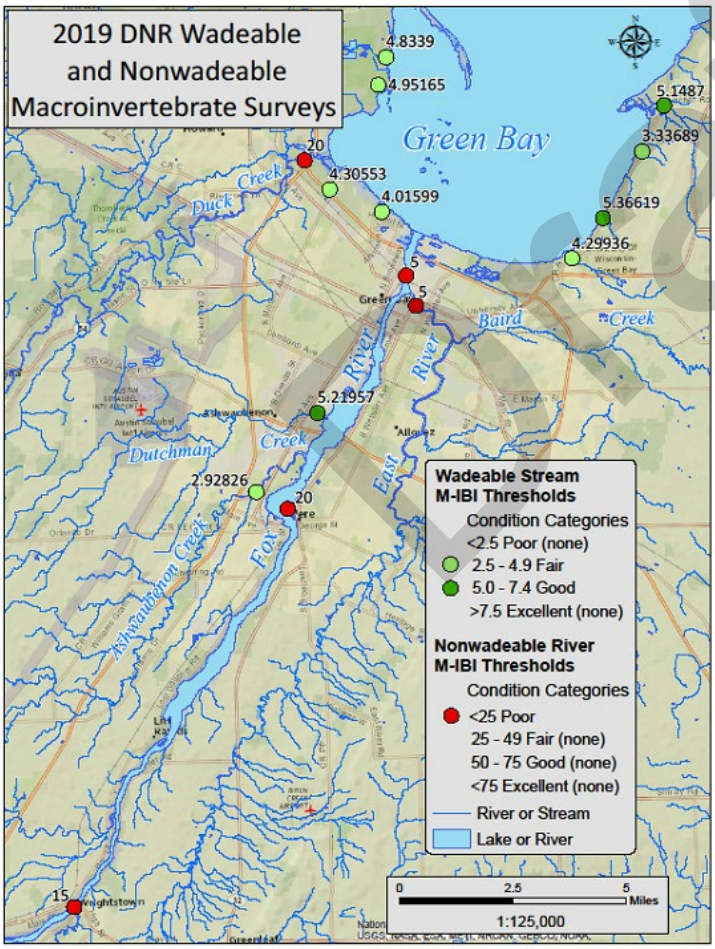


Figure 28. Wadeable macroinvertebrate index of biological integrity (M-IBI) and nonwadeable river M-IBI thresholds for several tributaries in the AOC and its watershed basin.

Additionally, a recent benthic community and habitat suitability assessment documented improvements in species richness and diversity in benthic communities in the AOC in 2019-2020 when compared to 1978 (Figure 29), though the benthic species present still reflect a eutrophic to highly eutrophic system.[88] Water quality and habitat restoration efforts in the west Green Bay priority area are therefore likely to improve not only the Loss of Fish and Wildlife and Degradation of Fish and Wildlife Populations BUIs, but also the Degradation of Benthos BUI.

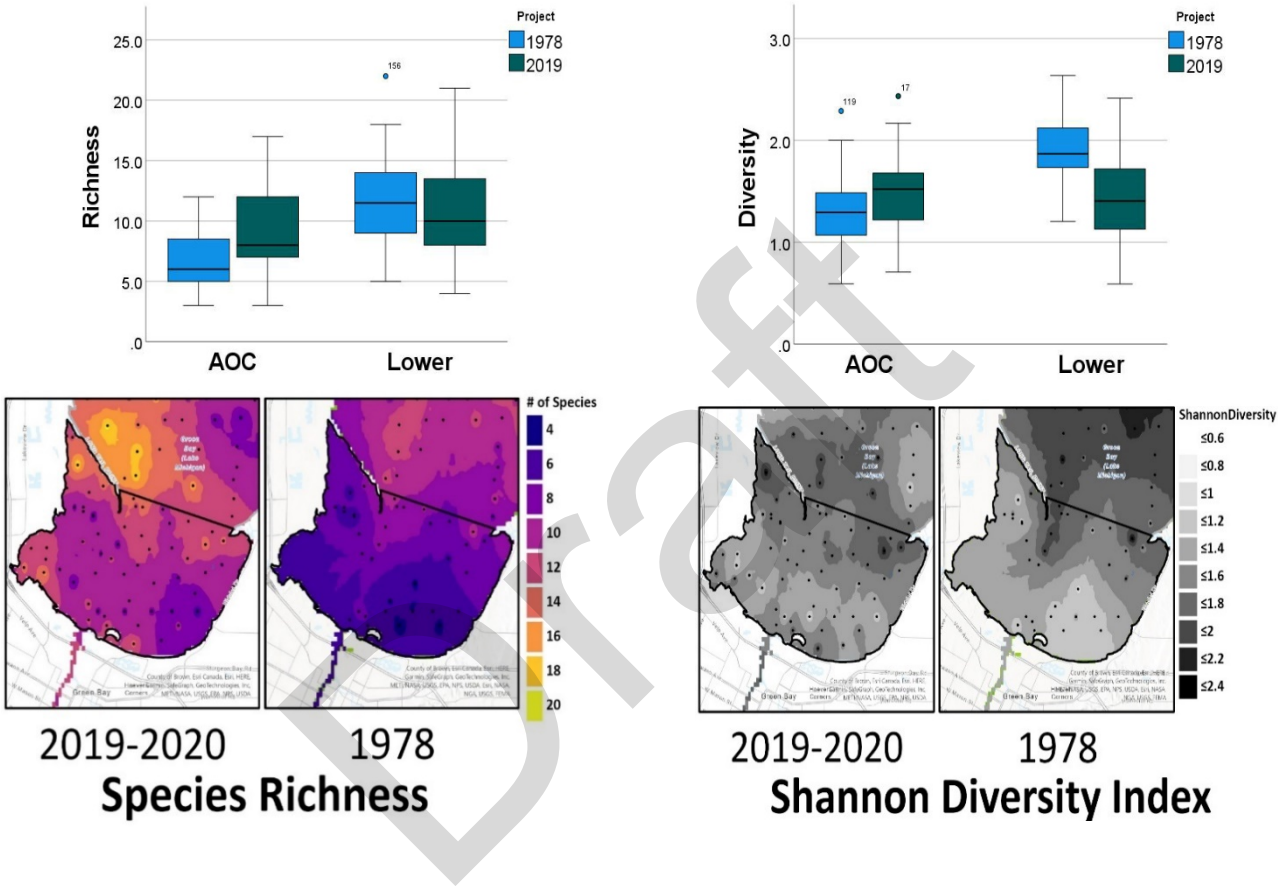


Figure 29. Species richness and Shannon diversity index values for benthic invertebrate collected within lower Green Bay during 2019-2020, compared to 1978 (Markert 1982). Richness values are number of identified taxa per site and diversity the Shannon Diversity index of each site. Boxplots indicate median, quartiles, and range of data (whiskers) with outliers individually labeled. Predictive "heat maps" are inverse distance weighted interpolation results.

[88] Houghton, C. 2022. Benthic Macroinvertebrate Community Assessment of Lower Green Bay. Final Report for GLRI Grant # GL00E02456.

The primary assessment methodology for open water habitats in the AOC is designating important/high-quality habitat areas for spawning, rearing, and feeding for fish and native mussel priority populations (i.e., DHAs). The TAC evaluated **Green Bay Open Water** and **Tributary Open Water** habitats along the west shore to designate as DHAs using USFWS AIS, DNR Fisheries, and DNR Natural Heritage Conservation program data. The group determined that the following DHAs currently occur within the Lower East Green Bay priority area (Table 37):

Table 37. Green Bay Open Water and Tributary Open Water DHAs in the Lower West Green Bay priority area:

DHA	Priority Population Utilization	Points Contributed to Habitat Condition Score
Cat Island Wave Barrier	Shoreline Fish	1.0
Shoreline extending from Cat Island Wave Barrier to Longtail Point	Shoreline Fish	1.0
Duck Creek Delta	Shoreline Fish	0.5
Duck Creek	Tributary Fish Native Freshwater Mussels	0.5 0.5
West Shore Tributaries	Tributary Fish	0.5

Nearshore Habitats

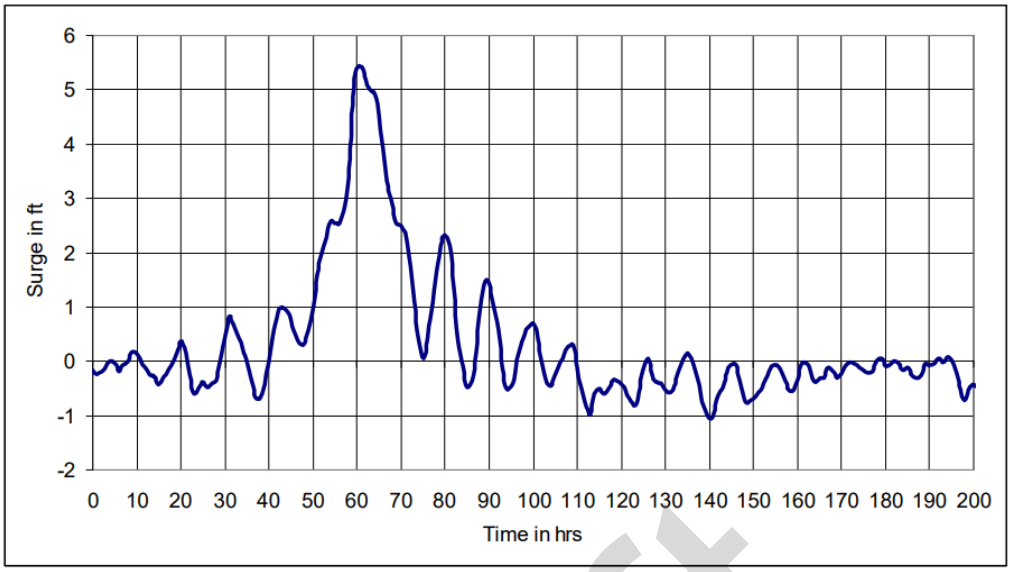
By far, some of the most important priority habitats along the nearshore of the West Green Bay Priority area include **Coastal Emergent Marsh**, **Submergent Marsh** and **Wet Meadow** wetland complexes. These and other priority habitats are heavily impacted by water levels through wind-driven seiche events that result in an average 9-inch water level fluctuation daily, and through storm surges that can increase water level fluctuations by several feet (Figure 30).[89,90]

In addition to the daily seiche and intermittent storm surge water level changes, these priority habitats are also impacted by changes in annual Lake Michigan water levels driven by several regional factors (e.g., precipitation, ice cover, etc.). These dynamic water levels lead to an extremely dynamic coastal wetland complex observed in lower Green Bay in terms of annual extent/acreage of various wetland types, location of the land/water interface, species observed, species characteristics, and other factors (Figure 31).[91]

[89] US Army Corps of Engineers, Engineer Research and Development Center. 2012. Wave Height and Water Level Variability on Lakes Michigan and St. Clair. ERDC/CHL TR-12-23. 183 pp.

[90] Trebitz, A.S. 2006. Characterizing Seiche and Tide-driven Daily Water Level Fluctuations Affecting Coastal Ecosystems of the Great Lakes. Journal of Great Lakes Research, 32: 102 -116.

[91] Klump, J.V., J. Bratton, K. Fermanich, P. Forsythe, H.J. Harris, R.W. Howe, J.L. Kaster. 2018. Green Bay, Lake Michigan: A proving ground for Great Lakes restoration. Journal of Great Lakes Research, 44(2018): 825-828.



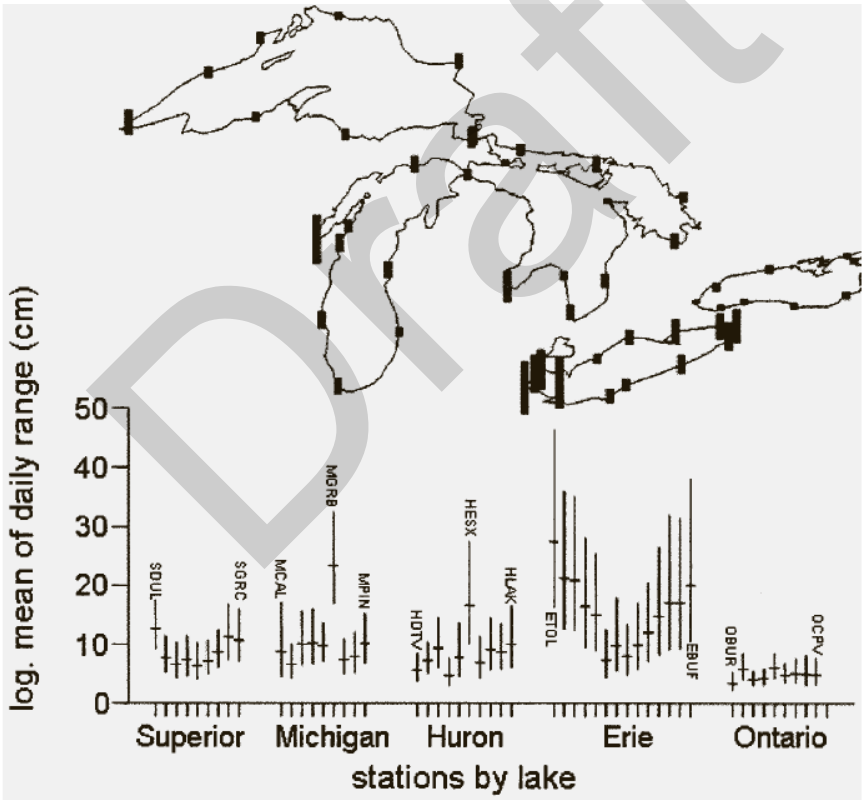


Figure 30. Top image shows time series of measurements from Green Bay water level gage showing both storm surge and seiche for storm on December 3rd, 1990; bottom image shows comparison of daily water level ranges across several locations in the Great Lakes.

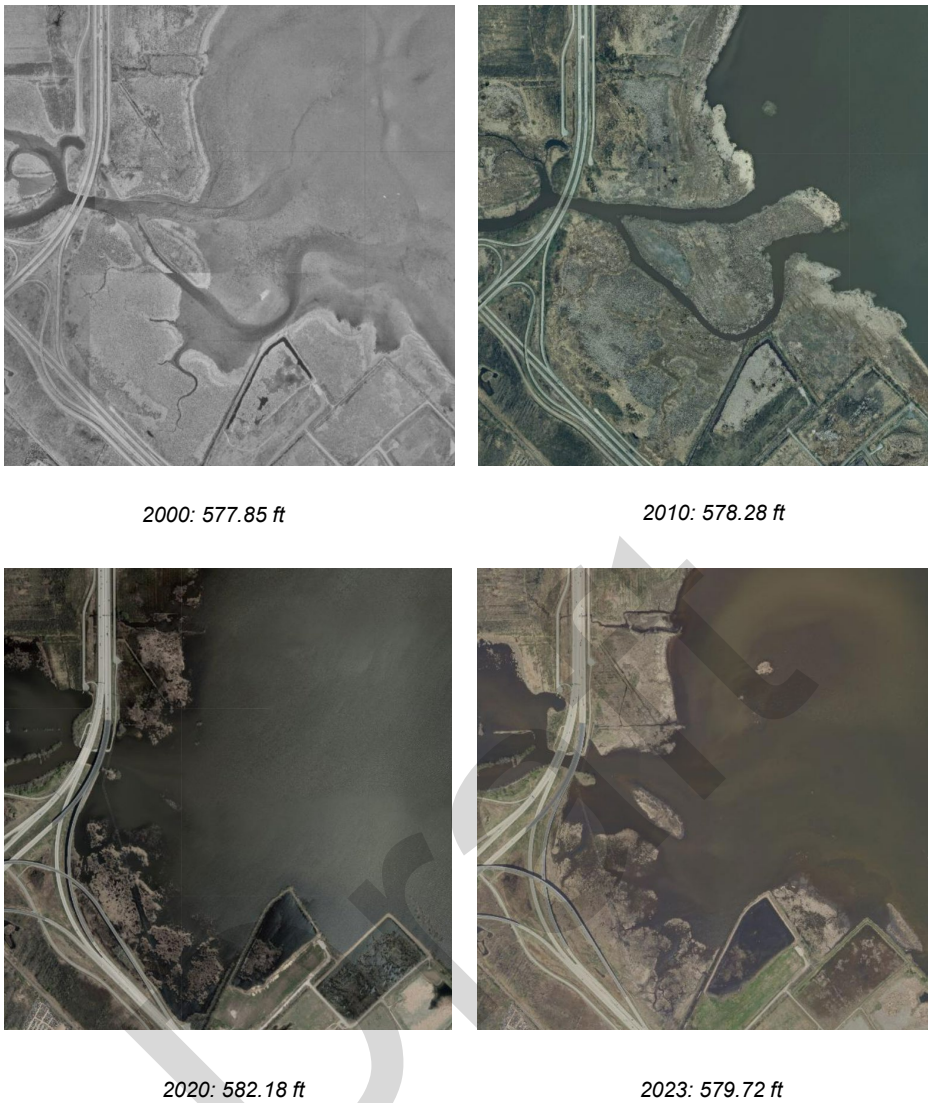


Figure 31. Aerial photo panel demonstrating how water level changes influence coastal wetland complexes in the West Green Bay priority area within the Duck Creek Delta. Each photo is captioned with the year it was taken and average Great Lakes water level in July of that year.

The primary assessment methodology for marsh and wet meadow priority habitats considers both total acreage and floristic quality. Historically, coastal wetlands along the west shore of Green Bay were much more prevalent than they are today, making increases in coastal wetland extent a primary goal for achieving the Loss of Fish and Wildlife BUI target. Much of these efforts to increase the overall coastal wetland complex acreage and improve floristic quality will occur in the Duck Creek Delta, though additional improvements such as managing invasive species will also occur in coastal, inland, and roadside emergent marsh habitat occurring at several project locations throughout this priority area. These activities are expected to benefit myriad fish and wildlife populations, including aquatic-dependent mammals such as muskrat,

mink, otter, and bats, wetland tern species and other birds, and fish such as northern pike that frequent spawn in the coastal marshes of Green Bay.

Forests and woodlands have and continue to be dominant habitat along the west shore of Green Bay. While some changes in forest composition have certainly occurred over time, **Hardwood Swamp, Northern Mesic Forest, Southern Dry Mesic Forest,** and **Other Forest** are well-represented along the west shores of Green Bay as compared to the two other priority areas in the AOC. Additionally, nearly all **Shrub Carr** habitat occurs within the West Green Bay priority area. All of these priority habitats are impacted by invasive species such as European buckthorn (*Rhamnus cathartica*), Glossy buckthorn (*Frangula alnus*), Showy bush honeysuckle (*Lonicera x bella*), Common Reed (*Phragmites australis*), and Garlic Mustard (*Alliaria petiolata*). The primary assessment methodology for forest habitat considers both total acreage and floristic quality. While limited opportunities exist to expand forest habitat, substantial opportunity to improve floristic quality in the current extent of priority forest habitats exists near the Duck Creek Delta and Longtail Point.

Another important habitat that occurs in smaller natural and man-made patches throughout this priority area is **Inland Open Water**, with the largest natural open water area located within the Tank Farm Marsh. This habitat type is particularly important for priority populations such as anurans, turtles, macroinvertebrates, and several other fish and bird species. The primary assessment methodology considers the number of acres of inland open water that are in different qualitative quality categories to calculate an Open Water metric (OW). There is very limited opportunity to increase the acreage/extent of Inland Open Water habitat, therefore all activities conducted will focus on improvement of habitat quality, such as shoreline and in-water vegetation improvements and demonstrated utilization by select priority population groups.

Great Lakes Beach is an important but limited habitat type along the West Shore and across the AOC in general. The primary assessment methodology for this priority habitat is calculating a Beach metric (B), which considers what kind of management is completed along a linear stretch of beach (i.e., no management, recreational management, conservation management, or conservation management with recreational restrictions). Most of the Great Lakes Beach habitat occurs within the Cat Island Restoration Chain and along much of Longtail Point, both of which are primarily managed for fish and wildlife conservation. Keeping Great Lakes Beaches free of invasive species is the biggest management challenge in the AOC. Common reed (*Phragmites australis*), or *Phragmites,* has frequently overwhelmed Great Lakes Beach habitat in the AOC, particularly when Great Lakes water levels are low. Therefore, all improvements to this habitat type will require strong maintenance and adaptive management strategies in place before restoration activities commence.

The following sections provide information regarding how each of the Lower West Green Bay priority area projects will achieve these goals and improve identified priority habitats and populations.

Lower West Green Bay Project Narratives and Recommended Management Actions

Project #7: Tank Farm Marsh

Site Description and Location

The broader southwestern shoreline of the bay of Green Bay was once considered one of the highest-quality and largest coastal marshes in the Midwest known as “Atkinson’s Marsh” (Scharf, 1979). However, significant expansion and filling to create an industrial park largely with dredge spoils from Green Bay and the Fox River for many decades reduced the original footprint to small, disjointed coastal and inland marsh remnants (Figure 32). Carr (1890) documented this marsh complex as being one of the few places that whooping cranes were reported to breed in Wisconsin.

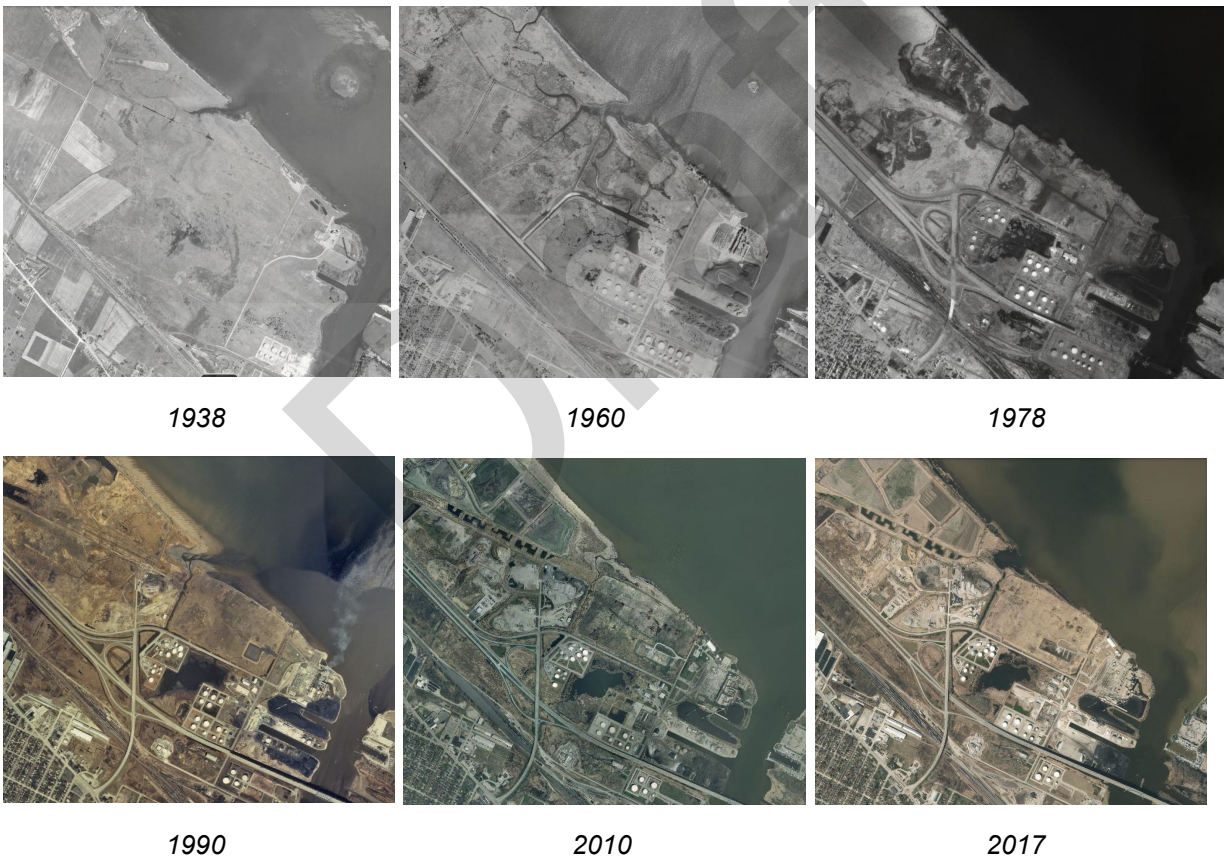


Figure 32. Panel shows changes in Atkinson’s Marsh as industrialization and development has occurred, leaving small, isolated tracts of inland wetlands such as the Tank Farm Marsh.

A USFWS report documented several species of waterfowl and other wetland-dependent birds observed to be breeding and nesting in the 'Bay Port Industrial Tract' in 1976 and 1977 (Figure 33), as well as tens of thousands of migrating waterfowl and shorebirds using the area as an important stopover site. The report included a list of over 250 species of birds identified in the area, with several endangered and/or rare species documented in the area annually, such as piping plovers, ruff, godwits, peregrine falcon, osprey, whistling swans, and snowy owls.

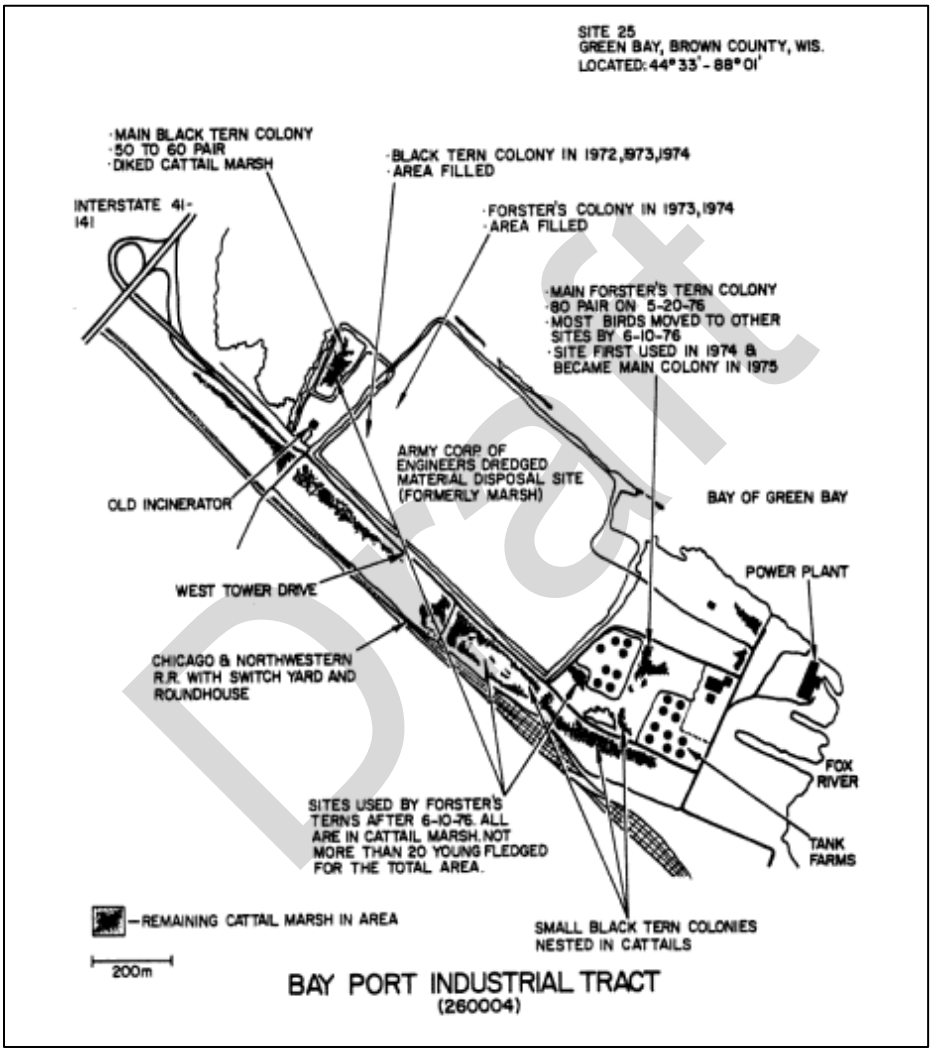


Figure 33. Drawing of the 'Bay Port Industrial Area' from a 1979 USFWS Report by W. Scharf

In 1978, a report on an approximately 40-acre marsh area in the Bay Port Industrial Tract located between the petroleum storage tank farms, or "Tank Farm Marsh", described the

importance of this remnant as a refugium for both plants and animals as the broader marsh footprint was gradually diked, filled, and shorelines hardened.[92] This refugia function provided by the Tank Farm Marsh was particularly important under periods of sustained high-water levels in which coastal marsh extent and associated available habitat is significantly reduced. Erdman reported that:

> *"…these refugia are the breeding nucleus for the repopulation of the entire lower bay area, once the water levels recede and the vegetation returns to the stage where It can again be recolonized. If such refugia did not exist – then the further existence on lower Green Bay of certain life forms, ie; Forester's Terns, Black Terns, Yellow-headed Blackbirds, Ruddy Ducks, Redhead Ducks, etc…would be threatened. In the case of the Forester's Terns, their existence in the state of Wisconsin would be jeopardized."*

Erdman's report included a list of 200 bird species that had been observed at the Tank Farm Marsh between 1965 and 1978. The report described the importance of the Tank Farm Marsh for foraging colonial waterbird species (great blue heron, egrets, and black-crowned night herons) which remains true today, though island rookery sites in the AOC are now dominated by large populations of American white pelican and double-crested cormorants. Additionally, the site harbored a colony of 50 nesting pairs of Forester's terns (now state endangered status) and small populations of nesting black terns (now state endangered status) after a sustained higher water period in the 1970's.

Today, much of the shoreline areas of the Tank Farm Marsh have been heavily invaded by *Phragmites*, and eBird checklists total 71 species observed as compared to the 200 cited in Erdman 1978. Furthermore, black terns have not been observed to nest in the area for several years, though Forester's tern was listed as a "probable" breeding status in 2018. However, several bird species are still observed annually at the Tank Farm Marsh, with sightings of uncommon birds more recently such as osprey, American avocet, glaucous gull, white-faced ibis, and short-billed dowitcher. Additionally, the connection of the Tank Farm Marsh to the bay of Green Bay and Fox River has been altered as industrial expansion has occurred, which has largely reduced the area's ability to serve as a more static refugia for wildlife under periods of sustained high-water levels.

A total of 5 out of the 18 priority habitats are currently represented in the Tank Farm Marsh project, though there is significant potential to expand and improve the area and quality of coastal and inland marsh habitat habitats through the project elements described below (Figure 34).

[92] Erdman, T. 1978. Avian usage of Tank Farm Marsh area – Green Bay, Wisconsin. Report to Ayres and Associates representing City of Green Bay Planning Department. 21 pp.

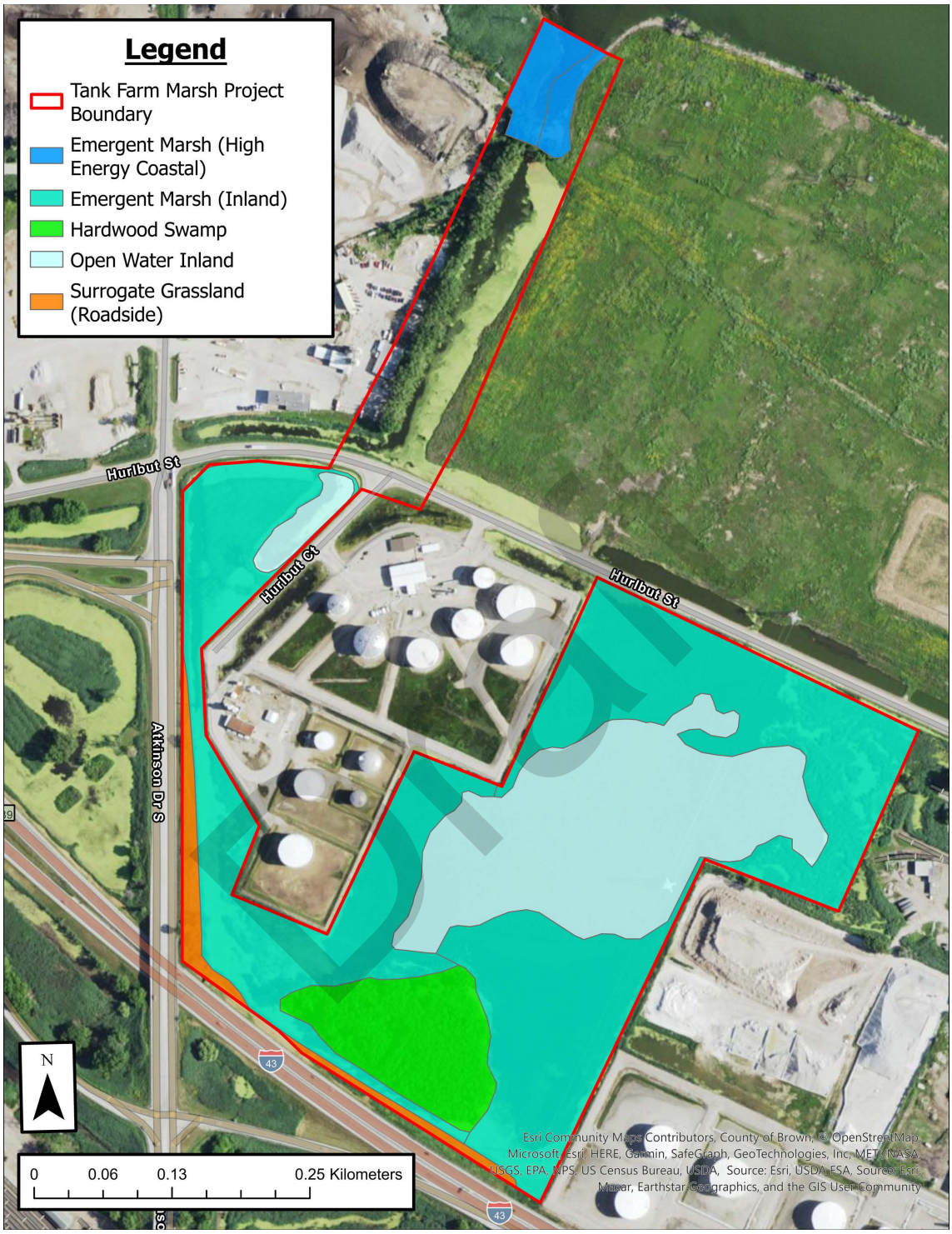


Figure 34. The Tank Farm Marsh project boundary.

Project Scope and Priority Habitats/Populations Benefited

Priority Habitats

Proposed habitat improvements within the Tank Farm Marsh project are anticipated to provide direct benefits to 3 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 38 shows priority habitats that have been mapped within the Tank Farm Marsh project boundary and how baseline and post-implementation BUI condition scores were derived.

Table 38. Priority habitats mapped within the Tank Farm Marsh project boundaries with baseline and post-implementation BUI condition scores.

Priority Habitats Within Project Boundaries	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Wet Meadow	0.00 x 0.50	**0.00**	2.50 x 0.65	**1.63**
Submergent Marsh	0.00 x 0.50	**0.00**	13.5 x 0.65	**8.78**
Inland Emergent Marsh	35.00 x 0.45	**15.75**	35.00 x 0.65	**22.75**
Hardwood Swamp	35.00 x 0.40	**14.0**	35.00 x 0.65	**22.75**
Shrub Carr	0.04 x 0.50	**0.02**	0.04 x 0.65	**0.3**
Quantity (acres or km) x Management Based Metrics				
Inland Open Water	12.00 x 0.25OW	**3.00**	12.00 x 0.50OW	**6.00**

Some of the project scope will focus on vegetation management activities to improve floristic quality in existing habitat acreages/lengths (e.g., removal of invasive species, addition of higher quality native species). These activities will improve the BUI condition score for Quantity x Quality and Quantity x Management based priority habitat metrics. A primary goal is to add 13.5 acres of Submergent Marsh and 2.5 acres each of Wet Meadow to form a complex of wetland habitats that can thrive at varying water levels (targeting marsh breeding birds, anurans, and turtles) and habitat installations for migratory waterfowl, coastal birds, and bats. Additionally, improving the quality of a subset of the 35 acres of Hardwood Swamp (targeting colonial waterbirds and wooded wetland birds) will contribute to the overall project goal.

The Inland Open Water habitat at the Tank Farm Marsh is currently considered to have a “Low Quality” Open Water metric, indicative of low quality or non-native vegetation present along the shoreline, little to no native submerged aquatic or excessive floating vegetation and some

evidence of tolerant fish or wildlife. The goal is to improve this shoreline and in-water habitat to a “Moderate Quality” Open Water metric, indicative of some higher quality shoreline and SAV or dominance by floating plant species, as well as evidence of higher quality fish or wildlife utilization.

Priority Populations

These restoration activities are anticipated to benefit 15 out of the 22 priority AOC populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year for the IEC and Count-Based metrics, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 39 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 39. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	**Metric Type**	**Metric Assessment Methodology**	**Data Source**
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Colonial Waterbirds	IEC	Average IEC based on number of nests for 8 Colonial Waterbird species	USDA + DNR
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor
Coastal Wetland Aquatic Macroinvertebrates	IEC	CWMP Environmental Reference Gradient	CWMP
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Breeding Shorebirds	Count-Based	Number of sites breeding documented for Killdeer + Spotted Sandpiper + Rare Species (Piping Plover, Wilson’s Phalarope, American Avocet, etc.) to generate Breeding Shorebird (Sb) Metric	Contractor
Coastal Birds (Breeding)	Count-Based	Number of sites with breeding documented for Belted Kingfisher + Green Heron + Tree	Contractor

		Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	Contractor + DNR
Wetland Terns	Count-Based	Number of nesting colonies at least 1 km apart from each other	DNR
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR

As described above, DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 40 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 40. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	0.0	1.0	**1.0**
Migratory Shorebirds	0.0	1.0	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

When implemented, the Tank Farm Marsh project represents a 2.4% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 3.0% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

DNR requested Fox River NRDA and GLRI funding to support the design phase of this project in 2020 and 2021, respectively. Going forward, DNR and the City of Green Bay will request GLRI funding to support the implementation, maintenance, and monitoring phases of the project in 2024. Key partners of the project include City of Green Bay, US Venture and other adjacent landowners, Audubon Great Lakes, Northeast Wisconsin Audubon, DU, UWGB, USFWS, and others.

In addition to soliciting technical expertise, the Project Management Team has also solicited feedback for accessibility, recreation, educational and EJ considerations during the project design phase and will continue to encourage broader stakeholder and public participation.

Timeline, estimated costs for applicable project phases, and cost-sharing opportunities

An initial GLRI and Fox River NRDA proposal to support planning and design for this project was developed in 2021 to secure funding in 2022; a second GLRI proposal will be developed and submitted in 2024 to secure funding for both the implementation and maintenance phases (Table 41). Given the need to complete planning and design for this project, implementation and maintenance costs are contingent upon the completion of the planning and design phase. The total project cost is anticipated to be $3,000,000 with cost estimates generated in consultation with GEI Consultants.

Table 41. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2021		2024	2025	2026	2027	2028	2029	2030
Planning/Design	$175,000								
Implementation			$2,825,000						
Maintenance									

Project Maintenance

The Wisconsin DNR, City of Green Bay, and Green Bay Restoration Partners (GBRP) will work collaboratively to manage restored habitat. Habitat installations will be monitored and maintained by staff and volunteer networks associated with Audubon Great Lakes and Northeast Wisconsin Audubon Society.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

One important aspect that was identified during the project's design phase is that while the Tank Farm Marsh exists in a seriously degraded condition, it still draws significant migratory and breeding bird populations and therefore is often visited by birders throughout the year and accessed via Hurlbut Street. Given the surrounding industrial land use, Hurlbut Street has nearly constant truck traffic and a very slim shoulder for birders to pull off and park, making the site somewhat dangerous to access currently. As a result, the project design has integrated two parking areas that will support multiple parking spaces for birders to get off of Hurlbut Street and view birds safely. Another aspect is a gated and paved gravel trail near the wetland enhancement area that was primarily integrated for lite vehicles to gain access for maintenance but will also support enhanced access and enjoyment of the project area.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST), this project will take place within a census tract that is identified as disadvantaged, citing issues related to income, housing, and legacy pollution criteria.

Please see Appendix 4 for the full EJ Screen Community Report for this census tract.

Climate Change

While an initial part of the project scope included restoring access for fish passage and potential water control to maintain the site at a static water depth, site history conditions precluded those goals from being integrated into the project design. However, the original intention for completing these activities was because the water levels in the Tank Farm Marsh fluctuate with annual Green Bay/Lake Michigan water levels as some connection to the bay exists through the substantial ditching that's taken place throughout the area. The lack of water control could have made it difficult to ensure that the site acts as a refugia under high water level periods and increased variability in annual lake levels and stormwater runoff events. However, the project design dealt with these concerns by incorporating different sediment elevations to support multiple wetland types, supporting enhanced resiliency not currently present at the site.

Project #8: Ken Euers Nature Area

Site Description and Location

Ken Euers Nature Area is a public park managed and owned by the City of Green Bay. While history of the site is somewhat scarce, anecdotal evidence suggests that some of the original acreage granted to the Bayport Industrial Site was set aside in the late 1970's to mitigate the wetlands lost from filling the majority of Atkinson's Marsh and adjacent bridge/highway construction. Today, the City of Green Bay manages the site as a 117-acre passive greenway with walking trails that are frequently visited by birders and other community members. Since 2016, the City of Green Bay, DU, UWGB, DNR, and USFWS have worked to restore the project site, which suffered from invasive species encroachment and impacts to impounded wetland berms.

While invasive species management continues at the site, much of the active restoration measures have been complete. These include the East Marsh restoration in 2019 that enhanced waterfowl habitat and improved public accessibility through tree removal, berm regrading, and the installation of a water control structure. Prairie plantings were also implemented over a closed landfill on the site by the City of Green Bay. Additionally, wild rice was seeded in the impounded wetland area in 2020, and in-water woody structures were installed along the bay in 2021. These restoration measures have widened the trail system, enhanced views of Green Bay, and provided improved access to the water.

In 2021, three breakwaters totaling 2,000 ft, were constructed offshore of the Ken Euers Nature Area into the Duck Creek Delta. This pilot project anticipates the benefit of the structure to include protection to shallow wetland habitat from wind/wave impacts that will support native species re-establishment and to protect the park shoreline from erosion. Wild rice was seeded behind the breakwater in 2021 and point intercept surveys are tracking aquatic plant response. As of 2023, the design and permitting phase for the West Marsh restoration was complete and will include similar restoration measures to that of the East Marsh restoration project. Construction of the project is expected in late 2023 and into 2024.

Given that nearly all restoration measures suggested through the development of the management action list have already been completed, no additional management actions are being recommended in this document for the Ken Euers project area (Figure 35). However, monitoring to evaluate if the project has improved BUI baseline condition scores is being recommended.

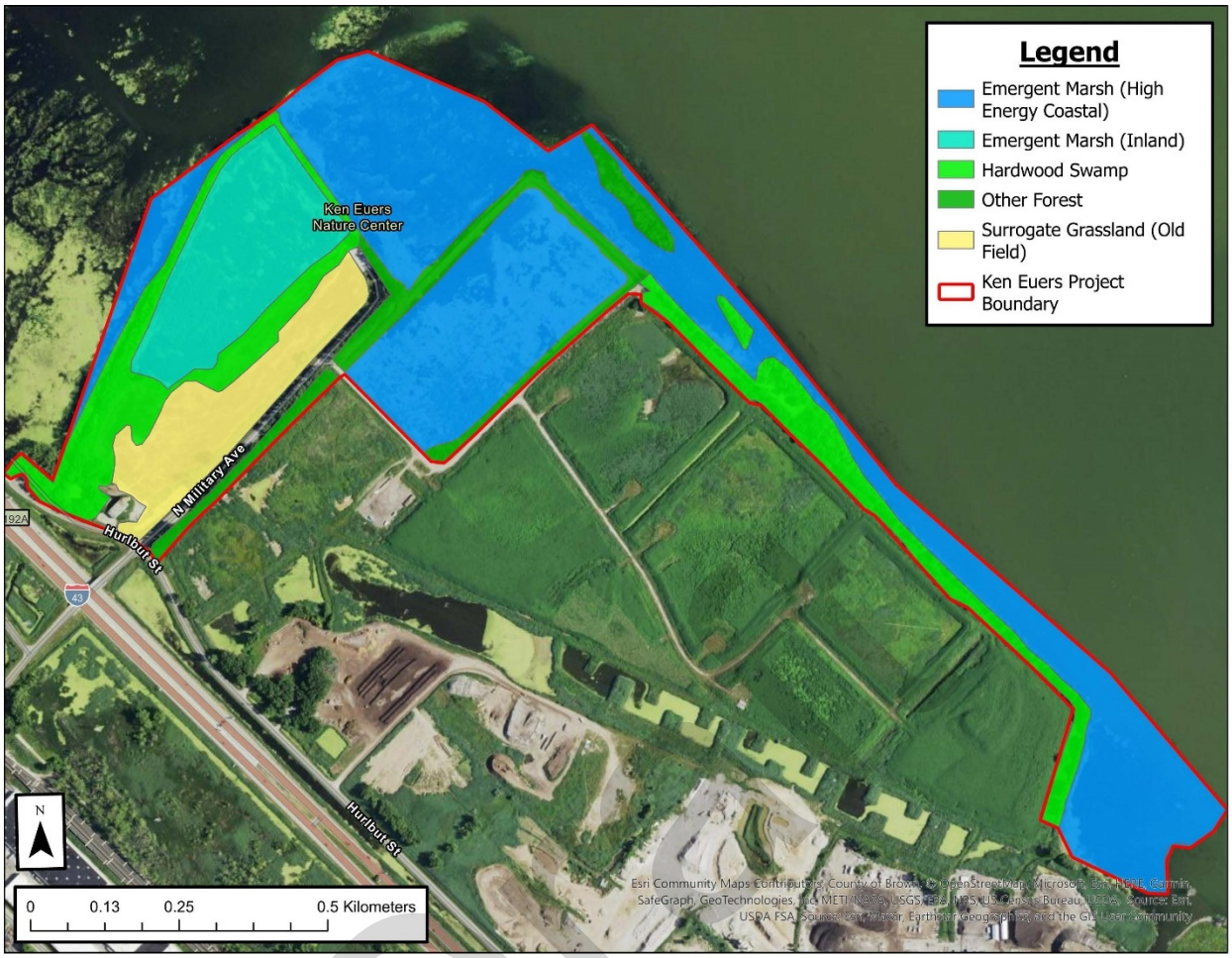


Figure 35. The Ken Euers Nature Area project boundaries.

Project Scope and Priority Habitats/Populations Benefited

Priority Habitats

Proposed habitat improvements within the Ken Euers Nature Area project are anticipated to provide direct benefits to 3 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 42 shows priority habitats that have been mapped within the Ken Euers Nature Area project boundary and how baseline and post-implementation BUI condition scores were derived.

*Table 42. Priority habitats mapped within the Ken Euers Nature Area project boundaries with baseline and post-implementation BUI condition scores. **Note that improvements to Coastal Emergent Marsh habitat will largely occur through the Duck Creek Delta project going forward, and though this habitat is mapped within the project boundary, those habitat improvements are accounted for in the Duck Creek Delta project narrative*

Priority Habitats Within Project Boundaries	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Inland Emergent Marsh	35.00 x 0.45	**15.75**	35.00 x 0.65	**22.75**
Quantity (acres or km) x Management Based Metrics				
Inland Open Water	12.00 x 0.25OW	**3.00**	12.00 x 0.50OW	**6.00**

Priority Populations

These restoration activities are anticipated to benefit 8 out of the 22 priority AOC populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year for the IEC and Count-Based metrics, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 43 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 43. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	Metric Type	Metric Assessment Methodology	Data Source
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP

Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Coastal Wetland Aquatic Macroinvertebrates	IEC	CWMP Environmental Reference Gradient	CWMP
Coastal Birds (Breeding)	Count-Based	Number of sites with breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	Contractor
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR

As described above, DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 44 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 44. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Coastal Terrestrial Macroinvertebrates	0.0	1.0 Marsh/Wet Meadow 1.0 Upland	**2.0**
Migratory Landbirds	1.0	0.0	**1.0**
Migratory Shorebirds	0.0	1.0	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

The Ken Euers Nature Area project represents a 1% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 1% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

This project was cooperatively planned, designed, and managed by the City of Green Bay, DU, and UWGB with technical assistance from DNR and USFWS.

Timeline, estimated costs for applicable project phases, and cost-sharing opportunities

Given that all management actions are either complete or will be complete within the next year, the only funding request for this project will be to support monitoring activities in 2024 and 2025 (Table 45).

Table 45. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2024	2025	2026	2027	2028	2029	2030
Planning/Design	$50,000						
Implementation							
Maintenance							

Project Maintenance

The City of Green Bay and GBRP are responsible for management of restored habitat.

Ken Euers Nature Area view of East Marsh restoration – photo courtesy UWGB.

Project #9: Duck Creek at Wietor Wharf

Site Description and Location

Duck Creek is a tributary that feeds into lower Green Bay from the west and empties into the Duck Creek Delta. Like all tributaries that feed into the AOC, the environmental characteristics and biota of the mouth of Duck Creek is highly influenced by temporal seiche effects and annual water level dynamics typical of Green Bay. The sub-basin that drains into Duck Creek is the largest in the Lower Fox River Basin, encompassing approximately 130 square miles (Figure 36). Just over 56% of the watershed is classified as agricultural land use, 25% is classified as urban land use, and 20% is classified as natural background. A total of 32.9 stream miles were listed as impaired for contaminated fish tissue, low dissolved oxygen, and degraded habitat with total phosphorus, total suspended solids, and mercury listed as the pollutants of concern in the most recent Wisconsin 2018 Water Quality Report to Congress.

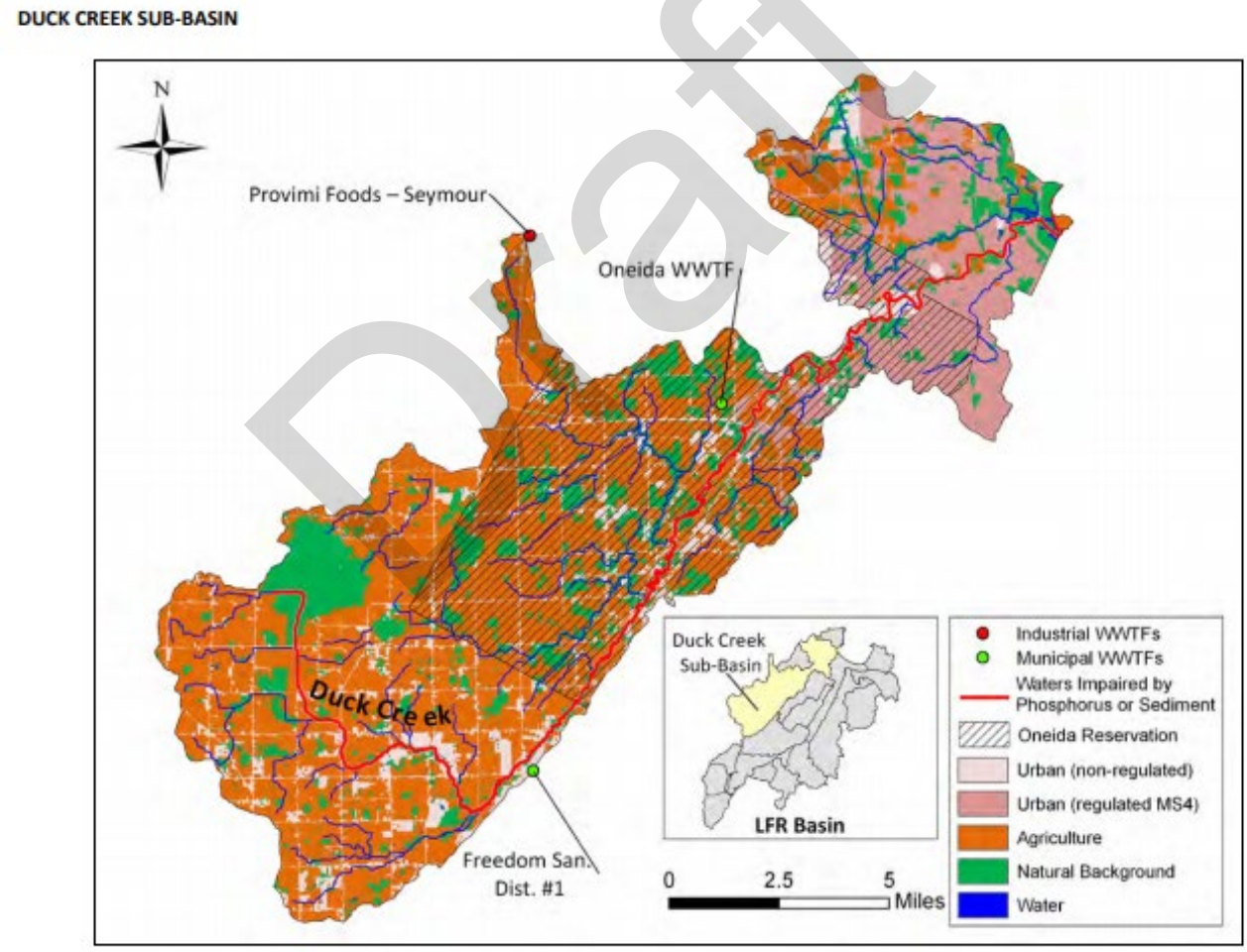


Figure 36. The Duck Creek watershed.

Some of the environmental challenges Duck Creek faces within 1 km of the AOC boundary (Figure 37) and higher stream reaches include flashiness under storm events causing significant bank erosion, poor solid bedrock substrates above Overland Road, soft substrates near the mouth of Duck Creek, depauperate submergent and emergent vegetation communities, low dissolved oxygen levels, cyanobacterial algal blooms, and both agricultural and urban nonpoint source runoff. These issues, contributing to a degraded macroinvertebrate and fish community within Duck Creek, have catalyzed efforts to improve water quality, in-stream and riparian habitat, and fish passage within the watershed.

An important element of this project will focus on expanding efforts to the lower stream reaches of Duck Creek by improving substrates for native freshwater mussel species. A 2018 and 2019 assessment conducted by the DNR Natural Heritage Conservation program observed evidence of 8 native mussel species in lower reaches of Duck Creek, including Mapleleaf (*Quadrula quadrula)*, a protected Wisconsin species of special concern.

Although densities of individual native mussels within the project footprint were low ($0.02m^2$), high replacement ratios and evidence of recent native mussel recruitment suggests mussels are recolonizing areas of Duck Creek where they may not have occurred recently. Fragile Papershell (*Leptodea fragilis*) and Giant Floater (*Pyganodon grandis)* comprised 83% of live mussel abundance during surveys. Both species are considered opportunistic, indicating tolerance to poor water quality and significant population fluctuations from year to year. As such, these species are not necessarily representative of areas that can support stable mussel populations; though, the presence of five stable / keystone mussel species provides evidence that Duck Creek can support native mussel species with more stable population dynamics. Reasons for the low densities and evenness within the project footprint cannot be fully determined. However, the lack of in-stream habitat heterogeneity may contribute to low mussel densities and lack of mussel diversity. Finally, habitat enhancements for preferred mussel species should consider habitat needs for host fish.

This project will provide habitat enhancements for many fish species including centrarchids and northern pike, which are the primary monitoring species for this site. Recent boat electrofishing surveys conducted at the mouth of Duck Creek by the USFWS's AIS early detection team found a total of 1331 fish representing 25 species. These ten surveys, conducted between 2016 – 2018, were dominated by yellow perch (57% of total fish caught), emerald shiner (23%), gizzard shad (5%), centrarchids (5%) and northern pike (2%). The area immediately west of the highway provides a unique overwintering habitat for centrarchids given adequate depth and dissolved oxygen levels. Ice fisherman can often be found fishing here in winter months.

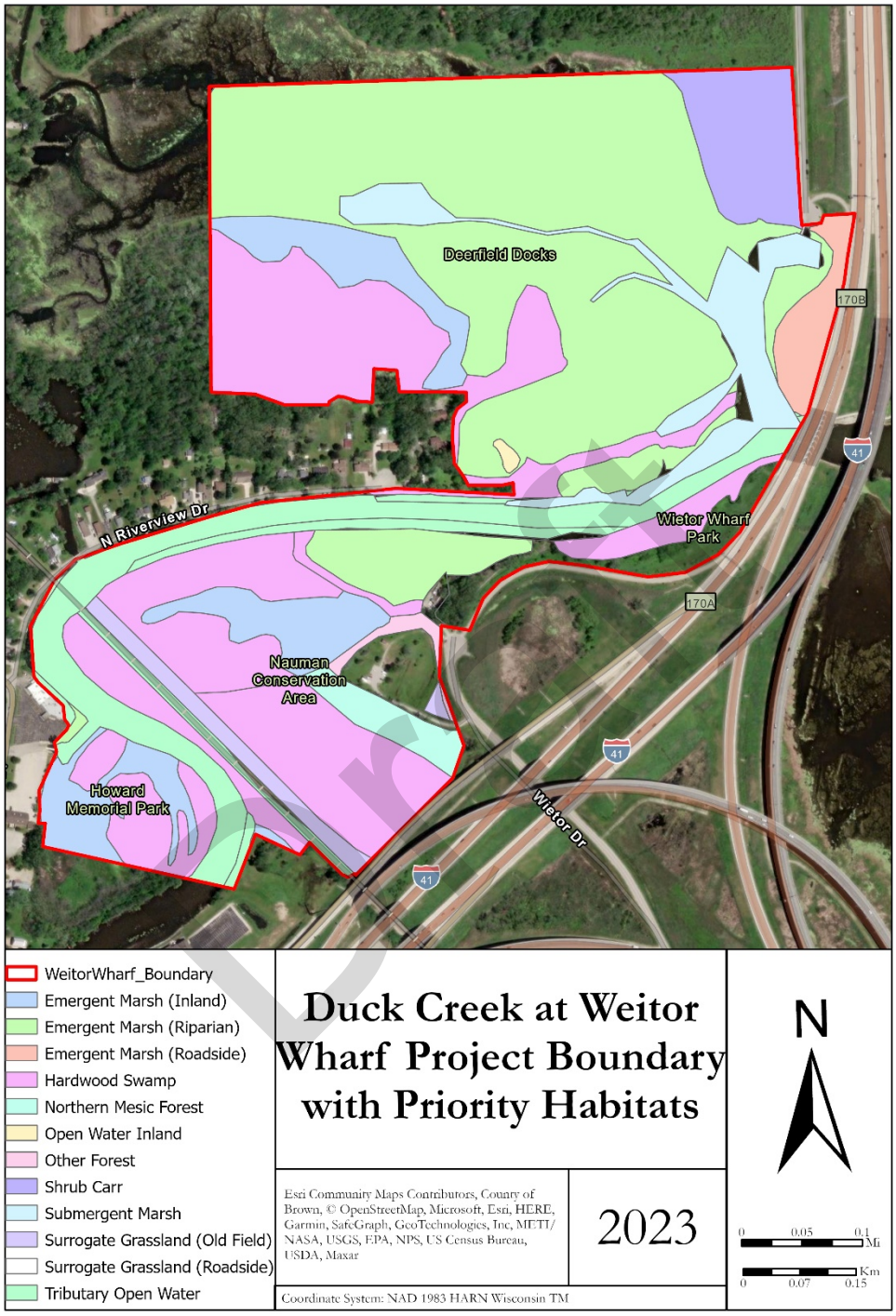


Figure 37. Priority habitats within Duck Creek at Wietor Wharf project boundary.

Project Scope and Priority Habitats/Populations Benefited

Priority Habitats

Proposed habitat improvements within the Duck Creek at Wietor Wharf project are anticipated to provide direct benefits to 3 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA). Priority habitats have been mapped within the project boundaries and baseline and post-implementation BUI condition scores are estimated below (Table 46).

Table 46. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundary	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Submergent Marsh	7.00 x 0.50	**3.50**	7.00 x 0.65	**4.55**
Riparian Marsh	70.0 x 0.50	**35.00**	70.0 x 0.65	**45.5**
Wet Meadow	0.00 x 0.60	**0.00**	10.0 x 0.65	**6.50**
Hardwood Swamp	35.0 x 0.40	**14.0**	35.0 x 0.65	**22.8**
Northern Mesic Forest	1.15 x 0.40	**0.46**	1.15 x 0.65	**0.75**
Old Field Grassland	2.75	**2.75**	2.75	**2.75**
Designated Habitat Area Based Metrics				
Tributary Open Water	0.50 +0.50 Tributary Fish + Freshwater Native Mussels	**1.00**	1.00 + 1.00 Tributary Fish + Freshwater Native Mussels	**3.00**

Much of the project scope will focus on vegetation management activities to improve floristic quality in existing habitat acreages/lengths (e.g., removal of invasive species, addition of higher quality native species). These activities will improve the BUI condition score for Quantity x Quality and Quantity x Management based priority habitat metrics. Primary goals are to improve 70 acres of Riparian Emergent Marsh and 7 acres of submergent marsh and to add 10 acres of wet meadow to create a complex for tributary fish and Unionid mussels.

The tributary open water area currently provides 1.0 DHA points for Tributary Open Water due to lack of important habitat for Tributary Fish and Freshwater Unionid Mussels. Substrate

enhancement (targeting Centrarchids, Northern Pike or Musky), shoreline improvements, and native mussel propagation efforts will create a 3.0 DHA point for Tributary Open Water when the project is fully implemented.

Priority Populations

Proposed habitat improvements are anticipated to benefit at least 16 of the 22 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year for the IEC and Count-Based metrics, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project (Table 47).

Table 47. Priority populations expected to utilize the Wietor Wharf project site, the primary metric type, assessment methodology, and anticipated data sources for evaluating BUI condition scores after project implementation.

Priority Populations	Metric Type	Metric Assessment Methodology	Data Source
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Coastal Wetland Aquatic Macroinvertebrates	IEC	CWMP Environmental Reference Gradient	CWMP
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Wetland Terns	Count-Based	Number of nesting colonies at least 1 km apart from each other	DNR
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	Contractor + DNR
Coastal Birds (Breeding)	Count-Based	Number of sites with breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin,	Contractor

		Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	
Stream Macroinvertebrates	Count-Based	Average Citizen Monitoring Biotic Index across six sites	Contractor
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Native Freshwater Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Tributary Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR

A total of 2.0 DHA points for Tributary Open Water can be additionally designated for this project, 1.0 point for each Tributary Fish and Freshwater Unionid Mussels. The primary monitoring target for Tributary Fish adult and juvenile/YOY species are Centrarchids and Norther Pike, though additional points will be awarded for observed utilization by Rare/Sensitive fish species. Verification monitoring will be required to demonstrate utilization by target species. USFWS AIS data will be used to evaluate the Tributary Fish BUI condition score. Any observed Opportunistic, Stable/Keystone, or Rare/Sensitive Freshwater Unionid Mussels will count toward the BUI condition score, but habitat enhancements and propagation efforts will focus on native mussels that use centrarchid species as host fish to complete their life cycle. DNR Natural Heritage Conservation program will work with OGW to provide recommended native mussel species propagation and provide post-implementation monitoring efforts.

As described above, DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 48 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 48. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	1.0	0.0	1.0

Coastal Terrestrial Macroinvertebrates	0.0	1.0	**1.0**
Landbirds (migratory)	0.0	1.0	**1.0**
Shorebirds (migratory)	0.0	1.0	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

Taken in whole, the Duck Creek at Wietor Wharf project represents a 7.8% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat BUI and a 7.9% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

DNR will request NRDA funding for design, implementation, and maintain/monitor phases of this project.

DNR and a selected contractor will collaborate as a Project Management Team and will solicit technical expertise from a number of partners, including but not limited to the Village of Howard, TNC, DU, Oneida Nation, and Northeast Wisconsin Land Trust.

In addition to soliciting technical expertise, the Project Management Team will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase.

Timeline, estimated costs for applicable project phases, and cost-sharing opportunities

An initial proposal to support planning and design for this project will be developed and submitted in 2024 to secure funding to begin in 2024; this funding will be requested through the Fox River NRDA. A second proposal will be developed and submitted in early 2025 to secure funding for both the implementation and maintenance phases beginning in 2025 (Table 49). Given the need to complete planning and design for this project, implementation and maintenance costs are contingent upon the completion of the planning and design phase. The total estimated cost for this project is $2,500,000 with cost estimates generated in consultation with GEI Consultants.

Table 49. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2025	2026	2027	2028	2029	2030
Planning/Design	$300,000					
Implementation		$2,200,000				

Maintenance						

Some early cost-sharing opportunities that were identified by the TAC and City of Green Bay are:

- DNR River Planning Grants
- North American Wetlands Conservation Act (NAWCA)
- USFWS Coastal Wetland Grants
- Fund for Lake Michigan
- Village of Howard

Additionally, existing, or historic investments have been made at the area surrounding the xxxx including:

- Green Bay Southwest High School teachers and students have provided volunteer water quality monitoring in Duck Creek since 2003
- Green Bay West High School teachers and students have joined the volunteer water quality monitoring effort in 2019

Project Maintenance

The GBRP will work with the Village of Howard to complete maintenance activities on their respective properties. In water features are not anticipated to require maintenance, though any issues that arise would be addressed to the extent practical by conservation partners.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

While most conservation-focused stakeholders have had some engagement with the project concept to date through various public meetings, technical groups, events, and/or presentations, much more work is needed to engage the community and user groups who could be impacted by this project. DNR will rely heavily on the partnership with the Leadership Council and relevant sub-teams, the GBCP to assist with outreach and communications, and with a re-established Citizens Advisory Committee to identify potential benefits and burdens of the project.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the census tract immediately adjacent to the Duck Creek at Wietor Wharf project boundaries are identified as partially disadvantaged,

though this is primarily because the <1% of this tract are within the Oneida Nation boundaries. EJ issues that can be addressed through this project will be identified in conjunction with the broader group of stakeholders that both live within/near the Lower Green Bay & Fox River AOC, as well as those who interact with AOC resources.

Climate Change Considerations

The project team will review Adaptation Strategies and Approaches specified in The Coastal Adaptation Menu to promote resiliency of management actions under a changing climate. Measures will be taken during the project design phase to ensure long-term resiliency of in water and nearshore habitat restoration and guide long-term operation and maintenance plans.

Project #10: Duck Creek Delta Wetland Complex

Site Description and Location

Duck Creek Delta Open Water Area

Historic accounts describe the nearshore areas of Green Bay as a verdant water body, dominated by miles of coastal wetlands that supported a diverse and abundant faunal community. Today, an estimated 75-90% of the coastal wetlands historically present have been lost in Green Bay, with the most significant losses occurring along the most southwestern areas of the bay known today as the Duck Creek Delta (Figure 38).[93] Even with the substantial loss in coastal wetlands, the Duck Creek Delta is the southernmost area of the Green Bay West Shores (GBWS) Wildlife Area that reaches as far north as Marinette and is considered a Conservation Opportunity Area (COA) and Important Bird Area (IBA) in the most recent Wisconsin Wildlife Action Plan.

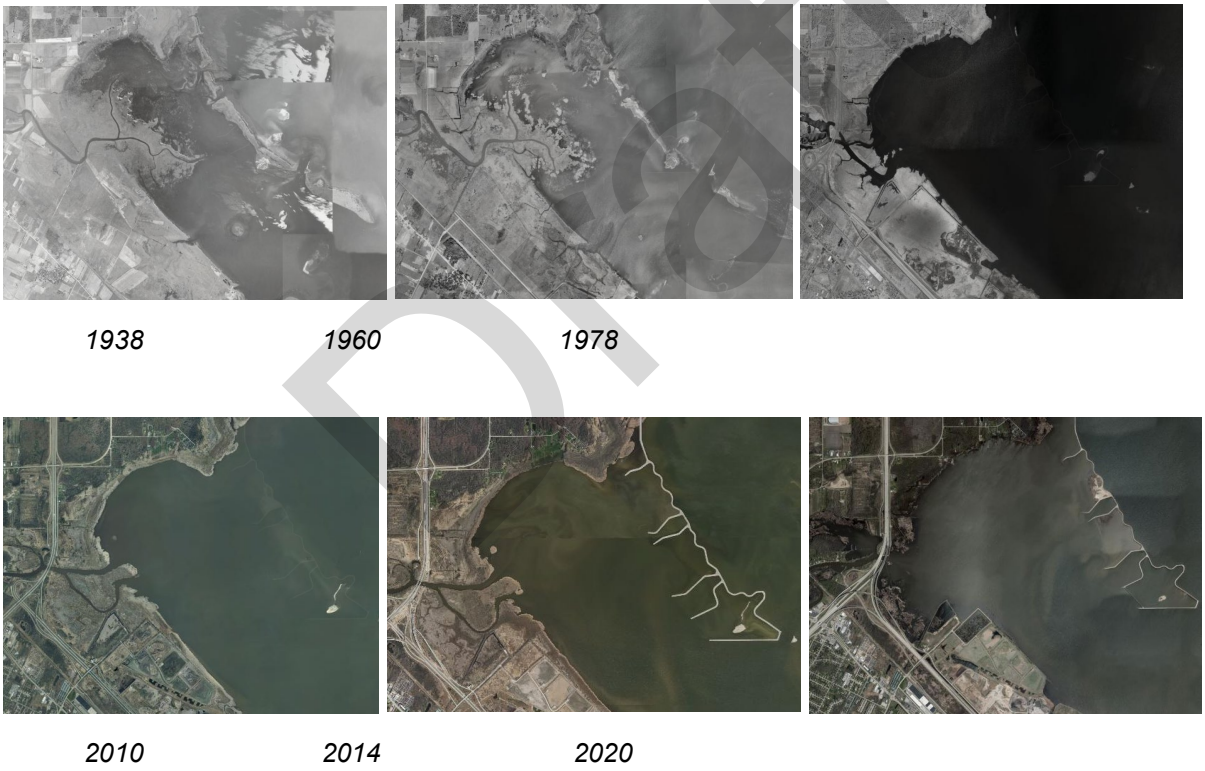


Figure 38. Aerial imagery showing the progression of habitat loss in the DCD from 1938 to 2020. Text underneath each photo shows the year in which the image was taken.

[93] Bosley, T.R. 1978. Loss of wetlands on the west shore of Green Bay. Transactions of the Wisconsin Academy of Sciences, Arts and Letters, 66: 235 – 245.

These changes in habitat extent and species diversity in the DCD are attributed to a long history of water quality degradation, habitat conversion, invasion by exotic species, and the loss of a series of natural barrier islands known as the Cat Island Chain in the late 1960's. The loss of the island chain very closely coincided with the disappearance of nearly 90% of the coastal wetland habitat in the DCD, and this significant habitat loss contributed, in part, to the designation of the Lower Green Bay & Fox River as an AOC.[94,95] The AOC designation has served as a key catalyst for efforts to restore beneficial uses that have been lost through habitat degradation, such as restoration of the Cat Island Chain. While the newly established Cat Island Restoration Chain wave spine has likely provided significant protection from wave and ice scour from northeast storm surges and seiche events, continued barriers to re-establishment of the delta habitat appear to be present as the coastal wetland habitat remains limited in species richness and extent of colonization (Figure 39 and Table 50).

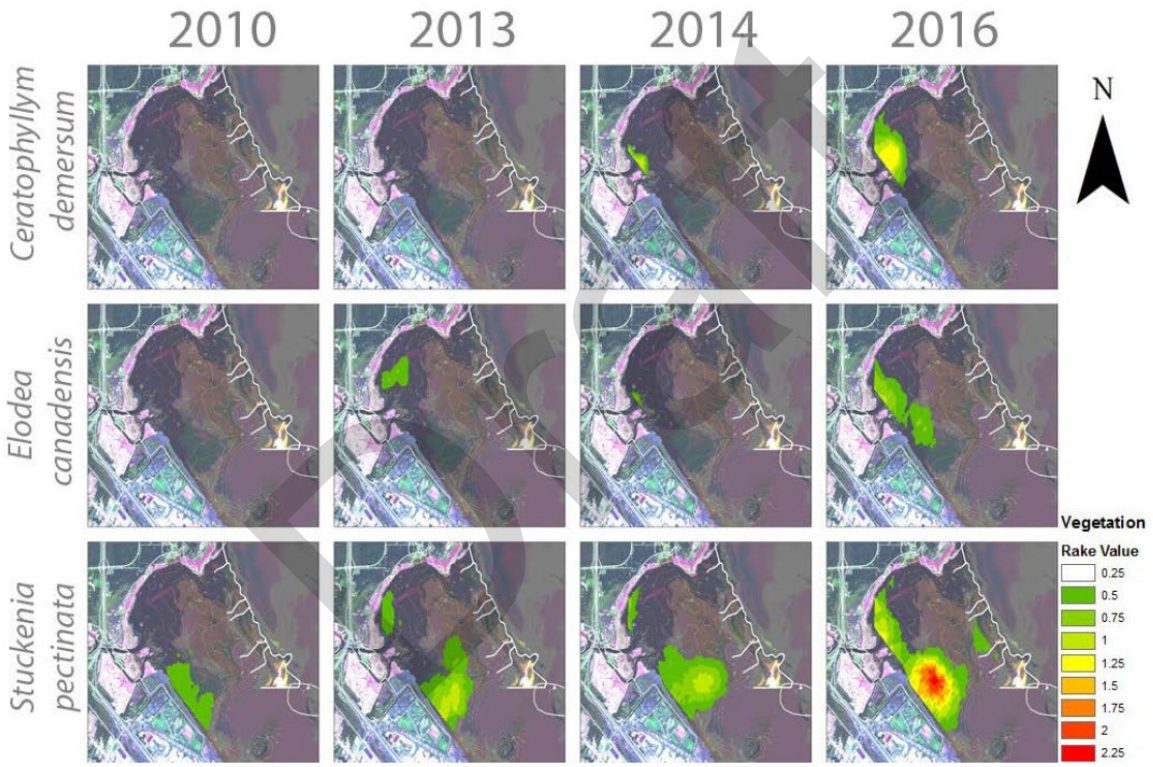


Figure 39. Predicted rake fullness values of C. desmersum, E. canadensis, and S. pectinata in 2010, 2013, 2014 and 2016 in the DCD.[96]

Table 50. Summary of total species richness observed during each survey period from 2010 to 2023 and annual July average Lake Michigan water levels for reference. While some increases in observed SAV

[94] DNR, 1988. Area of Concern Remedial Action Plan. 339 pp.
[95] DNR, 1993. Area of Concern Remedial Action Plan Update. 267 pp.
[96] Houghton, C., C. Moratz, B. Kupsky, P. Robinson. 2017. Submerged aquatic vegetation assessment of Duck Creek Delta, Final Report. 27 pp.

species richness was observed as water levels increased, there may be a threshold at which water levels preclude increases in species richness.

Survey Year	Average Lake Michigan July Water Depth	Total Species Richness
2010	176.26 m	3
2013	176.09 m	6
2014	176.46 m	6
2016	176.84 m	8
2018	176.98 m	10
2021	177.00 m	6
2023	176.70 m	3

While point intercept surveys have observed some increases in diversity, rake fullness and SAV colonization extent, the primary plant species contributing to this increase was sago pondweed, most of which has been observed to disappear by late July in the growing season. This disappearance has been suggested to be partially due to shading from poor water quality conditions as well as wind/storm events during the growing season leading to southeastern fetch from which the Cat Island Restoration Chain wave spine does not provide protection.

Another documented barrier is propagule and establishment limitations, in which limited propagule banks have been observed throughout the DCD with greenhouse trials observing no additional species diversity in sediments collected from the DCD. [97,98] However, from 2015 to 2016, >100% survival of restored wild celery plants in several experimental plots was observed in a more protected area near the DCD, suggesting that providing some additional protection from southeast seiche/fetch events and actively restoring coastal wetland vegetation could increase SAV extent and diversity in the DCD.[99]

The 2020 management action list draft also included two additional adjacent areas to the DCD as their own discrete projects (DNR GBWS Peats Lake Unit and Fort Howard Nature Area & Peters Marsh), though it was determined by DNR that it was more efficient for planning and design to integrate those projects and respective concepts into the Duck Creek Delta Wetland Complex project. Site descriptions for those project areas are included below.

GBWS Peats Lake Unit

The DNR Peats Lake Unit is located within the Villages of Howard and Suamico and is one of 11 non-contiguous units of DNR owned and managed properties. These properties stretch along the west shore of Green Bay from the mouth of Duck Creek north to Marinette and are known collectively as the Green Bay West Shores Wildlife Area (GBWS). The GBWS properties were targeted and prioritized for acquisition to protect and preserve critically important wetland habitat in Green Bay, with properties acquired as early as 1948 and as recently as 2018. These properties constitute nearly 50% of all coastal wetlands in Lake Michigan. As such, they are

[97] Flood, T.J. 2015. Monitoring water quality and submergent aquatic vegetation of Lower Green Bay wetlands and influences of the Cat Island Chain re-establishment project. M.S. Thesis in Environmental Science and Policy. UW-Green Bay.

[98] Kupsky, B. and M.E. Dornbush. 2017. Cat Island and Duck Creek Delta Restoration: Restoring Green Bay Aquatic Vegetation Final Grant Report to Ducks Unlimited. 82 pp.

[99] Kupsky, B and M.E. Dornbush. 2019. Experimental test of abiotic and biotic factors driving restoration success of Vallisneria americana in the Lower Bay of Green Bay. Journal of Great Lakes Research, 45: 340 – 349.

important breeding and stopover areas for several species of birds, spawning, rearing, and foraging habitat for fish, and provide important public recreational opportunities for the state of Wisconsin.

There are approximately 486 acres of Coastal Emergent Marsh, Wet Meadow and Shrub Carr habitat within the Peats Lake Unit, all of which are impacted by encroachment of Phragmites and dynamic water level fluctuations. Upland habitats include a warm-season grassland (Old Field Grassland) and multiple forest types, though both experience encroachment by native and invasive shrub species as fire management is not suitable near US Highway 41.

Fort Howard Nature Area & Peters Marsh

This area is another large tract of coastal wetland, wet meadow, and forest habitat along the west shore of Green Bay. The Fort Howard Paper Company Foundation owned most of the upland forest and a portion of the marsh until the 1970's when it was donated to Brown County. Several trails connect the Fort Howard Nature Area with the Barkhausen Waterfowl Preserve, making up just over 1,000 acres of public land with over 9 miles of hiking trails throughout. A local family owned a large portion of Peters Marsh until the state of Wisconsin began acquiring portions in 1978. Today, Brown County Parks owns and primarily manages most of the project area, though a small acreage is also under the ownership of DNR and privately held.

Summary

Across all three sites, a total of 13 out of the 18 priority habitats are currently represented in the Duck Creek Delta Wetland Complex project (Figure 40), though there is significant potential to expand the area and improve the quality of high energy emergent coastal, submerged marsh, wet meadow and shoreline fish habitat through the project elements described below.

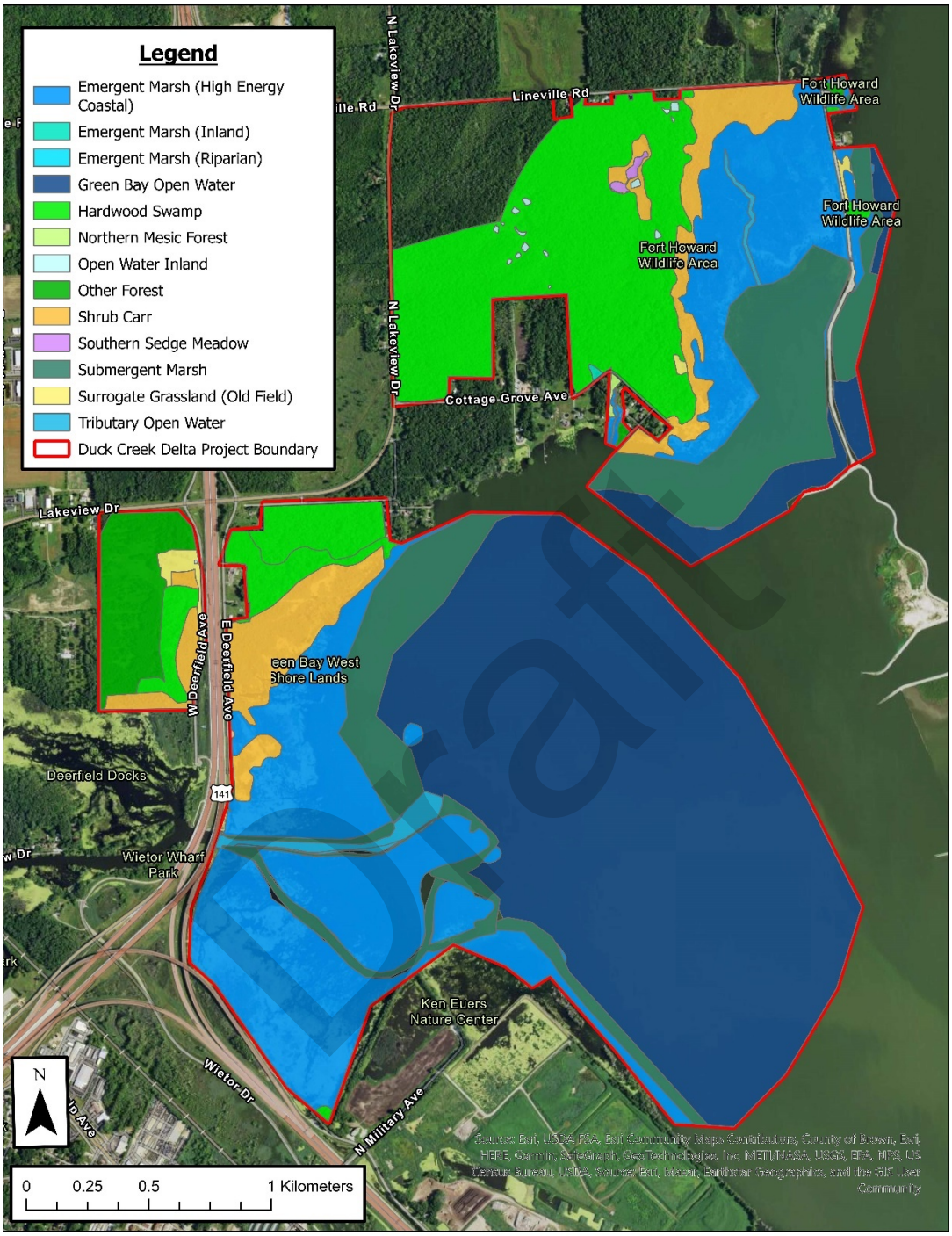


Figure 40. Priority habitats within the Duck Creek Delta project boundary.

Project Scope and Priority Habitats/Populations Benefited

In general, resource managers agree that more active restoration measures are needed to overcome additional stressors not ameliorated by the Cat Island Restoration Chain. As a result, the TAC recommended the investigation and implementation of nature-based solutions to accelerate coastal wetland re-establishment in the DCD.

However, questions surrounding what nature-based solutions are feasible and could withstand the strong wind, wave and ice scour characteristic of the lower Bay of Green Bay needed to be made before pursuing a full design phase for the project. As a result, EPA GLNPO and DNR partnered with USACE in 2021 to complete a pre-design investigation for the project, as USACE has considerable technical expertise, understanding of Lower Green Bay dynamics, and can provide the nexus to beneficially reused clean dredge materials that could be used to construct the project. The results of the pre-design investigation are documented in a TM to be finalized in late 2023 and appended to this document when available. Results of this effort indicate that it is possible to construct a series of barrier islands by manipulating sediments in the DCD to provide additional protection from the SE fetch, capture sediment to accelerate coastal wetland re-establishment, and increase heterogeneity of substrates and water depths no longer present in the DCD. Next steps include modeling of this approach in early 2024, followed by a full design and permitting phase that will continue through early 2025, and construction of the project in mid to late 2025.

Coastal wetland enhancements within the project area will benefit many fish species, including northern pike and centrarchids which are the primary monitoring species for the site. A total of 21 fisheries surveys were conducted in the Duck Creek Delta project area from 2016 – 2018 by the USFWS' AIS early detection team, using a variety of gears (boat electrofishing, paired fyke nets, and mini paired fyke nets). Combining the results of all gear types, a total of 7682 fish representing 23 different species were surveyed. These were dominated by spottail shiner (75% of total fish caught), yellow perch (12.7%) followed by gizzard shad (4.3%), and emerald shiner (4.32%). Of note, 62.5% of all spottail shiners surveyed came from one paired mini fyke net in 2016. The majority of northern pike, centrarchids and yellow perch densities came from survey sites near the mouth of Duck Creek. Northern pike and centrarchids represented .29% and 1.1% of the total catch respectively.

Additionally, conservation partners have established Forster's Tern (*Sterna forsteri*) nesting structures in existing emergent marsh areas in the DCD over recent years with several successful clutches observed. An increase in emergent marsh is likely to establish new and/or expanded Forster's Tern nesting colonies and contribute to re-establishing populations of this state Endangered species statewide.

Priority Habitats

Proposed habitat improvements within the Duck Creek Delta Wetland Complex project are anticipated to provide direct benefits to 11 of the 18 priority habitats. Priority habitat metrics fall

into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 51 shows priority habitats have been mapped within the DCD project boundary and how baseline and post-implementation BUI condition scores were derived.

Table 51. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundary	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Coastal Emergent Marsh	125.0 x 0.50	**62.5**	325 x 0.65	**211.3**
Submergent Marsh	50.0 x 0.50	**25.0**	250 x 0.65	**162.5**
Inland Emergent Marsh	0.50 x 0.40	**0.20**	0.50 x 0.65	**0.33**
Wet Meadow	0.00 x 0.60	**0.00**	40.0 x 0.65	**26.0**
Hardwood Swamp	100.0 x 0.40	**40.0**	100.0 x 0.65	**65.0**
Shrub Carr	100.0 x 0.50	**50.0**	100.0 x 0.65	**65.0**
Other Forest	50.0 x 0.50	**25.0**	50.0 x 0.65	**32.5**
Old Field Grassland	5.00	**5.00**	5.00	**5.00**
Quantity (acres or km) x Management Based Metrics				
Inland Open Water	2.0 x 0.5B	**1.00**	2.0 x 0.75B	**1.75**
Designated Habitat Area Based Metrics				
Green Bay Open Water	0.50 Shoreline Fish	**0.50 Shoreline Fish**	1.50 Shoreline Fish	**2.00**
Tributary Open Water	0.50 Tributary Fish	**0.50 Tributary Fish**	0.50 Tributary Fish	**1.00**

The primary project scope is to increase the extent and diversity of Coastal Emergent Marsh, Submergent Marsh, and Wet Meadow habitat through barrier island implementation and installation of woody/rocky substrates throughout the open water and nearshore areas of the DCD. This could increase the current Green Bay Open Water DHA score for Shoreline Fish from 0.5 to a final combined score of 2.0 if utilization of restored/re-established habitat by target species (centrarchids, northern pike, and/or musky) is observed. Inland Emergent Marsh and Inland Open Water habitat improvements will occur through a partnership with Brown County Parks to better manage small and ephemeral ponds in the Fort Howard Wildlife Area for a variety of wildlife, including anurans. For Shrub Carr and other forest habitats, much of the

project scope will focus on vegetation management activities to improve floristic quality in existing habitat acreages/lengths (e.g., removal of invasive species, addition of higher quality native species). These activities will improve the BUI condition score for all Quantity x Quality and Quantity x Management based priority habitat metrics.

A total of 0.5 DHA Tributary Open Water points was established as a baseline for existing Tributary Fish habitat for several small tributaries/ditches along the western shoreline of this project area that already provide fish passage. However, two important fish passage barriers were identified several years ago, and restoring passage is another goal for this project at a culvert on Cottage Grove Road and under US Highway 41 that are heavily invaded by Phragmites and other vegetation. With these improvements, the Tributary Open Water DHA score could increase to a total of 1.0 DHA points if target species are observed utilizing the habitat.

Priority Populations

Proposed habitat improvements are anticipated to benefit at least 20 of the 22 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 52 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 52. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	**Metric Type**	**Metric Assessment Methodology**	**Data Source**
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Coastal Wetland Aquatic Macroinvertebrates	IEC	CWMP Environmental Reference Gradient	CWMP
Colonial Waterbirds	IEC	Average IEC based on number of nests for 8 Colonial Waterbird species	USDA + DNR
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP

Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	UWGB
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Breeding Coastal Birds	Count-Based	Number of sites breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	UWGB
Breeding Shorebirds	Count-Based	Number of sites breeding documented for Killdeer + Spotted Sandpiper + Rare Species (Piping Plover, Wilson's Phalarope, American Avocet, etc.) to generate Breeding Shorebird (Sb) Metric	UWGB
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	UWGB + Citizen Science
Wetland Terns	Count-Based	Number of nesting colonies at least 1 km apart from each other	DNR + UWGB
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Freshwater Unionid Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Shoreline Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR
Tributary Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	UWGB

As described in the Metrics and Monitoring Plan, some DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 53 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points

possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 53. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	1.0	0.0	**1.0**
Coastal Terrestrial Macroinvertebrates	0.0	1.0 Marsh/Sedge	**1.0**
Migratory Landbirds	0.0	1.0	**1.0**
Migratory Shorebirds	0.0	1.0	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

If implemented, the Duck Creek Delta project represents a 23% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 17% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

EPA GLNPO and USACE entered into an Inter-Agency Agreement (IA) to support the pre-investigation design phase in partnership with DNR. Going forward, EPA GLNPO, USACE, DNR will continue to collaboratively manage the project, with USACE leading the project design and construction. DNR will work with local and regional partners to implement a restoration design and adaptively manage the site.

Many federal, state, and local partners will participate in informing the project design, including but not limited to the riparian landowners, Village of Howard, Village of Suamico, Brown County Parks, Brown County Port, UWGB, UW-Stevens Point, USFWS, and others.

In addition to soliciting technical expertise, DNR will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase.

Timeline, estimated costs for applicable project phases, and cost-sharing opportunities

An initial IA to support feasibility for this project was awarded in 2021 to USACE. Future IAs are expected to move forward to support various aspects of implementation phases from 2024 – 2026 (Table 54). DNR will submit a GLRI proposal in 2025 to secure funding needed for the

restoration plan and maintenance phase. GLRI requests for this project will not exceed >$20,000,000. If additional funding is needed to complete various phases of the project, AOC partners will collaborate with DNR on requests to other funders.

Table 54. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Planning/Design	$250,000			$600,000						
Implementation					<$19,150,000					
Maintenance										

Project Maintenance

DNR, USACE and local partners will be responsible for cooperatively managing the in-water features; DNR will work with adjacent riparian landowners and the GBRP to complete vegetation maintenance activities.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

Given the complexity and scale of the project, stakeholder engagement is critical for project buy-in. While most conservation-focused stakeholders have had some engagement with the project concept to date through various public meetings, technical groups, events, and/or presentations, much more work is needed to engage the community and user groups who could be impacted by this project. DNR will rely heavily on the partnership with the Leadership Council and relevant sub-teams, the GBCP to assist with outreach and communications, and with a re-established Citizens Advisory Committee to identify potential benefits and burdens of the project.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the census tracts immediately adjacent to the Duck Creek Delta Wetland Complex project boundaries are not identified as disadvantaged. However, the project represents a unique opportunity to restore a globally significant habitat, and as such will provide tremendous opportunities for citizen science, education/training/workforce development, increasing the diversity of user groups and recreational interests in the area, and other community benefits. DNR will continue to scope and

better define these benefits through partnership with the Leadership Council and Citizens Advisory Committee ahead of project design.

Climate Change

All of the proposed project elements are nature-based features that are designed to integrate into Green Bay's hydrologic and hydraulic regime. USACE will continue to evaluate resiliency measures throughout the project's design phase.

Project #11: Cat Island Fisheries and Wetland Improvement

Site Description and Location

The Cat Island Restoration Chain is a ~4.5 km long causeway that extends from Peters Marsh into the open water of the lower west Green Bay. Extending off the causeway are six “legs”, between which are three “cells”, where artificial island development is encouraged by the placement of dredge material.

Historically, three large barrier islands called the Cat Island Chain provided critical fish and wildlife habitat for birds, fish, invertebrates, and furbearers and offered a protected refugium for native plants and extensive Great Lakes beach. These islands were very popular among duck hunters as well. Due to extremely high-water levels in the bay, massive storms, and hardened shorelines, these islands and associated wetlands habitats washed away during the spring of 1973 except for a few small sandy islands including parts of Cat Island (Figure 41).

In the 1980s, a group of local conservationists proposed the idea of reconstructing the barrier islands of the Cat Island Chain and formalized the idea in the LGBFR AOC’s 1988 Remedial Action Plan (RAP). It took decades of extensive planning and acquiring funding for that idea to materialize and become a reality as part of a $20,000,000 GLRI Focus Area 1 grant. Local, state, federal, and citizen groups collaborated with Brown County, Brown County Port and Resource Recovery Office, and USACE and devised a plan to reconstruct these islands. Eventually, the Cat Island Wave Barrier and island “cells” were constructed by May 2013. These cells will be filled over the next 20-30 years with clean dredge material taken from the Green Bay/Fox River navigation channel and will ultimately re-establish critical fish and wildlife habitat.

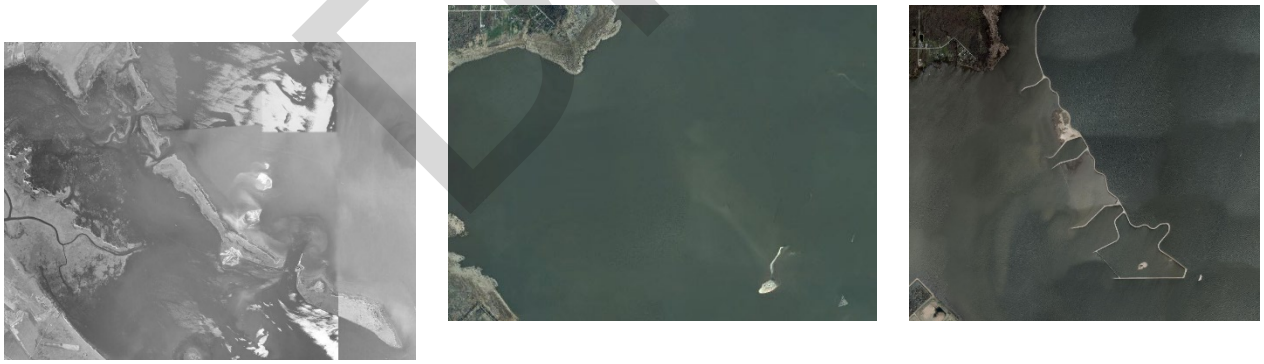


Figure 41. Left photo shows natural Cat Island Chain in 1938, center photo shows extirpation of majority of natural Cat Island Chain in 2010, and right photo shows Cat Island Wave Barrier and start of island building in West Cell in 2020.

Currently, one out the 18 priority habitats is represented in the Cat Island Fisheries and Wetland Improvement project area (Figure 42). This project aims to establish habitat between the first and second “cells” on the leeward side of the Cat Island Wave Barrier that will benefit a variety of fish and wildlife species. This project also includes wetland plantings to encourage Coastal Emergent Marsh and Submergent Marsh re-establishment in the area. Habitat improvements made in this area may also provide the added benefit of increased habitat connectivity and re-establishing a wetland corridor in the lower Green Bay that was greatly diminished in the 1970s.

Figure 42. Priority habitats within the Cat Island Restoration Chain project boundary.

A total of 39 fisheries surveys were conducted in the Cat Island Chain project area from 2016 – 2018 by the USFWS' AIS early detection team, using a variety of gear types (boat electrofishing, cloverleaf trap, gillnet, paired fyke nets, and beach seine). Combining the results of all gear types, a total of 6439 fishes representing 34 different species were surveyed. These were dominated by spottail shiner (68.1% of total fish caught), yellow perch (10.4%), emerald shiner (4.5%), centrarchids (3.4%), gizzard shad (2.9%), round goby (2.3%) and walleye (1.9%). Note, although spottail shiners were the most abundant fish sampled, 25% of these came from one paired fyke net in May of 2016. Initially, walleye were recommended as the target species for this project by the TAC. However, after further investigation, the fisheries experts on the Project Team concluded that the Cat Island area is not well suited for walleye habitat due to high wave action on the windward side and end of the Restoration Chain near the navigational channel. With concurrence from the recently organized (2022) LGBFR AOC Fish Technical Team and the TAC, the Team decided that muskellunge are a more feasible target species.

Project Scope and Priority Habitats/Populations Benefited

The project scope focuses on the improvement of esocid and centrarchid rearing and spawning habitat in the Cat Island Restoration Chain area. Habitat improvements in the area are expected to increase the current Green Bay Open Water DHA score for Shoreline Fish from 1.0 to a final combined score of 1.75 if the target species (muskie) are identified utilizing re-established habitat.

The project team proposes to accomplish this through the addition habitat groynes arranged in "hook" and "S" formations extending off of the "legs" (constructed using 8-10 in diameter rocks and lined with 3-4 ft diameter boulders to help dissipate any wave/ice action); gravel skirts extending 8-10 ft off the ends of the groynes (constructed using rounded pea gravel); and woody habitat structures placed along the "legs", groynes, and in the open water area (constructed using root wads and/or tree crowns, 25-35 ft logs, 2-3 ft diameter boulders, gravel, and potentially brush). Woody habitat structures could also be placed strategically in front of habitat groynes to help dissipate wave/ice energy.

Wetland plantings will also be incorporated behind habitat groynes to re-establish Coastal Emergent and Submergent Marsh habitat in the project area. A species list has not yet been finalized though a variety of vegetation types will be planted to encourage high-quality wetland habitat. Wetland plantings, paired with those proposed at nearby Duck Creek Delta, may also help address water quality issues in the area.

The primary goal of this project is to create contiguous habitat to increase primarily muskie, but also northern pike, spawning activity in the area. However, proposed habitat improvements are expected to provide a variety of benefits to several priority populations. Of note, the woody structures and newly established wetland habitat are expected to be utilized by a variety of other Shoreline Fish species, especially centrarchids, for refuge, foraging, and rearing habitat. Wetland plantings are also expected to provide habitat for Anurans, Turtles, and Coastal Wetland Aquatic Macroinvertebrates. Shoreline Fish, Coastal Wetland Aquatic Macroinvertebrate, and Anuran species utilizing improved/re-established habitat in the area may

also provide food sources for other priority populations, including Bald Eagles/Ospreys, Colonial Waterbirds, Breeding Coastal Birds, Coastal Wetland Mustelids, and Wetland Terns.

The work outlined above is anticipated to improve the BUI condition scores for Quantity x Quality and DHA based priority habitat metrics.

Priority Habitats

Proposed habitat improvements within the Cat Island project are anticipated to provide direct benefits to 3 of the 18 priority habitats. Priority habitat metrics fall into two main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 55 shows the priority habitats that have been mapped within the Cat Island Fisheries and Wetland Improvement project boundaries and how baseline and post-implementation BUI condition scores were derived:

Table 55. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundaries	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Coastal Emergent Marsh	0.00 x 0.50	0.00	1.00 x 0.65	0.65
Submergent Marsh	0.00 x 0.50	0.00	1.00 x 0.65	0.65
Designated Habitat Area Based Metrics				
Green Bay Open Water	1.00 Shoreline Fish	1.00	0.75 Shoreline Fish	1.75

Priority Populations

Proposed habitat improvements and historical investments at Cat Island are anticipated to provide benefits to 15 of the 22 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA

focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 56 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 56. Priority populations expected to utilize the Cat Island project site, the primary metric type, assessment methodology, and anticipated data sources for evaluating BUI condition scores after project implementation.

Priority Populations	**Metric Type**	**Metric Assessment Methodology**	**Data Source**
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Coastal Wetland Aquatic Macroinvertebrates	IEC	CWMP Environmental Reference Gradient	CWMP
Colonial Waterbirds	IEC	Average IEC based on number of nests for 8 Colonial Waterbird species	USDA + DNR
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Breeding Coastal Birds	Count-Based	Number of sites breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	Contractor
Breeding Shorebirds	Count-Based	Number of sites breeding documented for Killdeer + Spotted Sandpiper + Rare Species (Piping Plover, Wilson's Phalarope, American Avocet, etc.) to generate Breeding Shorebird (Sb) Metric	Contractor
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	Contractor + DNR
Wetland Terns	Count-Based	Number of nesting colonies at least 1 km apart from each other	DNR

Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Shoreline Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY, and Rare/Sensitive target species present	DNR/USFWS

As described above, DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 57 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 57. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Coastal Terrestrial Macroinvertebrates	1.0 Beach	0.0	**1.0**
Migratory Shorebirds	1.0	0.0	1.0

Anticipated progress toward overall fish and wildlife BUI removal criteria

If implemented, the Cat Island Fisheries and Wetland Improvement project represents a 1.6% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat BUI, and a 5.4% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

USFWS, DNR, and DU collaboratively manage the project as the Project Management Team. The Project Management Team organized a Technical Team to solicit technical expertise compromised of individuals from DNR, DU, USFWS and UWGB.

Other key partners whose involvement will be critical during implementation discussions include USACE, Brown County, and the Port of Green Bay.

Project Timeline and Estimated Costs

USFWS submitted an NRDA and GLRI proposal in 2020 and 2021, respectively, to fund a 30% design phase. In 2022, USFWS requested additional GLRI support to complete the design, and will be requesting support for implementation in 2024 (Table 58). Given the need to complete planning and design for this project, implementation and maintenance costs are contingent upon the completion of the planning and design phase. The total estimated cost for all phases of this project is $2,600,000.

Table 58. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2021	2022	2023	2024	2025	2026	2027
Planning/Design	$100,000		$100,000				
Implementation				$2,600,000			
Maintenance							

A review of investments made to date by GLRI at the Cat Island Restoration Chain includes:

- Cat Island Wave Barrier construction and maintenance - ~$3,000,000
- Piping Plover Monitoring and Recovery Efforts – ~$470,000
- Common and Forster's Tern Recovery Efforts - ~$243,000

Project Maintenance

Habitat structures and vegetation enhancements will be cooperatively maintained in coordination with the Cat Island Advisory Committee (CIAC) and GBRP. No maintenance of rock substrates and woody structures is expected though these partners will work cooperatively to address any needs post-implementation.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

DNR and USFWS have given updates on project progress and solicitated input/feedback at CIAC meetings and will continue to do so for subsequent project phases as meetings are scheduled. Additionally, DU has given project progress updates at quarterly TAC meetings and will continue to do so into the implementation phase.

During the implementation phase, the project team will update technical and community stakeholders of construction timeline, milestones, and access/recreation restrictions through appropriate public notices and meetings.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the census tract immediately adjacent to the Cat Island Fisheries and Wetland Restoration project boundaries are identified as partially disadvantaged, though this is primarily because the <1% of this tract are within the Oneida Nation boundaries.

Much of the Cat Island Chain is not currently publicly accessible as the USACE and Brown County manage it as an active construction site, though the first ~ 0.5 miles of the causeway is open to the public for foot traffic. This project will improve shoreline fishing opportunities for anglers, as well as kayaking opportunities.

Climate Change

During the planning and design phase, data pertinent to to historical and predicted climatic conditions, projected rainfall and water levels, and daily weather patterns were compiled and considered prior to any engineered design work was commenced. Climate resiliency has been incorporated into the project design by ensuring that the muskellunge, the primary target species for this project, and other Shoreline Fishes will have access to habitat during high and low water levels. Groins and woody habitat features will be designed to be resilient against increased wave action and sediment resuspension, though the project boundary is already located within a fairly protected area. Additionally, woody habitat features will be placed strategically to help dissipate wave action and ice scour. DU will continue to evaluate climate resiliency measures into the implementation phase.

Project #12: Longtail Point Beach Restoration and Reefs

Site Description and Location

Longtail Point

Longtail Point is a peninsula that extends approximately three miles into lower Green Bay along the west shore and constitutes the northwestern-most border of the AOC. In 1936, a federal waterfowl refuge was established on the peninsula, though the refuge was terminated in 1961 and the land turned over to the state of Wisconsin to become the Longtail Wildlife Unit within the larger GBWS Wildlife Area. Longtail Point is a 138-acre narrow sand spit peninsula located within the Long Tail Wildlife Unit, and largely consists of coastal emergent marsh, though there are smaller patches of hardwood swamp, sedge meadow, and shrub carr habitat. The entire peninsula is subject to the highly dynamic Great Lakes coastal system and can largely be underwater during high Lake Michigan water levels or dry and sandy during low water years (Figure 43).

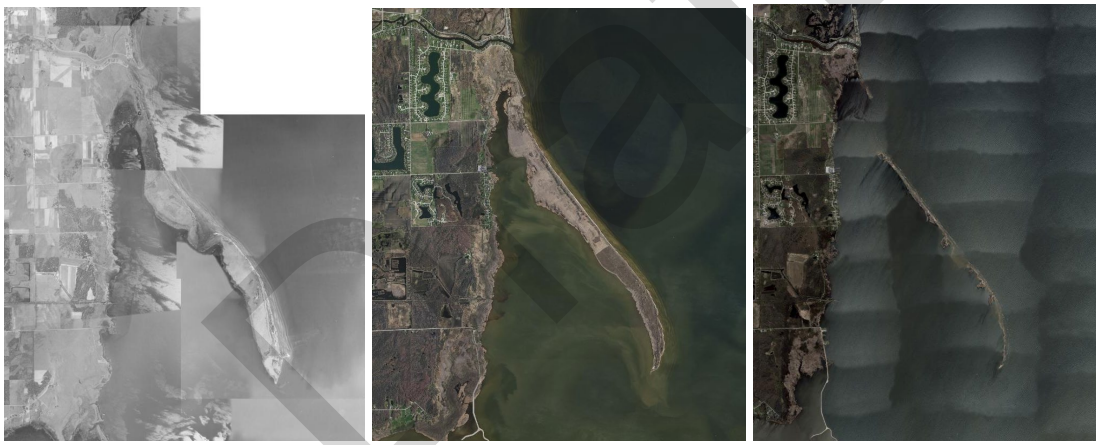


Figure 43. Aerial imagery showing the progression habitat changes at Longtail Point from 1938 to 2020 under various Lake Michigan water levels.

The peninsula is recognized as a high-quality Migratory Bird Concentration Site and has supported black and Forester's tern breeding habitat for decades, though both wetland tern colony densities at Longtail Point have decreased significantly. Several other species of birds of conservation interest through various plans/initiatives have also been recorded using Longtail Point across all seasons (e.g. federal species of concern, state endangered species, state threatened species, etc.).

The most recent high water level period in 2020 significantly reduced the extent of sandbar habitat, and for many years there have been concerns amongst conservation partners that a prolonged high-water period coupled with strong NE storm events may cause a similar outcome to that of the original Cat Island Chain. As a result, DNR has worked with partners to evaluate solutions for stabilizing the point that balance the conservation of the high-quality remnant coastal habitats under dynamic water levels, continued removal of exotic species in an area where access can be limited, preservation of several archaeological and historic sites located on the peninsula, and considerable year-round recreation. It should be noted that the area currently experiences heavy day use during the summer months from recreational boaters using the sandy nearshore areas of the peninsula, and expansion of beach habitat may create user conflicts since the intention is to provide habitat for nesting waterbirds throughout the summer breeding season.

The 2020 management action list draft also included one adjacent area to Longtail Point as its own discrete project (Deadhorse Bay), though it was determined by DNR that it was more efficient for planning and design to couple the respective concepts for both projects into one known as the Longtail Point Beach Restoration and Reef project. A site description for the Deadhorse Bay portion of this project is provided below.

Deadhorse Bay

Deadhorse Bay occupies the leeward area of Longtail Point and includes one of the highest quality coastal wetlands in the AOC, as well as some of the deepest water habitat throughout the AOC portion of Green Bay. Historically and contemporarily, Deadhorse Bay has been an important location for anglers to target yellow perch and northern pike, and fisheries surveys throughout the area have observed some of the highest densities of centrarchids near the base of Longtail Point.

A 2018 assessment conducted by the DNR Natural Heritage Conservation program also observed 3 native mussel species: Threeridge (*Amblema plicata), Wabash Pigtoe* (*Fusconaia flava*), and Lilliput (*Toxoplasma parvum*).[100] While native mussel densities were low, the Longtail/Deadhorse Bay area had high replacement ratios indicating low mortality rates. Sites where live unionid mussels occurred composed primarily of soft benthic substrates, which allow for increased survivability in the presence of non-native zebra mussels. The soft stable substrates act as a mechanism for native mussels to avoid or remove zebra mussels via burrowing and prevent fouling. Extant species in the Longtail/Deadhorse Bay area are considered stable or keystone mussel species whose presence may indicate that current environmental conditions can support stable population dynamics. One suggestion for improving native mussel populations within the AOC would be to stock extant keystone species in suitable locations, such as the soft stable substrates adjacent to Longtail Point. This area has also been stocked with *Hexagenia* mayflies for several years by researchers at UW-Milwaukee which also require soft stable substrates to complete their lifecycle and have been documented to be completely lost from naturally reproducing and thriving in the AOC.

[100] Weinzinger and Kitchel, 2020. Investing Native Mussel Communities Within Nearshore Habitats

Summary

Across both sites, a total of 8 out of the 18 priority habitats are currently represented in the Longtail Point Beach Restoration and Reefs project (Figure 44).

Project Scope and Priority Habitats/Populations Benefited

Restoration enhancements proposed as part of this project include the re-establishment of Great Lakes beach habitat along the length of Longtail Point. In addition to increasing resiliency of habitat on the point and ensuring the sandbar habitat continues to provide protection to the leeward coastal wetland habitat, another primary goal is to provide additional beach habitat for breeding bird species such as the Federally endangered Piping Plover and other fish and wildlife. These improvements are also expected to provide expanded spawning, rearing and foraging habitat for yellow perch.

A second primary goal is to implement three deep-water reefs in Deadhorse Bay to establish spawning habitat for smallmouth bass and walleye, given that few areas in the AOC currently house cobble or gravel substrates.

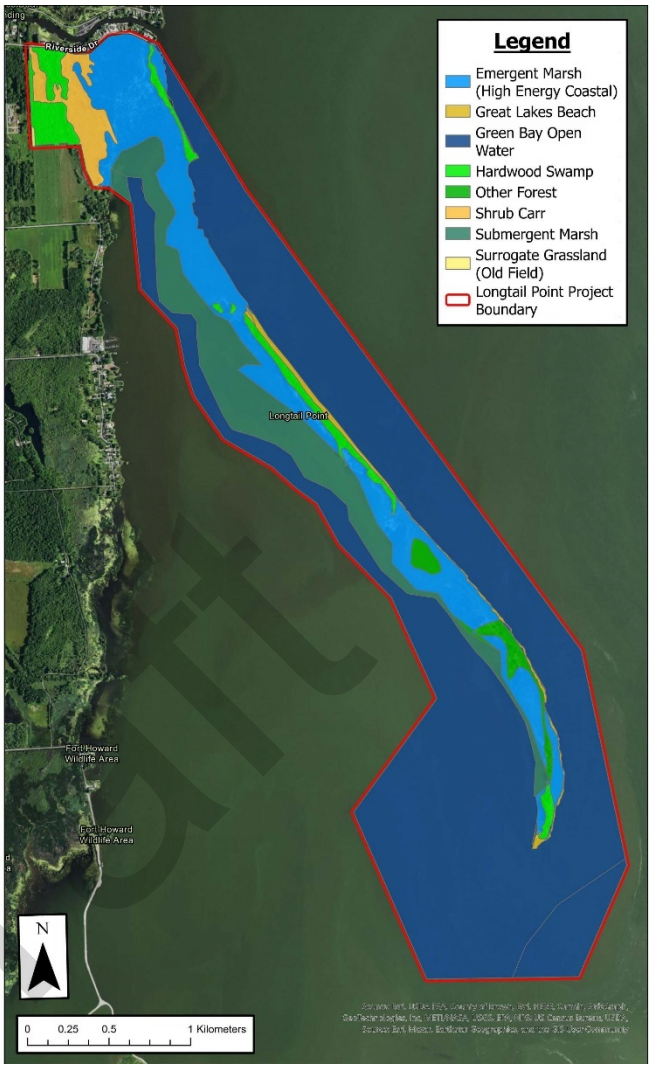


Figure 44. Priority habitats within the Longtail Point project boundary.

However, questions surrounding the feasibility of a beach nourishment project on this scale and material source needed to be better understood before pursuing a full design phase for the project. As a result, EPA GLNPO and DNR partnered with USACE in 2021 to complete a pre-design investigation for the project, as USACE has considerable technical expertise, understanding of Lower Green Bay dynamics, and can provide the nexus to beneficially reused clean dredge materials that could be used to construct the project. The results of the pre-design investigation are documented in a TM to be finalized in late 2023 and appended to this document when available. Results of this effort indicate that if an appropriate quantity and quality of sand was placed at Longtail Point to extend both the width and height of dune habitat, the beach nourishment would provide increased protection from wind, wave and ice and build

resiliency of habitat at Longtail Point. Next steps include characterizing sediment from Green Bay harbors in mid-2024 to determine if there is a beneficial reuse source of material to construct the beach nourishment portion of the project, followed by a full design and permitting phase that will begin in 2025, and construction of the project in mid to late 2026.

Additionally, the pre-design investigation also developed design criteria for three 1-acre spawning reefs targeting utilization by smallmouth bass and walleye, among other fish species. A total of 55 fisheries surveys were conducted in this area from 2016 – 2018 by the USFWS' AIS early detection team, using a variety of gear types (boat electrofishing, gillnet, paired fyke net, cloverleaf trap, and beach seine). Combining the results of all gear types, a total of 7607 fish, representing 40 different species were sampled. These were dominated by spottail shiners (34.4% of total fish caught), gizzard shad (25.9%), and yellow perch (24.4%), followed by white perch (2.5%), brown bullhead (1.9%), white sucker (1.5%), alewife (1.4%), and freshwater drum (1.1%). Centrarchids represented 1.42% of total catch and their highest densities came from the base of Longtail Point. Of note, 53.5% of spottail shiners came from one May 2016 fyke net off the western shoreline at the middle of Longtail Point. Most gizzard shad (85%) were surveyed in 6 fyke nets in May of 2016. Only 52 walleye were surveyed but the majority were located off the tip of Longtail Point. Next steps include beginning a full design and permitting phase for the reef portion of the project in early 2024, with reef construction scheduled for 2025.

Priority Habitats

Proposed habitat improvements within the Longtail Point Beach Restoration and Reef project is anticipated to provide direct benefits to 6 of the 18 priority habitats. Priority habitat metrics fall into three main categories: Quantity of Habitat (acres) x Floristic Quality, Quantity of Habitat (acres or km) x Management, and Designated Habitat Area (DHA).

Table 59 shows priority habitats have been mapped within the DCD project boundary and how baseline and post-implementation BUI condition scores were derived.

Table 59. Current priority habitats and points contributed to the overall habitat BUI condition score as compared to improved/added priority habitats and points contributed to the overall habitat BUI condition score following project implementation.

Priority Habitats Within Project Boundary	Total Mapped Acres or Km x Current Quality Multiplier or DHA Units	Current Points Contributed Toward BUI Condition Score	Total Mapped Acres Improved or Added x Quality Multiplier or DHA Units	Post-Implementation Points Contributed Toward BUI Condition Scores
Quantity (acres) x Quality Based Metrics				
Coastal Emergent Marsh	100.0 x 0.50	**50.0**	100.0 x 0.65	**65.0**
Hardwood Swamp	100.0 x 0.40	**40.0**	100.0 x 0.65	**65.0**
Shrub Carr	41.0 x 0.50	**20.5**	41.0 x 0.65	**26.7**
Other Forest	20.0 x 0.50	**10.0**	20.0 x 0.65	**13.0**

Quantity (acres or km) x Management Based Metrics				
Great Lakes Beach	3.5mi X 0.50B	**1.75**	3.5mi X 0.75	**2.63**
Designated Habitat Area Based Metrics				
Green Bay Open Water	1.0 Shoreline Fish	**1.0**	0.5 + 1.0 Native Freshwater Mussels + Shoreline Fish	**2.5**

The primary project scope is to integrate native herbaceous and woody species in the Great Lakes Beach and forest habitat types and manage invasive species throughout all vegetative communities at Longtail Point. These activities will improve the BUI condition score for all Quantity x Quality and Quantity x Management based priority habitat metrics.

Beach nourishment activities will also improve the current Great Lakes Beach Metric from "Recreational Management" where the beach is regularly maintained for recreational purposes that provide some conservation or wildlife value, to "Conservation Management" where the beach is managed for invasive species, maintains open portions for nesting, lacks unnatural shoreline features (e.g., rip-rap), and may clear persistent zebra/quagga mussels and other refuse.

Implementation of the three 1-acre spawning reefs could increase the current Green Bay Open Water DHA score for Shoreline Fish from 1.0 (assigned for the entire west shore from Cat Island to Longtail Point) to a final combined score of 2.5 if utilization of restored/re-established habitat by target species (smallmouth bass, walleye, and/or native freshwater mussels) is observed.

Priority Populations

Proposed habitat improvements are anticipated to benefit at least 20 of the 22 priority populations. Priority population metrics fall into four main categories: Index of Ecological Condition (IEC), Count-based, Designated Habitat Area (DHA), and DHA/Count-based Hybrid. IEC, Count-based, and DHA/Count-based Hybrid assessment methods require verification monitoring to occur after the project is implemented to assess priority population utilization within the project boundary. The assessment method for DHA focuses only on the habitat being present for utilization by priority populations and does not require verification monitoring.

While it is impossible to assume what priority populations will be present in any given area of the AOC from year to year, the TAC reviewed the project scope and developed a list of priority populations with high confidence of utilization and improved BUI condition scores because of this project. Table 60 lists these priority populations, the primary metric type, assessment methodology, and likely data sources for evaluating BUI condition scores after this project is implemented.

Table 60. Priority populations likely to be benefited following project implementation, their respective metric type and assessment methodology, and anticipated source of data collection for pre and post restoration monitoring.

Priority Populations	Metric Type	Metric Assessment Methodology	Data Source
Anurans	IEC	Average IEC based on 10 best wetland breeding anuran surveys	CWMP
Coastal Wetland Aquatic Macroinvertebrates	IEC	CWMP Environmental Reference Gradient	CWMP
Colonial Waterbirds	IEC	Average IEC based on number of nests for 8 Colonial Waterbird species	USDA + DNR
Marsh Breeding Birds	IEC	Average IEC based on 10 best wetland breeding bird surveys	CWMP
Migratory Waterfowl	IEC	Spring waterfowl abundance and species richness from point count surveys	UWGB
Wooded Wetland Birds	IEC	Average IEC based on 10 best forest breeding bird surveys	Contractor
Bald Eagle/Osprey	Count-Based	Number of Bald Eagle and Osprey nesting locations	DNR
Breeding Coastal Birds	Count-Based	Number of sites breeding documented for Belted Kingfisher + Green Heron + Tree Swallow + Cliff Swallow + Purple Martin, Bank Swallow, or Northern Rough-winged Swallow to generate Coastal Bird (Cb) Metric	UWGB
Breeding Shorebirds	Count-Based	Number of sites breeding documented for Killdeer + Spotted Sandpiper + Rare Species (Piping Plover, Wilson's Phalarope, American Avocet, etc.) to generate Breeding Shorebird (Sb) Metric	UWGB
Coastal Wetland Mustelids	Count-Based	Catch per unit effort (CPUE) of otter and mink trapped within one zip code of AOC shoreline to generate Mustelid Abundance (M) Metric	DNR
Muskrat	Count-Based	Catch per unit effort (CPUE) of muskrat trapped within one zip code of AOC shoreline to generate Muskrat Abundance (Mk) Metric	DNR
Turtles	Count-Based	Number of sites with documented Snapping Turtles + Painted Turtles + Uncommon/Rare species (Spiny Softshell, Blanding's, Wood, Northern Map Turtle, etc.) to generate Turtle Occupancy (T) Metric	UWGB + Citizen Science
Wetland Terns	Count-Based	Number of nesting colonies at least 1 km apart from each other	DNR + UWGB
Bats	DHA	Number of DHAs present in Forest and Riparian corridor habitats in project boundary	DNR
Coastal Terrestrial Macroinvertebrates	DHA	Number of DHAs present in Upland, Great Lakes Beach, and Marsh and Sedge Meadow habitats in project boundary	DNR
Migratory Landbirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR
Migratory Shorebirds	DHA	Number of DHAs present in Migratory Stopover habitats in project boundary	DNR

Freshwater Unionid Mussels	DHA + Count Based	Number of DHAs present in project boundary with Opportunistic, Keystone, and Rare/Uncommon species present	DNR
Shoreline Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	DNR
Tributary Fish	DHA + Count Based	Number of DHAs present in project boundary with Adult, Juvenile/YOY and Rare/Sensitive target species present	UWGB

As described in the Metrics and Monitoring Plan, some DHA metrics do not require verification monitoring to demonstrate that the respective intended priority population is utilizing the site. These priority populations were recommended for this assessment method because they are migratory or have significant stressors that go beyond the availability of habitat in the AOC. Table 61 shows which populations have current DHA points awarded to the project boundary, which will have new DHA points awarded post-implementation, and the total DHA points possible in the project boundary that can be counted toward the overall BUI condition score for respective priority populations.

Table 61. Current and new DHA points awarded for priority populations that do not require verification monitoring to demonstrate species are utilizing the site.

Priority Population	Current DHA Points	New DHA Points	Post-Implementation Total DHA Points
Bats	0.0	1.0	**1.0**
Coastal Terrestrial Macroinvertebrates	0.0	1.0 Great Lakes Beach	**1.0**
Migratory Landbirds	0.0	1.0	**1.0**
Migratory Shorebirds	0.0	1.0	**1.0**

Anticipated progress toward overall fish and wildlife BUI removal criteria

If implemented, the Longtail Point Beach Restoration and Reefs project represents a 13.2% increase in the baseline BUI condition score for the Loss of Fish and Wildlife Habitat, and a 8.5% increase in the baseline BUI condition score for the Degradation of Fish and Wildlife Populations BUI.

Project Collaboration

EPA GLNPO and USACE entered into an Inter-Agency Agreement (IA) to support the pre-investigation design phase in partnership with DNR. Going forward, EPA GLNPO, USACE, DNR will continue to collaboratively manage the project, with USACE leading the project design and construction. DNR will work with local and regional partners to implement a restoration design and adaptively manage the site.

Many federal, state, and local partners will participate in informing the project design, including but not limited to the riparian landowners, Village of Howard, Village of Suamico, Brown County Parks, Brown County Port, UWGB, UW-Stevens Point, USFWS, and others.

In addition to soliciting technical expertise, DNR will also develop a list of interested stakeholders to solicit feedback for accessibility, recreation, educational and EJ considerations during the project design phase.

Timeline, estimated costs for applicable project phases, and cost-sharing opportunities

An initial IA to support feasibility for this project was awarded in 2021 to USACE. Future IAs are expected to move forward to support various aspects of implementation phases from 2024 – 2026 (Table 62). DNR will submit a GLRI proposal in 2026 to secure funding needed for the restoration plan and maintenance phase. GLRI requests for this project will not exceed >$20,000,000. If additional funding is needed to complete various phases of the project, AOC partners will collaborate with DNR on requests to other funders.

Table 62. Project planning/feasibility phase is in yellow, design phase in orange, implementation phase in green, and maintenance/monitoring phase in purple.

Phase	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Planning/Design	$250,000				$600,000					
Implementation						$19,150,000				
Maintenance										

Project Maintenance

DNR, USACE and local partners will be responsible for cooperatively managing the in-water features; DNR will work with adjacent riparian landowners and the GBRP to complete vegetation maintenance activities.

Specific Stakeholder Engagement, Environmental Justice, and Climate Change Considerations

Stakeholder Engagement

Given the complexity and scale of the project, stakeholder engagement is critical for project buy-in. While most conservation-focused stakeholders have had some engagement with the project

concept to date through various public meetings, technical groups, events, and/or presentations, much more work is needed to engage the community and user groups who could be impacted by this project. DNR will rely heavily on the partnership with the Leadership Council and relevant sub-teams, the GBCP to assist with outreach and communications, and with a re-established Citizens Advisory Committee to identify potential benefits and burdens of the project.

Environmental Justice

According to EJ Screen and the Justice40 (CEJST) tool, the census tracts immediately adjacent to the Longtail Point Beach Restoration and Reefs project boundary are not identified as disadvantaged. However, the project represents a unique opportunity to restore a globally significant habitat, and as such will provide tremendous opportunities for citizen science, education/training/workforce development, increasing the diversity of user groups and recreational interests in the area, and other community benefits. DNR will continue to scope and better define these benefits through partnership with the Leadership Council and Citizens Advisory Committee ahead of project design.

Climate Change

All of the proposed project elements are nature-based features that are designed to integrate into Green Bay's hydrologic and hydraulic regime. USACE will continue to evaluate resiliency measures throughout the project's design phase.

Appendix 1:

Lower Green Bay & Fox River Area of Concern Fish and Wildlife Technical Advisory Committee Members

Andy Hudak, DNR
Eric Evensen, DNR
Josh Martinez, DNR
Jesse Weinzinger, DNR
Jason Breeggemann, DNR
Dave Halfmann, DNR
Steve Burns, DNR
Sue Virgilio, USEPA
Lainet Rivera-Garcia, USFWS
Betsy Galbraith, USFWS
Trina Soyk, USFWS
Brad Smith, USFWS
Gary Van Vreede, Retired USFWS
Angela Kowalzek-Adrians, NEW Water
Mike Grimm, TNC
Amy Carrozzino-Lyon, UWGB
Amy Wolf, UWGB
Bob Howe, UWGB
Bobbie Webster, UWGB
Chris Houghton, UWGB
Erin Gnass Giese, UWGB
Patrick Kennedy, USACE
Dan Ditscheit, City of Green Bay
Jason Petrella, Brown County Parks
Mark Walter, Brown County Port

Appendix 2:

List of Acronyms

AOC – Area of Concern

ADA – Americans with Disabilities Act

AEL – Aquatic Ecology Lab (UWGB)

AIS – Aquatic Invasive Species

AMP – Aquatic Monitoring Program (NEW Water)

BBWS – Bay Beach Wildlife Sanctuary

BUI – Beneficial Use Impairment

CDF – Confined Disposal Facility

CEJST – Climate and Economic Justice Screening Tool

CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)

CIAC – Cat Island Advisory Committee

COA – Conservation Opportunity Area

CPUE – Catch Per Unit Effort

CWMP – Coastal Wetland Monitoring Program

DHA – Designated Habitat Area

DNR – Department of Natural Resources

DU – Ducks Unlimited

EJ – Environmental Justice

EPA – Environmental Protection Agency

FRT – Fox River Trail

GBCP – Green Bay Conservation Partners

GBRP – Green Bay Restoration Partners

GBWS – Green Bay West Shores

GIS – Geographic Information System

GLFC – Great Lakes Fishery Commission

GLNPO – Great Lakes National Program Office (EPA)

GLRI – Great Lakes Restoration Initiative

HHSP – Heritage Hill State Park

HUD – Housing and Urban Development

IA – Interagency Agreement

IBA – Important Bird Area

IBI – Index of Biological Integrity

IEC – Index of Ecological Condition

IUCN – International Union for Conservation of Nature

MAP – Management Action Plan

NAWCA – North American Wetlands Conservation Act

NIACS – Northern Institute of Applied Climate Science

NOAA – National Oceanic and Atmospheric Administration

NRDA – Natural Resource Damage Assessment

OAK – Outdoor Adventure for Kids

OGW – Office of Great Waters

PCB – Polychlorinated Biphenyls

RAP – Remedial Action Plan

SAV – Submerged Aquatic Vegetation

SMART – Specific, Measurable, Achievable, Realistic, Timebound

SOGL – State of Our Great Lakes

TAC – Technical Advisory Committee

TM – Technical Memorandum

TMDL – Total Maximum Daily Load

TNC – The Nature Conservancy

USACE – United States Army Corps of Engineers

USDA – United States Department of Agriculture

USFS – United States Forest Services

USFWS – United States Fish and Wildlife Service

UW – University of Wisconsin

UWGB – University of Wisconsin Green Bay

WI - Wisconsin

WIBA – Wisconsin Important Bird Area

WICCI – Wisconsin Initiative on Climate Change Impacts

WPS – Wisconsin Public Service

YOY – Young of the Year

Appendix 3:

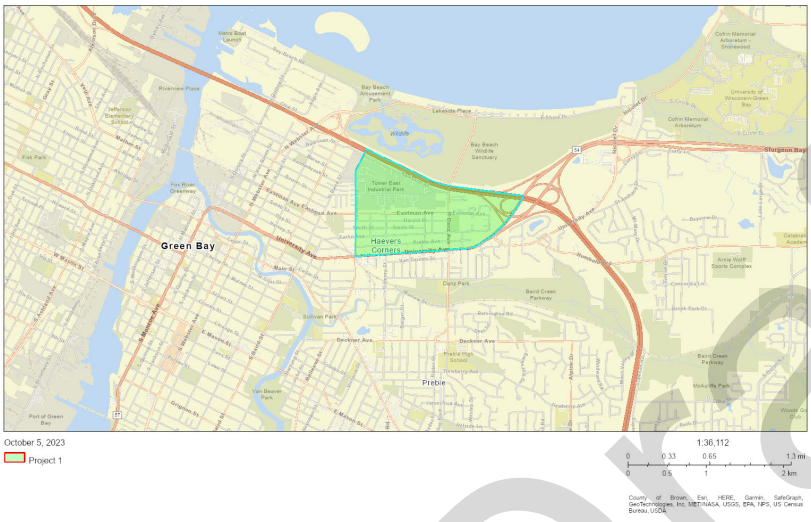
EJ Screen Reports

EJScreen Community Report

This report provides environmental and socioeconomic information for user-defined areas, and combines that data into environmental justice and supplemental indexes.

Green Bay, WI

Tract: 55009001701
Population: 4,228
Area in square miles: 0.71



LANGUAGES SPOKEN AT HOME

LANGUAGE	PERCENT
English	58%
Spanish	34%
French, Haitian, or Cajun	1%
Other Indo-European	1%
Other Asian and Pacific Island	4%
Other and Unspecified	1%
Total Non-English	42%

COMMUNITY INFORMATION

Low income: 49 percent
People of color: 64 percent
Less than high school education: 32 percent
Limited English households: 20 percent
Unemployment: 7 percent
Persons with disabilities: 11 percent
Male: 59 percent
Female: 41 percent
N/A
Average life expectancy
$19,750
Per capita income
Number of households: 1,691
Owner occupied: 30 percent

BREAKDOWN BY RACE

White: 36%
Black: 6%
American Indian: 1%
Asian: 6%
Hawaiian/Pacific Islander: 0%
Other race: 0%
Two or more races: 1%
Hispanic: 50%

BREAKDOWN BY AGE

From Ages 1 to 4	15%
From Ages 1 to 18	34%
From Ages 18 and up	66%
From Ages 65 and up	4%

LIMITED ENGLISH SPEAKING BREAKDOWN

Speak Spanish	79%
Speak Other Indo-European Languages	0%
Speak Asian-Pacific Island Languages	7%
Speak Other Languages	14%

Notes: Numbers may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, American Community Survey (ACS) 2017 -2021. Life expectancy data comes from the Centers for Disease Control.

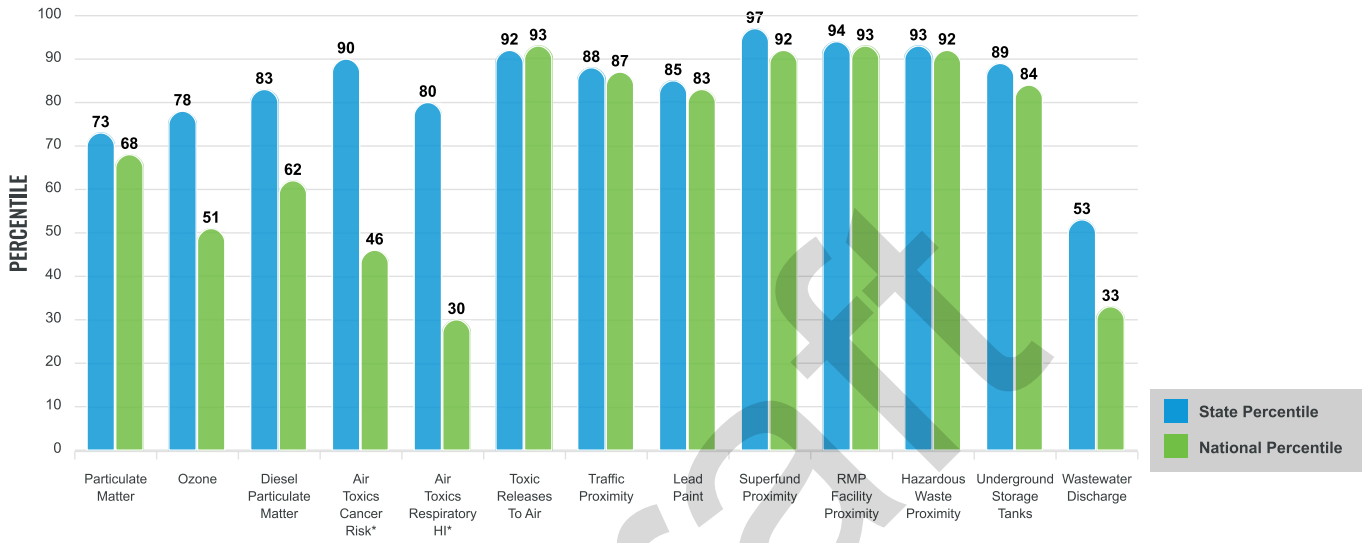
Environmental Justice & Supplemental Indexes

The environmental justice and supplemental indexes are a combination of environmental and socioeconomic information. There are thirteen EJ indexes and supplemental indexes in EJScreen reflecting the 13 environmental indicators. The indexes for a selected area are compared to those for all other locations in the state or nation. For more information and calculation details on the EJ and supplemental indexes, please visit the EJScreen website.

EJ INDEXES

The EJ indexes help users screen for potential EJ concerns. To do this, the EJ index combines data on low income and people of color populations with a single environmental indicator.

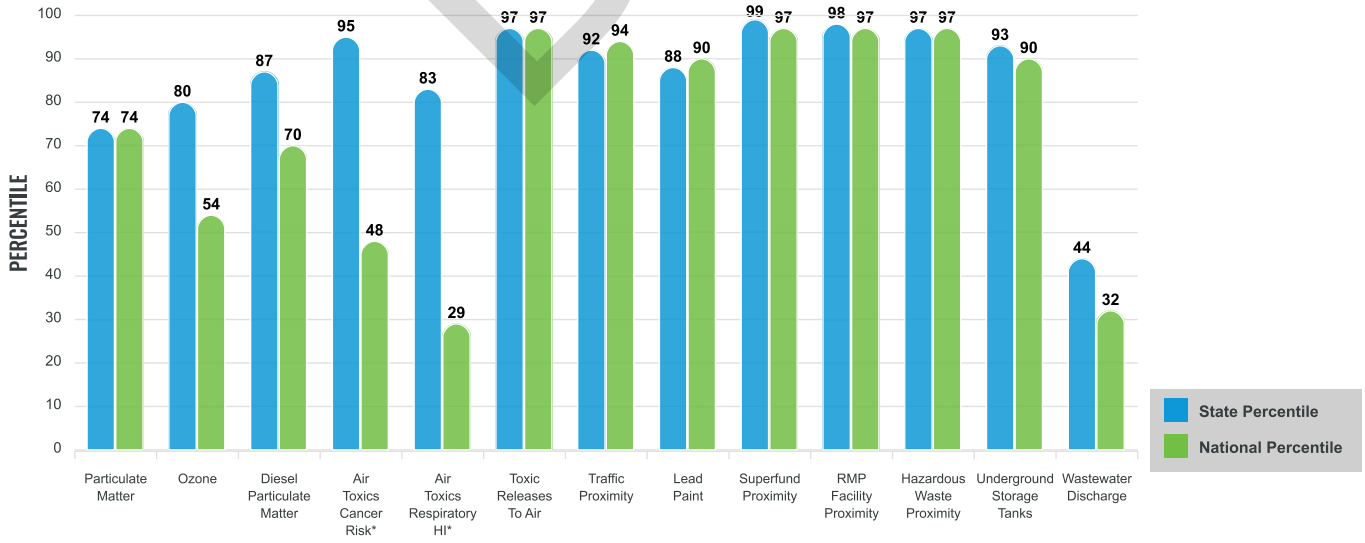
EJ INDEXES FOR THE SELECTED LOCATION



SUPPLEMENTAL INDEXES

The supplemental indexes offer a different perspective on community-level vulnerability. They combine data on percent low-income, percent linguistically isolated, percent less than high school education, percent unemployed, and low life expectancy with a single environmental indicator.

SUPPLEMENTAL INDEXES FOR THE SELECTED LOCATION



These percentiles provide perspective on how the selected block group or buffer area compares to the entire state or nation.

Report for Tract: 55009001701

EJScreen Environmental and Socioeconomic Indicators Data

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter (µg/m^3)	7.69	7.98	28	8.08	37
Ozone (ppb)	57.8	58.6	34	61.6	22
Diesel Particulate Matter (µg/m^3)	0.155	0.179	49	0.261	33
Air Toxics Cancer Risk* (lifetime risk per million)	20	19	12	25	5
Air Toxics Respiratory HI*	0.2	0.21	7	0.31	4
Toxic Releases to Air	15,000	8,100	92	4,600	95
Traffic Proximity (daily traffic count/distance to road)	310	320	68	210	83
Lead Paint (% Pre-1960 Housing)	0.39	0.4	56	0.3	66
Superfund Proximity (site count/km distance)	0.33	0.12	93	0.13	92
RMP Facility Proximity (facility count/km distance)	4.3	0.59	99	0.43	99
Hazardous Waste Proximity (facility count/km distance)	8.4	1.4	99	1.9	94
Underground Storage Tanks (count/km^2)	3.9	3.3	74	3.9	72
Wastewater Discharge (toxicity-weighted concentration/m distance)	4E-06	0.028	15	22	13
SOCIOECONOMIC INDICATORS					
Demographic Index	56%	24%	90	35%	80
Supplemental Demographic Index	27%	12%	96	14%	91
People of Color	64%	21%	90	39%	74
Low Income	49%	28%	86	31%	79
Unemployment Rate	7%	4%	83	6%	69
Limited English Speaking Households	20%	1%	98	5%	93
Less Than High School Education	32%	8%	97	12%	92
Under Age 5	15%	5%	97	6%	96
Over Age 64	4%	18%	6	17%	8
Low Life Expectancy	N/A	19%	N/A	20%	N/A

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Sites reporting to EPA within defined area:

Superfund 0
Hazardous Waste, Treatment, Storage, and Disposal Facilities 2
Water Dischargers 3
Air Pollution 0
Brownfields 0
Toxic Release Inventory 1

Other community features within defined area:

Schools 0
Hospitals 0
Places of Worship 0

Other environmental data:

Air Non-attainment ..... No
Impaired Waters ..... Yes

Selected location contains American Indian Reservation Lands* ..... No
Selected location contains a "Justice40 (CEJST)" disadvantaged community ..... Yes
Selected location contains an EPA IRA disadvantaged community ..... Yes

Report for Tract: 55009001701

EJScreen Environmental and Socioeconomic Indicators Data

HEALTH INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Low Life Expectancy	N/A	19%	N/A	20%	N/A
Heart Disease	4.7	5.8	17	6.1	22
Asthma	10.6	9.9	85	10	71
Cancer	4.1	6.6	6	6.1	12
Persons with Disabilities	9.7%	12.1%	31	13.4%	30

CLIMATE INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Flood Risk	1%	9%	16	12%	19
Wildfire Risk	0%	0%	0	14%	0

CRITICAL SERVICE GAPS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Broadband Internet	22%	14%	79	14%	77
Lack of Health Insurance	16%	6%	96	9%	86
Housing Burden	No	N/A	N/A	N/A	N/A
Transportation Access	Yes	N/A	N/A	N/A	N/A
Food Desert	No	N/A	N/A	N/A	N/A

Footnotes

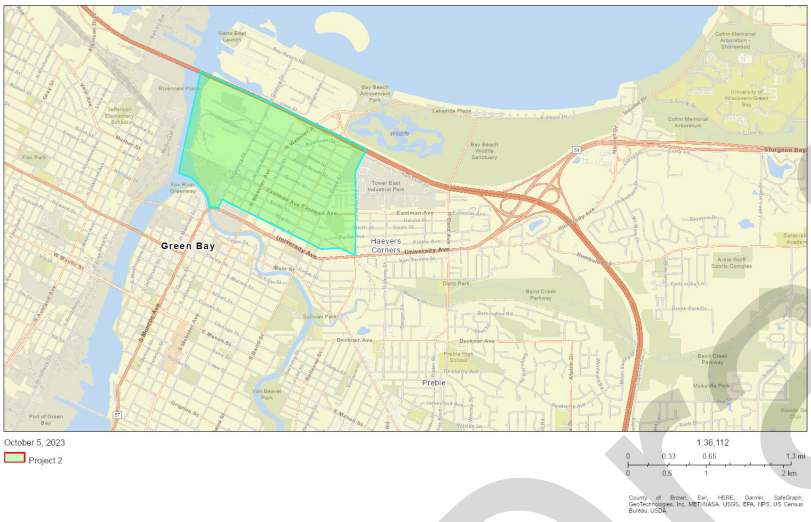
Report for Tract: 55009001701

EJScreen Community Report

This report provides environmental and socioeconomic information for user-defined areas, and combines that data into environmental justice and supplemental indexes.

Green Bay, WI

Tract: 55009000900
Population: 4,045
Area in square miles: 1.26



LANGUAGES SPOKEN AT HOME

LANGUAGE	PERCENT
English	63%
Spanish	36%
Vietnamese	1%
Total Non-English	37%

COMMUNITY INFORMATION

- Low income: 59 percent
- People of color: 61 percent
- Less than high school education: 33 percent
- Limited English households: 12 percent
- Unemployment: 10 percent
- Persons with disabilities: 17 percent
- Male: 49 percent
- Female: 51 percent
- 76 years — Average life expectancy
- $17,066 — Per capita income
- Number of households: 1,464
- Owner occupied: 52 percent

BREAKDOWN BY RACE

- White: 39%
- Black: 5%
- American Indian: 1%
- Asian: 1%
- Hawaiian/Pacific Islander: 0%
- Other race: 0%
- Two or more races: 5%
- Hispanic: 48%

BREAKDOWN BY AGE

From Ages 1 to 4	9%
From Ages 1 to 18	31%
From Ages 18 and up	69%
From Ages 65 and up	9%

LIMITED ENGLISH SPEAKING BREAKDOWN

Speak Spanish	100%
Speak Other Indo-European Languages	0%
Speak Asian-Pacific Island Languages	0%
Speak Other Languages	0%

Notes: Numbers may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, American Community Survey (ACS) 2017 -2021. Life expectancy data comes from the Centers for Disease Control.

Environmental Justice & Supplemental Indexes

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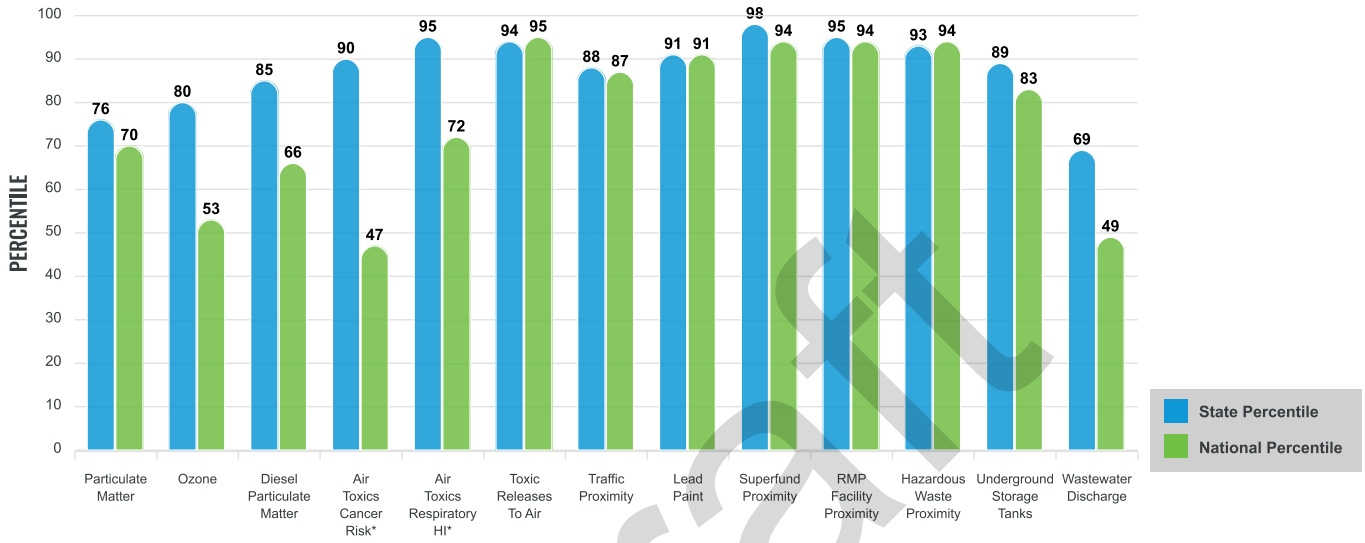
EJ INDEXES

The EJ indexes help users screen for potential EJ concerns. To do this, the EJ index combines data on low income and people of color populations with a single environmental indicator.

EJ INDEXES FOR THE SELECTED LOCATION



SUPPLEMENTAL INDEXES

The supplemental indexes offer a different perspective on community-level vulnerability. They combine data on percent low-income, percent linguistically isolated, percent less than high school education, percent unemployed, and low life expectancy with a single environmental indicator.

SUPPLEMENTAL INDEXES FOR THE SELECTED LOCATION

These percentiles provide perspective on how the selected block group or buffer area compares to the entire state or nation.

Report for Tract: 55009000900

EJScreen Environmental and Socioeconomic Indicators Data

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter (µg/m^3)	7.7	7.98	29	8.08	37
Ozone (ppb)	57.8	58.6	35	61.6	22
Diesel Particulate Matter (µg/m^3)	0.162	0.179	52	0.261	35
Air Toxics Cancer Risk* (lifetime risk per million)	20	19	12	25	5
Air Toxics Respiratory HI*	0.3	0.21	85	0.31	31
Toxic Releases to Air	19,000	8,100	94	4,600	96
Traffic Proximity (daily traffic count/distance to road)	290	320	66	210	82
Lead Paint (% Pre-1960 Housing)	0.59	0.4	74	0.3	79
Superfund Proximity (site count/km distance)	0.56	0.12	96	0.13	95
RMP Facility Proximity (facility count/km distance)	4.8	0.59	99	0.43	99
Hazardous Waste Proximity (facility count/km distance)	10	1.4	99	1.9	96
Underground Storage Tanks (count/km^2)	2.5	3.3	65	3.9	63
Wastewater Discharge (toxicity-weighted concentration/m distance)	3.4E-05	0.028	29	22	24
SOCIOECONOMIC INDICATORS					
Demographic Index	60%	24%	91	35%	82
Supplemental Demographic Index	27%	12%	96	14%	92
People of Color	61%	21%	90	39%	73
Low Income	59%	28%	91	31%	88
Unemployment Rate	10%	4%	90	6%	80
Limited English Speaking Households	12%	1%	97	5%	87
Less Than High School Education	33%	8%	97	12%	93
Under Age 5	9%	5%	83	6%	79
Over Age 64	9%	18%	19	17%	23
Low Life Expectancy	22%	19%	83	20%	76

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Sites reporting to EPA within defined area:

Superfund	0
Hazardous Waste, Treatment, Storage, and Disposal Facilities	3
Water Dischargers	7
Air Pollution	4
Brownfields	1
Toxic Release Inventory	5

Other community features within defined area:

Schools	0
Hospitals	0
Places of Worship	1

Other environmental data:

Air Non-attainment	No
Impaired Waters	Yes

Selected location contains American Indian Reservation Lands*	No
Selected location contains a "Justice40 (CEJST)" disadvantaged community	Yes
Selected location contains an EPA IRA disadvantaged community	Yes

Report for Tract: 55009000900

EJScreen Environmental and Socioeconomic Indicators Data

HEALTH INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Low Life Expectancy	22%	19%	83	20%	76
Heart Disease	5.9	5.8	53	6.1	48
Asthma	11.2	9.9	90	10	82
Cancer	4.5	6.6	10	6.1	18
Persons with Disabilities	15.9%	12.1%	81	13.4%	70

CLIMATE INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Flood Risk	5%	9%	37	12%	41
Wildfire Risk	0%	0%	0	14%	0

CRITICAL SERVICE GAPS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Broadband Internet	20%	14%	76	14%	75
Lack of Health Insurance	19%	6%	97	9%	90
Housing Burden	No	N/A	N/A	N/A	N/A
Transportation Access	Yes	N/A	N/A	N/A	N/A
Food Desert	No	N/A	N/A	N/A	N/A

Footnotes

Report for Tract: 55009000900

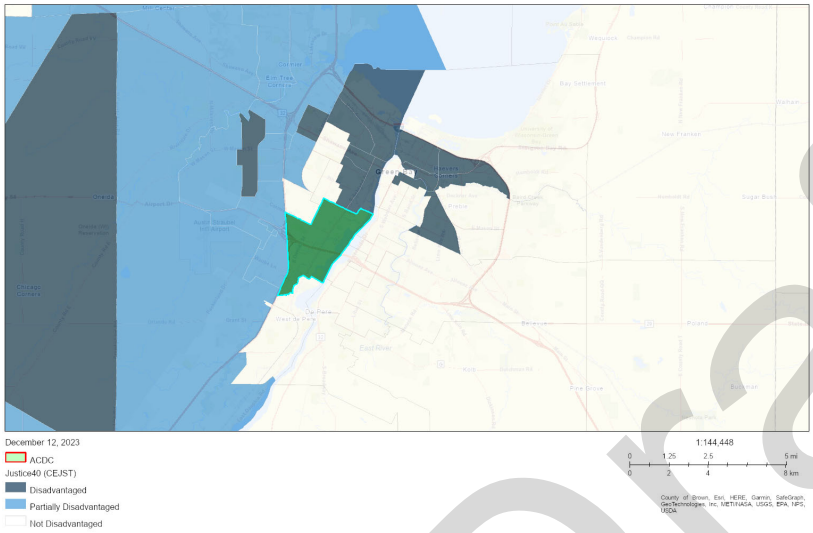
EJScreen Community Report

This report provides environmental and socioeconomic information for user-defined areas, and combines that data into environmental justice and supplemental indexes.

Ashwaubenon, WI

Tract: 55009021303
Population: 4,028
Area in square miles: 3.87

A3 Landscape



LANGUAGES SPOKEN AT HOME

LANGUAGE	PERCENT
English	90%
Spanish	8%
Other Indo-European	1%
Tagalog (including Filipino)	1%
Total Non-English	10%

COMMUNITY INFORMATION

- Low income: 51 percent
- People of color: 23 percent
- Less than high school education: 12 percent
- Limited English households: 5 percent
- Unemployment: 3 percent
- Persons with disabilities: 13 percent
- Male: 44 percent
- Female: 56 percent
- 69 years — Average life expectancy
- $24,869 — Per capita income
- Number of households: 2,018
- Owner occupied: 32 percent

BREAKDOWN BY RACE

- White: 77%
- Black: 3%
- American Indian: 3%
- Asian: 3%
- Hawaiian/Pacific Islander: 0%
- Other race: 0%
- Two or more races: 2%
- Hispanic: 12%

BREAKDOWN BY AGE

From Ages 1 to 4	5%
From Ages 1 to 18	22%
From Ages 18 and up	78%
From Ages 65 and up	17%

LIMITED ENGLISH SPEAKING BREAKDOWN

Speak Spanish	100%
Speak Other Indo-European Languages	0%
Speak Asian-Pacific Island Languages	0%
Speak Other Languages	0%

Notes: Numbers may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, American Community Survey (ACS) 2017 -2021. Life expectancy data comes from the Centers for Disease Control.

Environmental Justice & Supplemental Indexes

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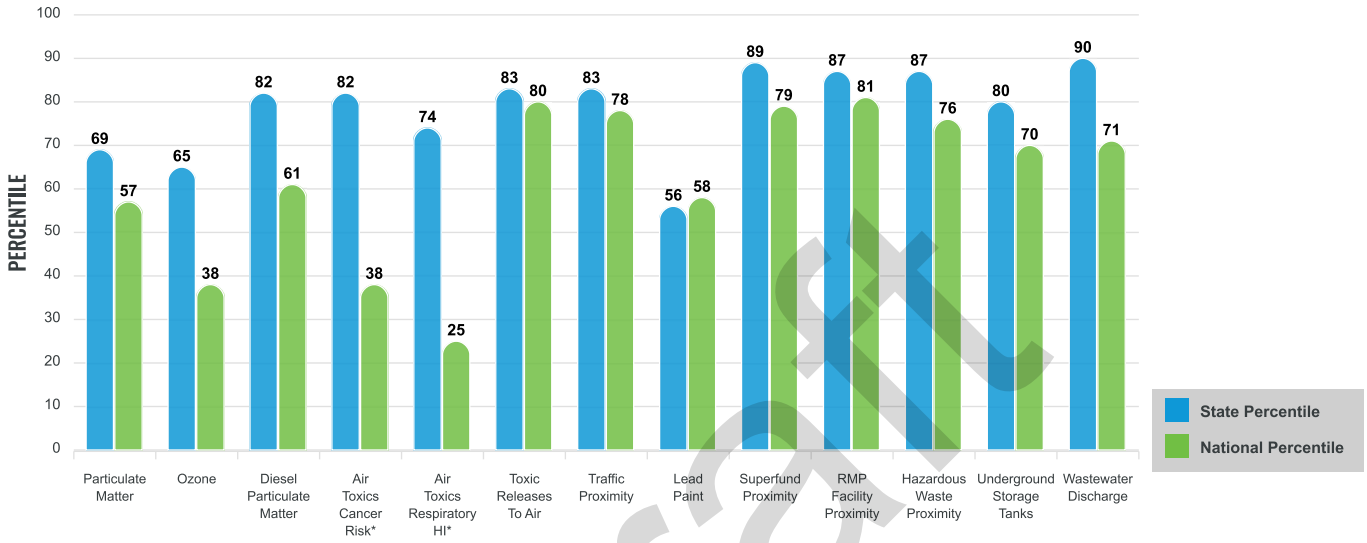
EJ INDEXES

The EJ indexes help users screen for potential EJ concerns. To do this, the EJ index combines data on low income and people of color populations with a single environmental indicator.

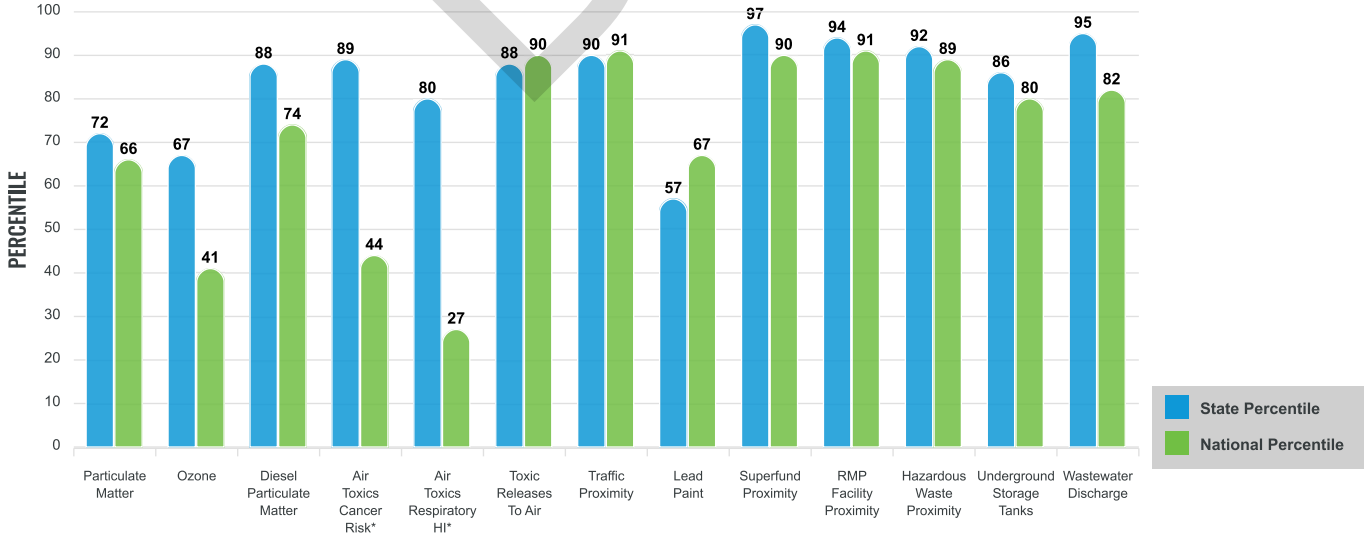
EJ INDEXES FOR THE SELECTED LOCATION



SUPPLEMENTAL INDEXES

The supplemental indexes offer a different perspective on community-level vulnerability. They combine data on percent low-income, percent linguistically isolated, percent less than high school education, percent unemployed, and low life expectancy with a single environmental indicator.

SUPPLEMENTAL INDEXES FOR THE SELECTED LOCATION



These percentiles provide perspective on how the selected block group or buffer area compares to the entire state or nation.

Report for Tract: 55009021303

EJScreen Environmental and Socioeconomic Indicators Data

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter (µg/m^3)	7.8	7.98	35	8.08	40
Ozone (ppb)	57.6	58.6	31	61.6	21
Diesel Particulate Matter (µg/m^3)	0.212	0.179	68	0.261	48
Air Toxics Cancer Risk* (lifetime risk per million)	20	19	12	25	5
Air Toxics Respiratory HI*	0.2	0.21	7	0.31	4
Toxic Releases to Air	3,900	8,100	68	4,600	83
Traffic Proximity (daily traffic count/distance to road)	540	320	79	210	91
Lead Paint (% Pre-1960 Housing)	0.22	0.4	32	0.3	50
Superfund Proximity (site count/km distance)	0.19	0.12	87	0.13	84
RMP Facility Proximity (facility count/km distance)	1.8	0.59	91	0.43	95
Hazardous Waste Proximity (facility count/km distance)	3.6	1.4	87	1.9	84
Underground Storage Tanks (count/km^2)	2.5	3.3	65	3.9	63
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.0063	0.028	78	22	64
SOCIOECONOMIC INDICATORS					
Demographic Index	37%	24%	82	35%	61
Supplemental Demographic Index	20%	12%	90	14%	79
People of Color	23%	21%	72	39%	41
Low Income	51%	28%	88	31%	81
Unemployment Rate	3%	4%	60	6%	45
Limited English Speaking Households	5%	1%	91	5%	75
Less Than High School Education	12%	8%	79	12%	63
Under Age 5	5%	5%	55	6%	55
Over Age 64	17%	18%	51	17%	56
Low Life Expectancy	29%	19%	99	20%	98

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Sites reporting to EPA within defined area:

Superfund	0
Hazardous Waste, Treatment, Storage, and Disposal Facilities	4
Water Dischargers	22
Air Pollution	3
Brownfields	9
Toxic Release Inventory	6

Other community features within defined area:

Schools	3
Hospitals	0
Places of Worship	0

Other environmental data:

Air Non-attainment	No
Impaired Waters	Yes

Selected location contains American Indian Reservation Lands*	No
Selected location contains a "Justice40 (CEJST)" disadvantaged community	Yes
Selected location contains an EPA IRA disadvantaged community	Yes

Report for Tract: 55009021303

EJScreen Environmental and Socioeconomic Indicators Data

HEALTH INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Low Life Expectancy	29%	19%	99	20%	98
Heart Disease	7	5.8	81	6.1	69
Asthma	10.2	9.9	77	10	61
Cancer	7.3	6.6	69	6.1	76
Persons with Disabilities	13%	12.1%	62	13.4%	53

CLIMATE INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Flood Risk	6%	9%	46	12%	50
Wildfire Risk	0%	0%	0	14%	0

CRITICAL SERVICE GAPS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Broadband Internet	17%	14%	67	14%	68
Lack of Health Insurance	2%	6%	15	9%	12
Housing Burden	No	N/A	N/A	N/A	N/A
Transportation Access	Yes	N/A	N/A	N/A	N/A
Food Desert	Yes	N/A	N/A	N/A	N/A

Footnotes

Report for Tract: 55009021303

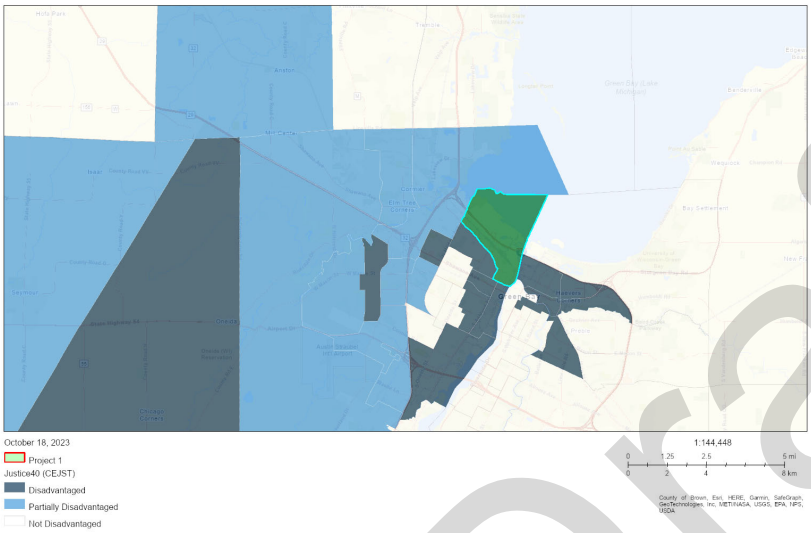
EJScreen Community Report

This report provides environmental and socioeconomic information for user-defined areas, and combines that data into environmental justice and supplemental indexes.

Green Bay, WI

Tract: 55009000100
Population: 2,521
Area in square miles: 4.57

A3 Landscape



LANGUAGES SPOKEN AT HOME

LANGUAGE	PERCENT
English	90%
Spanish	5%
French, Haitian, or Cajun	1%
Other Asian and Pacific Island	4%
Other and Unspecified	1%
Total Non-English	10%

COMMUNITY INFORMATION

- Low income: 41 percent
- People of color: 33 percent
- Less than high school education: 21 percent
- Limited English households: 1 percent
- Unemployment: 5 percent
- Persons with disabilities: 27 percent
- Male: 50 percent
- Female: 50 percent
- 77 years — Average life expectancy
- $24,484 — Per capita income
- Number of households: 1,057
- Owner occupied: 48 percent

BREAKDOWN BY RACE

- White: 67%
- Black: 7%
- American Indian: 1%
- Asian: 8%
- Hawaiian/Pacific Islander: 0%
- Other race: 0%
- Two or more races: 4%
- Hispanic: 15%

BREAKDOWN BY AGE

From Ages 1 to 4	6%
From Ages 1 to 18	22%
From Ages 18 and up	78%
From Ages 65 and up	13%

LIMITED ENGLISH SPEAKING BREAKDOWN

Speak Spanish	100%
Speak Other Indo-European Languages	0%
Speak Asian-Pacific Island Languages	0%
Speak Other Languages	0%

Notes: Numbers may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, American Community Survey (ACS) 2017 -2021. Life expectancy data comes from the Centers for Disease Control.

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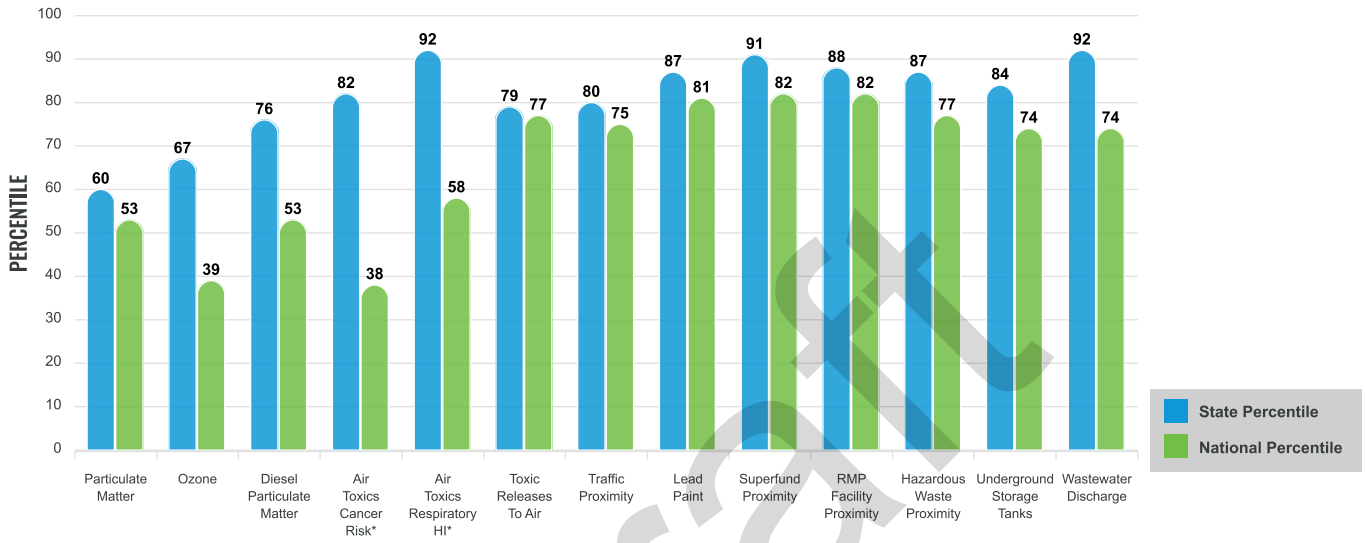

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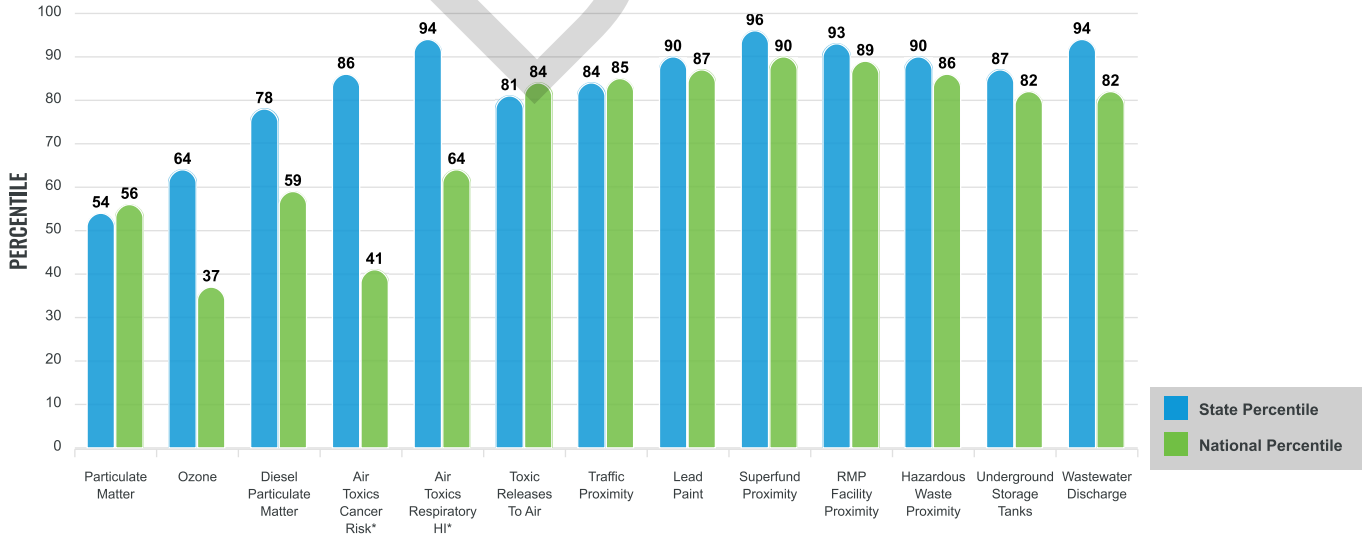
SUPPLEMENTAL INDEXES FOR THE SELECTED LOCATION



These percentiles provide perspective on how the selected block group or buffer area compares to the entire state or nation.

Report for Tract: 55009000100

EJScreen Environmental and Socioeconomic Indicators Data

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter (µg/m^3)	7.66	7.98	27	8.08	36
Ozone (ppb)	57.7	58.6	33	61.6	22
Diesel Particulate Matter (µg/m^3)	0.167	0.179	53	0.261	36
Air Toxics Cancer Risk* (lifetime risk per million)	20	19	12	25	5
Air Toxics Respiratory HI*	0.3	0.21	85	0.31	31
Toxic Releases to Air	2,200	8,100	57	4,600	74
Traffic Proximity (daily traffic count/distance to road)	320	320	69	210	84
Lead Paint (% Pre-1960 Housing)	0.75	0.4	83	0.3	89
Superfund Proximity (site count/km distance)	0.57	0.12	96	0.13	95
RMP Facility Proximity (facility count/km distance)	3.3	0.59	98	0.43	98
Hazardous Waste Proximity (facility count/km distance)	3.9	1.4	88	1.9	85
Underground Storage Tanks (count/km^2)	5.6	3.3	82	3.9	79
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.013	0.028	84	22	69
SOCIOECONOMIC INDICATORS					
Demographic Index	37%	24%	82	35%	60
Supplemental Demographic Index	18%	12%	86	14%	72
People of Color	33%	21%	81	39%	52
Low Income	41%	28%	79	31%	70
Unemployment Rate	5%	4%	76	6%	61
Limited English Speaking Households	1%	1%	76	5%	60
Less Than High School Education	21%	8%	93	12%	83
Under Age 5	6%	5%	63	6%	61
Over Age 64	13%	18%	32	17%	37
Low Life Expectancy	21%	19%	71	20%	62

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Sites reporting to EPA within defined area:

Superfund	0
Hazardous Waste, Treatment, Storage, and Disposal Facilities	0
Water Dischargers	20
Air Pollution	7
Brownfields	8
Toxic Release Inventory	7

Other community features within defined area:

Schools	2
Hospitals	0
Places of Worship	0

Other environmental data:

Air Non-attainment	No
Impaired Waters	Yes

Selected location contains American Indian Reservation Lands*	No
Selected location contains a "Justice40 (CEJST)" disadvantaged community	Yes
Selected location contains an EPA IRA disadvantaged community	Yes

Report for Tract: 55009000100

EJScreen Environmental and Socioeconomic Indicators Data

HEALTH INDICATORS					
INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Low Life Expectancy	21%	19%	71	20%	62
Heart Disease	5.3	5.8	35	6.1	35
Asthma	11.1	9.9	90	10	81
Cancer	4.5	6.6	10	6.1	18
Persons with Disabilities	25%	12.1%	98	13.4%	95

CLIMATE INDICATORS					
INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Flood Risk	3%	9%	24	12%	27
Wildfire Risk	0%	0%	0	14%	0

CRITICAL SERVICE GAPS					
INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Broadband Internet	17%	14%	66	14%	66
Lack of Health Insurance	12%	6%	92	9%	76
Housing Burden	No	N/A	N/A	N/A	N/A
Transportation Access	Yes	N/A	N/A	N/A	N/A
Food Desert	Yes	N/A	N/A	N/A	N/A

Footnotes

Report for Tract: 55009000100

EJScreen Community Report

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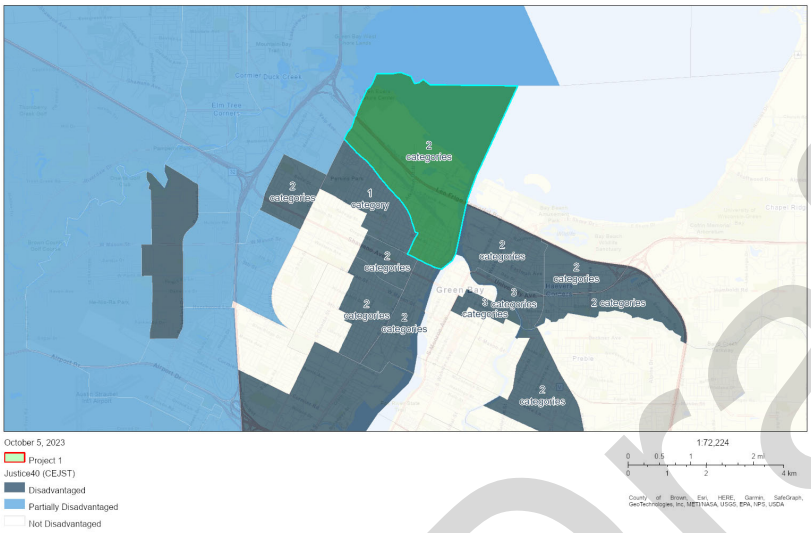
Green Bay, WI

Tract: 55009000100
Population: 2,521
Area in square miles: 4.57



LANGUAGES SPOKEN AT HOME

LANGUAGE	PERCENT
English	90%
Spanish	5%
French, Haitian, or Cajun	1%
Other Asian and Pacific Island	4%
Other and Unspecified	1%
Total Non-English	10%

COMMUNITY INFORMATION

- Low income: 41 percent
- People of color: 33 percent
- Less than high school education: 21 percent
- Limited English households: 1 percent
- Unemployment: 5 percent
- Persons with disabilities: 27 percent
- Male: 50 percent
- Female: 50 percent
- 77 years — Average life expectancy
- $24,484 — Per capita income
- Number of households: 1,057
- Owner occupied: 48 percent

BREAKDOWN BY RACE

- White: 67%
- Black: 7%
- American Indian: 1%
- Asian: 8%
- Hawaiian/Pacific Islander: 0%
- Other race: 0%
- Two or more races: 4%
- Hispanic: 15%

BREAKDOWN BY AGE

From Ages 1 to 4	6%
From Ages 1 to 18	22%
From Ages 18 and up	78%
From Ages 65 and up	13%

LIMITED ENGLISH SPEAKING BREAKDOWN

Speak Spanish	100%
Speak Other Indo-European Languages	0%
Speak Asian-Pacific Island Languages	0%
Speak Other Languages	0%

Notes: Numbers may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, American Community Survey (ACS) 2017 -2021. Life expectancy data comes from the Centers for Disease Control.

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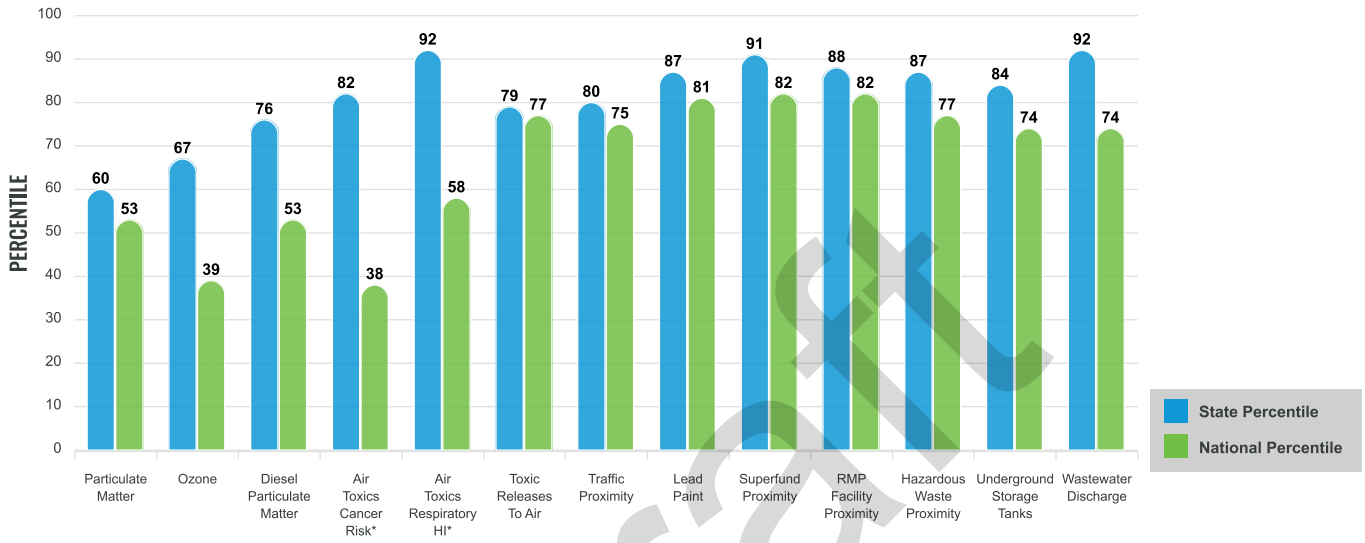
The environmental justice and supplemental indexes are a combination of environmental and socioeconomic information. There are thirteen EJ indexes and supplemental indexes in EJScreen reflecting the 13 environmental indicators. The indexes for a selected area are compared to those for all other locations in the state or nation. For more information and calculation details on the EJ and supplemental indexes, please visit the EJScreen website.

EJ INDEXES

The EJ indexes help users screen for potential EJ concerns. To do this, the EJ index combines data on low income and people of color populations with a single environmental indicator.

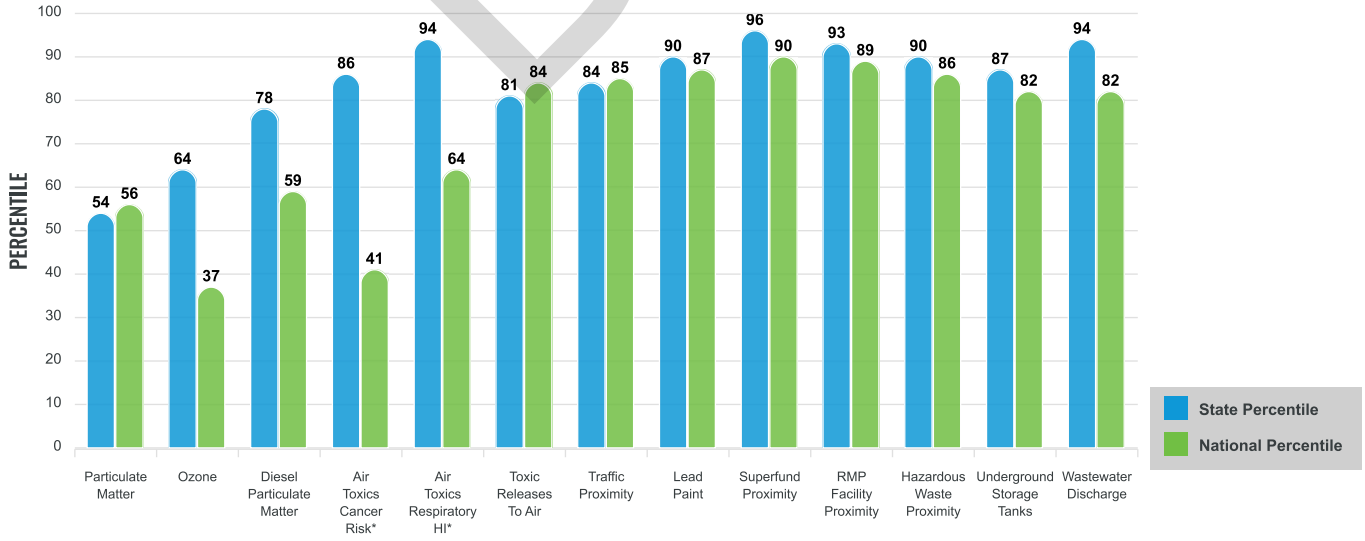
EJ INDEXES FOR THE SELECTED LOCATION



SUPPLEMENTAL INDEXES

The supplemental indexes offer a different perspective on community-level vulnerability. They combine data on percent low-income, percent linguistically isolated, percent less than high school education, percent unemployed, and low life expectancy with a single environmental indicator.

SUPPLEMENTAL INDEXES FOR THE SELECTED LOCATION



These percentiles provide perspective on how the selected block group or buffer area compares to the entire state or nation.

Report for Tract: 55009000100

EJScreen Environmental and Socioeconomic Indicators Data

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter (µg/m^3)	7.66	7.98	27	8.08	36
Ozone (ppb)	57.7	58.6	33	61.6	22
Diesel Particulate Matter (µg/m^3)	0.167	0.179	53	0.261	36
Air Toxics Cancer Risk* (lifetime risk per million)	20	19	12	25	5
Air Toxics Respiratory HI*	0.3	0.21	85	0.31	31
Toxic Releases to Air	2,200	8,100	57	4,600	74
Traffic Proximity (daily traffic count/distance to road)	320	320	69	210	84
Lead Paint (% Pre-1960 Housing)	0.75	0.4	83	0.3	89
Superfund Proximity (site count/km distance)	0.57	0.12	96	0.13	95
RMP Facility Proximity (facility count/km distance)	3.3	0.59	98	0.43	98
Hazardous Waste Proximity (facility count/km distance)	3.9	1.4	88	1.9	85
Underground Storage Tanks (count/km^2)	5.6	3.3	82	3.9	79
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.013	0.028	84	22	69
SOCIOECONOMIC INDICATORS					
Demographic Index	37%	24%	82	35%	60
Supplemental Demographic Index	18%	12%	86	14%	72
People of Color	33%	21%	81	39%	52
Low Income	41%	28%	79	31%	70
Unemployment Rate	5%	4%	76	6%	61
Limited English Speaking Households	1%	1%	76	5%	60
Less Than High School Education	21%	8%	93	12%	83
Under Age 5	6%	5%	63	6%	61
Over Age 64	13%	18%	32	17%	37
Low Life Expectancy	21%	19%	71	20%	62

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Sites reporting to EPA within defined area:

Superfund	0
Hazardous Waste, Treatment, Storage, and Disposal Facilities	0
Water Dischargers	20
Air Pollution	7
Brownfields	8
Toxic Release Inventory	7

Other community features within defined area:

Schools	2
Hospitals	0
Places of Worship	0

Other environmental data:

Air Non-attainment	No
Impaired Waters	Yes

Selected location contains American Indian Reservation Lands*	No
Selected location contains a "Justice40 (CEJST)" disadvantaged community	Yes
Selected location contains an EPA IRA disadvantaged community	Yes

Report for Tract: 55009000100

EJScreen Environmental and Socioeconomic Indicators Data

HEALTH INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Low Life Expectancy	21%	19%	71	20%	62
Heart Disease	5.3	5.8	35	6.1	35
Asthma	11.1	9.9	90	10	81
Cancer	4.5	6.6	10	6.1	18
Persons with Disabilities	25%	12.1%	98	13.4%	95

CLIMATE INDICATORS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Flood Risk	3%	9%	24	12%	27
Wildfire Risk	0%	0%	0	14%	0

CRITICAL SERVICE GAPS

INDICATOR	HEALTH VALUE	STATE AVERAGE	STATE PERCENTILE	US AVERAGE	US PERCENTILE
Broadband Internet	17%	14%	66	14%	66
Lack of Health Insurance	12%	6%	92	9%	76
Housing Burden	No	N/A	N/A	N/A	N/A
Transportation Access	Yes	N/A	N/A	N/A	N/A
Food Desert	Yes	N/A	N/A	N/A	N/A

Footnotes

Report for Tract: 55009000100

Appendix 4:

Connection to Historical RAP Goals and Other Relevant Local/Regional/National Plans

- DNR 1988 Remedial Action Plan
- DNR 2011 Stage II Remedial Action Plan
- Lower Green Bay & Fox River Area of Concern Habitat Restoration Plan and Path Toward Delisting (2018)
- Evaluating Progress Toward Removing Fish and Wildlife Habitat and Populations Beneficial Use Impairments in the Lower Green Bay & Fox River Area of Concern (2020)
- DNR Wisconsin Waterfowl Management Plan: 2020 - 2030
- DNR 2014 Green Bay Planning Group Master Plan
- DNR Lower Green Bay West Shore Habitat Management and Restoration Plan: 2020 - 2035
- USFWS Selecting Surrogate Species for Strategic Habitat Conservation in the Upper Midwest Great Lakes Geography (2014)
- Lake Michigan Integrated Fisheries Lakewide Management Plan (2017-2026)
- Great Lakes Fishery Commission Fish Community Objectives for Lake Michigan (1995)
- UW Green Bay Campus Master Plan (2005)
- East Shore Lower Green Bay Watershed Plan (2021)
- City of Green Bay Park, Recreation and Open Space Plan: 2014 – 2019
- City of Green Bay Smart Growth 2022 Comprehensive Plan: Parks, Greenways and Parkways Objectives and Policies
- Renard Island Strategic Master Plan, 2019
- Brown County Comprehensive Plan (2007)