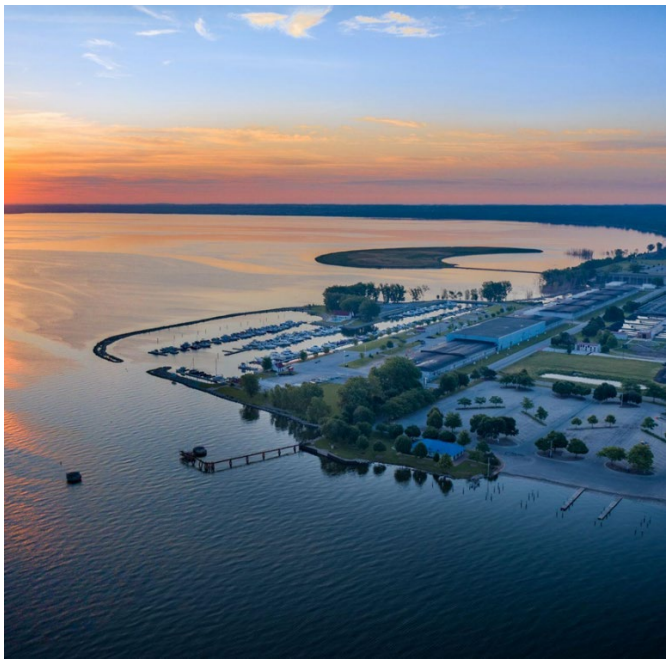


Photo Credit: Ben Young, NEW Water.

The National Oceanic and Atmospheric Administration (NOAA) evaluated the proposed designation of the Green Bay National Estuarine Research Reserve as the nation's 31st reserve. This federal action involves a formal designation by the NOAA Administrator and a joint declaration by the NOAA Administrator and the governor of Wisconsin. This Draft Environmental Impact Statement informs decision-makers and the public about potential impacts of the proposed reserve. It evaluates a no action alternative and two reasonable action alternatives that meet the action's purpose and need. Under either action alternative, reserve boundaries include upland, transitional, and aquatic habitats representative of the Green Bay estuary. The University of Wisconsin–Green Bay would serve as the lead management agency under both action alternatives, collaborating with the Wisconsin Department of Natural Resources, the City of Green Bay, Brown County, and other landowners. Reserve designation and implementation across all analyzed alternatives are not expected to cause significant adverse environmental or human impacts. The designation of the Green Bay Reserve would be followed by reserve operations, with associated education, research, training, stewardship, and monitoring opportunities and activities. A draft management plan for the proposed reserve highlights planned activities that, independently or when aggregated with other factors, have the potential to contribute to a range of reasonably foreseeable impacts on the affected environment. If a reserve is designated, future federal actions, including actions funded through NOAA cooperative agreements, would be evaluated individually to determine any necessary compliance activities pursuant to applicable regulations.

Proposed Green Bay National Estuarine Research Reserve
Draft Environmental Impact Statement
NOAA Office For Coastal Management
November 6, 2026
Unique ID Number EISX-006-48-2CDM-1784538288

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To All Interested Government Agencies and Public Groups:

In accordance with National Environmental Policy Act (NEPA) provisions, we enclose for your review the National Oceanic and Atmospheric Administration (NOAA) Draft Environmental Impact Statement regarding the proposed federal designation of the Green Bay National Estuarine Research Reserve in Wisconsin.

This document assesses the environmental impacts associated with the proposed designation. The National Estuarine Research Reserve System is a network of protected areas representing the various biogeographic regions and estuarine types in the United States. The Green Bay Reserve would be the nation's 31st and would be the first National Estuarine Research Reserve in the Lakes Michigan and Huron biogeographic subregion and the third in the Great Lakes biogeographic region. The Green Bay Reserve would facilitate long-term research, education, and interpretation to promote informed management of the nation's estuaries and coastal habitats. The designation of the proposed Green Bay Reserve would not restrict the public's access to any public lands in the proposed area, and no new federal regulations are being proposed pursuant to this action. All state, local, or privately owned lands will remain under current ownership.

NOAA is pleased to submit this draft for your review. Your review is an important part of the process. Comments made in writing will help us to develop a final environmental impact statement. The purpose of this report is to (1) assess the environmental impacts of NOAA's proposed action to designate the Green Bay Reserve and (2) inform decision-makers and the public of the reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment. The Draft Environmental Impact Statement is released for a 45-day public comment period to solicit input from interested parties.

Beginning November 6, 2026, written comments may be submitted electronically or by mail. All electronic public comments should be submitted through the federal eRulemaking portal at *https://www.regulations.gov* by entering NOAA-NOS-2024-0006 in the *Search* box, clicking the *Comment* icon, completing the required fields, and entering or attaching your comments. Written comments may also be mailed to the responsible official identified below by December 21, 2026.

This report is available for download via *https://www.regulations.gov*, or you may request a printed copy or an electronic copy on a CD or USB flash drive. Requests for copies should be directed to the responsible official.

Responsible Official:

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Sincerely,

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Environmental Compliance Coordinator
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Symbols and Abbreviations

&	and
%	percent
$	U.S. dollars
§	section
<	less than
#	number
“	inches (length measurement)
°C	degrees Celsius
°F	degrees Fahrenheit
ACS	American Community Survey
AOC	area of concern
AOR	Area of Responsibility
AQI	air quality index
BCE	Before the Common Era
BCPRRD	Brown County Port & Resource and Recovery Department
BUI	beneficial use impairment
CAFO	Concentrated Animal Feeding Operation
CE	Common Era
C.F.R.	Code of Federal Regulations
cm	centimeter
CO	carbon monoxide
CZMA	Coastal Zone Management Act
DEIS	Draft Environmental Impact Statement
DNR	Wisconsin Department of Natural Resources
e.g.	for example
EIS	Environmental Impact Statement
et al.	and others
et seq.	and the following
etc.	and the rest; and so forth
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ft	foot or feet (length measurement)

GBPS	Green Bay Area Public School District
GLRI	Great Lakes Restoration Initiative
Hg	mercury
HgT	total mercury
HUC	Hydrologic Unit Code
IBA	Important Bird Area
i.e.	that is
in	inches (length measurement)
K-12	kindergarten through twelfth grade
KEEP	K-12 Estuary Education Program
km	kilometer
km^2	square kilometer
lbs	pounds (weight measurement)
m	meter
M	million (currency)
m^3	cubic meter
mg kg^{-1}	milligrams per kilometer
MI	Michigan
mi^2	square miles
MOU	memorandum of understanding
MSD	Marine Safety Detachment
NAAQS	National Ambient Air Quality Standards
N/A	not applicable
NABCI	North American Bird Conservation Initiative
N.A.O.	NOAA Administrative Order
NE	Northeast, northeastern
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NEW	Northeast Wisconsin
NEWLT	Northeast Wisconsin Land Trust
NFL	National Football League
ng L^{-1}	nanograms per liter
NO	nitrogen oxide

NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NRDA	Natural Resource Damage Assessment
O_3	ozone
OCM	Office for Coastal Management
PCB	polychlorinated biphenyls
PFA	polyfluoroalkyl substances
PFO	perfluorooctanoic acid
PhD	Doctor of Philosophy (academic degree)
PM	particulate matter
RAP	remedial action plan
s	second or seconds (time measurement)
SCC	Site Coordination Committee
SDC	Site Development Committee
SEC	Site Evaluation Committee
SO_2	sulfur dioxide
TMDL	total maximum daily load
TOTE	Teachers on the Estuary
TP	total phosphorus
TSCA	Toxic Substances Control Act
TSS	total suspended solids
U.S.	United States of America
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UWGB	University of Wisconsin–Green Bay
WDNR	Wisconsin Department of Natural Resources
WHPD	Wisconsin Historical Preservation Database
WI	Wisconsin
WICCI	Wisconsin Initiative on Climate Change Impacts

Executive Summary

The proposed federal action is the designation of the nation's 31st National Estuarine Research Reserve, the Green Bay National Estuarine Research Reserve ("Green Bay Reserve"), which the National Oceanic and Atmospheric Administration (NOAA) has considered under this environmental review. This action includes a formal designation by the NOAA Administrator and a joint declaration by the NOAA Administrator and the governor of Wisconsin.

National Context

The National Estuarine Research Reserve System ("Reserve System") is a partnership program between NOAA and coastal states and territories ("states") that protects more than 1.3 million acres of coastal and estuarine habitat. Established by the Coastal Zone Management Act (CZMA) in 1972 (16 U.S.C. § 1451 *et seq*.), the Reserve System receives funding, national guidance, and technical assistance from NOAA, while state partners manage daily operations with input from local partners. The Reserve System protects estuarine areas, provides educational opportunities to the public, supports research and monitoring, and facilitates the transfer of relevant information to coastal communities. Currently, 30 reserves in 23 states and one U.S. territory represent diverse estuarine types and biogeographic regions.

The National Estuarine Research Reserve System's mission is to establish and manage, through federal-state cooperation, a national system of estuarine research reserves representative of the various regions and estuarine types in the United States (15 C.F.R. § 921.1 (a)). These reserves provide opportunities for long-term research, education, and interpretation.

The goals of the program are to

1) ensure a stable environment for research through long-term protection of Reserve System resources;
2) address coastal management issues identified as significant through coordinated estuarine research within the Reserve System;
3) enhance public awareness of estuarine areas and provide opportunities for public education and interpretation;
4) promote use of one or more reserves within the Reserve System by federal, state, public, and private entities for conducting estuarine research; and
5) conduct and coordinate estuarine research within the Reserve System to improve understanding and management of estuarine areas.

State Context

In March 2019, Wisconsin Governor Tony Evers submitted a letter to NOAA expressing the state's interest in establishing a National Estuarine Research Reserve on the Bay of Green Bay, with the University of Wisconsin–Green Bay (UWGB) as the lead state partner. On July 19, 2019, the Under Secretary of Commerce for Oceans and Atmosphere officially invited Wisconsin and the University of Wisconsin–Green Bay to begin the site selection process for "establish[ing] a National Estuarine Research Reserve System in the Green Bay coastal area of Lake Michigan." Between September 2020 and August 2022, the state collaborated with federal, state, and Tribal partners to conduct a transparent, objective site selection process for the proposed reserve. On December 29, 2022, Governor Evers nominated a Green Bay National Estuarine Research Reserve comprising three components: Peshtigo River, Lower Bay, and Sturgeon Bay. The nominated site, consisting of publicly owned or land trust–held areas, corresponds with Alternative A in this Draft Environmental Impact Statement.

The draft management plan (appendix 1) for the proposed Green Bay National Estuarine Research Reserve supports the goals of the Reserve System (15 C.F.R. § 921.1(b)) and addresses issues relevant to northeastern Wisconsin. The goals reflect the priorities of the proposed reserve during the first five years after designation.

> Goal 1: Strengthen community adaptation and preparation for projected impacts of climate-driven hydrologic shifts and changing lake levels.
>
> Goal 2: Reduce or eliminate excessive sediment, nutrient, and contaminant loadings into the Bay from watershed inputs.
>
> Goal 3: Strengthen habitat connectivity to allow native and noninvasive species to access terrestrial, wetland, and aquatic habitats and improve integration of ecosystem components.
>
> Goal 4: Restore healthy wetlands and submerged aquatic and benthic habitats and promote diverse species assemblages.
>
> Goal 5: Foster historical awareness and contemporary connections between people and the Green Bay estuary.
>
> Goal 6: Promote sustainable, beneficial uses of the Bay for regional communities.

This *Draft Environmental Impact Statement* informs decision-makers and the public about the potential environmental impacts of designating the proposed Green Bay National Estuarine Research Reserve under federal authorities. NOAA prepared this document pursuant to the National Environmental Policy Act (NEPA; 42 U.S.C. § 4321 *et seq*.) to assess the environmental impacts of the proposed action to designate the Green Bay National Estuarine Research Reserve as the 31st national reserve. Preparation of an environmental impact statement under the National Environmental Policy Act is required to complete the reserve designation process (15 C.F.R. § 921.13(b)). As stated in the National Environmental Policy Act of 1969 (42 U.S.C. § 4321 *et seq*.) and amended by P.L. 119–21, an environmental impact statement will be prepared for

> *"major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on— (i) reasonably foreseeable environmental effects of the proposed agency action; (ii) any reasonably foreseeable adverse environmental effects which cannot be avoided should the proposal be implemented; (iii) a reasonable range of alternatives to the proposed agency action, including an analysis of any negative environmental impacts of not implementing the proposed agency action in the case of a no action alternative, that are technically and economically feasible, and meet the purpose and need of the proposal; (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and (v) any irreversible and irretrievable commitments of Federal resources which would be involved in the proposed agency action should it be implemented."* (42 U.S.C. § 4331 (2)(c)).

To this end, NOAA developed a set of reasonable alternatives that meet the purpose and need (see chapter 2), including a no action alternative, the originally nominated site (Alternative A), and a revision to the nominated site (Alternative B). These alternatives allow NOAA to evaluate environmental impacts while addressing the proposed action's purpose and need. Designating and implementing the proposed Green Bay National Estuarine Research Reserve, under any of the analyzed alternatives, is not expected to result in significant adverse impacts to the natural or human environment. Once designated, the Green Bay Reserve would commence operations, with associated education, research, training, stewardship, and monitoring opportunities and activities. The draft management plan highlights activities that, independently or when aggregated with other factors, may contribute to reasonably foreseeable impacts on the affected environment. If a reserve is designated, future federal actions (including actions funded through NOAA cooperative agreements) will be evaluated individually to determine any necessary compliance activities pursuant to applicable regulations.

Boundary Alternatives and the Natural Environment

Three alternatives were evaluated as part of the *Draft Environmental Impact Statement*:

1. No Action Alternative: As required by the National Environmental Policy Act, a "no action alternative" must be considered. The no action alternative represents what would happen if NOAA did not take the proposed action; in this case, the no action alternative is the result of not designating the Green Bay Reserve and implementing its draft management plan.
2. Alternative A: Under this alternative, NOAA would designate the originally nominated site as a reserve. Alternative A, including upland, wetland, and open waters, is approximately 37,714 acres in size. The proposed lands and waters are organized into three component areas by geography: the Peshtigo Component, the Lower Bay Component, and the Sturgeon Bay Component.
3. Alternative B: Under this alternative, NOAA would designate a revised nominated site as a reserve. Alternative B is similar to Alternative A, though with minor modifications. Specifically, additional lands adjacent to the originally nominated site that were acquired by landholding partners were integrated into the proposed reserve boundary; meanwhile, small parcels that were not closely aligned with the mission of the Reserve System were removed, and the delineation of core and buffer areas was revised. Alternative B is approximately 36,502 acres in size.

For an in-depth overview of the habitats within each alternative, please reference table 1. Under either action alternative, the proposed reserve would be located entirely within Wisconsin and no federal landholdings are included within the boundary.

The boundaries of the proposed reserve would include upland, transitional, and aquatic habitats in proportions reflective of the Green Bay estuary and approximating an ecological unit characteristic of a Great Lakes freshwater estuary. Each of the proposed reserve components contributes unique features to the proposed reserve. For example, the Peshtigo Component is representative of an undisturbed Great Lakes estuary. The Peshtigo River is unchanneled along the section included in the proposed Green Bay National Estuarine Research Reserve, with a natural river mouth that enters the Bay at Winegar Pond. The mouth of the Peshtigo River has extensive marshes and estuarine open waters, with bottomland hardwood forests along upstream portions of the river.

The Lower Bay Component adds a seiche-influenced estuary representative of Great Lakes coastal estuarine ecosystems and additional basin types to the proposed reserve. For example, some areas within the Duck Creek Delta are best characterized as embayments; a natural lagoon exists at Point au Sable; and human-modified lagoons can be found at Sensiba State Wildlife Area and Ken Euers Natural Area. The Cat Island Chain (which is not included within the reserve boundary but is entirely surrounded by the proposed reserve) and Long Tail Point provide two examples of sheltered coasts. These sheltered coasts and the ecosystems protected by them starkly contrast the extensively exposed coast that is present throughout the proposed site. The basin structure is a coastal plains estuary with bar-bounded features around the Duck Creek Delta, which has been protected from wave action and coastal erosion by the recent Cat Island Chain restoration. Inlet types range from unrestricted near the mouth of the Fox River to often restricted by a barrier beach at Point au Sable's Wequiock Creek, particularly during low-flow periods. Finally, within the Lower Bay, a micro-gradient of recently restored habitats spans from Duck Creek and Ken Euers Natural Area in the south to less disturbed areas in the northern portion of the Lower Bay Component at Sensiba State Wildlife Area and Long Tail Point.

The Sturgeon Bay Component contributes unique watersheds to the proposed reserve. The Strawberry Creek and Big Creek watersheds represent smaller drainage areas than those in the Lower Bay and Peshtigo Components and feature distinct geologic characteristics, broadening the scope and diversity of watershed research. Additionally, this component encompasses ridge and swale habitats—a unique ecosystem type for the reserve system—along with endangered plant species not found elsewhere in the proposed Green Bay National Estuarine Research Reserve.

Table 1. Total Acreage and Acreage of Selected Habitats Within the Proposed Green Bay Reserve Boundaries.

	No Action Alternative	Alternative A	Alternative B
Area			
Total area (acres)	0	37,714	36,502
Upland/wetland area (acres)	0	10,624	11,428
Open water area (acres)	0	27,090	25,074
Selected Habitats (acres)			
Crop rotation	0	303	296
Developed, high-intensity	0	7	6
Developed, low-intensity	0	75	36
Emergent/wet meadow	0	2,716	2,742
Forage grassland	0	139	121
Forested	0	790	735
Forested (palustrine)	0	4,617	4,423
Forested wetland	0	252	242
Idle grassland	0	108	105
Scurb/shrub	0	1,623	1,580
Unclassified upland/wetland	0	0	1,142
Open water	0	27,090	25,074

Human Environment

Current human activity within the Bay of Green Bay includes tourism and recreation (e.g., boating, hiking, biking, kayaking, birdwatching, skiing, snowshoeing), commercial fishing, recreational fishing, hunting, agriculture, several U.S. Coast Guard units, and a robust manufacturing industry (e.g., meat and poultry processing, pulp and paper mills). The Green Bay estuary is also home to the Port of Green Bay, Port of Marinette, Port of Sturgeon Bay, several harbors, and navigation channels used to transport goods in and out of the region.

The presence of the Lower Fox River and Green Bay Area of Concern, combined with the long-standing involvement of multiple institutions of higher education and management agencies, has resulted in the development of a robust research and monitoring network throughout the Green Bay estuary. The estuary supports an extensive and expanding network of long-term research and monitoring programs conducted by federal and state agencies, universities, Tribal nations, local organizations, and nonprofit partners. Examples include the U.S. Environmental Protection Agency, U.S. Geological Survey, Wisconsin Department of Natural Resources, National Oceanic and Atmospheric Administration, University of Wisconsin–Green Bay, University of Wisconsin–Milwaukee, the Great Lakes Observing System, NEW Water, and many other partners. Collectively, these programs provide critical baseline information on riverine loading, water quality, primary production, harmful algal blooms, submerged aquatic vegetation, fisheries, coastal wetland condition, hydrodynamics, flooding, and long-term climate trends throughout the estuary and watershed.

The Bay of Green Bay is also home to a large network of schools and educational programs. There are 103 public school districts within a 90-mile driving radius of the proposed reserve. These school districts serve approximately 330,000 K-12 students. There are also seven institutions of higher education located within the project area: (1) University of Wisconsin–Green Bay, (2) University of Wisconsin–Green Bay at Marinette, (3) St. Norbert College, (4) Northeast Wisconsin Technical College, (5) Rasmussen College, (6) Medical College of Wisconsin, and (7) Bellin College. The largest of these institutions, the University of Wisconsin–Green Bay, serves 9,000 students. A well-established network of environmental education and research facilities are located in the Bay of Green Bay, including the West Shores Interpretive Center at the L.H. Barkhausen Waterfowl Preserve, which is located within the Lower Bay Component of the proposed reserve. The center provides year-round experiential environmental education programming and regularly hosts field experiences for K-12 students. Crossroads at Big Creek, within the Sturgeon Bay Component of the proposed reserve, operates the John and Helen Collins Learning Center, supporting environmental education programs and providing laboratory space and equipment for visiting researchers. Both centers maintain strong relationships with regional schools, teachers, after-school programs, community science volunteers, and visitors and have extensive experience providing hands-on educational programs to audiences of all ages.

Proposed Green Bay Reserve Operations

Under either action alternative, the University of Wisconsin–Green Bay would serve as the lead management agency for the proposed Green Bay National Estuarine Research Reserve. In this role, the university would work in close collaboration with the Wisconsin Department of Natural Resources, the City of Green Bay, Brown County, and other landowners of properties located within the proposed reserve boundary. The university would employ a reserve manager and staff to oversee daily operations of the reserve, supported by a Reserve Advisory Committee for advice and guidance and a Friends Group for volunteer recruitment and coordination. Further information regarding administration and management of the proposed reserve can be found in the draft management plan (appendix 1). The plan includes information about the goals and objectives for the proposed reserve; core research, training, monitoring, education and stewardship programs; administration; boundaries and acquisition; facilities and construction; visitor access; and resource protection, restoration, and manipulation.

Environmental Impacts of the Designation

Designating the proposed Green Bay Reserve and implementing its draft management plan would provide multiple benefits. First, the reserve would support existing efforts and establish new research, monitoring, education, and stewardship programs to address priority coastal management issues in the Green Bay estuary. Additionally, the reserve would leverage existing authorities to ensure a stable environment for long-term research and provide a framework for coordination and oversight to achieve its goals. Finally, the designation would bring additional financial and staff resources to support estuary management. While most predicted impacts are beneficial, some minor adverse impacts could arise. For instance, the designation of the proposed reserve may lead to minor increases in vehicular traffic, which could result in negligible increases in air pollution.

The proposed reserve encompasses land owned and managed by counties, municipalities, universities, nonprofit conservation organizations, and others that would retain full ownership and management authority upon designation. Management decisions within the reserve's boundary will remain guided by existing comprehensive plans, parks and recreation plans, zoning ordinances, conservation easements, land trust stewardship commitments, and organizational policies. The proposed designation is also nonregulatory; therefore, the designation does not interfere with or inhibit any existing uses of the Green Bay estuary such as manufacturing, shipping, commercial and recreational fishing, boating, or the management of existing navigation channels nor will the designation alter or inhibit existing uses (e.g., hunting, fishing, recreation) of the land and waters proposed for inclusion within the Green Bay Reserve's boundaries.

Overview of Contents

This Draft Environmental Impact Statement includes the following chapters:

Chapter 1. *National Context* provides background information about the Reserve System and introduces a potential Green Bay Reserve.

Chapter 2. *Purpose of and Need for Action* details the rationale for the designation and provides additional information about the Reserve System and its programs.

Chapter 3. *State Context* provides an overview of the site selection process, the project area, and the public scoping process.

Chapter 4. *Boundary Alternatives* discusses the three evaluated alternatives. The first— the no action alternative—rejects designation of a reserve in Green Bay. Two viable action alternatives, as well as alternatives considered but rejected from further analysis, are also discussed.

Chapter 5. *Affected Environment* describes the possible physical, biological, and social environments affected by the proposed action. The affected environment associated with the proposed action varies by the type of resource considered but generally includes the areas around the Bay of Green Bay.

Chapter 6. *Environmental Consequences* discusses reasonably foreseeable environmental impacts of establishing a reserve in Green Bay. These effects include but are not limited to historic properties, coastal resources and uses, and threatened and endangered species and their critical habitats.

Chapter 7. *List of Federal Permits, Licenses, or Other Authorizations and NEPA Certifications* provides a list of compliance and other environmental review requirements to implement the proposed action.

Chapter 8. *List of Preparers, Contributors, and Consultants* lists the individuals involved or consulted during the development of this report.

Chapter 9. *References* provides a comprehensive list of cited works.

Appendices to the document include the draft management plan, public comments received during the scoping phase of draft development, and supplemental information.

1 National Context

Estuaries provide vast resources and services to people. An estuary is an ecosystem, comprising both biological and physical environments, which typically develop where rivers meet the sea. In these regions, fresh river water mingles with tidal saltwater to become brackish (or partly salty). Several types of freshwater ecosystems have similar characteristics to traditional brackish estuaries; for example, in the Great Lakes, chemically and physically distinct river water mixes with lake water in coastal wetlands affected by tides and storms, much like estuaries found along oceanic coasts.

Sediment and nutrient transport at the land-water interface supports a diverse array of habitats and species. Because estuaries provide food, fresh water, habitat, flood regulation, nutrients, recreational opportunities, soils, and other essential services, they have long been a focal point of human activity. Consequently, estuaries have been heavily exploited throughout history for natural resources, commerce, tourism, and other purposes. By 2010, 52 percent of the U.S. population resided within coastal watershed counties (NOAA 2013). Persistent population and development pressures, along with ongoing economic activities, have subjected these critical areas to continuous degradation.

1.1 The Coastal Zone Management Act

In 1972, Congress passed the National Coastal Zone Management Act, as amended (16 U.S.C. § 1451 *et seq*.). Congress recognized the significance of coastal resources and their importance to national, regional, and local economies. The Act further acknowledged the interrelationships between the land, water, and their transitional areas. These relationships were highlighted in the Act's 1996 reauthorization, which noted that increasing and competing demands on coastal lands and waters have led to the loss of living marine resources, wildlife, and nutrient-rich areas, as well as permanent ecological damage, decreased open space, and shoreline erosion (16 U.S.C. § 1451(c)).

The reauthorization also noted that coastal habitat areas—along with the fish, shellfish, living marine resources, and wildlife within them—are ecologically fragile and extremely vulnerable to human-induced destruction (16 U.S.C. § 1451(d)). In response, the Coastal Zone Management Act established a national policy to preserve, protect, develop, and, where possible, restore and enhance the nation's coastal resources for current and future generations (16 U.S.C. § 1452(1)). The Act supports coastal states, territories, and local governments in developing tools and programs to improve management capabilities in rapidly developing areas. This support helps protect, preserve, develop, and restore fragile natural resources, such as the bays, estuaries, beaches, dunes, wetlands, and the flora and fauna dependent on these habitats.

Congress also recognized that scientific data about the coastal zone were often limited, yet local decision-makers, developers, and the public need to understand how ecosystems function and the consequences of development activities on these systems. To improve understanding of these ecosystems and support coastal management, Congress incentivized the establishment of the Reserve System (16 U.S.C. § 1461), as amended by the Coastal Zone Management Reauthorization Act of 1985 (Pub. L. No. 99–272, 100 Stat. 82). The Reserve System provides states and territories with opportunities to explore critical questions about our nation's estuaries through a network of protected areas.

1.1.1 National Estuarine Research Reserve System

The mission of the National Estuarine Research Reserve System is stated in the Coastal Zone Management Act's implementing regulations: "The establishment and management, through federal-state cooperation, of a national system . . . of estuarine research reserves . . . representative of the various regions and estuarine types in the United States" (15 C.F.R. § 921.1). Pursuant to the Act's implementing regulations, estuary habitats that typify different estuarine types within the United States can be designated as a National Estuarine Research Reserve (15 C.F.R. § 921.3(a)). National reserves operate to provide long-term research and monitoring, estuarine education, training, and interpretation. The Reserve System provides a framework to conduct research; monitor estuarine health and conditions; model restoration techniques; and disseminate information for estuarine education, interpretation, or decision-maker training.

1.1.2 National Estuarine Research Reserve System Administrative Framework

The Reserve System is a partnership program between NOAA and the coastal states. NOAA provides funding, national guidance, and technical assistance through its Office for Coastal Management, which plays four important roles in operating the Reserve System:

1) The Office for Coastal Management supports the NOAA Administrator in reviewing and approving the designation of individual reserves.
2) It disburses and oversees expenditures of federal funds for research, monitoring, education, land acquisition, facilities construction, and operation of designated reserves, as well as for the development of future reserves.
3) It coordinates and provides policy guidance for the system.
4) It periodically evaluates the operation of reserves for compliance with applicable federal requirements and its approved five-year management plan (16 U.S.C. § 1461(f)). The office's Stewardship Division has day-to-day responsibility for the implementation of the Reserve System. Each reserve's daily operations are managed by a lead state agency or university with input from local partners.

1.1.3 National Estuarine Research Reserve System Biogeographic Regions

In the more than 50 years since Section 315 of the Coastal Zone Management Act established the Reserve System, the network has grown to include 30 protected estuaries that serve as reference sites for research, education, and stewardship. The reserves represent different biogeographic regions of the United States. A biogeographic region is defined as a geographic area with similar dominant plants, animals, and prevailing climates. These regions are classified by ecosystem type (e.g., maritime forest, coastal mangroves) and physical characteristics, such as geologic, chemical, or hydrographic features. Eleven major biogeographic regions line U.S. coasts, encompassing 29 subregions (fig. 1).

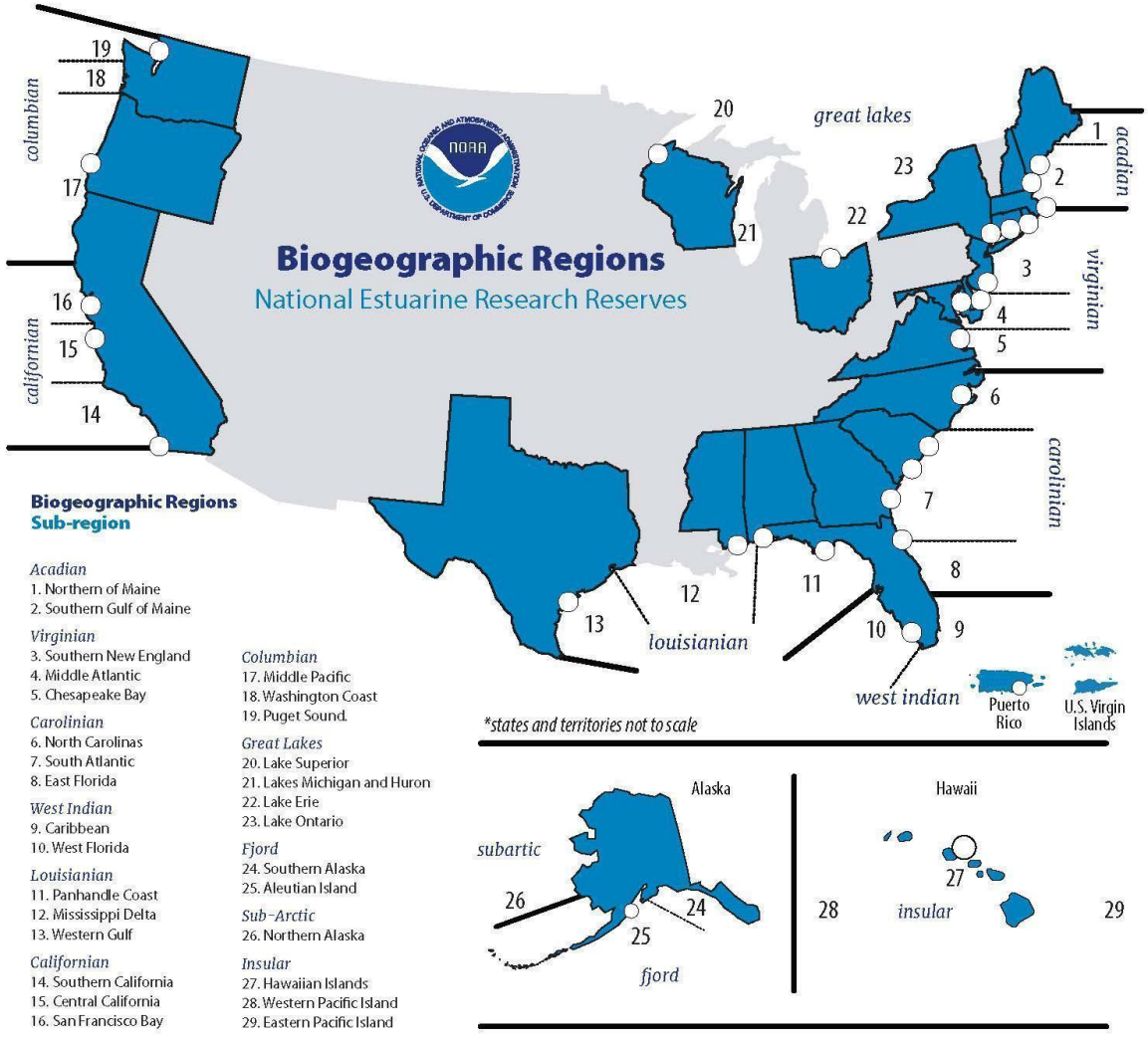


Figure 1. National Estuarine Research Reserve System biogeographic regions.

The Reserve System currently represents nine major biogeographic regions and 20 subregions. In the near term, priority for new Reserve System site designation is given to coastal states with unrepresented biogeographic regions or those not yet represented in the system. Table 2 lists the existing Reserve System sites, along with their designation year, size, and region. The region column includes the biogeographic subregion (see fig. 1).

Table 2. Name, Designation Year, Size, and Biogeographic Region of Existing Research Reserves.

RESERVE	YEAR	ACRES	SQUARE MILES	REGION
South Slough, OR	1974	4,771	7.5	Columbian (17)
Sapelo Island, GA	1976	6,110	9.5	Carolinian (7)
Rookery Bay, FL	1978	110,000	171.9	West Indian (10)
Apalachicola Bay, FL	1979	234,715	366.5	Louisianian (11)
Elkhorn Slough, CA	1979	1,439	2.2	Californian (15)
Padilla Bay, WA	1980	12,100	18.9	Columbian (19)
Narragansett Bay, RI	1980	4,259	6.7	Virginian (3)
Old Woman Creek, OH	1980	573	0.9	Great Lakes (22)
Jobos Bay, PR	1981	2,883	4.5	West Indian (9)
Tijuana River, CA	1982	2,293	3.6	Californian (14)
Hudson River, NY (4 components)	1982	4,838	7.6	Virginian (3)
North Carolina (4 components)	1985, 1991	10,568	16.5	Carolinian (7) & Virginian (3)
Chesapeake Bay, MD (3 components)	1985, 1990	6,249	9.8	Virginian (5)
Wells, ME	1986	2,250	3.5	Acadian (2)

RESERVE	YEAR	ACRES	SQUARE MILES	REGION
Weeks Bay, AL	1986	6,525	10.2	Louisianian (11)
Waquoit Bay, MA	1988	2,804	4.4	Virginian (3)
Great Bay, NH	1989	10,235	16	Acadian (2)
Chesapeake Bay, VA (4 components)	1991	3,072	4.8	Virginian (5)
Ashepoo-Combahee-Edisto (ACE) Basin, SC	1992	99,308	155.2	Carolinian (7)
North Inlet–Winyah Bay, SC	1992	18,916	29.6	Carolinian (7)
Delaware, DE	1993	6,206	9.7	Virginian (4)
Jacques Cousteau, NJ	1998	114,873	179.5	Virginian (4)
Kachemak Bay, AK	1999	371,950	581.2	Fjord (25)
Grand Bay, MS	1999	18,049	28.2	Louisianian (12)
Guana Tolomato Matanzas (GTM), FL	1999	73,352	114.6	Carolinian (8)
San Francisco Bay, CA	2003	3,710	5.8	Californian (16)
Mission-Aransas, TX	2006	185,708	290.2	Louisianian (13)
Lake Superior, WI	2010	16,697	26.1	Great Lakes (20)
He‘eia, HI	2016	1,385	2.2	Insular (27)
Connecticut, CT	2022	52,160	81.5	Virginian (3)
*Green Bay, WI	Proposed for 2027	TBD	TBD	Great Lakes (21)

The 30 existing reserves encompass more than 1.3 million acres and over 2,000 square miles.

Although Wisconsin already hosts one national reserve, the state encompasses two biogeographic subregions. One of these—the Great Lakes' Lakes Michigan and Huron—is currently unrepresented within the national system. The Wisconsin site selection process focused on the Green Bay coastal area of Lake Michigan, which lies entirely within this unrepresented subregion. Consequently, the proposed designation will significantly enhance the system's diversity.

1.2 Proposed Action: Designation of a Green Bay National Estuarine Research Reserve

The State of Wisconsin proposed the Green Bay National Estuarine Research Reserve on March 25, 2019 (appendix 2). The University of Wisconsin–Green Bay was identified as the lead state agency for the proposed reserve. Operating under a proposed five-year management plan (appendix 1), reserve staff would work with resource managers, Tribal nations, local communities, land trusts, and regional groups to address natural resource management issues, such as changing water levels, legacy contamination, nonpoint source pollution, habitat restoration, and invasive species.

In addition to designating a reserve, as required by 15 C.F.R. § 921.20, the proposed action includes NOAA approval of a state-developed management plan that meets applicable Reserve System regulatory requirements. This includes a memorandum of understanding "detailing the Federal-state role in Reserve management during the initial period of Federal funding and expressing the state's long-term commitment to operate and manage the Reserve" (15 C.F.R. § 921.12(a)(2)). If all requirements of the process are met and the Green Bay Reserve is designated, NOAA and the state would partner in the operation and management of the proposed Green Bay Reserve pursuant to 15 C.F.R. § 921.32. The proposed action encompasses the designation of the Green Bay National Estuarine Research Reserve, NOAA's approval of the Green Bay Reserve's *final management plan*, and the subsequent implementation of the plan following designation.

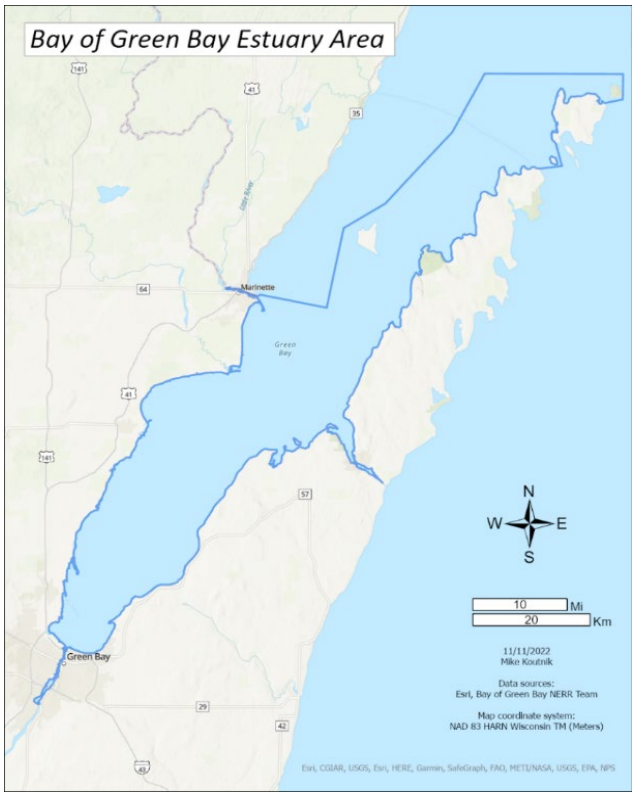


Figure 2. General location of the proposed Green Bay Research Reserve.

2 Purpose and Need

2.1 Purpose of the Proposed Action

The purpose of the action is to designate a National Estuarine Research Reserve representative of the Green Bay estuary (fig. 2) and located in the Green Bay coastal area of Lake Michigan in response to a request by the governor of Wisconsin. In order to designate a national reserve, NOAA must find that the regulatory requirements outlined in 15 CFR § 921.30 have been met, including:

1. The proposed reserve area is a representative estuarine ecosystem that is suitable for long-term research and contributes to the biogeographical and typological balance of the Reserve System.
2. Key land and water areas of the proposed reserve, as identified in the management plan, are under adequate state control sufficient to provide long-term protection for reserve resources to ensure a stable environment for research.
3. The proposed reserve would enhance public awareness and understanding of estuarine areas and provide opportunities for public education and interpretation.
4. The nominating state has prepared a final NOAA-approved management plan for the proposed reserve.

To create a reserve that is representative of the Green Bay estuary, NOAA and the state determined that the proposed site must capture two gradients observed within the estuary:

1. the disturbance gradient, ranging from minimally impacted habitats to areas recently restored areas and
2. the south-to-north gradient, capturing both the nutrient-rich waters of the Fox-Wolf watershed and the nutrient-poor waters entering Green Bay from Lake Michigan.

2.2 Need for the Proposed Action

As described in section 1.1.3, only 20 of the 29 U.S. biogeographic subregions are currently represented in the national system. The Green Bay coastal area of Lake Michigan, a geography that encompasses the five Wisconsin counties of Brown, Door, Kewaunee, Marinette, and Oconto and border Green Bay (hereafter the Bay of Green Bay), is located within the Lakes Michigan and Huron biogeographic subregion (region 21 in fig. 1). This subregion is not currently represented within the National Estuarine Research Reserve System. With designation of a new reserve in Wisconsin, the Reserve System would add a third location to the Great Lakes biogeographic region and provide representation for a new subregion, increasing the total represented subregions to 21. As such, the proposed Green Bay Reserve would meet the needs outlined in Wisconsin's 2019 letter of interest and further the national goal to ensure the Reserve System reflects the full diversity of U.S. estuarine types.

A new reserve in Wisconsin is needed to coordinate existing programs and establish new research, education, and monitoring initiatives addressing priority coastal management issues identified in the draft management plan (see appendix 1 and section 4.1). Furthermore, the proposed reserve would use existing authorities to ensure a stable environment for long-term research and provide the coordination and oversight necessary to achieve reserve goals.

3 State Context

3.1 Wisconsin Site Selection and Nomination History and Process

Efforts to establish a research center focused on the Bay of Green Bay began in the summer of 2015. Engaged citizens, governmental agencies, and nongovernmental organizations met to discuss the need for an accessible, collaborative water and terrestrial research facility in Door County, Wisconsin. Following three collective meetings and a broader 32-person meeting at the University of Wisconsin–Green Bay in January 2016, the group identified four critical needs that a research facility could meet: laboratory facilities for field researchers, temporary housing, community outreach and K-12 education, and environmental stewardship. These discussions about a Bay-focused research facility also addressed long-standing calls for better coordination of scientific research and place-based intellectual productivity across the arts, humanities, and social sciences within the Green Bay ecosystem. Further, these discussions responded to growing interest from local businesses, nonprofit organizations, and community groups for a stronger academic presence in Door County. While stakeholders reached a consensus about a research facility's benefits, they identified the following actionable items to transition the concept to implementation:

1. Identify one or more potential operational models.
2. Define the core mission to ensure strategic focus, prevent mission creep, and pursue tangential opportunities.
3. Develop business and financial models for each operational approach, including detailed expense projections and potential funding sources.
4. Solidify broad stakeholder engagement by securing formal letters of support.

Their proposal was submitted to the Wisconsin Coastal Management Program and subsequently funded by NOAA (Green Bay Freshwater Research Initiative 017.22 306-27 Great Lakes Education NA16NOS4190108). It contended that the Bay of Green Bay ecosystem is an essential natural resource for Northeast Wisconsin, and the Bay of Green Bay provides ready access to outdoor recreational activities and creates a sense of place for the people of northeastern Wisconsin. The Bay of Green Bay also faces critical challenges from past ecological degradation. Federal and state agencies, as well as nongovernmental and private organizations, are investing significant funds to remediate lingering environmental challenges, including the polychlorinated biphenyl (PCB) remediation of the Fox River and the reconstruction of the Cat Island Chain, in addition to numerous ongoing smaller restoration projects within the Bay and its supporting watershed. The success of these initiatives depends on building broad, collaborative partnerships. The Bay of Green Bay ecosystem illustrates both the benefits and challenges of a world-class natural resource coexisting with a growing metropolitan area and a thriving agricultural economy. The proposal suggested that a dedicated research and outreach center was essential to

- create a universal contact point and clear coordination for research and restoration;
- engage the arts, humanities, and social sciences in natural resource and quality-of-life issues;
- connect place-based natural resources to the daily lives of northeastern Wisconsin citizens; and
- integrate natural resource assets more effectively into urban and economic development projects.

The project evaluated public support for these assumptions and explored existing options to meet these needs.

The project team identified two potential strategies for establishing a research and outreach center within the Bay of Green Bay:

1. Formation of an independent research center funded through donations and grants (referred to as the Lake Michigan Research Institute)
2. Inclusion into the Reserve System and its associated funding mechanisms

To gauge community interest in and possible support for a potential Lake Michigan Research Institute or Research Reserve site in the Bay of Green Bay ecosystem, the project team held discussions with over 30 stakeholder groups during the grant period. Specifically, the Reserve System's broad vision statement reflected the integration requested by local partners and identified during listening sessions to promote resilient estuaries and coastal watersheds where human and natural communities thrive. The partnership program between NOAA and coastal states through the Reserve System provides essential habitat for wildlife; exceptional educational opportunities for students, teachers, and the public; and a living laboratory for scientists. Importantly, the size of the network and its direct affiliation with NOAA provide reserves with the exposure and credibility required to attract world-class scholars. During meetings with targeted stakeholders, broad, positive support was expressed for aligning the Reserve System with the development recommendations received from diverse organizations such as the Green Bay Port Authority, Greater Green Bay Chamber of Commerce, Greater Green Bay Convention and Visitors Bureau, Ducks Unlimited, and The Nature Conservancy. The University of Wisconsin–Green Bay engaged in in-depth conversations with two consecutive governors and secured over a dozen letters of support, including a letter from the Oneida Nation, to pursue a Reserve System designation for the Green Bay coastal area of Lake Michigan (appendix 3). The project ultimately concluded that the state of Wisconsin should pursue designation of a National Estuarine Research Reserve.

The designation process officially began in March 2019 with a letter to NOAA from Wisconsin Governor Tony Evers. Governor Evers expressed the state's interest in establishing a National Estuarine Research Reserve in the Bay of Green Bay with the University of Wisconsin–Green Bay serving as the lead state agency. On July 19, 2019, Governor Evers received a letter from the Under Secretary of Commerce for Oceans and Atmosphere, officially inviting Wisconsin and the university to enter the site selection process "to establish a National Estuarine Research Reserve System in the Green Bay coastal area of Lake Michigan." See appendix 3 for copies of these letters.

Following NOAA's approval, the proposed Green Bay National Estuarine Research Reserve site selection process commenced, and the University of Wisconsin–Green Bay began the steps to complete the formal site selection process for the proposed reserve. Most critical among these steps was the identification of internal and external funds to support a full-time director of freshwater strategy to lead the university in an external-facing capacity for its water-related initiatives. The position's top priority was to lead the university's efforts, in partnership with NOAA and regional stakeholders, in seeking designation of the Green Bay ecosystem as a research reserve. This position was filled in September 2020. With the director role filled, the organizational structure needed to lead the proposed Green Bay Reserve site selection process was formed. Three committees were formed: (1) the Site Coordination Committee (SCC), (2) the Site Development Committee (SDC), and (3) the Site Evaluation Committee (SEC). Between spring 2021 and summer 2022, these committees executed the site selection and nomination process.

The selection and nomination process began with the Site Development Committee defining the relevant coastal geography (fig. 4); this is the geography portion of the state's efforts to identify a location for the future reserve. Next, the Site Development Committee used local knowledge and criteria from the Lake Superior Reserve Site Selection and Nomination Process to modify recommended site selection criteria provided by NOAA to suit the needs of a freshwater system and the Green Bay estuary.

The Site Development Committee then leveraged four criteria to preliminarily screen and ultimately identify suitable properties for a research reserve. Preliminary screening criteria included:

1. Is the property coastal or estuarine?
2. Does the property include features aligned with the research and education goals of the Reserve System (e.g., not a playground)?
3. Is the property owned publicly or by a land trust with promoted public access?
4. Does the property link directly with Green Bay estuary waters, facilitating a bidirectional flow of water and energy between the land and the Bay?

Through this preliminary screening process, nine candidate sites (fig. 3) were recommended for further analysis.

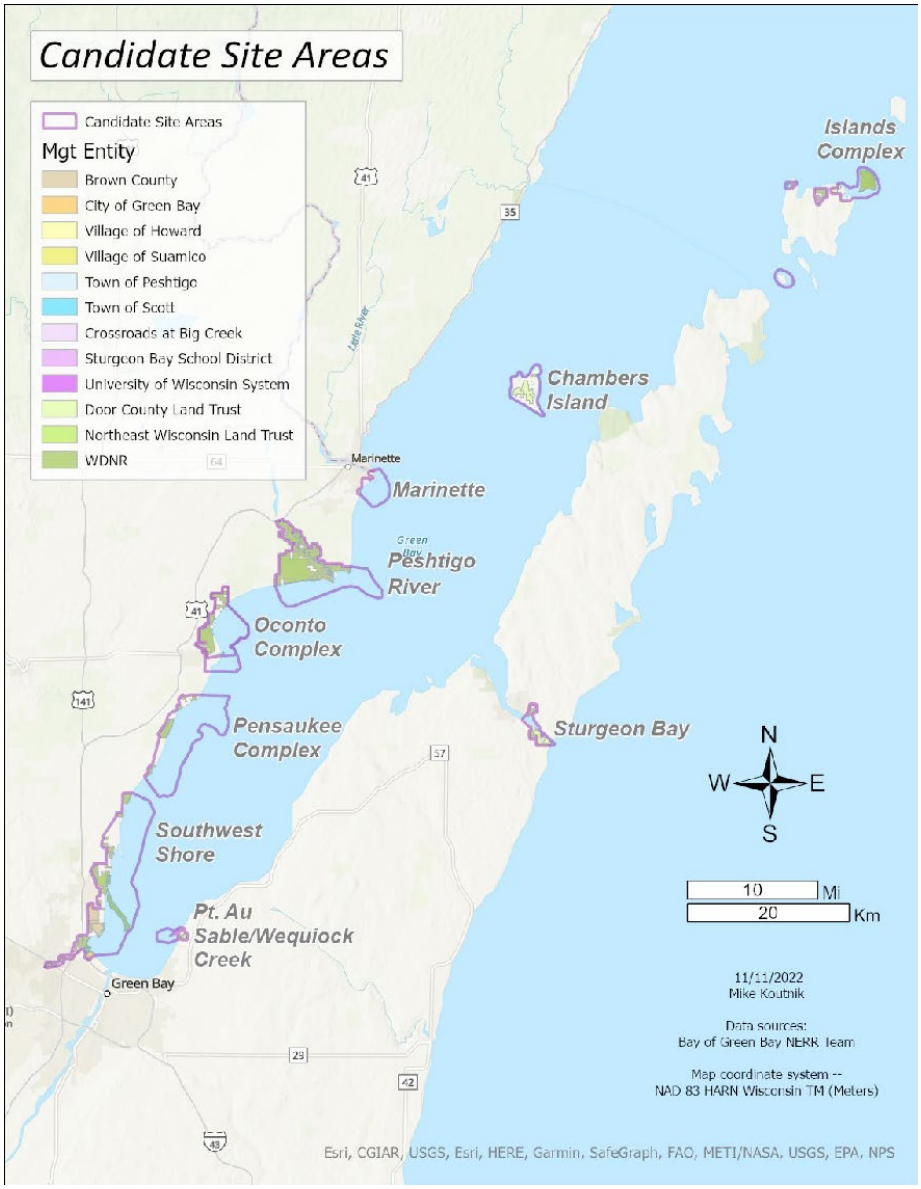


Figure 3. Candidate sites identified through the Wisconsin site selection and nomination process.

The Site Evaluation Committee then applied criteria developed by the Site Development Committee to the nine candidate site areas. These criteria were designed to evaluate each candidate site's capacity for research, education, training, stewardship, manageability, and resilience. After scoring was completed, the Site Evaluation Committee performed Strengths, Weaknesses, Opportunities, and Threats analyses to determine which combination of sites would best represent the Green Bay estuary. Ultimately, a multicomponent site comprising the Peshtigo River, Southwest Shore, Point au Sable, and Sturgeon Bay areas had the highest rating.

On September 7 and 8, 2022, NOAA and the University of Wisconsin–Green Bay sought public input on the multicomponent site during an in-person and virtual public hearing. On September 26, 2022, the Site Coordination Committee nominated by majority vote the proposed multicomponent site for the natural areas of the proposed Green Bay Reserve. Through a press release, Governor Evers publicly announced his intention to nominate the sites to NOAA on October 28, 2022.

The nomination process was formally completed with the submission of a site nomination document from the Governor's Office to NOAA detailing the outcomes of the site selection and nomination process. The site nomination document was submitted to the NOAA Administrator on December 29, 2022. Following a review period in 2023, NOAA formally accepted the site nomination in early 2024. NOAA and the University of Wisconsin–Green Bay began the next phase of the designation process by developing draft versions of the required environmental impact statement and reserve management plan.

If designated, the University of Wisconsin–Green Bay will assume the role of lead state agency for the proposed Green Bay National Estuarine Research Reserve.

3.2 Project Area

The University of Wisconsin–Green Bay evaluated an extensive swath of Wisconsin's Green Bay coast during the site selection process for the proposed Green Bay Reserve. This area, referred to in section 3.1 as the "relevant coastal geography" and shown in figure 4, comprises all sites evaluated during the university's site selection process (see fig. 3) and all boundary alternatives considered in this Draft Environmental Impact Statement.

This Bay of Green Bay area is most influenced by estuarine conditions that result from interactions between Lake Michigan water inputs in the north and river and stream inputs occurring along the West Shore and Lower Green Bay. With some limited exceptions, this "relevant coastal geography" includes all small coastal watersheds (U.S. Geological Survey Hydrologic Unit Code 12) that surround the Wisconsin portion of the Green Bay estuary.

This area contains a wide range of upland, transitional, and aquatic habitats, plant and animal species, and geological features; provides numerous opportunities for partnership, education, training, research, and stewardship; serves as home to both major cities and rural communities; and contains ecosystems that reflect the full range of human impacts from minimally disturbed to in need of restoration to recently restored. More information about the human and natural environments found in this area is detailed in chapter 5.

Early in the designation process, the state determined that site selection for the reserve's natural areas would be conducted separately from the site selection for a visitor and education center. The visitor center does not need to be located within the boundaries of the proposed reserve, and its location will be determined through a separate state-led process should the reserve be designated. As such, this document does not consider direct impacts associated with construction of a visitor center facility.

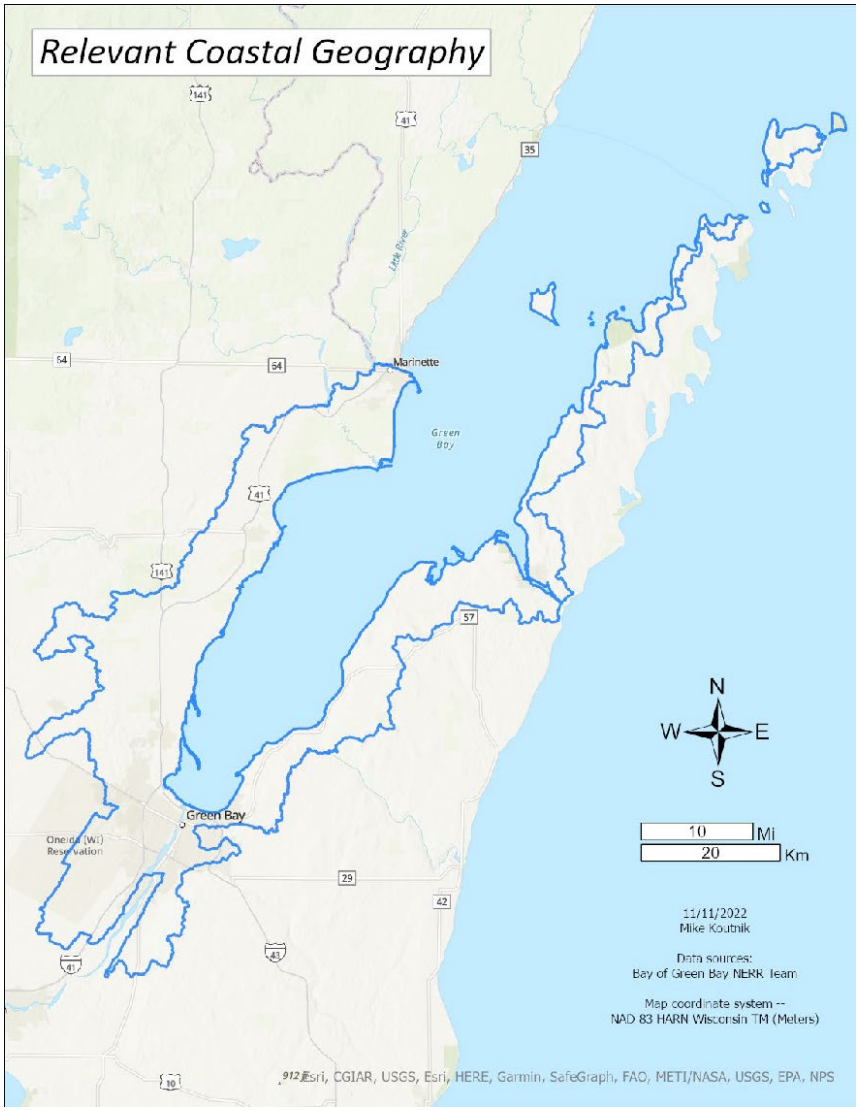


Figure 4. Relevant coastal geography: The swath of Wisconsin's Green Bay coast evaluated during the site selection process for the proposed Green Bay Research Reserve.

3.3 Scoping

This draft environmental impact statement provides information to decision-makers and the interested public on the potential impacts associated with designation of the proposed Green Bay National Estuarine Research Reserve under federal authorities. To better understand the concerns of interested parties regarding this designation, the National Environmental Policy Act (NEPA) scoping process prioritized broad and diverse public and private participation.

Individuals and groups have been given opportunities to provide input and support since the commencement of the designation process. Reserve System regulations require that at least one public scoping meeting is held and a Notice of Intent (NOI) to Prepare an Environmental Impact Statement is published in the *Federal Register* at least 15 days prior to the meeting (15 C.F.R. § 921.13(c)). Accordingly, the public was provided notice of the meetings in the *Federal Register* on January 25, 2024 (89 FR 4916), 54 days in advance of the public scoping meeting, and through advertisements posted on February 21, 2024, in the Green Bay Press Gazette and Oconto

Reporter, and February 23, 2024, in the Door County Pulse. Both virtual and in-person public scoping meetings—offering the same information and opportunities for public comment—were held on March 19, 2024.

For Tribal nations with current or historical connections to the Bay of Green Bay, NOAA hosted a virtual tribal engagement webinar on February 21, 2024, to provide advance notice of NOAA's intent to prepare a draft environmental impact statement, host public scoping meetings, and invite participation by Tribal members and citizens in the scoping phase as well as in subsequent phases of the designation process. The director of NOAA's Office for Coastal Management invited Tribal chairpersons to join this webinar via email. Relevant staff (e.g., a Tribal historic preservation officer and a staff person from the Wisconsin Department of Natural Resources) were invited to attend via email by NOAA's lead staff person for the designation process. Despite this targeted outreach, the webinar had no attendees.

Altogether, over 100 individuals attended the virtual and in-person public scoping meetings. Ten comments were received during the scoping phase, and a compendium these comments is found in appendix 4.

3.4 Permits, Licenses, and Entitlements Associated with Implementation of the Action

The designation of the proposed Green Bay Reserve and approval of a Reserve System management plan are not, in themselves, actions that would affect protected species or impact cultural and historic properties. If designated, future research and management activities may affect species or impact cultural resources. Projects involving the study of fish, wildlife (including birds), and threatened or endangered species may require consultations with or permits issued by the U.S. Fish and Wildlife Service, depending on the proposed activity and affected species. Impacts to cultural and historic resources from reserve activities would be considered as needed. Consultations about future activities will be conducted with appropriate entities, including Wisconsin's State Historic Preservation Office and Tribes in and adjacent to the Bay of Green Bay. In the future, all required permits will be obtained and consultations conducted in accordance with all applicable requirements. See chapter 7 and appendix 5 for more information regarding compliance.

4 Boundary Alternatives

NOAA considered two action alternatives representing different boundary configurations for the proposed Green Bay National Estuarine Research Reserve and a no action alternative. Both action alternatives include core and buffer areas per Reserve System guidelines (15 C.F.R. § 921.11(c)(3)).

4.1 Description of Alternatives

NOAA proposes a federal action to establish a National Estuarine Research Reserve in the Green Bay coastal area of Lake Michigan (appendix 2). This proposed action includes formal designation by the NOAA Administrator and joint declaration by the NOAA Administrator and the governor of Wisconsin. This action provides eligibility for the Green Bay Reserve to receive financial assistance, as funding allows, from NOAA for up to 70 percent of the reserve's operation and program costs, as well as potential funding for acquisition and construction of facilities through a competitive award process.

Designating a reserve, approving its management plan, and selecting an action alternative must comply with the Reserve System's statutory and regulatory requirements, as described in chapter 3. The alternatives described in this chapter and summarized in table 3 were developed in accordance with 15 C.F.R. § 921.11(c)(2)-(3), which discuss overall ecological characteristics, their relationship with reserve goals, the degree of human influence, and the delineation of core land and water areas and buffers. The analyzed alternatives include the no action alternative (i.e., not designating the proposed Green Bay Reserve), the proposed Green Bay Reserve site as nominated by the state of Wisconsin, and an alternate boundary configuration. Because each alternative offers different opportunities for research, land management, and education, each has varying environmental impacts, which inform the analysis of the reserve configurations discussed in chapter 6.

The alternative boundary configuration provides appropriate accessibility to all portions of the properties, and it is equally supportive of the site's purpose and need to enable long-term research, education, and enhanced estuarine awareness.

Under either action alternative, the University of Wisconsin–Green Bay is the lead management agency for the proposed Green Bay Reserve, working in close collaboration with the Wisconsin Department of Natural Resources, City of Green Bay, Brown County, and other landowners. The university will employ a reserve manager and staff to implement daily operations and activities, with a Reserve Advisory Committee to provide advice and guidance and a Friends Group to assist with volunteer recruitment and coordination, advocacy, and fundraising. Reserve staff will initially include the core positions of a reserve manager, an education coordinator, and a research coordinator, with the addition of a stewardship coordinator, a coastal training coordinator, and a tribal engagement convener at a later time. As indicated in the draft management plan (appendix 1), additional program staff (e.g., volunteer liaison, communications specialist) and support staff (e.g., technicians, program assistants) will be added to support evolving needs as the reserve builds capacity. Reserve partners will engage with reserve staff to address the goals and objectives identified in the draft management plan.

The plan, which outlines the mission (core purpose), vision (i.e., what the proposed Green Bay Reserve will achieve), and values (e.g., guiding how reserve staff work), is relevant to the action alternatives.

> **Mission:** In fulfillment of our responsibility to future generations, the Green Bay National Estuarine Research Reserve celebrates and advances community interests, opportunities, investments, and connections to the region's globally significant and unique freshwater resources through innovative and collaborative research, education, stewardship, and training activities that restore and sustain healthy, resilient, and working estuaries.
>
> **Vision:** The Green Bay National Estuarine Research Reserve will gain national recognition as a hub for freshwater estuary research and large-scale restoration, a testing ground for relevant, emerging technologies, and a partner for integrating diverse perspectives and approaches to celebrate and learn about freshwater estuaries.
>
> **Values:** In living out the mission, the following core values reflect how reserve staff will work:
>
> - Collaboration – A recognition that the complexity and scale of challenges and opportunities surrounding our waters necessitate strong partnerships and solutions embedded in community.
> - Holistic approaches – A commitment to adopt multidisciplinary thinking and diverse perspectives to connect, know, and value the region's globally unique freshwater estuaries.
> - Generational perspectives – An awareness that fresh water has shaped the history of the region's people, shapes our lived experiences today, and will shape our future.
> - Learning – A shared belief that membership in the National Estuarine Research Reserve System enables the Green Bay estuary to serve as a model for testing new technologies and creating and contributing knowledge to restore and steward estuarine systems globally.

The proposed action also includes approval of a management plan that applies to each action alternative. The plan identifies four priority coastal management issues, along with goals and objectives that the proposed Green Bay Reserve would seek to address, which are relevant to both action alternatives. The priority coastal management issues (below) and their associated goals and objectives can be found in the draft management plan (appendix 1).

1. Preparing Great Lakes communities for long-term ecosystem change and variability
2. Restoring sustainable and holistic land-water connections
3. Preserving biodiversity through improved ecological integrity and ecosystem resilience
4. Enhancing the Bay of Green Bay's sense of place and connection to quality of life

The draft management plan for the proposed Green Bay Reserve also identifies ways to both support the goals of the Reserve System (15 C.F.R. § 921.1(b)) and address the Green Bay–specific issues identified above.

4.2 Boundary Alternatives

Three boundary alternatives are presented. An introductory summary is provided in table 3 with details of the three alternatives provided in sections 4.2.1 through 4.2.3.3. A comparison of the alternatives is provided in section 4.2.4.

Table 3. Summary of the Three Boundary Alternatives Considered Within the Bay of Green Bay.

Alternative	Approximate Total Size (Acres)
No action alternative: The proposed Green Bay Reserve is not designated as a National Estuarine Research Reserve.	0
Alternative A – Originally nominated site: The upland and offshore areas as proposed by the State of Wisconsin in the original site nomination.	37,714
Alternative B – Revised nominated site: Additional lands and the removal of small parcels from the originally nominated site (Alternative A), including lands that became public after evaluation of the nominated site and reevaluation of some small parcels following a review of National Estuarine Research Reserve goals.	36,502

4.2.1 No Action Alternative

As required by the National Environmental Policy Act, a "no action alternative" must be considered. The no action alternative occurs if NOAA does not act upon the proposal; in this scenario, a National Estuarine Research Reserve would *not* be established in Green Bay.

NOAA provides guidance to states regarding how and where new reserves might be added to the national system (NOAA Office for Coastal Management 2021). While NOAA provides support (e.g., personnel, resources, funding) for applicants to undertake the site evaluation process, the agency retains discretion as to site designation; thus, the no action alternative is considered viable.

Under this alternative, no portion of the Green Bay estuary would be designated as part of the Reserve System. As a result, there would be no changes in the current management or uses of the areas evaluated in the following sections (fig. 5).

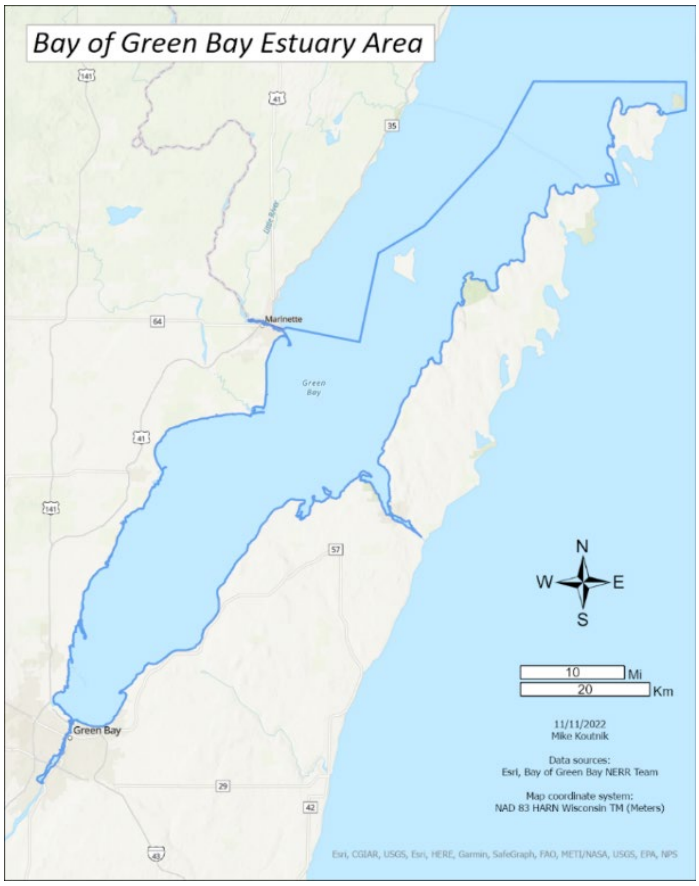


Figure 5. The no action alternative.

4.2.2 Alternative A – Originally Nominated Site

Alternative A comprises the nominated site described in the *Bay of Green Bay National Estuarine Research Reserve Site Selection and Nomination Report* (fig. 6).

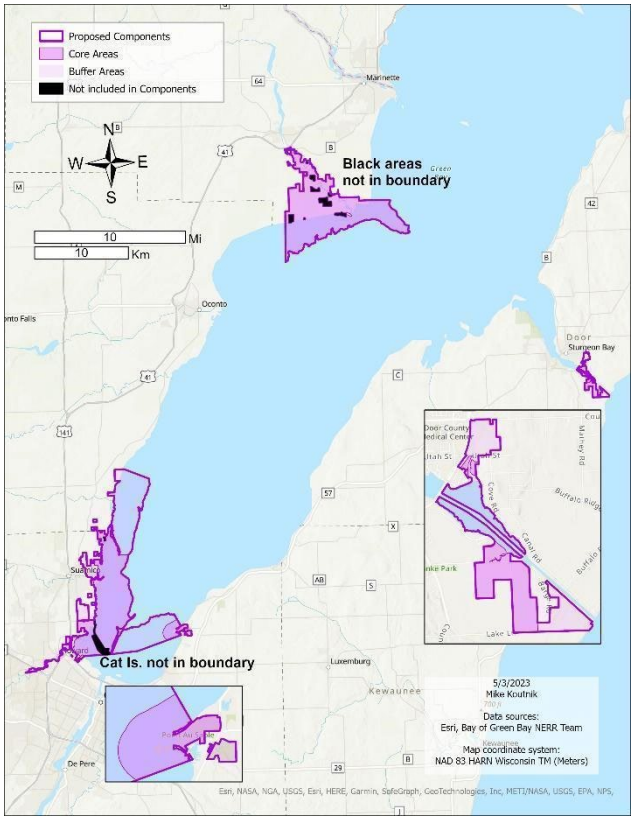


Figure 6. Originally nominated site.

4.2.2.1 Nominated Site Boundary – Alternative A

Alternative A, including its upland, wetland, and open waters, is approximately 37,714 acres. The proposed land and waters are organized into three component areas by geography: the Peshtigo Component, the Lower Bay Component (a combination of the previously described Southwest Shore and Point au Sable candidate site areas), and the Sturgeon Bay Component.

- Peshtigo Component: 13,807 acres (6,551 land and wetland; 7,256 open waters)
- Lower Bay Component: 23,010 acres (3,415 land and wetland; 19,595 open waters)
- Sturgeon Bay Component: 908 acres (663 land and wetland; 245 open waters)

The proposed reserve is located entirely within the boundaries of Wisconsin, and no federal landholdings are included within the boundary. The boundaries were selected to include upland, transitional, and aquatic habitats in proportions reflective of the Green Bay estuary and approximating an ecological unit characteristic of a Great Lakes freshwater estuary. Finally, the proposed reserve would be located entirely within the Lakes Michigan–Huron biogeographic subregion.

4.2.2.2 Purpose and Need – Alternative A

Alternative A satisfies the purpose and need of the proposed action in the following ways:

1. Key land and water areas of the proposed Green Bay Reserve are under adequate state control sufficient to provide long-term protection for reserve resources and ensure a stable environment for research.

Upland and wetland properties are owned and managed by various partners whose existing protections and management practices safeguard long-term habitat viability, ensure a stable environment for research, and support appropriate human uses. Similarly, open water areas are subject to federal, state, and local controls that balance resource protection with diverse uses and activities. For an in-depth discussion of the authorities ensuring state control, please refer to the Resource Protection Plan within the Green Bay Reserve draft management plan (appendix 1).

Alternative A defines key land and water areas ("core") vital ecosystem function of the ecosystem, as well as buffer areas designed to protect core areas or facilitate habitat shifts (15 C.F.R. § 921.11(c)(3)). Core and buffer areas, with a description of landownership and acreage, for each proposed component are summarized throughout this section.

Peshtigo Component: The majority of this component is defined as *core*, as the area is relatively undisturbed and represents a large and contiguous wetland and estuary habitat for the western shore of Green Bay. Buffer areas are drawn around privately held in-holdings.

- 13,340 acres core (96% of Peshtigo) and 467 acres buffer (4%) = 13,802 acres
  - Land and wetland: 6,552 acres
  - Open water: 7,250 acres

Landholding partners and land-wetland parcels included in the Peshtigo Component are summarized in table 4.

Table 4. Alternative A: Peshtigo-Component Landowners, Included Parcels, and Acreage.

Landowner	Included Parcel(s)	Acreage
Wisconsin Department of Natural Resources	Bloch Oxbow State Natural Area, Peshtigo Harbor Lacustrine Forest State Natural Area, Peshtigo River Delta Marshes State Natural Area, Badger Gift Lands, Green Bay West Shores State Wildlife Area	6,550
Town of Peshtigo	Unnamed parcel of Peshtigo	2
Total acres of land and wetland in the Peshtigo Component		6,552

Lower Bay Component: Sections of this component capture primary estuarine characteristics (e.g., seiche, estuarine river mouths) in the Lower Bay and are defined as *core*, with fringe lands classified as buffer, including those areas with active water-level manipulation through diking.

- 11,291 acres core (49%) and 11,722 acres buffer (51%) = 23,013 acres
  - Land and wetland: 3,418 acres
  - Open water: 19,595 acres

Landholding partners and land-wetland parcels included in the Lower Bay Component are summarized in table 5.

Table 5. Alternative A: Lower Bay–Component Landowners, Included Parcels, and Acreage.

Landowner	Included Parcel(s)	Acreage
Wisconsin Department of Natural Resources	Tibbet-Suamico, Sensiba, Long Tail, and Peats Lake (managed units)	1,963
Brown County	Barkhausen Waterfowl Preserve and Fort Howard Paper Foundation Wildlife Area	979
City of Green Bay	Ken Euers Nature Area	129
Village of Howard	Village property along Duck Creek: Nauman Conservation Area, Howard Memorial Park, Williams Conservation Area, Pioneer Parkway, Pamperin Park	48
Village of Suamico	Sunset Beach Park	<1
Town of Scott	Wequiock Creek Natural Area	2
University of Wisconsin System	Point au Sable Natural Area	187
Northeast Wisconsin Land Trust	Wequiock Creek Natural Area	109
Total acres of land and wetland in the Lower Bay Component		3,418

Sturgeon Bay Component: The areas surrounding the mouths of the Big Creek and Strawberry Creek estuaries are designated *core* due to extensive ownership and management of these lands by landholding partners. At Big Creek, the core area is restricted to land adjacent to open water, as the presence of trails and a boat launch elsewhere precludes its classification as core habitat. At Strawberry Creek, lands with relatively undisturbed habitat and limited trail and recreational access are defined as *core*, including an area of the Door County Land Trust's Sturgeon Bay Ship Canal Nature Preserve that lacks a trail system. Buffer areas surround the core areas both north and south of the Sturgeon Bay Ship Canal.

- 370 acres core (41%) and 529 acres buffer (59%) = 899 acres
  - Land and wetland: 654 acres
  - Open water: 245 acres

Landholding partners and land-wetland parcels included in the Sturgeon Bay Component are summarized in table 6.

Table 6. Alternative A: Sturgeon Bay–Component Landowners, Included Parcels, and Acreage.

Landowner	Included Parcel(s)	Acreage
Wisconsin Department of Natural Resources	Big Creek State Habitat Area, Strawberry Creek Chinook Facility, Strawberry Creek State Habitat Area, Ahnapee State Trail Easement	102
Crossroads at Big Creek	Big Creek Preserve, Cove Preserve	109
Sturgeon Bay School District	Unnamed parcel managed by Crossroads at Big Creek as part of the Big Creek Preserve	20
Door County Land Trust	Sturgeon Bay Ship Canal Nature Preserve	424
Total acres of land and wetland in the Sturgeon Bay Component		655

2. The proposed site is a representative estuarine ecosystem that provides suitable opportunities for long-term research, education, and interpretation and enhances public awareness and understanding of estuarine areas.

Each of the three Alternative A components has unique ecologic features, supports and provides opportunities for long-term research and education programs, and would enhance awareness and understanding of the Green Bay estuary and the Reserve System.

Peshtigo Component: A key contribution of Peshtigo Component to the Green Bay Reserve and the Reserve System is its representation of an undisturbed Great Lakes estuary. The Peshtigo River remains unchanneled within the proposed Green Bay Reserve, featuring a natural river mouth at Winegar Pond with extensive marshes, estuarine open waters, and upstream bottomland hardwood forests. With the exception of a two-acre parcel owned by the Town of Peshtigo, this component is entirely managed by the Wisconsin Department of

Natural Resources. All land and water areas within this component are managed in a manner consistent with the Reserve System, with key land and water areas functioning as a cohesive ecological unit regardless of landownership. This component includes estuarine open waters within the Bay, transitional habitat at the river mouth, and an extensive upland area. Its undisturbed state and significance for bird nesting and migration, combined with a history of long-term coastal monitoring and recent research into native fish health and wild rice habitats, attract diverse research interests. Additionally, its proximity to school districts in Oconto, Peshtigo, Marinette, and Michigan's Upper Peninsula makes it ideal for K-12 educational programming. Located just 20 minutes from the Marinette campus of the University of Wisconsin–Green Bay, the Peshtigo Component is suitable for long-term estuarine research due to its ecological features and its accessibility to students and faculty.

Lower Bay Component: This component adds a seiche-influenced estuary, representative of Great Lakes coastal estuarine ecosystems, to the proposed reserve. Although outside the proposed reserve's boundaries, the mouth of the Fox River—a large Great Lakes tributary—defines the estuarine conditions of Lower Green Bay. The Lower Bay Component also contributes additional basin types to the proposed multicomponent site. For example, some areas within the Duck Creek Delta are best characterized as embayments; Point au Sable contains a natural lagoon, while Sensiba State Wildlife Area and Ken Euers Natural Area feature human-modified lagoons. The Cat Island Chain (not included within the reserve boundary but entirely surrounded by it) and Long Tail Point provide two examples of sheltered coasts. These sheltered coasts and the ecosystems protected by them starkly contrast with the extensively exposed coastline present throughout the proposed site. The basin structure is a coastal plains estuary that features bar-bounded characteristics around the Duck Creek Delta, which recent restoration of the Cat Island Chain has protected from wave action and coastal erosion. Inlet types range from unrestricted near the mouth of the Fox River, adjacent to the Lower Bay Component, to restricted—often by a barrier beach during low-flow periods—at Wequiock Creek. Finally, the Lower Bay exhibits a micro-gradient of habitats, ranging from recently restored areas along Duck Creek and Ken Euers Natural Area in the south to less disturbed environments in the north at Sensiba State Wildlife Area and Long Tail Point.

The Bay of Green Bay is recovering from past ecological degradation. Federal and state agencies and nongovernmental and private organizations are investing significant funds toward remediating lingering environmental challenges, including active polychlorinated biphenyl (PCB) remediation of the Fox River (completed in 2020) and the reconstruction of the Cat Island Chain, as well as numerous ongoing smaller restoration projects within the Bay and supporting watershed.

The Lower Fox River, which empties into the Bay of Green Bay, remains a major area for paper production. According to the U.S. Environmental Protection Agency, over 25 paper and pulp mills are located in the eight Wisconsin counties that contain portions of the Lower Fox River or are adjacent to the Bay of Green Bay (U.S. Environmental Protection Agency n.d.b). The Port of Green Bay is an international and domestic port with a navigation season extending from April through December. In 2024 alone, more than 180 commercial vessels transported cargo via the port and over 1.6 million tons of cargo were handled (Greater Green Bay Chamber n.d.).

The Lower Bay Component is home to many active research projects, including studies of favorable conditions for wild rice at Sensiba State Wildlife Area and L.H. Barkhausen Waterfowl Preserve, investigations into bird feeding and migration at Point au Sable, and long-term monitoring of coastal wetlands in the Suamico River area, Little Tail Point, Dead Horse Bay, Peters Marsh, Peats Lake, and Atkinson Marsh. These and other projects are not only relevant to the research community but also to educators. K-12 classrooms grow wild rice for eventual seeding as part of a wild rice monitoring project, and research at Point au Sable and Wequiock Creek is led by students at the University of Wisconsin–Green Bay. The university's proximity to portions of the Lower Bay Component would facilitate long-term research and educational collaborations. The Lower Bay Component would be a key site for educational and interpretive efforts. Also within this component, the West Shores

Interpretive Center at L.H. Barkhausen Waterfowl Preserve offers year-round environmental educational programming at its estuary and upland sites. The center also hosts UWGB-organized estuary education field trips for area classrooms. The existence of an established and well-regarded site for educational programming would contribute to the educational interests of both the Lower Bay Component and the Green Bay Reserve.

The Lower Bay Component has various landholding partners (see table 5), each with management plans compatible with reserve functions. While the Lower Bay Component is located near urban areas, the land included in this component is minimally affected by human activity, with use restricted to recreational activities compatible with reserve operations. Finally, the Lower Bay Component contains parcels along both the western and eastern shore of Green Bay, encompassing an adequate portion of key land and water areas to approximate an ecological unit representative of a Great Lakes estuarine ecosystem and including key features of an estuary, such as drowned river mouths, seiche influence, and a balance of upland, transitional, and open water habitat.

Sturgeon Bay Component: Sturgeon Bay, the smallest of the three components, adds unique watersheds to the proposed reserve. The Strawberry Creek and Big Creek watersheds represent smaller drainage areas than those included in the Lower Bay and Peshtigo Components. These watersheds also have different geologic characteristics than those included in the Lower Bay and Peshtigo Components, adding to the diversity of potential watershed research. The Sturgeon Bay Component includes ridge and swale habitats—a unique ecosystem type for the Reserve System—and endangered plant species not found elsewhere in the proposed Green Bay Reserve. This component includes educational and research facilities at the Crossroads at Big Creek Nature Area, where active monitoring programs study water quality, bird breeding, amphibians, bats, and northern pike. Recent collaborations between Crossroads, Cornell University, and the Shedd Aquarium to monitor the spring spawning of suckers will connect the proposed reserve to research and educational partners at these institutions. Also included within the Sturgeon Bay Component is the Strawberry Creek Chinook Facility, which is owned and managed by the Wisconsin Department of Natural Resources. This hatchery is Wisconsin's primary source of Chinook salmon eggs for stocking in Lake Michigan. Chinook salmon return to Strawberry Creek from Lake Michigan to spawn; the eggs are then collected, cleaned, and prepared for transport to the hatcheries. In late September, the peak of the salmon spawning run, staff from the Department of Natural Resources collect eggs twice weekly. The rustic hatchery facility is open to the public when department personnel are present from late September through early November. The salmon stocking program provides a diverse sport fishery for Lake Michigan. The facility's footprint and activities are minimal and do not conflict with reserve activities and operations. Further, the presence of the hatchery creates unique opportunities for education and collaboration.

Established facilities and existing educational programs at the Crossroads would be leveraged with reserve offerings to enhance the education and interpretive programs offered to Door County residents and students and visitors to Door County traveling through Sturgeon Bay. The Crossroads complex features contiguous coastal wetlands at the mouth of Big Creek, extending upstream through a 3,000-foot riparian corridor of wetlands and forest. Partners within the Sturgeon Bay Component include the Wisconsin Department of Natural Resources and Door County Land Trust, both of which maintain management plans aligned with reserve goals. Despite proximity to the city of Sturgeon Bay, these areas are minimally affected by human activity and primarily used for recreation, which aligns with future reserve activities.

The proposed, multicomponent Green Bay Reserve will enhance the biogeographical and typological balance of the Reserve System and provide unique opportunities for research, monitoring, and resource protection (15 C.F.R. § 921.11).

3. The proposed site balances ecological characteristics with human uses.

Alternative A encompasses both ecosystems and processes characteristic of a large Great Lakes river estuary and ecological attributes that highlight the unique nature of the Green Bay estuary. The management of a sizable portion of the proposed reserve as part of the Department of Natural Resources' Green Bay West Shore Wildlife Area reflects the importance of this area within the Green Bay estuary system, the state of Wisconsin, and the broader Great Lakes region. The proposed partnership with a single, large-scale landholder further demonstrates the proposed reserve's ability to effectively manage the environment and human activity within the site. The Green Bay West Shore Wildlife Area is described in the Department of Natural Resources' West Shore Master Plan as "an area with abundant natural resources and a long history of human occupation, both by Native Americans and by a succession of European and Euro-American explorers, traders, missionaries, and immigrants'' (2014). The wildlife area contains critically important and productive wetland habitat, representing approximately 50 percent of all wetlands remaining on Lake Michigan and underscoring its high value for conservation and protection (Wisconsin Department of Natural Resources 2014). The proposed reserve provides critical breeding and migratory stopover areas for birds, essential spawning habitat for fish, and support for populations of rare flora and fauna. As the world's largest freshwater estuary, the Bay of Green Bay provides a unique and important habitat for Northeast Wisconsin, the Great Lakes, and the National Estuarine Research Reserve System. Alternative A includes a sufficiently large area of transitional and wetland habitat so that a wet transition between the land and open water would remain within the reserve boundaries even at low lake levels (i.e., six feet below the long-term average). The relatively small percentage of area classified as upland habitat reflects the limited availability of contiguous, undeveloped public land surrounding the Bay.

Despite significant development and industrial activity on the lands surrounding the proposed reserve, the area remains an important recreational resource for local residents and visitors to northeastern Wisconsin. Human activities within the proposed site vary and include hunting, fishing, and trapping on many DNR-managed sites; kayaking, canoeing, birdwatching, cross-country skiing, wildlife viewing, and hiking across most of the proposed area; and pleasure boating and recreational fishing in the open water of Green Bay. While human use has influenced portions of the resources found in Alternative A, many valuable habitats and their ecosystem functions are managed to maintain their integrity, ensuring long-term ecological health and human benefit.

4. The proposed site is representative of the Green Bay estuary.

As detailed in chapter 2, to create a reserve that is representative of the Green Bay estuary, NOAA and the state of Wisconsin determined that the proposed reserve site must capture two observable gradients:

1. the disturbance gradient from minimally impacted habitats to recently restored areas and
2. the south-to-north gradient, which captures the nutrient-rich waters of the Fox-Wolf watershed in the south to the relatively nutrient-poor waters entering Green Bay from Lake Michigan in the north.

As previously described, Alternative A includes a range of habitats, from those minimally impacted by human use to those recently restored. Specifically, the Peshtigo Component, which remains unchanneled in the proposed reserve boundaries and contains extensive marsh habitat and a broad estuary mouth into the Bay, is representative of an undisturbed Great Lakes estuary. The Lower Bay Component, which is adjacent to major habitat restoration initiatives such as the recently completed PCB remediation at the mouth of the Lower Fox River, the ongoing Cat Island Chain reconstruction, and parcels of recently restored habitats along Duck Creek at Ken Euers Natural Area and within the Sensiba Unit of the Green Bay West Shores Wildlife Area, provides representation of more recently restored habitats within the Green Bay estuary. Areas within the Sturgeon Bay Component represent smaller watersheds than those along Green Bay's western shore and include unique geologic features, including ridge and swale and Great Lakes beach habitat.

In addition, the Alternative A components contain parcels near the northernmost reaches of Wisconsin's land and waters at Green Bay's western shore; these lower portions of Green Bay are most heavily influenced by the Fox River and habitats along the eastern shore of Green Bay at Point au Sable and Sturgeon Bay. As a result, Alternative A includes land and water areas that adequately capture the south-to-north gradient of nutrients found within the Green Bay estuary.

4.2.2.3 Alternative A – In Context

Alternative A is similar in composition and inclusion of habitat types to Alternative B. Minor changes are proposed for the Peshtigo and Lower Bay Components. Proposed changes are described in section 4.2.3.1.

4.2.3 Alternative B – Revised Nominated Site

Alternative B closely resembles Alternative A, incorporating the same three reserve components with only minor adjustments to the parcels included within the Peshtigo and Lower Bay Components, as well as to the delineated core and buffer areas for each component. Alternative B is also located entirely within the boundaries of Wisconsin and excludes federal landholdings. Its boundaries were designed to include upland, transitional, and aquatic habitats in proportions that reflect the Green Bay estuary, approximating an ecological unit characteristic of a Great Lakes freshwater estuary within the Lakes Michigan–Huron biogeographic subregion.

Maps reflecting the minor changes to each component can be found in figures 7, 8, and 9.

4.2.3.1 Site Boundary – Alternative B

Alternative B, including upland, wetland, and open water properties, is approximately 36,502 acres. This subsection describes the proposed changes to Alternative B relative to Alternative A.

Peshtigo Component:

Alternative B is composed of the same land and water areas as Alternative A with two exceptions. Specifically, two parcels were removed from the Peshtigo Component:

1. A red pine plantation in the northeast corner of the component, owned and managed by the Wisconsin Department of Natural Resources. This parcel was removed from Alternative B because it is not contiguous with the rest of the Peshtigo Component, and the plantation offers no significant additional natural resource benefits to the proposed reserve.
2. A two-acre parcel owned by the Town of Peshtigo. This parcel was removed from Alternative B because the logistical challenges of adding another landowning partner outweigh the benefits of including the parcel in the reserve boundaries. Consequently, the Town of Peshtigo would not be a formal landowning partner of the proposed reserve under Alternative B.

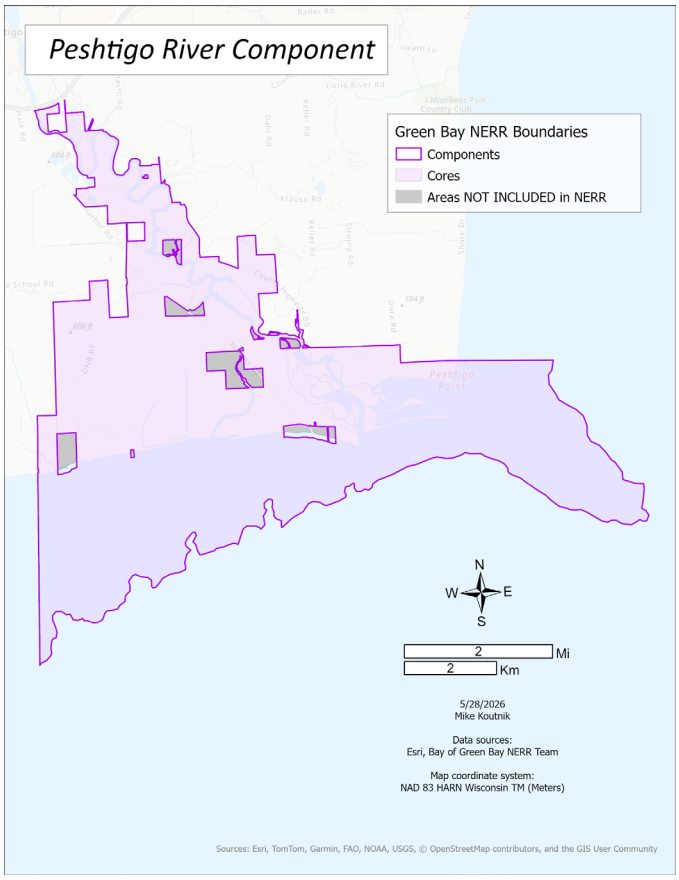


Figure 7. Alternative B: Peshtigo River Component.

Relative to Alternative A, minor modifications were also made to the core and buffer area delineations. In Alternative B, all proposed upland, wetland, and open water areas are classified as core. As such, the composition of Alternative B is defined as follows:

- 13,405 acres core (100% of Peshtigo) and 0 acres buffer (0%) = 13,403 acres
  - Upland and wetland: 6,560 acres
  - Open water: 6,843 acres

Landholding partners and land- wetland parcels included within the Peshtigo Component of Alternative B are summarized in table 7.

Table 7. Alternative B: Peshtigo-Component Landowners, Included Parcels, and Acreage.

Landowner	Included Parcel(s)	Acreage
Wisconsin Department of Natural Resources	Bloch Oxbow State Natural Area, Peshtigo Harbor Lacustrine Forest State Natural Area, Peshtigo River Delta Marshes State Natural Area, Badger Gift Lands, Green Bay West Shores State Wildlife Area	6,560
Total acres of land and wetland in the revised Peshtigo Component		6,560

Lower Bay Component:

Alternative B comprises the same land and water areas as Alternative A with seven exceptions. Specifically, four parcels were removed from the Lower Bay Component and three parcels were added (fig. 8).

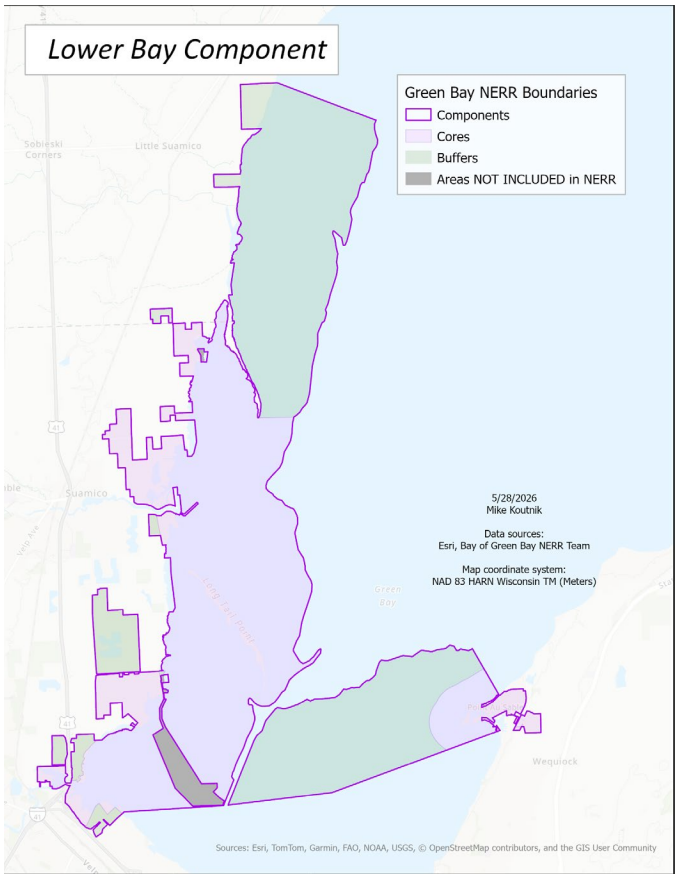


Figure 8. Alternative B: Lower Bay Component.

Parcels added to the Lower Bay Component of Alternative B:

- A 113-acre parcel of publicly owned land in the Duck Creek Delta called the "Duck Creek Conservation Corridor." These wetlands are adjacent to (1) Ken Euers Nature Area to the east, a Green Bay–owned property included in the proposed reserve boundaries, and (2) WDNR-owned lands to the north. The Village of Howard, an existing Green Bay Reserve landholding partner, acquired the Duck Creek Conservation Corridor in late 2022. Including these lands under Alternative B would enhance wetland research opportunities within the Lower Bay site and add connectivity to the Duck Creek wetland habitat within the proposed reserve boundaries.
- A 20.7-acre parcel at Point au Sable was added due to its recent acquisition by Northeast Wisconsin Land Trust. This newly acquired parcel is adjacent to land owned by the University of Wisconsin System at Point au Sable and within the proposed reserve boundaries.
- A 0.4-acre parcel at Point au Sable owned by Brown County (Brown County Parks) and adjacent to lands within the proposed reserve boundaries owned by the University of Wisconsin System.

Parcels removed from the Lower Bay Component of Alternative B:

- A small parcel of WDNR-owned land near Little Tail Point disconnected from other proposed areas within the Lower Bay Component. This parcel is a small, rustic fishery property with limited educational and research value and limited public access.
- A small parcel of WDNR-owned land near Long Tail Point disconnected from other proposed areas within the Lower Bay Component. This parcel is not contiguous to other WDNR-owned parcels, and it is not along the lakeshore. It also has limited educational or research value.
- Sunset Beach Park, owned by the Village of Suamico, is primarily a playground, and inclusion of this 0.5-acre parcel does not align with Green Bay Reserve purposes. Consequently, the Village of Suamico would not be a formal landowning partner of the reserve under Alternative B.
- Public lands along Duck Creek owned by the Village of Howard. Removed parcels total 169 acres and include (1) Nauman Conservation Area, (2) Howard Memorial Park, (3) Williams Conservation Area, and (4) Pioneer Parkway. Following a review of land management and usage, the state determined that these areas are primarily managed for recreation and do not align with Green Bay Reserve purposes. The Village of Howard would remain a landowning partner in Alternative B with inclusion of the Duck Creek Conservation Corridor, a significant wetland property (see above).

Relative to Alternative A, minor modifications were made to the core and buffer area delineations. In Alternative B, buffer areas within open water areas and around private docks were reduced to ensure proposed boundaries did not run adjacent to private property in the Lower Bay Component. A similar approach was applied to the Sturgeon Bay Component. For Alternative B, two properties owned by the Wisconsin Department of Natural Resources—Sensiba and Deerfield Docks, part of Peats Lake managed units—were reclassified as core for Alternative B, following consultation with the land manager who confirmed that Sensiba and Deerfield Docks activities aligned with core area requirements. As such, the composition of Alternative B includes:

- 11,852 acres core (53% of Lower Bay) and 10,395 acres buffer (47%) = 22,247 acres
  - Upland and wetland: 4,210 acres
  - Open water: 18,037 acres

Landholding partners and land-wetland parcels included in the revised Lower Bay Component are summarized in table 8.

Table 8. Alternative B: Revised Lower Bay–Component Landowners, Included Parcels, and Acreage.

Landowner	Included Parcel(s)	Acreage
Wisconsin Department of Natural Resources	Tibbet-Suamico, Sensiba, Long Tail, and Peats Lake managed units	2,670
Brown County	Barkhausen Waterfowl Preserve, Fort Howard Paper Foundation Wildlife Area, Wequiock Creek Natural Area	978
City of Green Bay	Ken Euers Nature Area	129
Village of Howard	Duck Creek Conservation Corridor	110
Town of Scott	Wequiock Creek Natural Area	2
University of Wisconsin System	Point au Sable Natural Area	191
Northeast Wisconsin Land Trust	Wequiock Creek Natural Area	130
Total acres of land and wetland in the revised Lower Bay Component		4,210

Sturgeon Bay Component: Alternative B comprises the same land areas as Alternative A.

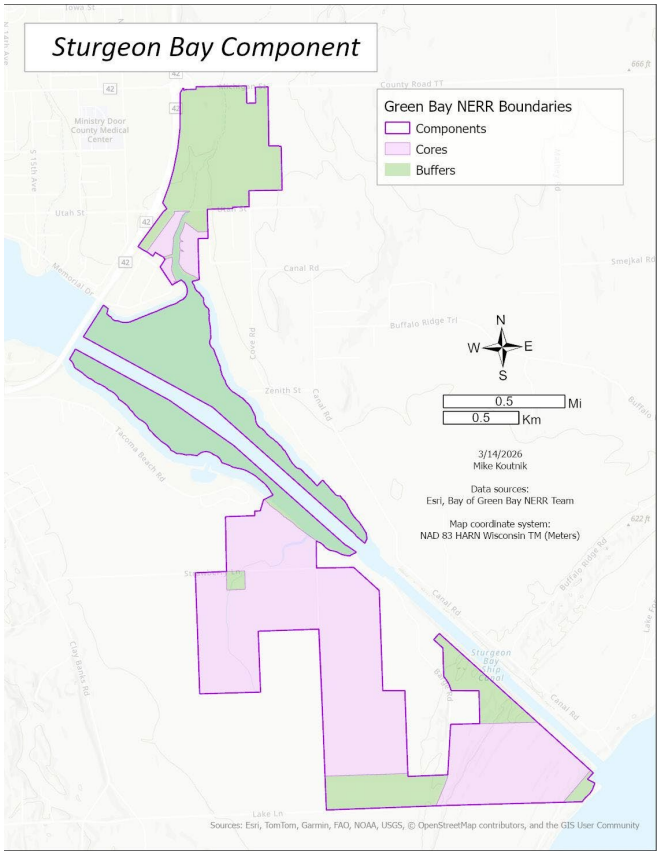


Figure 9. Alternative B: Sturgeon Bay Component.

While the total acreage of open water included in the Sturgeon Bay Component decreased from 899 acres in Alternative A to 852 acres in Alternative B, this decrease in open water acreage is due to additional clearance provided around private docks within the Sturgeon Bay Ship Canal.

Relative to Alternative A, minor modifications were made to the core- and buffer-area delineations. In Alternative B, buffer areas within the Sturgeon Bay Ship Canal were reduced to ensure proposed boundaries did not run adjacent to private docks in the canal. Additionally, some upland areas determined to be buffer in Alternative A were reclassified as core in Alternative B after consulting with the Wisconsin Department of Natural Resources on land use. As such, the composition of Alternative B includes:

- 437 acres core (51% of Lower Bay) and 415 acres buffer (49%) = 852 acres
  - Upland and wetland: 658 acres
  - Open water: 194 acres

4.2.3.2 Purpose and Need – Alternative B

Alternative B also satisfies the purpose and needs of the proposed action.

1. Key land and water areas of the proposed Green Bay Reserve are under adequate state control sufficient to provide long-term protection for reserve resources and ensure a stable environment for research.

As with Alternative A, upland and wetland properties included in Alternative B are owned and managed by various partners whose existing protections and management authorities safeguard the long-term habitat viability, ensure a stable environment for research, and support appropriate human uses. Under Alternative B, the removal of small parcels from the Peshtigo and Lower Bay Components removes the Town of Peshtigo and Village of Suamico as landowning partners within the proposed reserve boundary. While the Green Bay Reserve would be slightly less managerially complex, this scenario does not impact the ability of Alternative B to satisfy this aspect of the proposed action's purpose and need.

2. The proposed site is a representative estuarine ecosystem that provides suitable opportunities for long-term research, education, and interpretation and enhances public awareness and understanding of estuarine areas.

As with Alternative A, the three components of Alternative B feature unique ecological characteristics, support existing programs and provide opportunities for long-term research and education initiatives, and enhance awareness and understanding of the Green Bay estuary and the National Estuarine Research Reserve System. Inclusion of the Duck Creek Conservation Corridor connects wetlands and waters included in the proposed reserve, protects additional areas of the ecologically significant Duck Creek Delta for long-term research and education, and allows expanded research and educational opportunities within the delta. Alternative B also expands the publicly accessible Wequiock Creek Natural Area, which is owned by the Northeast Wisconsin Land Trust. This additional upland habitat expands public access opportunities along the eastern shore of the Bay.

3. The proposed site balances ecological characteristics with human uses.

As with Alternative A, Alternative B contains both ecosystems and processes characteristic of a Great Lakes large river estuary and ecological features that demonstrate the uniqueness of the Green Bay estuary. As previously mentioned, the management of a sizable portion of the proposed land and wetlands as part of the Department of Natural Resources' Green Bay West Shore Wildlife Area reflects the importance of this area within the Green Bay estuary system, the state of Wisconsin, and the broader Great Lakes region. Under Alternative B, several relatively small parcels of land were proposed for inclusion in and removal from the proposed reserve boundary. These modifications do not substantially change the balance between ecological characteristics and human uses as described under Alternative A. As such, Alternative B also satisfies this aspect of the proposed action's purpose and need.

4. The proposed site is representative of the Green Bay estuary.

Alternative B contains the same proposed components as Alternative A. Minor differences between Alternatives A and B have negligible impacts on the proposed site's ability to represent the two ecological gradients that NOAA and the state of Wisconsin deemed necessary to ensure the proposed reserve is representative of the Green Bay estuary. As such, Alternative B also satisfies this aspect of the proposed action's purpose and need.

4.2.3.3 Alternative B – In Context

The ecosystem composition of Alternative B is similar to Alternative A. The addition of the Duck Creek Conservation Corridor and the removal of two small, noncontiguous and non-lakefront parcels in the Wisconsin Department of Natural Resources' West Shore Wildlife Area provide small but significant improvements over Alternative A from a managerial and ecological perspective. In particular, the Duck Creek Conservation Corridor connects the mouth of the Duck Creek Delta for near continuous inclusion of wetlands within the proposed reserve. Numerous research and educational opportunities are provided by the inclusion of this ecologically significant area. Other changes to represented ecosystems with Alternative B include the removal of land from Duck Creek, which is managed for recreational purposes, and the inclusion of newly public wetland habitat at Point au Sable, which is contiguous to public lands included in the proposed reserve. Adding this wetland habitat enhances opportunities to access and study this significant wetland complex, which is actively managed by the University of Wisconsin–Green Bay and serves as a site for long-term research on Great Lakes wetlands. Furthermore, removing two small parcels from the Peshtigo River and Lower Bay Components with little ecological or programmatic benefit to the proposed reserve removes two landholding partners (i.e., Town of Peshtigo and Village of Suamico). Consequently, Alternative B is less managerially complex than Alternative A.

4.2.4 Comparison of Alternatives

This section provides a consolidated comparison of the three alternatives described in sections 4.2.1 through 4.2.3 (table 9).

Table 9. Comparison of Boundary Alternatives.

	No Action Alternative	Alternative A	Alternative B
Area			
Total area (acres)	0	37,714	36,502
Upland/wetland area (acres)	0	10,624	11,428
Open water area (acres)	0	27,090	25,074
Selected Habitats (acres)			
Crop rotation	0	303	296
Developed, high intensity	0	7	6
Developed, low intensity	0	75	36
Emergent/wet meadow	0	2,716	2,742
Forage grassland	0	139	121
Forested	0	790	735
Forested (palustrine)	0	4,617	4,423

	No Action Alternative	Alternative A	Alternative B
Forested wetland	0	252	242
Idle grassland	0	108	105
Scrub/shrub	0	1,623	1,580
Unclassified upland/wetland	0	0	1,142
Open water	0	27,090	25,074

For more information about the habitat classification scheme leveraged by the State of Wisconsin, please reference appendix 6.

4.3 Other Alternatives Previously Considered but Eliminated

The state conducted a robust site selection process prior to its 2023 nomination. To identify potential alternatives for detailed study under the National Environmental Policy Act, NOAA reviewed public comments regarding the formal site nomination, which frequently suggested adding or removing specific areas from the proposed Green Bay Reserve, including the Oconto Complex and the Sturgeon Bay Complex. These potential alternatives were eliminated because they failed to satisfy the purpose and need for the proposed action in the following ways:

- The state's ability to demonstrate adequate control over key land and water areas to provide sufficient long-term protection for reserve resources and ensure a stable environment for research (15 C.F.R. § 921.30(a)(2))
- The suitability of these areas (i.e., types and distribution of estuarine habitats and ecosystems) for long-term research, specifically regarding their contribution to systemic typological balances and capacity for enhancing public awareness, education, and interpretation of estuarine environments (15 C.F.R. § 921.30(a)(1), (3))
- The purpose and need for the designation, specifically to create a research reserve representative of the Green Bay estuary and to expand the system with the Lakes Michigan and Huron biogeographic subregion. As detailed in section 2.2, a "representative" National Estuarine Research Reserve must address two key ecological gradients:
    - The disturbance gradient from minimally impacted habitats to recently restored areas
    - The south-to-north gradient, which captures the nutrient-rich waters of the Fox-Wolf watershed in the south to the nutrient-poor waters entering Green Bay from Lake Michigan in the north.

4.3.1 Inclusion of the Oconto Complex Within the Nominated Site

The Oconto Complex is located on the western shore of Green Bay, approximately 20 miles south of the Peshtigo Component. Encompassing approximately 1,960 acres of land and water, the complex is managed by multiple entities. Its parcels are primarily adjacent to the Oconto River mouth and the Bay of Green Bay. Specific landowners and management units within the complex include:

- Wisconsin Department of Natural Resources – Rush Point Unit (~380 acres): The department's Rush Point Unit contains various habitat types, including open water, coastal marsh, and bottomland hardwoods. Forested portions of this unit are actively managed by the department through timber sales. The Department of Natural Resources also conducts invasive species management within the property's

wetlands. This property is open to the public for birdwatching, cross-country skiing (no trails), fishing, hiking (no designated trails), hunting, trapping, and wildlife viewing (Wisconsin Department of Natural Resources n.d.p).

- Wisconsin Department of Natural Resources – Oconto Marsh Unit (~1065 acres): The department's Oconto Marsh Unit contains various habitats, including open water, emergent marsh, shrub-carr, and bottomland hardwoods. More than 200 acres of this property are impounded, and a water pump allows the department the ability to manage water levels. The impoundment helps to maintain an emergent marsh and provides habitat for wetland-dependent wildlife. Both timber- and invasive species–management activities occur at the site. This property is open to the public for birdwatching, cross-country skiing (no trails available), fishing, hiking (trails available), hunting, trapping, and wildlife viewing (Wisconsin Department of Natural Resources n.d.m).
- Northeast Wisconsin Land Trust – Oconto Preserve (~150 acres): The Oconto Preserve borders the WDNR-owned and -managed Oconto Marsh Unit. A majority of the preserve is WDNR-designated wetland. This property is open to the public for hunting, fishing, hiking, birdwatching, cross-country skiing, and researching the natural environment. In the long term, the land trust intends to leverage this preserve for promoting local land conservation, recreation, education, and increased connectivity by creating trails and working with the community and school groups (Northeast Wisconsin Land Trust n.d.).
- Oconto Sportsmen's Club – Oconto Sportsmen's Club (~310 acres): The Oconto Sportsmen's Club borders the Wisconsin Department of Natural Resources' Oconto Marsh Unit. This property is owned by a private sportsmen's club but is open to the public. The property is managed primarily for hunting, but the club also supports stewardship and educational activities, such as wild rice restoration, annual marsh burns, and an annual Youth Outdoors Day.
- Oconto County (~40 acres): Oconto County holds two unnamed land parcels within this complex. The first parcel is adjacent to the Oconto Marsh Unit and approximately 3 acres. The second parcel is adjacent to the Rush Point Unit and approximately 37 acres.
- City of Oconto (~20 acres): The City of Oconto's approximately 20-acre Breakwater Park is included in this complex. The park includes the Splinter Causeway, Oconto Harbor, and Oconto River mouth.
- U.S. Forest Service (>1 acre): The U.S. Forest Service holds less than one acre of land adjacent to the City of Oconto's Breakwater Park.

One primary issue arose when considering the addition of the Oconto Complex to the nominated reserve site. Specifically, adding nearly 2,000 acres of land and water and a fourth component to the nominated multicomponent site raised concerns regarding the University of Wisconsin–Green Bay's ability to successfully manage the reserve. In accordance with 15 CFR 921.10(b), multiple-site reserves are treated as one reserve in terms of financial assistance; regardless of size or number of components, multi-site reserves receive no funding more than the maximum allowed for any one reserve per year. As a result, increasing the number of reserve components and the total acreage of a reserve effectively reduces the level of investment (financial, staff, or otherwise) that can be dedicated to any one component, making it more challenging to administer the research, education, training, and stewardship programs outlined in the reserve's management plan. Thus, the addition of the Oconto Complex as a fourth reserve component is not included as part of this environmental impact analysis due to concerns it would not satisfy the purpose and need for the proposed action.

Substitution of the Oconto Complex in place of a proposed reserve component was also considered but ultimately raised several concerns. First, while the Oconto Complex contains high-quality habitat, holds a rich history of restoration, and supports a variety of research, education, and training opportunities, substituting it for any of the proposed reserve components means the proposed reserve site would no longer address the

two ecological gradients deemed essential by NOAA and the state of Wisconsin to ensure the site is representative of the Green Bay estuary. Therefore, substitution of the Oconto Complex would not meet the expressed purpose and need for the designation.

For example, the marshes within the proposed Peshtigo Component are considered among the highest quality remaining along the Wisconsin shoreline of Lake Michigan, and per the site nomination document, these marshes are considered among the least impacted by human influence. Alternatively, the Oconto Complex, along with the South Shore and Sturgeon Bay Complexes, has significant existing or historical anthropogenic disturbance. Consequently, replacing the Peshtigo Component with the Oconto Complex would omit habitats characterized by minimal human disturbance.

Furthermore, substituting the Oconto Complex for the Lower Bay and Sturgeon Bay Components would fail to capture the Green Bay estuary's unique nutrient gradient and circulation pattern. These waters enter north of Door County, flow south along the western shore of Green Bay, and then circulate north along the eastern shore in a counter-clockwise pattern. Replacing the Lower Bay Component with the Oconto Complex excludes in-water and aquatic habitats heavily influenced by the addition of nutrient-rich waters from the Fox-Wolf watershed at the southernmost end of the estuary. Similarly, replacing the Sturgeon Bay Component with the Oconto Complex provides a less accurate representation of the eastern shore's water circulation.

Lastly, the habitat types and opportunities for research, public access, education, training, and stewardship at the Oconto Complex do not meaningfully differ from other analyzed properties that offer the same or similar attributes. As a result, the Oconto Complex substitution is excluded from this environmental impact analysis.

4.3.2 Removal of the Sturgeon Bay Component from the Nominated Site

The Sturgeon Bay Complex is located on the eastern shore of Green Bay approximately 34 miles north of Point au Sable (the northernmost point within the Lower Bay Component) and at the midpoint of the Door Peninsula. The Sturgeon Bay Component includes 908 acres of land and water managed by various entities. Parcels included in this complex are generally adjacent to Sturgeon Bay or the human-made Sturgeon Bay Ship Canal, which connects the Bay of Green Bay to Lake Michigan. Section 4.2.1 describes the landownership, acreage, and characteristics of the Sturgeon Bay Component.

Two issues arose when considering the removal of the Sturgeon Bay Component from the proposed reserve. First, its inclusion allows the proposed reserve to better engage permanent residents and tourists in Door County through targeted programming. It also ensures that the unique habitats, geology, and shorter estuarine systems found along the eastern shore of Green Bay are represented and protected. Therefore, removal of the Sturgeon Bay Component offers fewer benefits to both the human and natural environment compared to the nominated site.

Second, as previously discussed, removing the Sturgeon Bay Component would prevent the reserve from capturing the circulation of water and nutrients moving north along the Bay of Green Bay's eastern shore. Capturing the complete gradient of nutrients is essential for the proposed site to be representative of the Green Bay estuary. Therefore, removing the Sturgeon Bay Component without a replacement would result in a site that fails to meet the purpose and need for the designation.

4.4 NEPA EIS Public Engagement Efforts

This Draft Environmental Impact Statement provides information to decision-makers and the interested public about the potential impacts associated with designation of the proposed Green Bay Reserve under federal authorities. To better understand the concerns of interested parties regarding the Green Bay Reserve designation, significant effort was made to include broad and diverse public and private participation throughout the NEPA process. Groups and individuals have had opportunities to provide input since the site designation process began. This approach was designed to foster a sense of ownership in the process and the future of the proposed Green Bay Reserve. Reserve System regulations require at least one public scoping meeting, with notice published in the *Federal Register* at least 15 days prior to the meeting (15 C.F.R. § 921.13(c)). Accordingly, a virtual public scoping meeting was held on March 19, 2024, at 10 a.m. Central time, and an in-person public scoping meeting was held on March 19, 2024, at 1:30 p.m. Central time. The public received notice of these meetings in the *Federal Register* on January 25, 2024 (89 FR 4916), 54 days in advance, and through an advertisement in the *Door County Daily News* on March 15, 2024.

During scoping, the public questioned the purpose of a research reserve and its implications for adjacent private landowners. Participants also raised environmental concerns impacting the Green Bay estuary and suggested topics for the draft management plan, such as climate change, invasive species, and future land acquisitions. Finally, the public offered suggestions for a future visitor center location; however, the impacts of a future visitor center are outside of the scope of this report.

5 Affected Environment

This chapter describes the resources and uses within the study area that may be affected by the designation and implementation of the proposed Green Bay National Estuarine Research Reserve, as detailed in chapter 4. This information provides the foundation for NOAA's evaluation of potential environmental impacts across the range of alternatives presented in chapter 6.

The scope of the affected environment includes

- the natural environment, comprising
  - the physical environment (e.g., weather and climate, water quality, hydrology) and
  - the biological environment (e.g., riparian and freshwater habitats, estuarine habitats, living resources, protected species), as well as
- the human environment, comprising
  - prehistoric, historic, and cultural resources;
  - the current socioeconomic setting; and
  - current human uses.

5.1 Natural Environment

Green Bay is approximately 120 miles long, with its main axis oriented roughly 30 degrees northeast, following the western bluffs of the Niagara Escarpment along its eastern shore. The Bay extends from the Big and Little Bays de Noc in Michigan's Upper Peninsula south to the mouth of the Fox River. It is separated from the main body of Lake Michigan by the Garden Peninsula of Upper Michigan and the Door Peninsula in Wisconsin. Between these peninsulas are the Grand Traverse Islands, a linear archipelago of dolomite islands. Deep preglacial river channels separate these islands, facilitating a complex array of surface and deepwater currents between Lake Michigan and the mouth of the Bay of Green Bay. A 1.3-mile (2.1 km) ship canal, constructed in the late nineteenth century (1870s–1880s) through the isthmus that divides Sturgeon Bay and Lake Michigan, provides another avenue of water exchange between the Bay of Green Bay and Lake Michigan (Door County Pulse 2015).

The open waters of the Bay range from 10 to 20 miles in width, widening slightly to the north and covering 1,626 square miles. While Green Bay represents only 7 percent of Lake Michigan's surface area and 1.4 percent of its volume, it encompasses 33 percent of the watershed and receives 33 percent of the basin's total nutrient load (National Oceanic and Atmospheric Administration n.d.b). The project area covers the southern Wisconsin waters and shorelines, spanning five Wisconsin counties: Brown, Door, Kewaunee, Marinette, and Oconto.

5.1.1 Physical Environment

5.1.1.1 Weather and Climate

Weather describes short-term (day-to-day) atmospheric states and its variation between minutes and weeks, while climate refers to long-term regional trends. The Bay of Green Bay features a humid continental climate with distinct summer and winter seasons and transitional periods in spring and fall. Summers are warm and rainy, while winters are cold and snowy. Under the Köppen-Geiger climate classification system, the region is classified as having a cold climate with a humid continental mild summer and no dry season (Peel, Finlayson, and McMahon 2007; Beck et al. 2018). Humid summers in July and August typically have daytime high temperatures between 77°F and 81°F and average nighttime low temperatures around 58°F. The cold season, spanning from early December to early March, has an average daily high temperature below 40°F (GLISA n.d.b; GLISA n.d.c).

Due to localized moderating effects of Lake Michigan's thermal mass on nearshore land, the Sturgeon Bay area infrequently reaches the temperature extremes found in other areas of the Bay of Green Bay.

Lake Michigan's temperature-moderating effects result in both slightly lower average highs in summer and higher average lows in winter relative to the regional climate (table 10). As a result, the temperatures in Sturgeon Bay, and Door County more generally, rarely fall below -4°F in the winter or rise above 86°F in the summer.

Table 10. Recent Climate Data for the City of Green Bay and the Sturgeon Bay Area of Door County.

Recent Climate Summary 1991–2020		
	Sturgeon Bay	**Green Bay**
Average temperature	44.7°F	45.6°F
Average low temperature	36.3°F	36.2°F
Average high temperature	53.1°F	55.0°F
Days per year above 90°F	1.7	3.8
Days per year below 32°F	143.2	143.7
Lowest annual average temperature	40.6°F	42.1°F
Highest annual average temperature	48.8°F	49.4°F
Average annual precipitation	32.7 in	31.6 in
Lowest annual precipitation	25.3 in	24.8 in
Highest annual precipitation	50.1 in	48.6 in
Days per year that exceed 1.25" of precipitation	3.5	3.6

Regionally, rain falls consistently through the spring, summer, and fall, with an average 5 to 9 days of rainfall each month. The months of April through June have more rainy days than the rest of the year. Most of the area's annual precipitation falls in the form of rain with average annual rainfall of approximately 30 inches.

According to Beck et al. (2018), the Bay of Green Bay climate is expected to shift from a cold winter–warm summer climate with no dry season to a cold winter–hot summer climate with no dry season. For example, in a reduced greenhouse gas emissions scenario, Green Bay's climate in 2080 will feel most like the current climate of Toledo, Ohio, which is 4.2°C (7.6°F) warmer and 63 percent wetter in the winter than current-day Green Bay. Under a no-change emissions scenario, Green Bay's climate in 2080 will feel most like the current climate of Shiloh, Ohio, in which the typical winter temperature is 6.1°C (43°F), 6.2°C (11.2°F) warmer and 94.2 percent wetter in the winter than current-day Green Bay (University of Maryland Center for Environmental Science n.d.).

According to the Great Lakes Integrated Sciences and Assessments' (GLISA) Great Lakes Climate Adaptation Partnerships team, climate change is anticipated to have the following impacts on the Great Lakes region (n.d.a):

- Air and water temperatures are expected to increase, leading to higher rates of evapotranspiration.
- Total annual precipitation is expected to increase, with variable seasonal impacts.
- Storms are expected to increase in frequency and intensity.

- Great Lakes water levels will continue to fluctuate between periods of high water and periods of lower water, but variability is expected to increase.
- Winter precipitation is expected to increasingly fall as rain.
- Great Lakes ice cover is expected to decrease, leading to increased lake-effect precipitation and winter wave activity.

Models project Wisconsin will receive slightly more precipitation in more frequent and intense rainfall events, especially in early spring (Wisconsin Initiative on Climate Change Impacts 2011). Climate models also predict winter precipitation over most of Wisconsin to increase by approximately 10 percent by the middle of the century (WICCI n.d.b). When rain falls on frozen ground, the manure spread on fields and salt spread on roads is readily transported into waterways and wetlands, causing harm to wetland plants and worsening water quality (WICCI n.d.a). In addition, the combination of warmer and wetter winters, with longer and more frequent freeze-thaw periods and lack of winter ice cover, and more frequent and intense precipitation events in summer and fall may result in increased coastal erosion (Wittman 2008).

High-pressure and low-pressure weather systems generally move across the Bay of Green Bay from west to east, with wind direction and strength dependent on the location, speed, and intensity of the weather system. Research into wind direction and speed over the Great Lakes indicates a shift in both summer wind direction (Waples and Klump 2002) and intensity (Jabbari et al. 2021) over recent decades. Wind direction and wind-induced wave power affect both water movement (e.g., seiche events) and nearshore stability in the shallow estuarine systems of the Bay. Waples and Klump (2002) suggest that the shifting average wind field over Green Bay may result in a decreased inflow of cold hypoxic Lake Michigan water through the northern mouth of Green Bay, leading to warmer waters and increased benthic microbial metabolism in the Bay.

Increased evapotranspiration during growing seasons could lead to drying of soils and lower groundwater recharge amounts and durations. Species composition changes, both from native species migrations into and out of the area along with immigration and establishment of new non-native invasive species that benefit from warming temperatures and a longer growing season, may also occur (WICCI n.d.a). Based on regional and Great Lakes–specific climate change assessments (Wisconsin Initiative on Climate Change Impacts 2021; Hall, Stuntz, and Abrams 2008; Kling et al. 2003; Wittman 2008), species shifts are expected to occur in both the watershed of the Bay of Green Bay and the coastal wetland and estuarine systems. Future forests of the area and surrounding lands are expected to see declines in currently dominant species, including northern white cedar, paper birch, quaking aspen, and sugar maple. Conversely, species forecasted to increase or migrate into northeast Wisconsin forests include black oak, swamp white oak, white oak, shagbark hickory, and black cherry. In Green Bay, cool-water fish species like northern pike, yellow perch, and walleye are expected to decline, while fish species adapted to warm-water conditions, such as bluegill, largemouth bass, white bass, and smallmouth bass, are projected to increase.

5.1.1.2 Water (Hydrosphere)

Green Bay is a shallow, semi-enclosed basin with a mean depth of 16 meters (52 ft), situated parallel to the deeper and much larger basin of Lake Michigan. Spanning approximately 193 kilometers (120 mi) in length with a mean width of 22 kilometers (14 mi), the Bay covers a surface area of 1,640 square miles (Mortimer 1978). From the mouth of the Fox River, the head of Green Bay deepens regularly past a line extending from Sturgeon Bay to the mouth of the Peshtigo River (fig. 10).

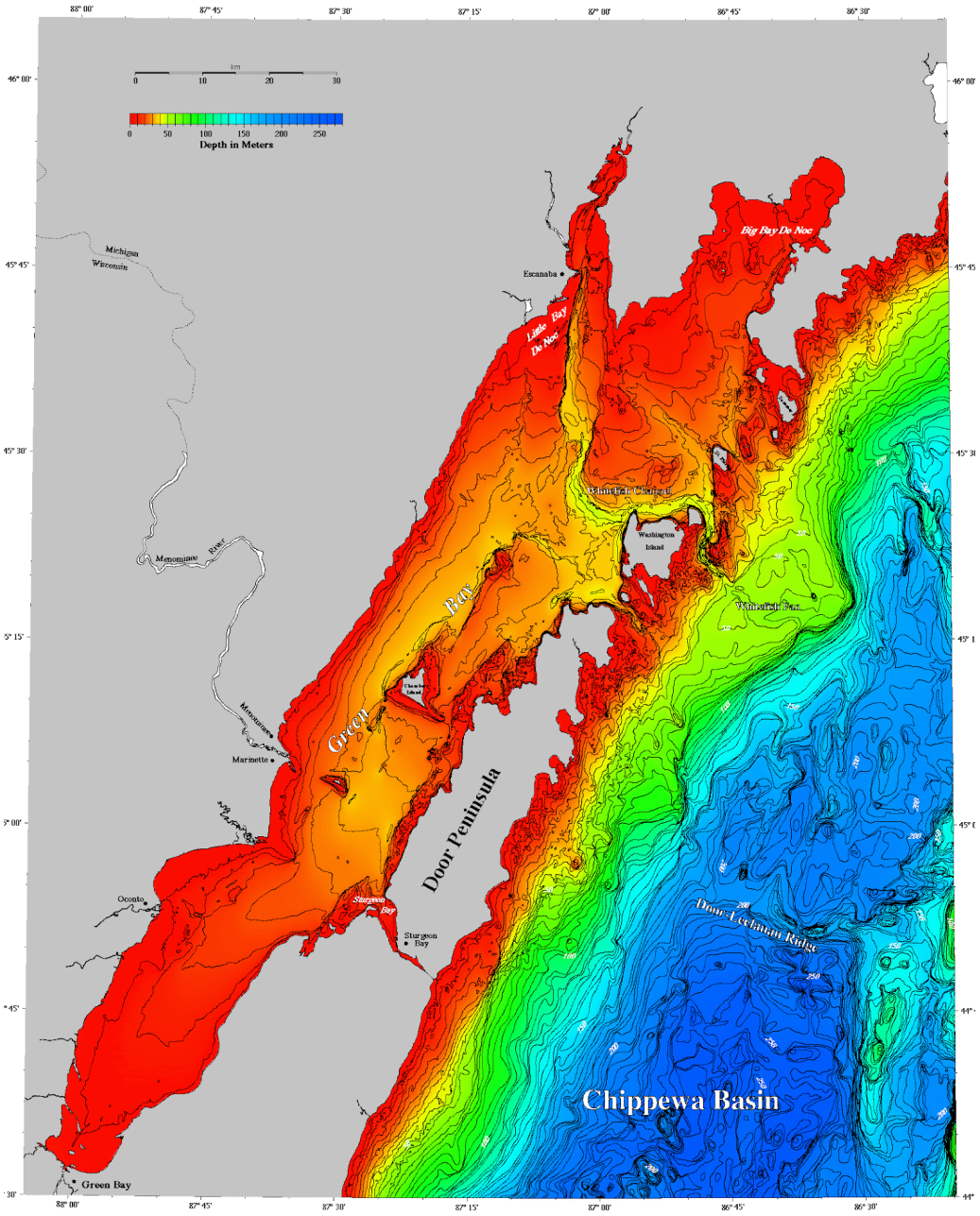


Figure 10. Bathymetric map of Green Bay (*National Geophysical Data Center 1996*).

There is evidence of significant postglacial coastal sediment transport and deposition processes, particularly in the Lower Bay. The Lower Bay's complex and often ephemeral sediment transport and depositional processes are evidenced by various landforms, including depositional points, islands, and shoals. Examples include Long Tail and Little Tail Points, Point au Sable, Frying Pan Shoal, and the transitory Cat Island Chain within the Duck Creek Delta.

5.1.1.2.1 Water Quality

Water quality varies in the Bay of Green Bay, generally improving northward through the Bay. Water quality in the proposed Lower Bay Component of the Green Bay Reserve is primarily dependent on that in the Fox River, which discharges into the southern end of Green Bay and, to a lesser degree, the smaller tributaries that enter the Bay adjacent to this component. Lower Green Bay is impaired by excessive phosphorus and sediment loading from the Fox River, which contributes to nuisance algae growth, areas of severe oxygen depletion in lower Green Bay, reduced water clarity and submerged aquatic vegetation, and generally degraded fish and wildlife habitat. Lower Green Bay is also under a fish consumption advisory notice for multiple species due to an excessive polychlorinated biphenyl (PCB) pollutant load (Wisconsin Department of Natural Resources n.d.e).

The smaller tributaries emptying into Green Bay's southwest shore, including those of Duck Creek, the Suamico River, the Pensaukee River, and the Little Suamico River, are also considered impaired due to excessive sediment and nutrient loading (i.e., phosphorus loading). The water quality of these tributaries is driven by land cover, land use, regional precipitation, soils, and the geomorphology of the stream network.

The lower estuarine portion of the Peshtigo River was added to the impaired waters list in 1998 due to excessive mercury in its fish tissue and sediment. Samples evaluated in 2014, 2020, and 2022 for phosphorus, chloride, macroinvertebrates, and temperature indicated no impairment. The Wisconsin Department of Natural Resources has placed a fish consumption advisory notice on the estuarine area of the Peshtigo River due to excessive loads of PCB and perfluoroalkyl (PFOS) pollutants (Wisconsin Department of Natural Resources n.d.e).

Big Creek and Strawberry Creek, the estuarine systems located within the proposed Sturgeon Bay Component, are not on the impaired waters list; however, a fish consumption advisory is in place due to pollutants (i.e., mercury and PCB) found in Sturgeon Bay waters (Wisconsin Department of Natural Resources n.d.e).

All major tributaries to Green Bay located within Green Bay Reserve boundaries are listed on the Clean Water Act 303(d) impaired waters list by the U.S. Environmental Protection Agency and Wisconsin Department of Natural Resources. This official list identifies waters failing to meet water quality standards, primarily due to point sources, nonpoint sources, and resuspension from contaminated sediments (Wisconsin Department of Natural Resources n.d.a). As required by Sections 303(d) and 305(b) of the Clean Water Act, the Wisconsin Department of Natural Resources must publish a list of all waters not meeting water quality standards, as well as an overall report on the status of surface water quality in all state waters. The state publishes three lists: impaired waters, waters in restoration, and waters attaining standards (*see* Wisconsin Department of Natural Resources n.d.s. for the current list).

5.1.1.2.2 Bay of Green Bay Areas of Concern

In the late 1980s, Lower Green Bay and the Fox River below the De Pere Dam were listed as one of 43 Great Lakes areas of concern by the International Joint Commission of Canada and the United States (fig. 11).



Figure 11. U.S. Great Lakes areas of concern (U.S. Environmental Protection Agency 2026).

Figure 12 displays the Lower Green Bay and Fox River area of concern, extending from the Lower Bay at Longtail Point and Point au Sable to the Fox River below the De Pere Dam (Wisconsin Department of Natural Resources n.d.j). During the 1950s and 1960s, local paper mills routinely used PCBs in their operations, ultimately contaminating the river. Pollution significantly altered the physical, chemical, and biotic components of the aquatic environment in the southern portion of Green Bay (Wisconsin Department of Natural Resources n.d.n). As discussed in section 5.2.3.9, agricultural runoff also contributes to historical and current water quality issues within the Lower Green Bay and Fox River area of concern.

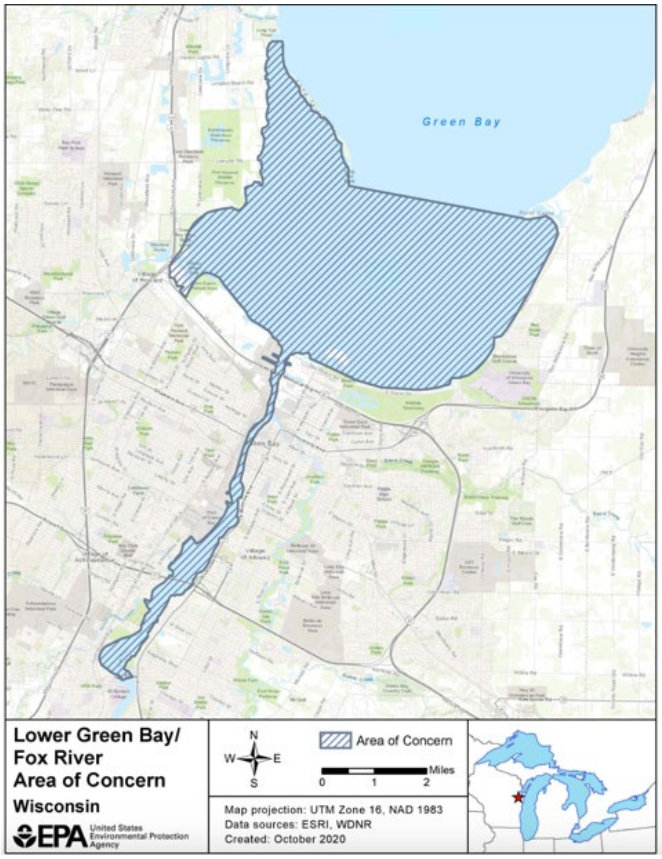


Figure 12. Map of the Lower Green Bay and Fox River area of concern (U.S. Environmental Protection Agency 2020a).

Fourteen beneficial use impairments (BUIs) were identified that impact water use in the area of concern. These impairments relate to water quality and environmental issues affecting humans, fish, and wildlife, such as contaminated sediment, poor water quality, and habitat loss or alteration. Thirteen of these beneficial use impairments—11 present and 2 suspected—were originally assigned to the Lower Fox River and Lower Green Bay area of concern (Wisconsin Department of Natural Resources n.d.j). Specifically, these beneficial use impairments include:

1. Restrictions on fish and wildlife consumption
2. Eutrophication or undesirable algae
3. Restrictions on drinking water or taste and odor problems
4. Beach closings
5. Degradation of fish and wildlife populations
6. Fish tumors or other deformities (suspected)
7. Bird or animal deformities or reproductive problems
8. Degradation of benthos
9. Degradation of phytoplankton and zooplankton populations
10. Loss of fish and wildlife habitat

Three beneficial use impairments were removed after meeting monitoring criteria:

1. Tainting of fish and wildlife flavor (removed in April 2020)
2. Restrictions on dredging activities (removed in September 2021)
3. Degradation of aesthetics (removed in April 2022)

Work on removing the remaining beneficial use impairments continues through the joint efforts of multiple federal, state, and county agencies, as well as nonprofit conservation organizations, under guidance from the Wisconsin Department of Natural Resources. The department works with community stakeholders to implement the recommendations provided by periodically updated "Remedial Action Plans," which incorporate data, research, and actions focused on removal of specific beneficial use impairments (Wisconsin Department of Natural Resources n.d.j). These action plans provide updated goals and recommendations and define long-term priorities. For additional information about the Lower Green Bay and Fox River area of concern, along with current and historical remedial action plan documents, see *https://dnr.wisconsin.gov/topic/GreatLakes/GreenBay.html*.

The Bay of Green Bay also hosts a separate delisted Great Lakes area of concern. The Lower Menominee River area of concern was located near the proposed Peshtigo Component of the Green Bay Reserve (fig. 13). The river forms the boundary between the northeast corner of Wisconsin and the southern tip of Michigan's Upper Peninsula and flows east into Green Bay. While the major cause of the river's pollution was arsenic from Tyco Fire Products LP in the turning basin and in polluted sediment along the right bank, other major pollution sources include a manufactured gas plant, chemical and ship building companies, two paper mills, two municipal wastewater treatment plants, a foundry, and stormwater runoff from storage piles of salt, coal and other materials. The Lower Menominee River area of concern was listed in 1987 and was officially delisted in 2020 (U.S. Environmental Protection Agency 2025).



Figure 13. Map of delisted Lower Menominee River area of concern (U.S. Environmental Protection Agency 2020b).

5.1.1.2.3. Specific Pollutants Impairing Green Bay and Its Contributing Waters

Pollutants entering the Fox River and Green Bay include industrial toxins, municipal wastewater discharge, and nonpoint source loadings primarily from agricultural land use within the watershed (fig.14; The Cadmus Group, Inc. 2012). Notably, 57 percent of the total phosphorus and 42 percent of the total suspended solids loading originate from Lake Winnebago, a large shallow lake that empties into the Lower Fox River (Wisconsin Department of Natural Resources n.d.q). Specific pollutants of high concern for this system include PCBs (polychlorinated biphenyls), PFAS and PFOS (per- and polyfluoroalkyl substances), mercury, and phosphorus.

Polychlorinated Biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are colorless and odorless chemicals widely used in electrical equipment and various commercial applications (U.S. Environmental Protection Agency 2026b). In the industrial corridor of the Lower Fox River, PCBs were used by paper mills in the production and recycling of “carbonless copy paper” (Wisconsin Department of Natural Resources n.d.n). In the 1950s and 1960s, paper companies discharged an estimated 700,000 pounds of PCBs into the Fox River (U.S. Environmental Protection Agency 2026a). Over time this material settled into the river sediments and slowly and steadily moved downstream to Green Bay. Highly stable and slow to degrade, PCBs persist in the environment and bioconcentrate over time. By adsorbing to waterborne sediment particles, they have accumulated in high concentrations within the Fox River and Lower Green Bay (Wisconsin Department of Natural Resources n.d.n).

The effort to physically remove contaminated sediment in the Lower Fox River began in 2004 and was one of the largest remediation projects of its kind worldwide. Final sediment removal and capping activities were completed in 2020, and in January of 2023, the Wisconsin Department of Natural Resources announced the removal of PCBs from the Lower Fox River. The U.S. Environmental Protection Agency reviewed and later certified the project complete. PCBs were dredged from the Fox River and lower Green Bay for 17 years. Cleanup efforts ultimately removed 6.5 million cubic yards of sediment from a 39-mile stretch of the Fox River at a cost of $1 billion (Wisconsin Department of Natural Resources 2020a; Kaeding 2020).

Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) refer to a large class of chemicals produced since the 1950s that are found in a wide range of consumer products and industrial applications, including firefighting foam, carpeting, coated paper, chrome metal plating, nonstick cookware, dental floss, and various food packaging (National Institute of Environmental Health Sciences n.d.; U.S. Environmental Protection Agency 2026d). The U.S. Environmental Protection Agency lists over 10,000 unique PFAS compounds in its CompTox Chemical Library (U.S. Environmental Protection Agency n.d.a). At least 1,462 PFAS compounds of those listed were regulated by the Toxic Substances Control Act as of February 2023 (U.S. Environmental Protection Agency 2026e). One of the most common types of PFAS is perfluorooctane sulfonate (PFOS).

Due to their extreme environmental persistence and widespread use in various products and applications, PFAS are now detected in environments and organisms worldwide. These compounds have a high potential for bioaccumulation, biomagnification, and toxicity. Humans can be exposed to PFAS through various mechanisms, including but not limited to drinking contaminated water, consuming PFAS-containing foods such as fish, and using products made with or packaged in materials containing PFAS (U.S. Environmental Protection Agency 2026d).

Mercury

While mercury (Hg) is a naturally occurring element, the high contamination levels found near Green Bay are a result of both natural and anthropogenic sources (Achman, Hornbuckle, and Eisenreich 1993). Anthropogenic sources include point sources, such as combustion and manufacturing industries, in addition to landfills, mine waste, and sewage sludge (U.S. Environmental Protection Agency 1997). Industrialization, specifically paper mills, has substantially impaired the health of the Fox River and Bay of Green Bay, resulting in high levels of mercury contamination.

A Green Bay and Fox River mass balance study determined the extent of HgT (total mercury) contamination (Gurtner-Zimmermann 1996) for 11 tributaries in Lake Michigan. The study determined that the Fox River estuary exhibited the highest mean HgT concentrations in water, at 27.9 $ng \cdot L^{-1}$ compared to the 1.05–10.3 $ng \cdot L^{-1}$ found in the other tributaries (Hurley et al. 1998). Sediment tested near the De Pere Dam had a HgT concentration as high as 7.400 $mg \cdot kg^{-1}$ (Hurley et al. 1998). Other studies by Hurley et al. (1996) found that water-column total mercury increased progressively downstream in the Fox River, mirroring trends in sediment HgT levels. The study concluded that resuspended HgT-laden sediment is the predominant source of mercury from the Fox River into Green Bay.

Phosphorus

Phosphorus loading to the Fox River watershed, and subsequently into Green Bay, is the primary contributor to poor water quality in Lower Green Bay. Sources of phosphorus include agricultural runoff, industrial and municipal waste water treatment facilities, urban regulated and nonregulated sources, construction sites, and natural background sources (fig.14; The Cadmus Group, Inc. 2012).

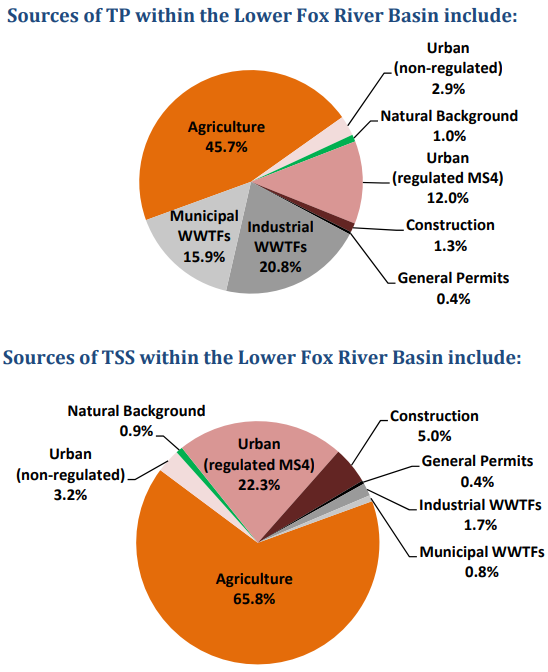


Figure 14. Sources of Total Phosphorus (TP) and Total Suspended Solids (TSS) within the Lower Fox River Basin.

Heavy loading from the Fox River creates a longitudinal gradient of discharged pollutants along the Bay's axis, influenced by internal circulation patterns (i.e., pollutant concentrations are higher in the Lower Bay and decrease with distance from the Fox River mouth). These water quality gradients are steepest within 15 miles of the river mouth (Yurista et al. 2015a). Nutrient pollutants and the resultant chlorophyll gradients have persisted

since initial monitoring decades ago, serving as a principal justification for designating the Lower Fox River and Green Bay as a Great Lakes area of concern.

A primary water quality concern resulting from the high levels of phosphorus entering the Bay is the annual development of hypoxic (low oxygen) conditions in late summer driven by nutrient loading—primarily phosphorus—from the Fox River. These episodic and spatially variable events can impact the assemblage of benthic organisms and Lower Bay fish. Thermal stratification in Green Bay, which facilitates the zonal development of these conditions, is a consequence of both direct and indirect atmospheric forcing. Extended periods of stable, low wind velocities, high air temperatures, and increased solar radiation directly drive hypoxia in the Lower Bay. Hypoxic conditions are also indirectly affected by atmospheric forcing that drives circulation patterns in the Bay; specifically, southerly flows of cooler bottom waters with lower oxygen levels from Lake Michigan move down the west side of the Bay, delivering low-oxygen water over sediments enriched with oxygen-demanding organic matter. A two-layer circulation regime—warm southern Bay water overlying cooler Lake Michigan bottom flows—can re-stratify a well-mixed water column within hours, causing broad areas of rapid oxygen depletion in the lower and generally eastern portions of the Bay. Figure 15 provides an example of a hypoxic event occurring in July 2010 (Klump et al. 2018).

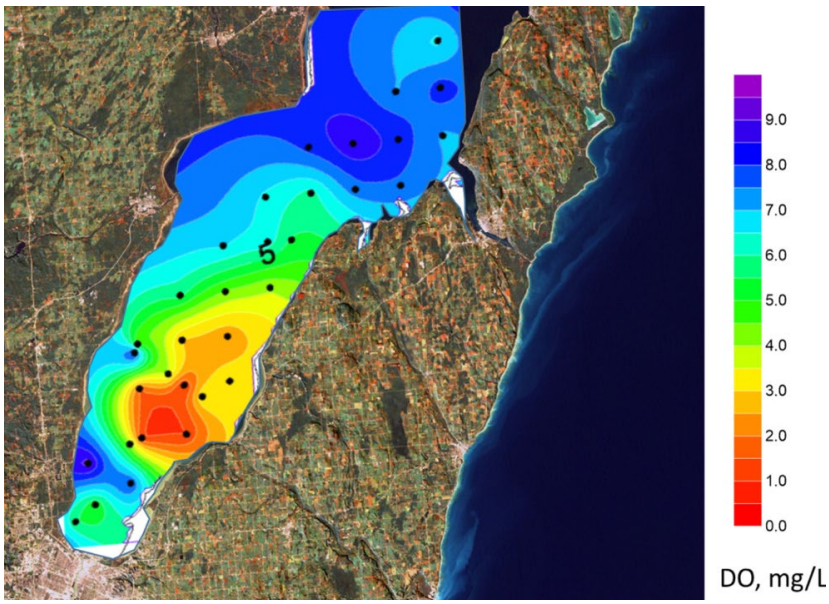


Figure 15. Summertime (July 2010) hypoxic conditions in lower Green Bay.

5.1.1.1.4 Structure and Dynamics of Green Bay Hydrology

5.1.1.1.4.1 Water Level Patterns

The Bay of Green Bay, its coastal wetlands, and the component areas of the proposed Green Bay Reserve are subject to multiyear, annual, seasonal, and daily water level fluctuations driven by the interacting dynamics of Lake Michigan and Green Bay (fig. 16). Multiyear fluctuations result from slow, irregularly persistent climatic shifts in precipitation (rain and snow) and temperature, which influence the extent of ice cover and winter evaporation. Yearly fluctuations are driven by regional precipitation patterns and seasonal temperature changes. Snowmelt typically causes water levels to rise by early to mid-summer, while seasonally drier conditions lead to a gradual decline, reaching annual lows in mid- to late winter.

Daily fluctuations are driven by persistent wind patterns creating seiche events (International Joint Commission n.d.). Given the shallow, gradually sloping bottom of the Bay at its southern end, even a minor drop in water levels can expose large nearshore mud flats. While critical to the processes that drive the biotic assemblage in the Lower Bay, large seiche events also affect the coastal communities of the Bay. For example, a strong, persistent northeasterly wind in April 1973 resulted in a storm surge that pushed about 1.2 meters (4 ft) of water into downtown Green Bay (U.S. Climate Resilience Toolkit 2018).

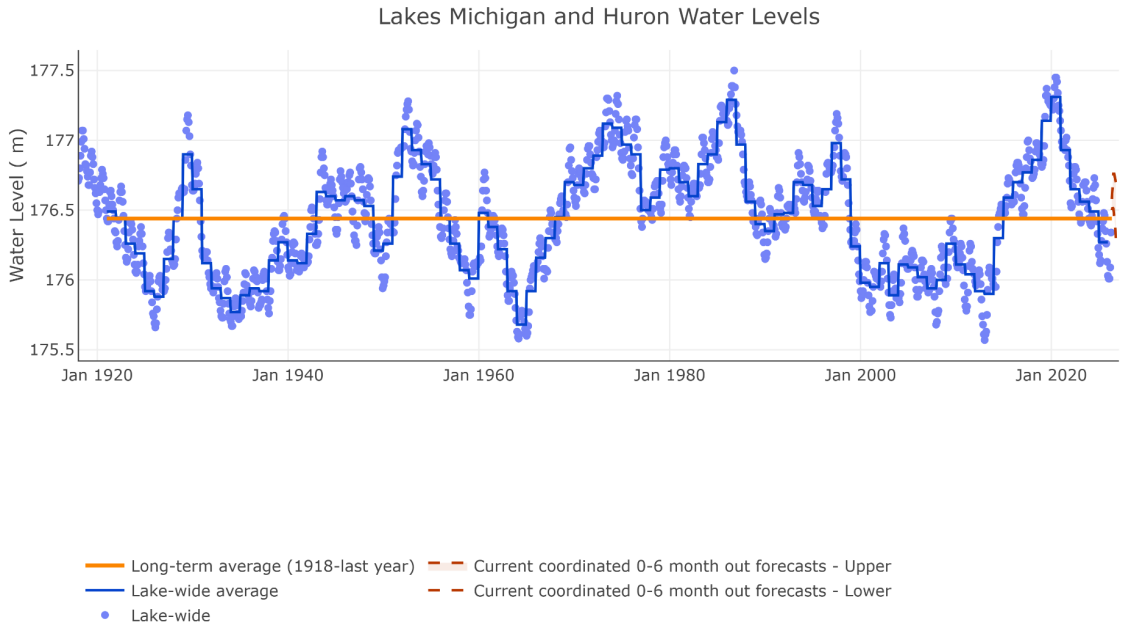


Figure 16. Lakes-wide annual average (1918–present) for the Lake Michigan–Lake Huron basin, showing decadal and annual variability (National Oceanic and Atmospheric Administration n.d.c).

5.1.1.1.4.2 Water Circulation Patterns

The Green Bay estuary receives cold, deepwater currents originating from the depths of the Lake Michigan basin via the channels through the Grand Traverse Island chain at the tip of the Door Peninsula; these currents are the dominant controlling water interchange between the Bay and Lake Michigan. While there are many tributary inputs to the Green Bay Estuary, the Fox River at the Bay's head is the largest and most significant.

Upon entering the Bay, those cold, deepwater currents flow down the Bay's western coastline, eventually mixing with the Bay's warmer waters. Upon meeting the river flows issued from the mouth of the Fox River, these currents push the river outflow up the eastern side of the Bay (Lathrop Jr., Castle, and Lillesand 1990). Driven by this counterclockwise flow through the lower end of the Bay, water continues to mix along the eastern shoreline, reaching the middle portions of the Bay near Sturgeon Bay.

Nutrient and sediment loading from the Fox-Wolf watershed into the mouth of the Fox River establishes the conditions for a north-south water quality gradient throughout the Lower Bay. Despite natural rapid flushing and conservation efforts, nutrient and chlorophyll gradients have persisted since they were first documented decades ago. The gradients are steepest within the 25 kilometers closest to the Fox River mouth and decrease with distance toward Lake Michigan (Yurista et al. 2015b).

Beyond tributary inputs and major deepwater currents that drive horizontal flow patterns through the Lower Bay, internal vertical water movements influenced by temperature and wind patterns diversify the flow and deposition of nutrient, carbon, and suspended solids. Seasonal stratification of the Lower Bay and significant resuspension rates for suspended solids drive substantial recharging of the epilimnion particle pool by either horizontal transport (e.g., tributary input) or local resuspension. Epilimnion recharging occurs year-round: flux between the upper and lower depths of the Bay is generally high prior to stratification, declines during the summer, and rises again with the fall turnover (Eadie, Bell, and Hawley 1991).

5.1.1.1.4.3 Green Bay Tributaries

The tributary network within the project area is highly variable in its geomorphology, chemistry, biology, adjoining land use and cover, and degree of human impact. Northern tributaries, such as the Menominee, Peshtigo, and Oconto Rivers, drain watersheds with a higher percentage of forest cover and less agricultural land compared to southern tributaries like the Lower Fox River, East River, and Duck Creek. Approximately two-thirds of the entire Bay of Green Bay watershed is in Wisconsin and covers all or portions of six Wisconsin ecological landscapes: Northeast Sands, Northern Lake Michigan Coastal, Southeast Glacial Plains, North Central Forest, Forest Transition, and Central Sand Plain (Wisconsin Department of Natural Resources n.d.d).

The Fox, Menominee, Oconto, and Peshtigo Rivers are the most functionally important rivers within the Bay of Green Bay because of their length, drainage area, and discharge volume. The Fox River, which enters the Bay of Green Bay at its southern end, drains the largest portion of the watershed—covering 6,349 square miles—and has the largest discharge (Wisconsin Department of Natural Resources n.d.h). In 2025, the average discharge rate was 5405.46 cubic feet per second (U.S. Geological Survey n.d.). The Fox-Wolf watershed is the primary contributor of sediment, nutrients, and various pollutants to the Bay. Approximately 50 percent of the phosphorus and total suspended solids loading originates from the Lower Fox River subbasin, which drains the Fox Valley urban corridor and the heavily agricultural landscape between Lake Winnebago and the river mouth (The Cadmus Group, Inc. 2012).

Nine HUC-10 (10-digit hydrologic unit code) watersheds—midsized local units within a national system—drain the immediate coastal landscape of the project area and share the Green Bay shoreline. These watersheds and their surface areas are listed below.

1. Door Peninsula–Frontal Lake Michigan: 286.8 mi^2
2. Red River–Frontal Green Bay: 145 mi^2
3. Fox River–Frontal Green Bay: 166 mi^2
4. Duck Creek–Frontal Green Bay: 165.5 mi^2
5. Suamico River–Frontal Green Bay: 159 mi^2
6. Pensaukee River–Frontal Green Bay: 173.7 mi^2
7. Oconto River: 177.6 mi^2
8. Lower Peshtigo River–Frontal Lake Michigan: 208.7 mi^2
9. Menominee River: 389.2 mi^2

Stream types throughout the Bay of Green Bay watershed range from cold, high-gradient trout streams in the northern and western headwaters to warm, low-gradient rivers and streams in the south. These tributaries, fed by surface and groundwater flows, support a hydrologic system rich in diverse wetland types and lakes. The network's wetland diversity includes headwater lakes, riparian and floodplain forests and wetlands, and deltaic marsh complexes.

5.1.1.1.4.4 Inland Open Waters and Wetlands

The project area contains a diversity of wetlands and open water features ranging from small ephemeral ponds and intermittent streams to open waters and extensive coastal wetlands. The vast majority of inland wetlands found within the proposed reserve and its alternatives are concentrated on the gradually sloping glacial till plain underlying the western shore of the Bay of Green Bay. The eastern shore is characterized by a rapid elevation rise along the rocky western face of the Niagara Escarpment, which precludes extensive wetland development. The generally thin, well-drained soils of the escarpment plateau also typically discourage wetland formation; exceptions include the headwaters of Wequiock Creek and the Red River.

Both the coastal and inland wetlands within the project area have significantly declined compared to historical conditions. Land office surveys conducted from 1834 to 1844 estimated that coastal wetlands along Green Bay's western shore covered approximately 86 square miles. By the 1970s, this area was reduced to 24 square miles during low-water periods and 17 square miles during high-water periods (Bosley 1978). Agricultural ditching and draining distant from population centers and industrial- and commercial-development filling near cities usually drove these losses (Miller et al. 2017).

Figure 17 illustrates the typical pattern of wetland distribution along Green Bay's western shore of Green Bay in the HUC-12 Duck-Pensaukee Basin. This map compares the historical (i.e., pre-colonization) extent of wetlands in the watershed—based on 1830s land office surveys—in pink, with current wetlands in green and "potentially restorable" wetlands in red (Miller et al. 2017). A comparison of historical and current extents indicates approximately 38 percent of the wetlands have been lost. Non-restorable wetlands have been converted (e.g., filling for commercial or industrial use) where restoration was not deemed practical. This watershed exhibits a typical distribution of wetlands and wetland loss along the Bay of Green Bay's western shore: existing wetlands are concentrated near the shore, while inland areas show greater losses.

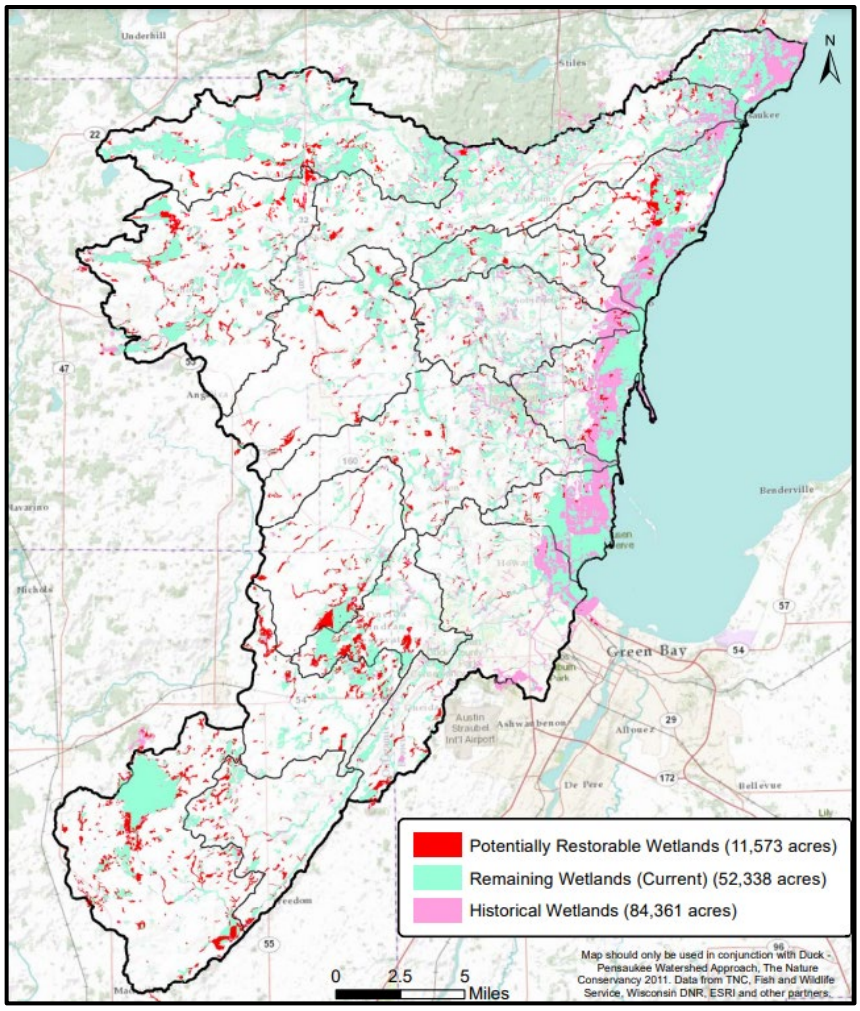


Figure 17. Historical, remaining, and potentially restorable wetlands of the Duck-Pensaukee watershed.

5.1.1.1.4.5 Groundwater

The term *groundwater* here refers to water contained in bedrock, such as the bedded horizontal dolostone on the Door Peninsula or glacial till deposits along the Bay's western shore. Groundwater generally follows the topographic relief of the landscape.

Given the differences in bedrock and surficial soils between the landscapes east and west of the Bay, groundwater dynamics, composition, and susceptibility to human impacts vary across the project area. The shallow soils and fractured bedrock characteristic of the Door Peninsula's karst landscape allow rapid infiltration and minimal attenuation of contaminants from surface waters. In contrast, the shallower gradient, poor drainage, and deeper soils of the Bay's western shore contribute to a shallower aquifer under soils and glacial drift better able to attenuate infiltrating surface waters.

5.1.2 Biological Environment

5.1.2.1 Riparian and Freshwater Habitats

5.1.2.1.1 Introduction

Local bathymetry and coastal geomorphology, as well as glacial and postglacial history and historical water elevations, fluctuations, human disturbance, and natural dynamism, substantially dictate the presence, absence, location, structure, composition, and permanence of freshwater estuary habitats in the Great Lakes (Herdendorf 1990). The proposed Green Bay Reserve encompasses a variety of habitat types categorized into three main classifications: upland/inland, transitional/wetland, and aquatic (see table 9).

Upland and inland habitats within the proposed reserve boundaries include forested areas, idle and forage grasslands, agricultural land, and limited areas of both low- and high-intensity developed land. Transitional and wetland habitats consist of forested palustrine areas, scrub/shrub wetlands, and forested wetlands. Aquatic habitats comprise the open waters of Green Bay as well as emergent/wet meadows and inland open water areas within the proposed land boundary. The overall habitat composition of the proposed reserve is approximately 13 percent upland/inland, 58 percent transitional/wetland, and 29 percent aquatic. This distribution reflects both the natural variability in Great Lakes water levels and the existing land use patterns around the Bay of Green Bay.

5.1.2.1.2 Wetland and Transitional Habitats

Coastal wetland complexes fringing the Bay of Green Bay are difficult to define, in part due to multiscalar and multitemporal variability of water levels in the Bay, as well as the coastal sediment transport mechanism which feeds and erodes material from coastal wetland sites. While there is no universally accepted definition of a Great Lakes coastal wetland (Epstein, Spencer, and Feldkirchner 2002), significant hydrogeomorphic characteristics distinguish these coastal wetland sites from their inland counterparts. The hydrogeomorphic classification of Great Lakes coastal wetlands developed by Albert et al. (2005) acknowledges these characteristics when classifying coarse habitat classes in the context of the Great Lakes, providing an understanding of both the hydrogeomorphic processes that create or sustain the wetland and the transitional habitats and natural communities of the Green Bay estuary or nearshore areas.

According to the hydrogeomorphic classification developed by Albert et al. (2005), three predominant types describe the variety of Great Lakes coastal wetlands and transitional-habitat hydrogeomorphic settings: lacustrine, riverine, and barrier-protected.

Lacustrine wetlands are coastal settings most openly affected by lake-level fluctuations, nearshore currents, seiches, sediment erosion, transport and deposition, and ice scour. Within the hydrogeomorphic classification system of Great Lakes coastal wetlands, lacustrine wetlands include those with trees, shrubs, persistent emergent vascular plants, and emergent mosses or lichens with greater than 30-percent cover. Under this classification system, lacustrine wetlands can either be “open” to nearshore processes or “protected” from high-energy wave action by some physical barrier (e.g., sand spit, offshore sandbar, shoal, bedrock bar).

Riverine wetlands fringe or span the tributary rivers and creeks as they discharge into the Great Lakes. Water levels controlled by the flow of the river or creek and the lake, along with the geomorphology of the tributary’s watershed and upstream land cover and use, strongly affect the structure and composition of these wetlands. These wetlands exhibit the lateral gradient, extending from beds of submerged aquatic vegetation in the stream channel, through riparian emergent marshes and willow/alder shrub-carr, to floodplain forests. Various landforms, including abandoned oxbow lakes, natural levees, meander scars, and floodplain terraces, provide diverse settings for riverine wetland development.

Barrier-protected wetlands are separated from the open waters of a Great Lake by coastal landforms created by postglacial nearshore processes. The embayment of a coastal indentation by longshore sediment deposition across the mouth of the indentation will result, if the deposition is adequately large and persistent, in an embayed coastal wetland system. Although separated from the lake's main body and its wave energy, an embayment can create and maintain a drainage channel from the embayed wetland to the lake if the watersheds—both ground and surface—move with sufficient hydrologic force to cut through lakeshore deposits and the rate and placement of lakeshore deposits are insufficient to stem the flow. The lake level may influence groundwater flow and, therefore, water levels in the wetland. Barrier-protected wetlands range in size from small lakes to very small embayed wetlands found in ridge and swale coastal systems.

The deltaic, estuarine, open-water, and coastal landscapes of the western shore—and to a lesser, modified extent on the eastern shore of the Bay of Green Bay project area—generally form a gradient from deepwater marshes to terrestrial conditions. Habitats of littoral benthic communities, submerged aquatic plants, emergent marsh wetlands, sedge meadows, shrub-carrs, hardwood swamps, and—on the highest terrain—upland forest lie on this gradient. These structurally and compositionally diverse ecological systems exist on a slight but significantly connected topographic gradient and are heavily influenced by the decadal, annual, seasonal, daily, and hourly rise and fall of Green Bay water levels. High water levels inundate and low water levels drain nearshore habitats. When periods of inundation or exposure are sufficiently long, conversion of habitat structure and species composition is forced. Even short periods of inundation, especially when accompanied by moving ice sheets, can cause significant habitat modifications.

The hydrogeomorphic classification of Great Lakes coastal wetlands (Albert et al. 2005) further subdivides these broad classes into refined wetland types based on physical attributes and shoreline processes. These hydrogeomorphically classified wetland types host a range of habitat types, which are mentioned briefly in this section but detailed in subsequent sections of this Draft Environmental Impact Statement.

The Wisconsin Department of Natural Resources' *Natural Heritage Conservation Working List* classifies native ecosystems into natural community types (Wisconsin Department of Natural Resources n.d.o), with modifications used by Howe et al. (2018) and other regional assessments. For example, WDNR coastal wetland assessments and UWGB Lower Green Bay and Fox River area of concern priority habitat information (University of Wisconsin–Green Bay n.d.c) were leveraged to describe the project area's habitats.

Based on the hydrogeomorphic classification types defined by Albert et al. (2005), the wetland types and associated habitats found in the project area include:

Open shoreline

These coastal wetlands occupy relatively flat gradients exposed to wave and wind action. Low-gradient water levels in Green Bay greatly impact the extent and composition of natural communities found in these marshes. Low water fosters expansion of the emergent marsh community, while high water compresses or eliminates the emergent marsh community, as well as the sedge meadow often found inland from emergent marshes. Further inland, the wetland complex may include expressions of shrub-carr and lowland forest with increases in elevation. Much of the coastal wetland habitat along the western shore of Green Bay and south of the Peshtigo River is open shoreline.

Open embayment

These wetland systems are exposed to wave energy and currents from the larger Bay, but they have shallow waters with gentle bottom gradients that reduce wave height and energy. Orientation to storm waves, bottom sediment types, and degrees of confinement or protection affect the development of wetlands within the embayment.

Moving inland from deeper water, a gradient of submerged aquatic vegetation, emergent marsh, northern or southern sedge meadow, shrub-carr, and hardwood swamp compose the natural communities found in these coastal wetlands. Little Sturgeon Bay on the eastern shore of Green Bay is an example of an open embayment exposed to storm waves from the west.

Protected embayment

These small, protected bays are created by the movement of till-derived sediment carried along the Bay's coast; the sediment is later deposited in areas with slower currents. These shallow bays can be completely vegetated with submergent or emergent marshes backed by wet meadows or sedge stands. A significant accumulation of organic sediment is usually present in these wetlands. While protected from the open energy of a bay or lake, these embayments often discharge a surface flow to the lake via a small permanent or intermittent stream and may serve as important migratory fish–spawning habitats.

Sand-spit embayment

Sand spits formed from deposition of sediment deposited from up-current river mouths create quiet, shallow water areas protected from storm waves on their landward side. Sediments settle in these protected embayment waters, allowing extensive wetland complexes to develop, which comprise submerged aquatic vegetation, emergent marsh, northern or southern sedge meadow, shrub-carr, and hardwood swamps. Water level greatly affects sand spits; in high-water years, some of the smaller, low-elevation, or recently formed portions may be submerged or washed away. In the Lower Bay, depositional islands and land points serve as barriers to high-energy waves, creating quiet bays that feature diverse wetland complexes. These Lower Bay islands serve as nesting and roosting sites for colonial nesting gulls, waterfowl, cormorants, and terns and recently white pelicans and piping plovers. The sand points and bars also serve as stopover areas for migrating birds. The embayments behind Long Tail Point, Little Tail Point, and Point au Sable in the Lower Bay are examples of sand-spit embayments.

Open drowned river mouth

Open drowned river mouths have no barrier at the river mouth and allow for rapid response to any lake or bay water-level fluctuation. The wetlands associated with these settings occur along the fringes of the stream or river, are often growing on deep organic soils, and have the typical gradient from submergent to emergent, wet meadow, shrub-carr, and lowland hardwood forest habitats. Examples are Big Creek and Strawberry Creek in the Sturgeon Bay Component.

Barred drowned river mouth

Sediments carried downstream and deposited outside the river mouth are modified into a barrier landform that may shield the opening, reduce river velocity, and allow for accumulation of mineral and organic material at the river mouth. Extensive wetland complexes, containing submerged aquatic vegetation, emergent marsh, northern or southern sedge meadow, shrub-carr, and hardwood swamps, can develop in these areas. While not common in Lower Green Bay, examples in Upper Green Bay are found at the mouths of the Whitefish, Rapid, and Tacoosh Rivers at the head of Little Bay de Noc in Upper Michigan.

Delta

This Great Lakes coastal wetland is typified by deposition and accumulation of stream sediments at the stream or river mouth and often exhibits multiple shallow channels, low islands, and abandoned meanders. Emergent marsh, ephemeral pond, northern or southern sedge meadow, shrub-carr, hardwood swamp, floodplain forest, and submergent aquatic natural communities may be found in these delta systems. The marshes at the mouths of Duck Creek, Strawberry Creek, Big Creek, and the Peshtigo and Oconto Rivers are examples of this wetland type. In wind-sheltered pockets of these deltaic wetlands, unconsolidated, high-organic content sediments can accumulate, functioning as short-term storage areas for nutrients and organic carbons. Macrophyte growth may

be sparse in these settings but heavily colonized by benthic diatoms, dinoflagellates, and filamentous blue-green and green algae. This system can support a considerable population of gastropods, bivalves, and polychaetes and may serve as a feeding area for various fish and wading birds. Sediment deposition, ice breaking patterns, vegetative succession, and streambed and stream bank erosion are dynamic in nature and constantly changing the morphology of the delta.

Successional barrier beach lagoon

These wetlands form in a bay behind a coastal sand barrier protected from wave energy, nutrient mixing, food-web dynamics, erosional processes, and other factors. Very similar in form and floristics to embayment features, these wetlands—if small and shallow—can be completely vegetated with no open water.

Ridge and swale

These floristically diverse wetlands comprise a series of linear, uniform sand ridges paired with adjacent complementary depressions (i.e., swales). Formation of these landforms is accretionary and driven by episodic lake-level fluctuations to a degree and for a period that allows for the development (through sand accretion) and stabilization (through vegetative colonization) of beach dunes sufficiently tall and armored to withstand the next high-water period. The next low-water period, if sufficiently low and for a long duration, can provide conditions suitable for the development of a new ridge-swale pair. Ground, surface, and Green Bay water levels all drive ecological processes within this wetland type. An example of this coastal wetland type is the ridge and swale complex of the Sturgeon Bay site, located in the isthmus of Sturgeon Bay at the Bay's east end. Though not as dramatic in relief or extensive in area as ridge and swale complexes elsewhere in the Great Lakes, broad ridges with intervening swales occur in the Lower Bay Component of the proposed Green Bay Reserve, north of the Duck Creek Delta and at Point au Sable.

Bedrock-associated open water and coastal features

While not a formal designation of the Great Lakes Hydrogeomorphic Classification system defined by Albert et al. (2005), bedrock-formed reefs, shallow shoals, and Green Bay's eastern shore cobble beaches provide additional complexity to the coastal habitats of the proposed Green Bay Reserve. These geomorphic features are distinguished by their erosion-resistant dolomite and limestone foundations. Submerged or exposed (during low water) bedrock formations hold relatively small amounts of sediment due to wave energy and longshore or Bay currents. Due to wave energy and lack of substrate, relatively fewer shoreline wetland communities are associated with these features. Most exposed dolomite habitat types occur in Upper Green Bay (e.g., the Grand Traverse Islands), although rocky shoals occur through the middle bay below Chambers Island and off Sturgeon Bay. These areas range in size from Washington Island to the small, submerged shoals scattered throughout the Bay. Water levels may expose the shallowest shoals, forming ephemeral islands that are quickly colonized by nesting gulls and waterfowl.

5.1.2.1.3 Aquatic Habitats

The aquatic environment of the Bay of Green Bay is divided into three zones: pelagic, littoral, and benthic. Each zone is home to a unique ecological community.

Pelagic zone

The pelagic zone is the area of open water beyond the shore and above the floor, where there is no submerged aquatic vegetation. Species important to this zone include benthic invertebrates; fish, including cold-water fish; and diving ducks. Depending on water levels, the pelagic zone of the Lower Bay may cover only a relatively small area.

The biotic composition and dynamics of this zone are driven by Lake Michigan water levels, temperature and ice formation (i.e., weather and climate), nutrient and sediment loading from the Fox River Basin, circulatory current patterns in the Lower Bay, episodic wind-driven seiche events, sedimentary resuspension, species dynamics, and commercial and recreational fishing.

Littoral zone

The littoral zone encompasses underwater habitat beyond the emergent marshes of the shoreline and comprises submerged aquatic vegetation. It is delineated by the depth to which light can reach the substrate. This zone and the biota associated with it are largely defined by water clarity, with the deepest water depth of the littoral zone being the depth at which sunlight can sufficiently penetrate the water column to stimulate and sustain vascular plant growth. In favorable conditions, this depth can be about 1.5 meters, but the water clarity varies primarily due to water turbidity. This zone differs in bottom type throughout the Bay but generally has a soft bottom of sand and silt (University of Wisconsin–Green Bay n.d.h). The littoral zone is considered a major natural community of the Bay and provides habitat for many diverse species at some point in their life cycles.

Littoral zone–associated fish include centrarchids, yellow perch, "forage" fish species, and littoral zone–spawners like smallmouth bass and walleye. This zone is also a critical breeding and nursery area for many fish species, including centrarchids (e.g., bass and panfish), northern pike (*Esox lucius*), and yellow perch (*Perca flavescens*).

Littoral zone habitats depend on substrate type and wave energy. These habitats may not contain much or any vegetation in areas of rocky substrate or high wave energy, such as on Green Bay's eastern shore. In these cases, the habitat may serve as breeding ground for other fish species, such as walleye (*Stizostedion vitreum vitreum*) and smallmouth bass (*Micropterus dolomieu*). Other animals associated with this habitat include Hexagenia mayflies, centrarchids and other nearshore fish community species, fingernail clams, caddisflies, snails, crayfish, and dabbling and diving ducks. Much of this habitat has been taken over by the non-native zebra mussel (*Dreissena polymorpha*) and quagga mussel *(Dreissena rostriformis*, also known as *D. bugensis* or *D. rostriformis bugensis*). As a result, the littoral is increasingly populated by migratory diving ducks.

Current stresses on this habitat include sedimentation, increased phosphorus loading, and numerous invasive fish species (e.g., common carp and round goby (*Neogobius melanostomus*)).

Benthic zone

The benthic zone refers to the lowest water region, including the lake bed and its underlying sediments. The benthic community refers to the physical characteristics, species, and ecological processes associated with Green Bay's typically oxygenated area of bottom sediments found at a depth greater than the littoral zone. As the littoral zone varies with water depth, water clarity, and—to some extent— bottom type, the oxygenated area can shift seasonally and the exact boundaries of this zone are not fixed. Deepwater benthic communities are comprised of amphipods (*Diporeia* spp.) and various oligochaetes (including *Tubificidae* and *Lumbriculidae*), chironomids (nonbiting midges, including *Heterotrissocladius*, *Paracladopelma* and *Microspectra*), and sphaerids.

Benthic zone conditions contribute to bacterial and invertebrate productivity and are driven by the Bay's littoral and pelagic zones and its watershed. Periodic hypoxic conditions, occurring during late-summer periods of stable, low wind velocities and driven by nutrient loading from the Fox River, can affect the assemblage of benthic organisms and Lower Bay fish.

5.1.2.1.4 Coastal Marsh Habitats

The wetland, transitional, and open water areas described in the previous sections constitute the coastal marsh complex of the Bay of Green Bay. This area is characterized by a dynamic gradient of submergent and emergent marshes, shrub-sedge habitats, and forested wetlands. Because the Great Lakes coastal wetlands of the proposed Green Bay Reserve are inherently dynamic, any lines that define the extent, composition, and structure of these habitats will likely need re-delineation within one or two years. Given the transitional, dynamic, and fluid nature of the coastal systems in the proposed Green Bay Reserve, habitats have been lumped into four main structural types: submergent marshes, emergent marshes, coastal shrub-sedge wetlands, and forested wetlands. Information on these habitat types is largely gleaned from the Wisconsin Department of Natural Resources' Natural Heritage Inventory characterizations of its natural communities (Wisconsin Department of Natural Resources n.d.o; Epstein 2017; Howe et al. 2018) and the University of Wisconsin–Green Bay's Lower Green Bay and Fox River area of concern priority habitat information (University of Wisconsin–Green Bay n.d.c).

Submergent marshes

Submergent marshes support a diverse assemblage of submerged aquatic plants, including sago pondweed (*Stuckenia pectinata*), true pondweeds (*Potamogeton* spp., particularly *P. foliosus* and *P. nodosus*), waterweeds (*Elodea canadensis* and *E. nuttallii*), eelgrass (*Vallisneria americana*), water-milfoil (*Myriophyllum* spp., particularly *M. sibiricum*), bladderworts (*Utricularia* spp., particularly *U. vulgaris*), and coontail (*Ceratophyllum demersum*) (University of Wisconsin–Green Bay n.d.l; Wisconsin Department of Natural Resources n.d.z).

Emergent marshes

Up-gradient from this submerged aquatic plant assemblage are emergent marshes dominated by cattails (*Typha* spp.), bulrushes (*Schoenoplectus* spp.), river bulrush (*Bolboschoenus fluviatilis)*, bur-reeds (*Sparganium* spp.), arrowheads (*Sagittaria* spp.), rushes (*Juncus* spp.), and spikerush (*Eleocharis* spp.). These wetlands are also affected by lake-level fluctuations, along with variable nearshore currents, seiche events, storm wave energy, and ice scours, which influence and shape habitat patch size, location, and composition. This emergent marsh habitat can be extensive in bays and shoreline pockets (e.g., protected embayments and barred river mouths protected from high-energy wave impacts).

These coastal wetlands occupy relatively flat gradients along Green Bay's western shore and are generally open to wave and wind action off the Bay. Due to the low gradient, Green Bay's water levels greatly impact the extent and composition of natural communities found in these marshes. Low water fosters expansion of the emergent marsh community lakeward, while high water compresses inland or eliminates this community, as well as the sedge meadow often found inland from the emergent marsh. Consequently, the upper or landward limit to this habitat is determined by the height of the water level, and the lower limit is a water depth of approximately 0.7 meters, as this is the height at which plants of the emergent marsh assemblage can extend above the water. Nearshore currents, seiche events, storms surges, high-energy waves, and spring ice scouring also affect morphology and floral composition. This habitat thrives in protected bays and along other shores with low wave impact and relies heavily on its seed bank for reestablishment after disturbance events. Further inland, with a rise in elevation, the wetland complex may include expressions of sedge meadow, shrub-carr, and lowland forest. This is the predominant transitional wetland type in the Bay of Green Bay, and much of the coastal wetland habitat along Green Bay's western shore, south of the Peshtigo River, is classified as this type. These wetlands are dominated by grasses (*Poaceae*), sedges (*Cyperaceae*), rushes (*Juncaceae*), cattails (*Typhaceae*), and other graminoid species and are subject to periodic flooding. These essential habitats support many important estuarine fish and invertebrate species, as well as shorebirds and waterfowl, and serve important roles in shore stabilization, flood control, water purification, and nutrient transport and storage (University of Wisconsin–Green Bay n.d.j; Wisconsin Department of Natural Resources n.d.x).

Emergent marshes support a diversity of fish and wildlife including muskrat, northern pike, and common carp. These marshes also support a significant range of bird species. Sora and Virginia rails, marsh wren, pied-billed grebe, least bittern, and many other species use coastal marshes extensively for nesting and feeding and during migration.

Coastal shrub – sedge marsh

Up-gradient from the emergent marsh habitat, a sedge marsh (or shrub-carr) may form if water levels in the Bay of Green Bay remain relatively stable. This water level–dependent habitat generally lies between the emergent marsh and coastal forested wetland habitats with variable boundaries, unless constricted by built infrastructure (e.g., roads, filled land). Groundwater levels can impact this habitat's presence and stability. Historically, the dominant emergent marsh species have included sedges and shrub species mixed with patches of willow (*Salix* spp.) and dogwood (*Cornus* spp.). Since the 1990s, much of this habitat in the lower Green Bay coastal area has been invaded and dominated with the non-native common reed (*Phragmites australis*).

As noted, the Bay's fluctuating water levels are the primary natural force driving this habitat. Several consecutive low-water years can cause an increase in acreage, whereas high water can flood and destroy this community as storms and water remove substrate and drown species. Thus, the shrub-sedge habitat ranges in size from nonexistent in high-water years to wide in low-water years.

Historical stresses to this habitat include drainage and road building for farming during the 1930s, especially near Green Bay; hay cutting; road development; and hardening of the foredune for cottages. The latter impact has segregated this habitat from the emergent marsh in many places. The dominant current stressor to this habitat is rapid encroachment by invasive species, particularly *Phragmites* and to lesser degrees *Phalaris*, *Rhamnus* spp., and *Lythrum salicaria* (Wisconsin Department of Natural Resources n.d.y; University of Wisconsin–Green Bay n.d.k).

Coastal forested wetlands

Lying inland from the shrub-sedge marsh, coastal forested wetlands have relatively stable boundaries because they are not as influenced by water level fluctuations of the Bay. Historically, the boundaries of this habitat lie between the upland forest and the shrub-sedge marsh, although the coastal forested wetlands (as well as upland forests) have been greatly fragmented by development and are now bounded in many places by agricultural fields and commercial and residential development. These coastal forests comprise a mix of wetland forest types and small upland forest patches (Wisconsin Department of Natural Resources n.d.t). These forested lands are influenced by groundwater levels and flows, as well as overland flow from adjacent uplands. Water levels in the Bay affect this system, as low levels possibly draw down groundwater near the shore. Spring flooding of tributaries flows through these forests and supplies water to the system. Internal surface-water runoff and vernal ponding is present. Sandy soils and irregular topography allow variability in moisture regimes and forest composition.

The major species composition includes those of lowland forest, sedge meadows, shrub-carr, and alder thickets, although non-native glossy buckthorn (*Rhamnus frangula*) and reed canary grass (*Phalaris arrundinacea*) are prevalent in some areas. Soils are typically sandy; however, these regions were historically composed of more peatland and tamarack.

5.1.2.2 Upland and Terrestrial Habitats

5.1.2.2.1 Introduction

The proposed Green Bay Reserve encompasses a variety of habitat types categorized into three main classifications: upland/inland, transitional/wetland, and aquatic. Upland and inland habitats within the proposed reserve boundaries include forested areas, idle and forage grasslands, agricultural lands, and limited areas of both low- and high-intensity developed lands.

Table 9 provides the acreage of each of these classes in the proposed alternatives for the Green Bay Reserve. For more information on the habitat classification system leveraged by the state of Wisconsin, please reference appendix 6.

Along with upland natural communities or habitats associated with forested and grassland types, the project area includes several additional upland habitats. These types are largely associated with the bluffs, terraces, and plateau of the Niagara Escarpment, which in great part geologically defines the eastern shore of the Bay of Green Bay. A small area of Lake Michigan is shoreline included in the proposed Sturgeon Bay Component; this area contains additional upland habitats not found elsewhere in the proposed Green Bay Reserve boundaries. The natural communities associated with upland forests, upland grasslands, the Niagara Escarpment, and the Lake Michigan shoreline are described below and were informed by the Wisconsin Department of Natural Resources' Natural Heritage Inventory of natural communities (Wisconsin Department of Natural Resources n.d.o; Epstein 2017; and Howe et al. 2018).

5.1.2.2.2 Upland Forests

Upland forests of the Green Bay sites contain soils ranging from sand, sand loams, reddish loamy, or clayey soils formed in glacial outwash, glacial moraine, or postglacial lake bed (i.e., Lake Oshkosh) deposits. Accretionary sand deposits along the shores of Lake Michigan (e.g., at the Sturgeon Bay site) or sand spits and points in Green Bay supply the parent material for sandy coastal soils. The upland forests are categorized by moisture conditions present at the site.

Northern dry forests

Only small, scattered remnants of this forest type remain. The Peshtigo Component of the proposed Green Bay Reserve contains a small area of this forest type on an upland terrace elevated several feet above the Peshtigo River. This xeric site with well-drained, sandy soil is dominated by various oaks (Hill's, red, and white), pines (white, red, and jack), and bigtooth aspen.

Northern dry-mesic forests

Northern dry-mesic forests are typically found in well-drained glacial topography or postglacial accretionary sand deposits along the coasts of Green Bay or Lake Michigan. The Peshtigo Component of the proposed Green Bay Reserve also contains a high-quality example of this forest type. At this site, eastern white pine (*Pinus alba*) and to a lesser degree red pine (*Pinus resinosa*) are mixed with northern red oak (*Quercus rubra*), red maple (*Acer rubrum*), and sugar maple (*Acer saccharum*).

Younger or mid-seral stands of northern dry-mesic forests usually hold paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), and bigtooth aspen (*Populus grandidentata*). Common understory shrubs include hazelnuts (*Corylus* spp.), witch hazel (*Hamamelis virginiana*), and blueberries (*Vaccinium angustifolium* and *V. myrtilloides*), as well as low-growing species such as wintergreen (*Gaultheria procumbens*) and partridgeberry (*Mitchella repens*). Among the dominant herbs are wild sarsaparilla (*Aralia nudicaulis*), Canada mayflower (*Maianthemum canadense*), and cow wheat (*Melampyrum lineare*).

Examples of dry-mesic forest stands also occur on the well-drained accretionary sand landforms adjacent to Lake Michigan and found within the Sturgeon Bay Component of the proposed reserve. These stands are diverse, ranging from dense conifer stands—dominated by pole-sized to mature hemlocks and white cedars–to early successional stands of bigtooth aspen and balsam fir, as well as intermediate-aged forests of multiple species. This diversity of forest types reflects the disturbance history of the site, with the primary disturbance being logging following the settlement of Euro-Americans in the 1800s and likely collateral impacts from construction of the adjacent ship canal. The humid coastal microclimate near Lake Michigan also affects the forest composition, particularly the presence of more mesic species such as eastern hemlock and yellow birch.

Common herbaceous species in the dry-mesic forest ground cover of the proposed Sturgeon Bay Component include bracken fern (*Pteridium aquilinum*), false melic grass (*Schizachne purpurascens*), sedge (*Carex deweyana*), poverty grass (*Danthonia spicata*), baneberry (*Actea* spp.), twinflower (*Linnea borealis*), small enchanter's nightshade (*Circea alpina*), bedstraw (*Galium triflorum*), Canada mayflower, wild strawberry, helleborine orchid (*Epipactus helleborine*), common dandelion (*Taeraxacum officinale*), bluegrass (*Poa compressa*) and other ruderal non-native species in small numbers.

Northern mesic forests

Northern mesic forests form the matrix for most other upland forest types found in the Bay of Green Bay. These forests occur mainly on loamy soils within glacial till plains and moraines formed during the Wisconsin glaciation. In the project area's southern sections, sugar maple (*Acer saccharum*), basswood (*Tilia americana*), green ash (*Fraxinus pennsylvanica*), and black walnut (*Juglans nigra*) are the common tree types of a stand (University of Wisconsin–Green Bay n.d.). Younger secondary forests also include eastern cottonwood (*Populus deltoides*) and trembling aspen (*Populus tremuloides*) as canopy dominants. American elm (*Ulmus americana*), alternate-leaf dogwood (*Cornus alternifolia*), and hop-hornbeam (*Ostrya virginiana*) may contribute to a woody subcanopy tier. Frost grapes (*Vitis riparia*) and Virginia creeper (*Parthenocissus quinquefolia*) are conspicuous as woody climbers. Common shrubs include American highbush cranberry (*Viburnum trilobum*), red elderberry (*Sambucus racemosa*), and currant and gooseberry species (*Ribes* spp., particularly *R. americanum* and *R. cynosbati*). The herbaceous understory is diverse and includes many showy spring ephemerals, such as bloodroot (*Sanguinaria canadensis*), wild ginger (*Asarum canadense*), Jack-in-the-pulpit (*Arisaema triphyllum*), red baneberry (*Actaea rubra*), and large-flowered trillium (*Trillium grandiflorum*). Sedges (*Carex* spp.), ferns (including *Deparia arcostichoides* and *Athyrium filix-femina*), and an array of other forbs (including *Circaea canadensis*, *Smilax ecirrhat*a, and *Solidago flexicaulis*) are typically also present (Wisconsin Department of Natural Resources n.d.o).

Elsewhere in the project area, sugar maple dominates or shares the canopy with American beech (*Fagus grandifolia*). Historically, eastern hemlock (*Tsuga canadensis*) served as the second most important species, occasionally forming nearly pure stands alongside eastern white pine (*Pinus strobus*). In counties near Lake Michigan, hemlock often acts as a co-dominant species with sugar maple. Other important tree species are yellow birch (*Betula alleghaniensis*), basswood, and white ash (*Fraxinus americana*); however, yellow birch reproduction has become scarce in most stands.

Characteristic subcanopy trees include balsam fir (*Abies balsamea*), ironwood (*Carpinus caroliniana*), and American elm. The shrub layer includes species such as alternate-leaf dogwood, beaked hazelnut (*Corylus cornuta*), leatherwood (*Dirca palustris*), American fly honeysuckle (*Lonicera canadensis*), prickly gooseberry (*Ribes cynosbati*), red elderberry, and mapleleaf arrowwood (*Viburnum acerifolium*). Stands with high deer-browse pressure or dense overstory shade from hemlock may have sparse and species-poor ground-layer vegetation. Ground cover species in areas with dense shade often include ferns (*Dryopteris intermedia*), blue-bead lily (*Clintonia borealis*), club mosses (*Lycopodium* spp., *Dendrolycopodium* spp., and others), and Canada mayflower. Sites with dappled light and low deer pressure may be lush and species-rich with spring ephemeral displays of large-flowered trillium, Dutchman's breeches (*Dicentra cucullaria*), spring beauty (*Claytonia virginica*), and trout lilies (*Erythronium* spp.). Other characteristic species of rich stands include white baneberry

(*Actaea pachypoda*), downy Solomon's seal (*Polygonatum pubescens*), wild sarsaparilla (A*ralia nudicaulis*), rose twisted-stalk (*Streptopus roseus*), starflower (*Trientalis borealis*), maidenhair fern (*Adiantum pedatum*), and lady fern (*Athyrium filix-femina*).

Mesic forest sites have lost acreage and connectivity since the hardwood logging era began in northeastern Wisconsin. Invasive species within northern mesic forests include both shrubs and herbs. Common buckthorn (*Rhamnus cathartica*) is the most problematic invasive woody species, along with showy bush honeysuckle (*Lonicera × bella*, *L. morrowii* and *L. tartarica*), European highbush cranberry (*Viburnum opulus*), glossy buckthorn (*Frangula alnus*), and autumn olive (*Elaeagnus umbellata*). Garlic mustard (*Alliaria petiolata*) and dame's rocket (*Hesperis matronalis*) are herbaceous invasive species within this forest type.

Southern dry-mesic forests

Southern dry-mesic forests occupy well-drained, loamy soils formed in till and are found sparingly in the southern portions of the project area. The UWGB inventory of habitats in the Lower Green Bay and Fox River area of concern found that southern dry-mesic forests represented about 1 percent of the habitat (University of Wisconsin–Green Bay n.d.f). Red oaks (*Quercus rubra*) and white oaks (*Quercus alba*) dominate the canopy with lesser numbers of American basswood, sugar maple, and shagbark hickory (*Carya ovata*). Black cherry *(Prunus serotina*) is typically present but generally occupies an intermediate or suppressed canopy position. Examples in the area include a stand on the University of Wisconsin–Green Bay campus and near Longtail Beach Road on the Bay's western side.

Southern mesic forests

This upland forest community occupies rich, well-drained, loamy soils, primarily on glacial till plains. With regional warming, the extent of this forest type may increase in dominance. Like the northern mesic forest, the dominant tree species in this forest is sugar maple, but American basswood and American beech may co-dominate. Additional trees, some with more southerly ranges, in these forests include black walnut, butternut, ironwood, northern red oak, red maple (*Acer rubrum*), white ash, and slippery elm (*Ulmus rubra*). The understory is typically open or occasionally brushy with species of gooseberry (*Ribes* spp.) and characteristic herbs like spring beauty, trout lilies, trilliums (*Trillium* spp.), violets (*Viola* spp.), bloodroot (*Sanguinaria canadensis*), blue cohosh (*Caulophyllum thalictroides*), mayapple (*Podophyllum peltatum*), and Virginia waterleaf (*Hydrophyllum virginianum*). Similar to northern mesic forests, large tracts of southern mesic forests were cleared for agriculture to use its fertile soil.

5.1.2.2.3 Niagara Escarpment–Associated Uplands

The forests and other upland habitats of the Niagara Escarpment sit upon bedrock formations of marine sediments deposited approximately 425 to 600 million years ago in the Silurian and Ordovician periods. These hardened carbonate sedimentary rocks lie just beneath the surface or are exposed as the vertical cliffs along the westernmost edge of the Niagara Escarpment. This formation borders the eastern shore of Green Bay and underlies the entire Door Peninsula, as well as much of eastern Wisconsin (Martin 1965; fig. 18).

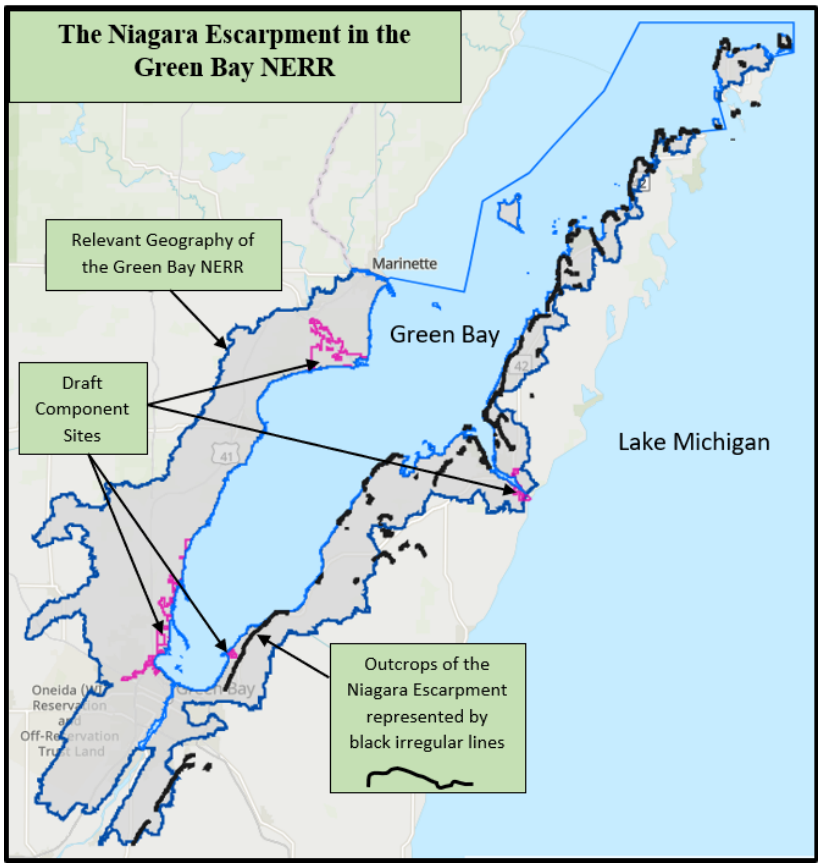


Figure 18. Niagara Escarpment outcrops in relation to proposed Green Bay Reserve components.

The younger and uppermost Silurian formation is as thick as 400 feet and comprises most of the exposed and near-surface bedrock in Door, Kewaunee, and Brown Counties (Sherrill 1977). This rock, buff-gray in color and medium- to coarse-grained, is hard and brittle but dissolves in an acidic solute like rainwater. The dissolution of rock creates a formation with abundant geological fractures, such as crevices, fracture traces, sinkholes, and caves that characterize a karst landscape, such as that found in northern Door County (Sherrill 1977). The habitats in the project area associated with the Niagara Escarpment include alvar, dry cliff, and moist cliff habitats.

Alvar habitats

Alvar habitats contain areas of thin, discontinuous soil overlying horizontal—often partially exposed—slabs of limestone or dolomite associated with the Niagara Escarpment. These habitats are rare in Wisconsin and found more commonly across the upper Lake Huron islands. These plant assemblages comprise an unusual blend of boreal and prairie species, which appear to be relicts of the cold period following the last glaciers and the warmer, drier period that followed. They are characterized by relatively low tree cover and a distinctive biota, which includes elements of rock pavement, prairie, savanna, and boreal forest communities. Among these assemblages are regional endemics, some of which are globally very rare.

Small, stunted-looking coniferous and deciduous trees, such as northern white cedar (*Thuja occidentalis*), balsam fir (*Abies balsamea*), pines (*Pinus* spp.), oaks (*Quercus* spp.), aspens (*Populus* spp.), and paper birch (*Betula papyrifera*), are scattered among an assemblage of species that can include big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), and wood lily (*Lilium philadelphicum*), as well as shoreline plants such as silverweed (*Potentilla anserine*) and dwarf lake iris (*Iris lacustris*).

Alvar habitats support wildlife species associated with open grassland and shrubland, along with many distinctive invertebrates such as leafhoppers and terrestrial snails.

Dry and moist cliff habitats

Dry and moist cliff habitats occupy the exposed vertical rock outcroppings throughout the length of the escarpment within the project area (fig. 19). Whether a cliff face holds a dry or moist habitat largely depends on the internal hydrology of the karst structure (i.e., pattern and extent of internal vertical and horizontal fissures) on the bluff. The compass orientation of the rock face, degree of exposure to the sun or prevailing winds, extent and degree of canopy cover, and structure of the rock face itself influences habitat conditions.

Several hundred species of upland vascular plants are clearly associated with the Niagara Escarpment in Wisconsin and Door County (Howe, Wolf, and Fewless 2016). According to Howe et al. (2018), the most consistently conspicuous species of the Wisconsin escarpment is northern white cedar (*Thuja occidentalis*), which is often found above the cliffs, in cracks and ledges on the cliffs, and at the base of the cliffs below the talus slope. In some cases, tall, individual white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) are present along the cliff tops as members of a dry-mesic forest habitat on the escarpment rim or an upper, well-drained plateau. On shaded cliff faces (i.e., those with moist conditions) and especially on the talus slopes below, dense growths of bulblet fern (*Cystopteris bulbifera*), as well as shrubs of mountain maple (*Acer spicatum*) and red elderberry (*Sambucus racemosa*), are common. More native ferns can be found on cliff faces and associated boulders and talus slopes. Distinctive upland habitats associated with the escarpment cover a hydrogeomorphological gradient ranging from dry, shallow-soiled plateau conditions at the cliff top to moist, shaded talus deposits at the base. Grimm (2022) provides additional details about the species found in habitats on the gradient from the upper escarpment plateau to sub-outcrop talus wetlands and postglacial beach ridges at the shoreline of Green Bay.

Familiar plant species like Canada columbine (*Aquilegia canadensis*) and rock polypode (*Polypodium virginianum*) are common along the rocky cliff faces and outcrops. In Wisconsin, several rare or uncommon forbs are found primarily within the Niagara Escarpment, including two rare members of the mustard family (*Brassicaceae*), rock whitlow-grass (*Draba arabisans*), and hoary whitlow-cress (*D. cana*), along with the uncommon maidenhair spleenwort (*Asplenium trichomanes*) and dwarf cliff brake (*Pellaea glabella*). Other Wisconsin rare species found in the Niagara Escarpment include limestone oak fern (*Gymnocarpium robertianum*) and Allegheny vine (*Adlumia fungosa*) (Howe, Wolf, and Fewless 2016). Uncommon Wisconsin plants like Canada yew (*Taxus canadensis*) can be found growing locally on Niagara Escarpment upon ledges inaccessible to white-tailed deer (*Odocoileus virginianus*). Distinct assemblages of bryophytes and epilithic (rock-attached) lichens are found on the horizontal, vertical, sloping, and undersides of exposed bedrock.



Figure 19. Moss-capped extruding bedrock of the Niagara Escarpment in northern Door County. *Photo: Mike Grimm, June 2022.*

On the steepest cliffs of Wisconsin's Niagara Escarpment, stunted, slow-growing northern white cedar, eastern red cedar, and other tree species can persist for hundreds or thousands of years as miniature specimens, often only centimeters in diameter but hundreds of years old. Larson (2001) maintains that extensive cliff outcrops of the Niagara Escarpment in Ontario and portions of the escarpment in eastern Wisconsin support some of the most ancient and least disturbed wooded habitats on Earth.

It should be noted that in addition to often unique assemblages of native plants, a group of "Pleistocene Relict" land snails have been found on the small, shaded mossy ledges and rock crevices and in debris chutes of the dolomite bluff escarpment face. Several members of this group of snails (e.g., *Vertigo hubrichtii*, *V. iowaensis*) are considered glacial relict taxa (Nekola 2000); that is, they are disjunct from relict populations found in the Driftless Area of northeastern Iowa, southeastern Minnesota, and southwestern Wisconsin and on the rock outcrops of the Niagara Escarpment in Door and Brown Counties in northeastern Wisconsin. In general, these snails inhabit the lower portions of rock face and uppermost portions of the talus slope that seep cold water and minor, cold airflow (Nekola and Schlicht 1996). Evidence suggests that increased physical and floral canopy heterogeneity of the free face promotes greater snail diversity at a site.

5.1.2.2.4 Great Lakes Shoreline Accretionary Landforms

The Bay of Green Bay project area includes a small portion of Lake Michigan shoreline, specifically within the proposed Sturgeon Bay Component. This shoreline hosts several unique habitat types, including:

- Great Lakes ridge and swale complex
- Great Lakes beach
- Great Lakes dune

Great Lakes shoreline accretionary landforms exist throughout the project area, with varying biophysical, compositional, and geologic expressions. Examples of these coastal landforms in the proposed Green Bay Reserve are found at Long Tail and Little Tail Points on the western shore of Green Bay, at Point au Sable on the southeastern shore of the Bay, and along the small stretch of Lake Michigan shoreline included in the proposed

Sturgeon Bay Component. These landforms are composed of sands, gravels, and organic materials transported and deposited by longshore currents in the coastal waters of Green Bay and Lake Michigan. Tributary sediment loads also provide source material to longshore currents. These materials accumulate in sheltered coastal areas where current energy is low enough to allow disposition. Onshore winds, lake-level fluctuations, and ice movement reshape these deposited materials into a complex of beaches, foredunes, dunes, interdunal swales, ridge and swale landforms, and eolian dunes. Figure 20 provides an example of these landforms at the proposed Sturgeon Bay Component. In addition to inorganic sands and gravels, storm waves off the Great Lakes deliver driftwood, aquatic plant debris, and dead insects and fish to the beach-water interface in a zone called "storm beach" (Albert 2006).

Marram grass (*Ammophila breviligulata*) and sand reed grass (*Calamovilfa longifolia*) are common sand-binding grasses of the foredunes located just above the open beach, and these species are often early colonizers and stabilizers of active sands. Important conservation species like dune thistle (*Cirsium pitcheri*), Ohio goldenrod (*Solidago ohioensis*), lance-leaved coreopsis (*Coreopsis lanceolata*), white camas (*Anticlea elegans*), American sea rocket (*Cakile edentula*), thickspike wheatgrass (*Elymus lanceolatus*), and Garber's sedge (*Carex garberi*) have been documented on these foredune sites. Other more common species present on the foredune include wormwood (*Artemisia campestre*), common milkweed (*Asclepias syriaca*), starry Solomon's seal (*Smilacina stellate*), big bluestem (*Andropogon gerardii*), Baltic rush (*Juncus balticus*), and several non-native species (e.g., evening primrose (*Oenothera oakesina*), soapwort (*Saponaria officinalis*), spotted knapweed (*Centaurea stoebe*)).



Figure 20. Topography and vegetative patterns of the Great Lakes shoreline's active beach and foredune at the proposed Green Bay Reserve's Sturgeon Bay Component (Grimm 2020).

5.1.2.2.5 Non-forested Upland Habitats

Surrogate grasslands (e.g., abandoned agricultural fields, upland shrub fields, seminatural meadows) are an example of non-forested upland habitat found within the proposed project area.



Figure 21. An example of surrogate grassland habitat at the Door County Land Trust's Sturgeon Bay Ship Canal Preserve as part of the proposed Sturgeon Bay Component *(Photo: Mike Grimm).*

According to the Wisconsin Department of Natural Resources (2024), surrogate grasslands resemble native grasslands in general structure but differ greatly in species composition. These habitats include agriculture-related cover types such as hayfields, small grains (oats, wheat, and barley), row crops (corn, soybeans, and potatoes), fallow fields, old fields, pastures, and set-aside fields. Examples also considered as surrogate prairie and grasslands by the Wisconsin Department of Natural Resources include young conifer plantations, orchards, parks, golf courses, airports, roadsides, cut-over or burned-over forests, and mossed bogs (i.e., bogs from which sphagnum moss is removed for commercial purposes). Overall, surrogate grasslands provide a prairie-like environment for plants and animals, characterized by the absence of a tree canopy. Surrogate grassland habitat exists at many locations within the proposed project area. Examples are found in the Point au Sable, Wequiock Creek, Duck Creek, Peshtigo, and Sturgeon Bay areas. Figure 21 presents an example of a surrogate grassland habitat in the proposed Sturgeon Bay Component (Wisconsin Department of Natural Resources n.d.a).

In another example of a surrogate grassland habitat setting found within the proposed Sturgeon Bay Component, tight, scattered tree groves comprise trembling aspen, white birch, and white pine and occupy small hilltops surrounded by muted, rolling dry meadows of thinly growing short grasses and old-field, xeric-soil ruderal herbs. Pole-sized and larger white pine, and an occasional large juneberry (*Amelanchier canadensis*), are scattered through the open fields. The most common ruderal species of the open, savanna-like fields include bush honeysuckle (*Diervilla lonicera*), poverty grass (*Danthonia spicata*), bracken fern (*Pteridium aquilinum*), common milkweed (*Asclepias syriaca*), St. John's wort (*Hypericum punctatum*), brome grass (*Bromis inermis*), hoary alyssum (*Berteroa incana*), and spotted knapweed (*Centaurea stoebe*). Other species scattered in small patches or dispersed in fewer numbers across the rolling sand fields include timothy grass (*Phleum pratense*), Canada goldenrod (*Solidago canadensis*), sheep sorel (*Rumex acetocella*), Canada rye grass (*Elymus canadensis*), mullein (*Verbascum thapsus*), yarrow (*Achillea millefolium*), yellow hawkweed (*Hieracium* spp.), wormwood

(*Artemisia campestris*), fleabane (*Erigeron strigosus*), old field juniper (*Juniperus communis*), and creeping juniper (*J. horizontalis*). The dry-meadow flora transition to more shade-tolerant species under the tree groves, though open field species (e.g., bracken fern and St. John's wort) do occur in reduced numbers under the trees. Other common herbaceous, ground-cover species of the groves include Canada mayflower, sedges (*Carex pedunculata, C. pennsylvanica,* and *C. arctata*), bedstraw (*Galium triflorum*), Solomon's seal (*Polygonatum pubescens*), Canada goldenrod (*Solidago canadensis*), knapweed (*Centaurea* spp.), wild strawberry (*Fragaria virginiana*), common speedwell (*Veronica officinalis*), timothy grass (*Phleum pratense*), false melic grass (*Schizachne purpurascens*), and Pipsissewa (*Chimaphila umbellata* or *C. maculata*). Non-native honeysuckle (*Lonicera tartarica*) seedlings and small shrubs are also present, along with scattered non-native buckthorn (*Frangula alnus*) seedlings.

5.1.2.3 Estuarine Environments

5.1.2.3.1 Habitats and Hydrographic Settings

5.1.2.3.1.1 Sturgeon Bay Component (Including the Estuaries of Big Creek and Strawberry Creek)

The small estuaries of Big Creek and Strawberry Creek flow into the eastern end of Sturgeon Bay, which extends from Green Bay's eastern side halfway up the Door Peninsula. The Big Creek estuary lies just over one kilometer northwest from the Strawberry Creek estuary mouth across the waters of Sturgeon Bay (fig. 22). Prior to the 1882 completion of the Sturgeon Bay Ship Canal that cut through the isthmus at the eastern end of Sturgeon Bay to reach Lake Michigan, the surface waters of Big Creek and Strawberry Creek flowed entirely into Sturgeon Bay and Green Bay.

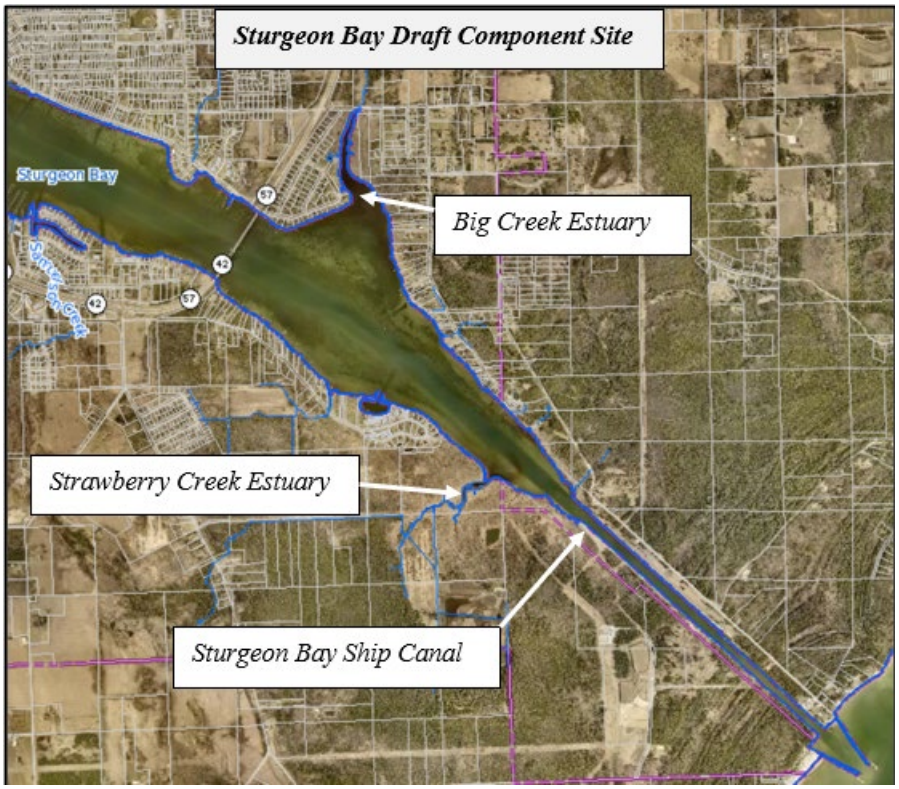


Figure 22. A map displays a portion of the proposed Green Bay Research Reserve's Sturgeon Bay component, the Big Creek and Strawberry Creek Estuaries, and the Sturgeon Bay Ship Canal.

Today, Big Creek and Strawberry Creek outflows mix with surface waters from either Green Bay or Lake Michigan, depending on the direction of water flow through the ship canal. Thus, the estuary dynamics of both sites are impacted by the interplay of relative water levels in Lake Michigan and Green Bay during seiche events.

5.1.2.3.1.2 Big Creek Hydrographic Setting

The Big Creek estuary is trumpet-shaped with a 0.8 kilometer–wide "bell" that narrows to a slightly bent "throat." The estuary flows from the singular, high-gradient channel of Big Creek. The confluence of Big Creek and Sturgeon Bay varies from about 13 meters wide at low water to approximately 84 meters wide during high water, almost seven times the low-water width. Big Creek, which is about eight kilometers long, drains a 24.5-km² watershed (fig. 23). Row crop agriculture is the predominant land use, covering 36 percent of the watershed (table 11). Pastureland covers an additional 28 percent of the watershed, while wooded wetlands cover 12 percent and upland forests cover an additional 7 percent (Stroud Research Center 2022).

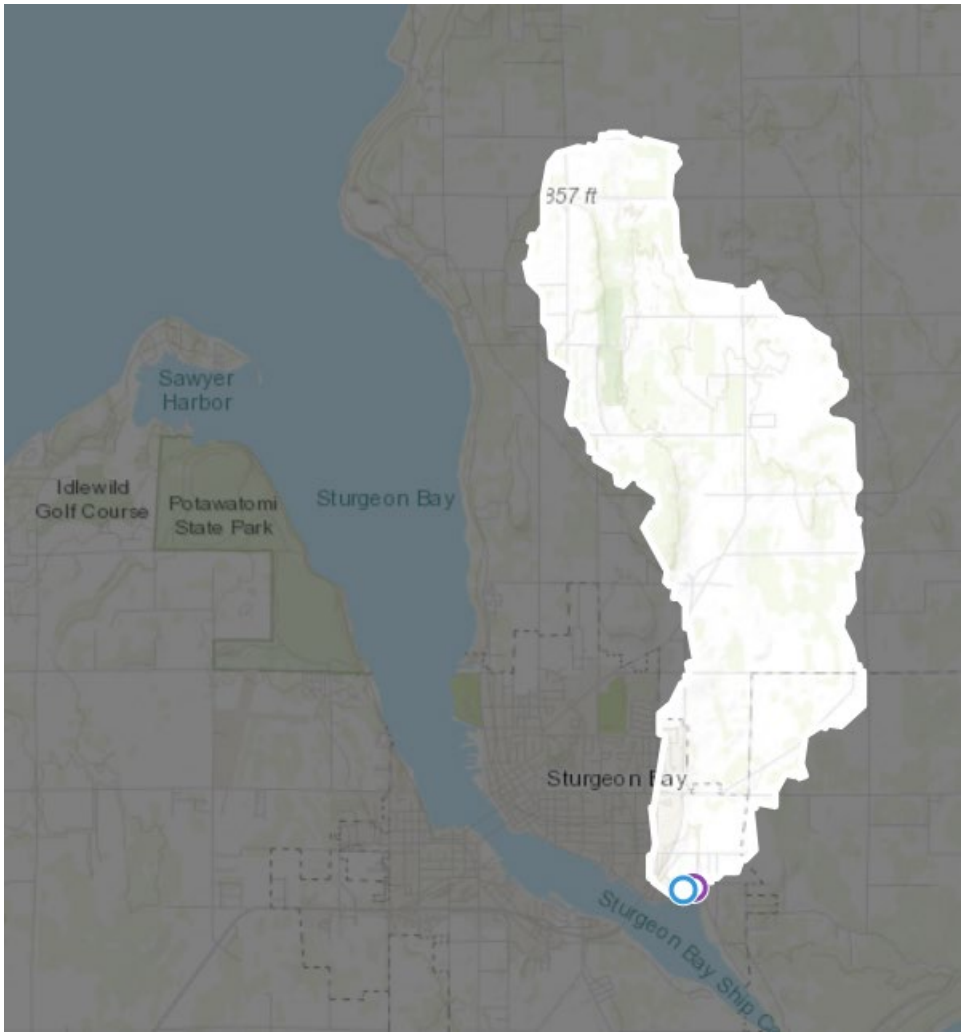


Figure 23. A map of the Big Creek watershed (*https://modelmywatershed.org/analyze*).

Table 11. Big Creek Watershed Land Cover Types from the National Land Cover Database.

Land Cover Type	NLCD Code	Area (km²)	Coverage (%)
Open water	11	0.02	0.08
Perennial ice/snow	12	0.0	0.0
Developed, open space	21	1.44	5.92
Developed, low-intensity	22	0.98	4.01
Developed, medium-intensity	23	0.29	1.2
Developed, high-intensity	24	0.04	0.15
Barren land (rock/sand/clay)	31	0.06	0.26
Deciduous forest	41	1.7	6.96
Evergreen forest	42	0.38	1.58
Mixed forest	43	0.67	2.74
Shrub/scrub	52	0.09	0.36
Grassland/herbaceous	71	0.02	0.1
Pasture/hay	81	6.86	28.17
Cultivated crops	82	8.79	36.09
Woody wetlands	90	2.87	11.77
Emergent herbaceous wetlands	95	0.15	0.6
Total	—	24.35	100

Source: https://modelmywatershed.org/analyze

Hard, calcareous bedrock beneath the proposed Sturgeon Bay Component dictates the composition and flow of surface water and groundwater. These bedrock conditions also influence base flow across both the Strawberry and Big Creek sites. Groundwater inputs are particularly evident in the higher-gradient Big Creek, which may run dry one kilometer upstream of the estuary during the summer months.

The characteristic landform pattern of the Big Creek watershed comprises a broadly undulating bedrock-controlled moraine with depressions containing forested wetlands. The soils formed from the moraine material are predominantly well-drained loams, with occasional lowland areas along the waterways or in closed depressions that hold wetland, organic soils (table 12).

Table 12. Big Creek Watershed Soil Groups Based on the USDA Gridded Soil Survey Geographic Database (gSSURGO).

Infiltration Type	Area (km²)	Coverage (%)
A – high	0.1	0.43
A/D – high/very slow	0.0	0.0
B – moderate	4.35	17.88
B/D – medium/very slow	2.21	9.08
C – slow	10.36	42.55
C/D – medium/very slow	2.01	8.27
D – very slow	5.31	21.79
Total	24.35	100

Source: https://modelmywatershed.org/analyze

5.1.2.3.1.3 Strawberry Creek Hydrographic Setting

The mouth of Strawberry Creek is much narrower than that of Big Creek and unconfined by filled land or surrounding high ground. Strawberry Creek drains a 9.21-km² watershed (fig. 24) with a channel slope of 27 percent and features a more gently sloping landscape than Big Creek. The watershed land cover is composed of 56-percent wooded wetlands, 16-percent pasture, and 11-percent row crops, with smaller percentages for other land cover types (table 13). Notably, upland forest covers only 2 percent of the watershed. The higher percentage of wooded wetlands is indicative of the Strawberry Creek watershed's low-lying land, especially within the estuarine landscape. The Strawberry Creek watershed transitions a gently rolling landscape of thin-to-thick, moderately well-drained glacial till in the headwaters to a mix of old beach deposits, nearshore sediments, and poorly drained organic wetland soils near Sturgeon Bay (table 14).



Figure 24. Strawberry Creek watershed map (*Source: https://modelmywatershed.org/analyze*).

Table 13. Strawberry Creek Land Cover Types from the National Land Cover Database.

Land Cover Type	NLCD Code	Area (km²)	Coverage (%)
Open water	11	0.0	0.03
Perennial ice/snow	12	0.0	0.0
Developed, open space	21	0.33	3.57
Developed, low-intensity	22	0.16	1.7
Developed, medium-intensity	23	0.04	0.47
Developed, high-intensity	24	0.0	0.03
Barren land (rock/sand/clay)	31	0.01	0.12
Deciduous forest	41	0.18	1.99
Evergreen forest	42	0.08	0.91
Mixed forest	43	0.03	0.36
Shrub/scrub	52	0.04	0.41
Grassland/herbaceous	71	0.15	1.58
Pasture/hay	81	1.46	15.8
Cultivated crops	82	1.01	10.96
Woody wetlands	90	5.19	56.41
Emergent herbaceous wetlands	95	0.52	5.67
Total	—	9.21	100

Source: https://modelmywatershed.org/analyze

Table 14. Strawberry Creek Watershed Soil Groups Based on the USDA Gridded Soil Survey Geographic Database (gSSURGO).

Infiltration Type	Area (km²)	Coverage (%)
A – high	0.8	8.67
A/D – high/very slow	0	0
B – moderate	0.43	4.66
B/D – medium/very slow	3.46	37.57
C – slow	3.66	39.66
C/D – medium/very slow	0.14	1.5
D – very slow	0.73	7.95
Total	9.22	100

Source: https://modelmywatershed.org/analyze

The Strawberry Creek estuary occupies a broad, gently sloping lake plain with sandy nearshore sediments overlain with organic deposits. This sloping lake plain interfaces with the waters of Sturgeon Bay to form an ecologically complex landform that supports a mosaic of recognizably diverse but often ephemeral and transitioning plant assemblages, all dependent on the water level fluctuations of Lake Michigan.

5.1.2.3.1.4 Peshtigo River Hydrographic Setting

The Peshtigo River flows 219 kilometers (136 mi) from its headwaters in Forest County, Wisconsin, draining a 2,908-km² watershed (fig. 25). The basin drains southeastward across the Wisconsin landscape to the waters of Green Bay, just south of the Wisconsin-Michigan state line. The river's watershed contains a complex bedrock geology of Precambrian granitic and basaltic rocks underlying the headwaters and Ordovician-aged sedimentary formations near the Bay.

Because the lower reaches and mouth where the Peshtigo River enters Green Bay contains very little development, the river is unusual in the region. Historically, the river mouth held lumber-shipping and -milling activities and infrastructure. Seven major tributary streams and smaller streams feed the Peshtigo River, and while there are no natural lakes in the watershed, there are three significant flowages on the main river stem. Two hydroelectric dams are located on the river, the Potato Rapids Dam and the Peshtigo Flowage Dam. Power-generating hydroelectric dams on the river quell reservoirs popular for recreational activities and affect downstream flows, aquatic organism movement, and sedimentation processes. The Lower Peshtigo River begins at the Peshtigo Flowage Dam in the city of Peshtigo and extends to the Bay of Green Bay.



Figure 25. Peshtigo River watershed map (*Source: https://modelmywatershed.org/analyze*).

About 78 percent of the Peshtigo watershed's land cover is forest and wetland with much of the remainder used for agricultural purposes (table 15). The Peshtigo River estuary is a complex wetland landscape, which includes multiple meandering and braided channels that cross a coastal alluvial or deltaic plain at its mouth. The river mouth during high-water levels (581 ft) absorbs multiple side channels to form a broad, indistinctly edged estuarine coastal wetland system. At low-lake levels, the river mouth is confined to its narrow main channel, approximately 0.2 kilometers in width (*https://coast.noaa.gov/llv/#/lake/michigan*).

The alluvial fan of the river mouth lies in the nearly level Lake Nipissing plain, consisting of silty sediments with a complex mix of sandy islands, swamp-filled depressions, and large stands of emergent marsh. These lake-plain sediments can be crudely to well stratified, are generally several meters thick, and include beach sand next to the Bay.

Table 15. Peshtigo River Land Cover Types from the National Land Cover Database.

Land Cover Type	NLCD Code	Area (km^2)	Coverage (%)
Open water	11	58.23	2.01
Perennial ice/snow	12	0.0	0.0
Developed, open space	21	90.78	3.13
Developed, low-intensity	22	25.61	0.88
Developed, medium-intensity	23	7.86	0.27
Developed, high-intensity	24	2.08	0.07
Barren land (rock/sand/clay)	31	2.25	0.08
Deciduous forest	41	928.02	31.96
Evergreen forest	42	43.13	1.49
Mixed forest	43	184.92	6.37
Shrub/scrub	52	26.97	0.93
Grassland/herbaceous	71	42.69	1.47
Pasture/hay	81	30.4	1.05
Cultivated crops	82	383.18	13.2
Woody wetlands	90	1,033.37	35.59
Emergent herbaceous wetlands	95	43.85	1.51
Total	—	2,903.35	100

Source: https://modelmywatershed.org/analyze

The region's complex geology contributes to formation of a broad array of soil types found within the Peshtigo River watershed (table 16).

Table 16. Peshtigo River Watershed Soil Groups Based on the USDA Gridded Soil Survey Geographic Database (gSSURGO).

Infiltration Type	Area (km²)	Coverage (%)
A – high	714.26	24.6
A/D – high/very slow	0.0	0.0
B – moderate	532.36	18.34
B/D – medium/very slow	241.41	8.32
C – slow	1,238.91	42.67
C/D – medium/very slow	172.74	5.95
D – very slow	3.67	0.13
Total	2,903.35	100

Source: https://modelmywatershed.org/analyze

5.1.2.3.1.5 Lower Bay Hydrographic Setting

Major tributaries within the Lower Bay Component include the Little Suamico River, Suamico River, and Duck Creek, along the western shore of the Bay of Green Bay, and Wequiock Creek on the eastern shore.

Lower Bay: Major Tributaries to Green Bay's Western Shore

Major tributaries located within the proposed Lower Bay Component include Duck Creek (fig. 26), Little Suamico River (fig. 27), and Suamico River (fig. 28). Long Tail and Little Tail Points, which extend from Green Bay's western shore, are included in the proposed Lower Bay Component and add an additional 12 kilometers and 6 kilometers of coastal shoreline, respectively. The constructed Cat Island Chain is not located in the proposed Green Bay Reserve boundaries. Hydrographic and watershed information on these three tributaries is included in tables 17–22.

Duck Creek

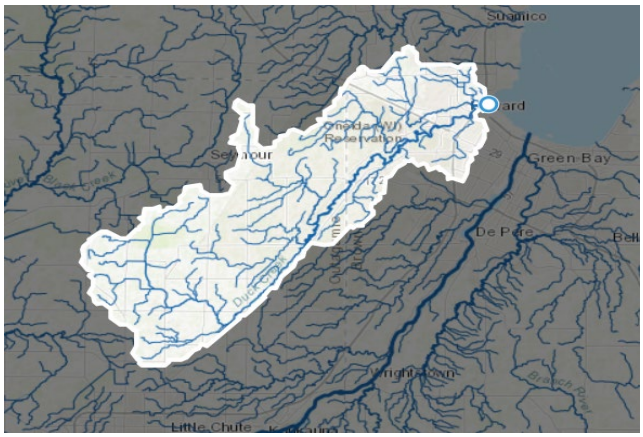


Figure 26. Duck Creek watershed map (*Source: https://modelmywatershed.org/analyze*).

Table 17. Duck Creek Land Cover Types from the National Land Cover Database.

Land Cover Type	NLCD Code	Area (km²)	Coverage (%)
Open water	11	1.09	0.28
Perennial ice/snow	12	0.0	0.0
Developed, open space	21	23.62	5.98
Developed, low-intensity	22	31.41	7.95
Developed, medium-intensity	23	16.5	4.18
Developed, high-intensity	24	5.59	1.42
Barren land (rock/sand/clay)	31	1.16	0.29
Deciduous forest	41	26.08	6.61
Evergreen forest	42	0.42	0.11
Mixed forest	43	1.0	0.25
Shrub/scrub	52	0.44	0.11
Grassland/herbaceous	71	1.01	0.26
Pasture/hay	81	24.24	6.14
Cultivated crops	82	211.18	53.49
Woody wetlands	90	47.47	12.02
Emergent herbaceous wetlands	95	3.61	0.91
Total	—	394.8	100

Source: https://modelmywatershed.org/analyze

Table 18. Duck Creek Watershed Soil Groups Based on the USDA Gridded Soil Survey Geographic Database (SSURGO).

Infiltration Type	Area (km²)	Coverage (%)
A – high	24.85	6.29
A/D – high/very slow	0.0	0.0
B – moderate	28.22	7.15
B/D – medium/very slow	53.73	13.61
C – slow	205.58	52.07
C/D – medium/very slow	66.34	16.8
D – very slow	16.08	4.07
Total	394.8	100

Source: https://modelmywatershed.org/analyze

Little Suamico River

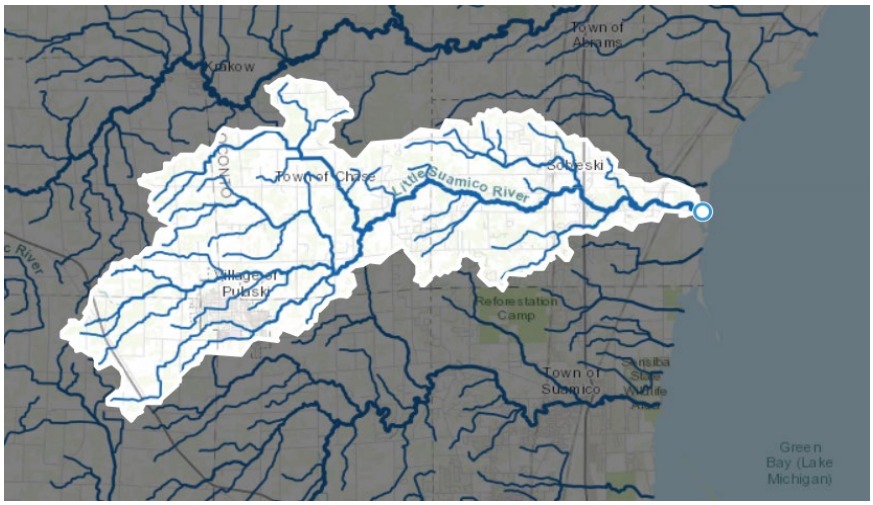


Figure 27. Little Suamico River watershed map (Source: *https://modelmywatershed.org/analyze*).

Table 19. Little Suamico River Land Cover Types from the National Land Cover Database.

Land Cover Type	NLCD Code	Area (km²)	Coverage (%)
Open water	11	0.52	0.33
Perennial ice/snow	12	0.0	0.0
Developed, open space	21	7.11	4.52
Developed, low-intensity	22	6.62	4.2
Developed, medium-intensity	23	2.91	1.85
Developed, high-intensity	24	0.78	0.49
Barren land (rock/sand/clay)	31	0.52	0.33
Deciduous forest	41	15.71	9.98
Evergreen forest	42	2.52	1.6
Mixed forest	43	1.39	0.88
Shrub/scrub	52	0.47	0.3
Grassland/herbaceous	71	0.65	0.41
Pasture/hay	81	7.39	4.69
Cultivated crops	82	87.13	55.33
Woody wetlands	90	22.62	14.37
Emergent herbaceous wetlands	95	1.13	0.72
Total	—	157.48	100

Source: https://modelmywatershed.org/analyze

Table 20. Little Suamico River Watershed Soil Groups Based on the USDA Gridded Soil Survey Geographic Database (gSSURGO).

Infiltration Type	Area (km²)	Coverage (%)
A – high	21.56	13.69
A/D – high/very slow	0.0	0.0
B – moderate	22.42	14.24
B/D – medium/very slow	25.4	16.13
C – slow	65.23	41.42
C/D – medium/very slow	22.75	14.45
D – very slow	0.12	0.08
Total	157.48	100

Source: https://modelmywatershed.org/analyze

Suamico River

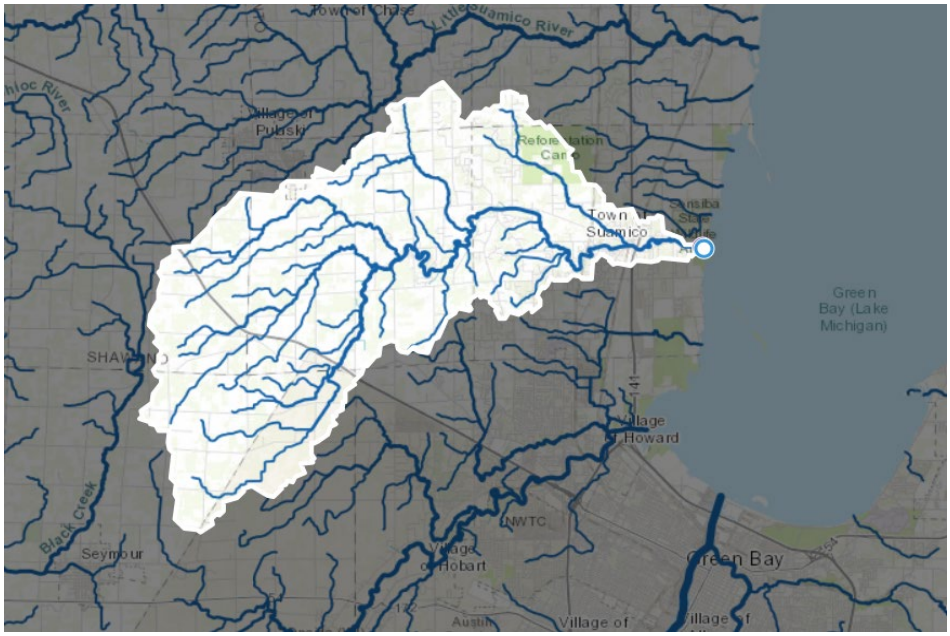


Figure 28. Suamico River watershed map (*Source: https://modelmywatershed.org/analyze*).

Table 21. Suamico River Watershed Land Cover Types from the National Land Cover Database.

Land Cover Type	NLCD Code	Area (km²)	Coverage (%)
Open water	11	0.85	0.49
Perennial ice/snow	12	0.0	0.0
Developed, open space	21	8.07	4.6
Developed, low-intensity	22	7.63	4.36
Developed, medium-intensity	23	2.65	1.51
Developed, high-intensity	24	0.5	0.29
Barren land (rock/sand/clay)	31	0.34	0.2
Deciduous forest	41	13.72	7.83
Evergreen forest	42	1.17	0.67
Mixed forest	43	1.41	0.8
Shrub/scrub	52	0.22	0.13
Grassland/herbaceous	71	0.47	0.27
Pasture/hay	81	7.76	4.43
Cultivated crops	82	106.31	60.65
Woody wetlands	90	23.22	13.25
Emergent herbaceous wetlands	95	0.94	0.54
Total	—	175.28	100

Source: https://modelmywatershed.org/analyze

Table 22. Suamico River Watershed Soil Groups Based on the USDA Gridded Soil Survey Geographic Database (gSSURGO).

Infiltration Type	Area (km²)	Coverage (%)
A – high	25.12	14.33
A/D – high/very slow	0.0	0.0
B – moderate	12.3	7.02
B/D – medium/very slow	46.74	26.67
C – slow	59.92	34.18
C/D – medium/very slow	30.11	17.18
D – very slow	1.09	0.62
Total	175.28	100

Source: https://modelmywatershed.org/analyze

The western landscape of the proposed Lower Bay Component features a gradual, variable gradient. It begins with broad coastal emergent wetlands that transition into lowland hardwood forests, interspersed with residential and light commercial development in the most inland reaches. Long Tail and Little Tail Points feature emergent wetland and forest, and the Duck Creek corridor contains a mix of riparian wetlands, forests, and emergent marsh, along with residential and light commercial development. Offshore, the western portion of the proposed Lower Bay Component includes the shallow littoral zone, often supporting aquatic plant beds.

Like the Peshtigo River Component, the western portion of the proposed Lower Bay Component occupies the lake plain of Lake Nipissing. This lake plain is characterized by nearly level topography, with occasional scattered low dunes. The soils are predominantly poorly drained, loamy fine sand over a sandy and silty lake bed and beach deposits.

Lower Bay: Major Tributaries to Green Bay's Eastern Shore

As previously noted, the proposed Lower Bay Component of the Green Bay Reserve includes one major tributary to Green Bay's eastern shore, Wequiock Creek (fig. 29).



Figure 29. Point au Sable/Wequiock Creek watershed map (*Source: https://modelmywatershed.org/analyze*).

Point au Sable extends a little over one kilometer from the southeastern shore into the shallow waters at the southern end of the Bay of Green Bay. It lies about eight kilometers northeast of the Fox River mouth and embodies a diverse emergent estuarine wetland assemblage at the mouth of Wequiock Creek. The creek drains a 39-km² watershed, with about 63 percent of the watershed in row crops, 13 percent in wooded wetlands, 8 percent in pasturelands, and 2.7 percent in upland forest (Stroud Research Center 2022; table 23).

Table 23. Point au Sable–Wequiock Creek Watershed Land Cover Types from the National Land Cover Database.

Land Cover Type	NLCD Code	Area (km²)	Coverage (%)
Open water	11	0.02	0.06
Perennial ice/snow	12	0.0	0.0
Developed, open space	21	0.74	2.57
Developed, low-intensity	22	1.07	3.7
Developed, medium-intensity	23	0.5	1.72
Developed, high-intensity	24	0.18	0.61
Barren land (rock/sand/clay)	31	0.32	1.1
Deciduous forest	41	0.79	2.72
Evergreen forest	42	0.02	0.06
Mixed forest	43	0.04	0.14
Shrub/scrub	52	0.01	0.03
Grassland/herbaceous	71	0.02	0.06
Pasture/hay	81	2.43	8.39
Cultivated crops	82	18.26	63.11
Woody wetlands	90	4.02	13.88
Emergent herbaceous wetlands	95	0.54	1.87
Total	—	28.93	100

Source: https://modelmywatershed.org/analyze

Table 24. Point au Sable–Wequiock Creek Watershed Soil Groups Based on the USDA Gridded Soil Survey Geographic Database (gSSURGO).

Infiltration Type	Area (km²)	Coverage (%)
A – high	0.05	0.17
A/D – high/very slow	0.0	0.0
B – moderate	0.59	2.04
B/D – medium/very slow	1.81	6.26
C – slow	7.29	25.2
C/D – medium/very slow	5.2	17.98
D – very slow	13.99	48.36
Total	28.93	100

Source: https://modelmywatershed.org/analyze

The Point au Sable–Wequiock Creek watershed includes an offshore area within the shallow shoal that arcs across the Bay to Long Tail Point, which projects from the Bay's western shore. This shoal is not continuous, as it is broken by the deeper shipping channel along the Fox River mouth. The low-lying Point au Sable area comprises silt and silt loams, ranging from irregularly to well stratified, and is bordered by beach sands adjacent to the open waters of Green Bay. These silt loams of the Glenmore Member Kewaunee Formation were formed in the lake plain of Lake Nipissing by postglacial lake levels and are superimposed on the sedimentary shale bedrock of the Maquoketa Formation. Upstream, this shale bedrock unit is visible below Wequiock Falls, where Wequiock Creek flows over the edge of the Niagara Escarpment about 2.7 kilometers from the Bay.

Below the falls, Wequiock Creek developed a complex, meandering channel network through an incised valley of sloping, well-drained silt loams over calcareous clay tills. Above the falls, Wequiock Creek drains relatively flat land characterized by poorly drained clay tills, which have been extensively ditched to facilitate conversion to agricultural use (table 24).

5.1.3 Living Resources

5.1.3.1 Introduction

The proposed Green Bay Reserve possesses an extensive and diverse floral composition, driven by a dynamic climate, a broad spatial scale, and geographically distinct components that each feature unique habitat mosaics. No complete flora inventory of the project area has been completed. The best records to date have been compiled by the University of Wisconsin–Green Bay. Specifically, to understand the diversity and distribution of species within the Lower Green Bay and Fox River area of concern (AOC), the University of Wisconsin–Green Bay created the *Lower Green Bay–Fox River AOC Biota Database*; its findings were summarized in the 2018 *Lower Green Bay and Fox River Area of Concern Habitat Restoration Plan and Path Toward Delisting* (Howe et al. 2018). This report lists species of vertebrates, invertebrates, and vascular plants known or expected to be found within one kilometer inland of the ordinary high-water mark of the area of concern boundary. While the listing only covers the land and water of the Lower Green Bay and Fox River area of concern, the overlap with the proposed Lower Bay Component is significant and useful to understanding the diversity of flora and fauna in the proposed reserve. Extensive reporting does not exist for the flora and fauna of the other proposed components. Information from other sources was used to create the species lists for those sites.

5.1.3.1.1 Flora

According to the 2018 *Lower Green Bay and Fox River Area of Concern Habitat Restoration Plan and Path Toward Delisting* (Howe et al. 2018), 635 vascular plant species, 127 diatoms, 24 fungi, and 23 lichens are known or expected to occur within the Lower Green Bay and Fox River area of concern. This report was used as the basis for additional biotic inventory work for the proposed Green Bay Reserve. Please see the aquatic, wetland/transitional, and upland habitat descriptions in this chapter for detailed information on the composition, diversity, and relationships of flora habitats.

5.1.3.1.2 Fauna

The proposed reserve's location is at the boundary of several ecoregional zones, as well as within a range of geographies captured by its proposed components, creating a site of significant climatic, geographic, and geologic diversity, which leads to a rich array of fauna. The proposed reserve's spatial and geochemical diversity drives biodiversity composition and trophic arrangements across time and space, with varying, multiscale impacts. The site's complexity provides opportunities to study, understand, and educate. This complexity also protects the estuarine system's ability to accommodate novel and fluctuating species assemblages and relationships that form in a shifting climate, continued anthropogenic stresses, and often unforeseen flora and fauna population dynamics.

The following sections list fish, anurans, reptiles, birds, and mammals recorded in the project area and compiled from various sources, including the 2018 *Lower Green Bay and Fox River Area of Concern Habitat Restoration Plan and Path Toward Delisting*, University of Wisconsin–Green Bay field survey data collected within the area of concern, and University of Wisconsin–Green Bay resources on priority fish and wildlife populations within the area of concern. These sources were instrumental in the development of this summary (Howe et al. 2018; University of Wisconsin–Green Bay n.d.b; University of Wisconsin–Green Bay n.d.d).

5.1.3.1.2.1 Mammals

The Bay of Green Bay's coastal wetlands, interior uplands, and agricultural areas support a diverse array of mammals, with 41 known or expected to occur within the Lower Green Bay and Fox River area of concern alone (Howe et al. 2018; table 25).

Table 25. Mammals Known or Expected to Occur in the Lower Green Bay and Fox River Area of Concern.

Common Name	Scientific Name	Group
Northern short-tailed shrew	*Blarina brevicauda*	Shrew
Coyote	*Canis latrans*	Carnivorans
North American beaver	*Castor canadensis*	Rodents
Bat spp.	*Chiroptera (order)*	Bats
Virginia opossum	*Didelphis virginiana*	Opossum
Big brown bat	*Eptesicus fuscus*	Bats
Northern flying squirrel	*Glaucomys sabrinus*	Rodents
Southern flying squirrel	*Glaucomys volans*	Rodents

Common Name	Scientific Name	Group
Thirteen-lined ground squirrel	*Ictidomys tridecemlineatus*	Rodents
Silver-haired bat	*Lasionycteris noctivagans*	Bats
Eastern red bat	*Lasiurus borealis*	Bats
Hoary bat	*Lasiurus cinereus*	Bats
North American river otter	*Lontra canadensis*	Carnivorans
Groundhog	*Marmota monax*	Rodents
Striped skunk	*Mephitis mephitis*	Carnivorans
Prairie vole	*Microtus ochrogaster*	Rodents
Meadow vole	*Microtus pennsylvanicus*	Rodents
Woodland vole	*Microtus pinetorum*	Rodents
House mouse	*Mus musculus*	Rodents
Weasel spp.	*Mustela (genus)*	Carnivorans
Short-tailed weasel	*Mustela erminea*	Carnivorans
Little brown bat	*Myotis lucifugus*	Bats
Northern long-eared bat	*Myotis septentrionalis*	Bats
Woodland jumping mouse	*Napaeozapus insignis*	Rodents
American mink	*Neovison vison*	Carnivorans
White-tailed deer	*Odocoileus virginianus*	Cervids
Muskrat	*Ondatra zibethicus*	Rodents
Tricolored bat	*Perimyotis subflavus*	Bats
White-footed mouse	*Peromyscus leucopus*	Rodents
Raccoon	*Procyon lotor*	Carnivorans
Brown rat	*Rattus norvegicus*	Rodents
Eastern gray squirrel	*Sciurus carolinensis*	Rodents
Fox squirrel	*Sciurus niger*	Rodents
Red squirrel	*Sciurus vulgaris*	Rodents
Masked shrew	*Sorex cinereus*	Shrew
American water shrew	*Sorex palustris*	Shrew
Eastern cottontail	*Sylvilagus floridanus*	Rodents
Eastern chipmunk	*Tamias striatus*	Rodents

Common Name	Scientific Name	Group
Gray fox	*Urocyon cinereoargenteus*	Carnivorans
Red fox	*Vulpes vulpes*	Carnivorans
Meadow jumping mouse	*Zapus hudsonius*	Rodents

The coastal marshes and estuary-riparian wetlands of the proposed Green Bay Reserve provide habitat to aquatic, furbearing mammals such as the American mink, North American river otter, muskrat, and American beaver. The mink and river otter are piscivorous, while the muskrat and beaver consume aquatic and terrestrial plants.

5.1.3.1.2.2 Fish

The coastal submerged and emergent marshes, along with the riparian wetlands of tributaries, provide habitat for many fish. According to McReynolds et al. (2021), at least 45 species representing 17 fish families have been found in the small tributaries of Green Bay, many of which are coastal wetland–spawning species. The diversity and interconnected nature of the Green Bay tributary network, with its headwater and riparian wetlands and its coastal marshes and shallow littoral zone, drives a highly diverse fish composition in this system. In total, 86 fish species have been recorded in the Lower Green Bay and Fox River estuaries by the University of Wisconsin–Green Bay (table 26).

Table 26. Fish Recorded in the Lower Green Bay Estuary.

Common Name	Scientific Name
Lake sturgeon	*Acipenser fulvescens*
Alewife	*Alosa pseudoharengus*
Rock bass	*Ambloplites rupestris*
Black bullhead	*Ameiurus melas*
Yellow bullhead	*Ameiurus natalis*
Brown bullhead	*Ameiurus nebulosus*
Bowfin	*Amia calva*
Freshwater drum	*Aplodinotus grunniens*
Sheepshead	*Archosargus probatocephalus*
Goldfish	*Carassius auratus*
Quillback	*Carpiodes cyprinus*
White sucker	*Catostomus commersonii*
Redside dace	*Clinostomus elongatus*
Lake herring	*Coregonus artedi*
Mottled sculpin	*Cottus bairdii*

Common Name	Scientific Name
Brook stickleback	*Culaea inconstans*
Spotfin shiner	*Cyprinella spiloptera*
Common carp	*Cyprinus carpio*
Gizzard shad	*Dorosoma cepedianum*
Northern pike	*Esox lucius*
Muskellunge	*Esox masquinongy*
Rainbow darter	*Etheostoma caeruleum*
Iowa darter	*Etheostoma exile*
Fantail darter	*Etheostoma flabellare*
Banded killifish	*Fundulus diaphanus*
Mooneye	*Hiodon tergisus*
Brassy minnow	*Hybognathus hankinsoni*
Northern hogsucker	*Hypentelium nigricans*
Channel catfish	*Ictalurus punctatus*
Bigmouth buffalo	*Ictiobus cyprinellus*
Brook silverside	*Labidesthes sicculus*
Longnose gar	*Lepisosteus osseus*
Shortnose gar	*Lepisosteus platostomus*
Green sunfish	*Lepomis cyanellus*
Pumpkinseed	*Lepomis gibbosus*
Warmouth	*Lepomis gulosus*
Orange-spotted sunfish	*Lepomis humilis*
Bluegill sunfish	*Lepomis macrochirus*
Longear sunfish	*Lepomis megalotis*
Burbot	*Lota lota*
Common shiner	*Luxilus cornutus*
Pearl dace	*Margariscus margarita*
Smallmouth bass	*Micropterus dolomieu*
Largemouth bass	*Micropterus salmoides*
White perch	*Morone americana*

Common Name	Scientific Name
White bass	*Morone chrysops*
Yellow bass	*Morone mississippiensis*
Silver redhorse	*Moxostoma anisurum*
River redhorse	*Moxostoma carinatum*
Golden redhorse	*Moxostoma erythrurum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Greater redhorse	*Moxostoma valenciennesi*
Round goby	*Neogobius melanostomus*
Hornyhead chub	*Nocomis biguttatus*
Golden shiner	*Notemigonus crysoleucas*
Emerald shiner	*Notropis atherinoides*
Blacknose shiner	*Notropis heterolepis*
Spottail shiner	*Notropis hudsonius*
Rosyface shiner	*Notropis rubellus*
Sand shiner	*Notropis stramineus*
Tadpole madtom	*Noturus gyrinus*
Coho salmon	*Oncorhynchus kisutch*
Rainbow smelt	*Osmerus mordax*
Yellow perch	*Perca flavescens*
Logperch	*Percina caprodes*
Blackside darter	*Percina maculata*
Trout perch	*Percopsis omiscomaycus*
Sea lamprey	*Petromyzon marinus*
Northern redbelly dace	*Phoxinus eos*
Southern redbelly dace	*Phoxinus erythrogaster*
Finescale dace	*Phoxinus neogaeus*
Bluntnose minnow	*Pimephales notatus*
Fathead minnow	*Pimephales promelas*
White crappie	*Pomoxis annularis*
Black crappie	*Pomoxis nigromaculatus*

Common Name	Scientific Name
Ninespine stickleback	*Pungitius pungitius*
Flathead catfish	*Pylodictis olivaris*
Eastern blacknose dace	*Rhinichthys atratulus*
Longnose dace	*Rhinichthys cataractae*
Western blacknose dace	*Rhinichthys obtusus*
Brown trout	*Salmo trutta*
Sauger	*Sander canadensis*
Walleye	*Sander vitreus*
Common rudd	*Scardinius erythrophthalmus*
Creek chub	*Semotilus atromaculatus*
Central mudminnow	*Umbra limi*

5.1.3.1.2.3 Frogs and Toads

According to recent surveys conducted by the University of Wisconsin–Green Bay, seven frog species and one toad species have been observed in the Lower Green Bay and Fox River area of concern (table 27). It is hypothesized that diversity and abundance of frogs and toads have decreased significantly in the last 100 years due in part to widespread coastal habitat loss (University of Wisconsin–Green Bay n.d.a).

Table 27. Frogs and Toads Recorded in the Lower Green Bay Estuary.

Common Name	Scientific Name
American toad	*Bufo americanus*
Cope's gray treefrog	*Hyla chrysoscelis*
Eastern gray treefrog	*Hyla versicolor*
American bullfrog	*Lithobates catesbeianus*
Green frog	*Lithobates clamitans*
Wood frog	*Lithobates sylvaticus*
Spring peeper	*Pseudacris crucifer*
Northern leopard frog	*Lithobates pipiens*

5.1.3.1.2.4 Reptiles

Snakes

The Wisconsin Department of Natural Resources maintains a county record map library of reptile species (Kapfer and Brown 2022). These data are updated annually. The snake species observed within one or more of the five Wisconsin counties surrounding the Bay of Green Bay are found in table 28.

Table 28. Snakes Observed Within the Bay of Green Bay.

Common Name	Scientific Name
Ring-necked snake	*Diadophis punctatus*
Eastern hognose snake	*Heterodon platirhinos*
Eastern milk snake	*Lampropeltis triangulum*
Common watersnake	*Nerodia sipedon*
Smooth green snake	*Opheodrys vernalis*
Eastern foxsnake	*Pantherophis vulpinus*
DeKay's brownsnake	*Storeria dekayi*
Redbelly snake	*Storeria occipitomaculata*
Eastern ribbon snake	*Thamnophis sauritus*
Common garter snake	*Thamnophis sirtalis*

Turtles

According to the University of Wisconsin–Green Bay (n.d.a), the turtle species listed in table 29 have been observed within the Lower Green Bay and Fox River area of concern or within Brown County, or a suitable habitat for said species is known to be present within these geographies.

Table 29. Turtles Observed Within the Bay of Green Bay.

Common Name	Scientific Name
Blanding's turtle	*Emydoidea blandingii*
Wood turtle	*Glyptemys insculpta*
Spiny softshell turtle	*Apalone spinifera*
Snapping turtle	*Chelydra serpentina*
Painted turtle	*Chrysemys picta*

5.1.3.1.2.5 Birds

The Bay of Green Bay project area is located in the center of the Mississippi migratory flyway through which more than 300 bird species and millions of individual birds migrate each year (National Audubon Society n.d.). As evidence of the avian diversity within the project area, over 200 bird species have been recorded migrating through or residing at Point au Sable alone within a single year (University of Wisconsin–Green Bay n.d.g). In addition, the Wisconsin Department of Natural Resources' 2017–2022 autumn waterfowl surveys (October–December) recorded tens of thousands of ducks using the waters of Green Bay annually, primarily lesser scaup, greater scaup, goldeneyes, and buffleheads. These species use Green Bay as a stopover resting area or over-wintering site in ice-free conditions (Wisconsin Department of Natural Resources n.d.v).

The proposed Green Bay Reserve hosts several Important Bird Areas (fig. 30). Important Bird Areas (IBAs) are sites that provide essential habitat to one or more bird species for breeding, wintering, or migrating (Wisconsin Bird Conservation Partnership n.d.a).

To qualify as an Important Bird Area, a site must support

- endangered or threatened species (i.e., presenting a conservation concern),
- vulnerable species due to narrow distribution,
- vulnerable species due to concentrated populations in one general habitat type, or
- vulnerable species due to congregation during breeding, feeding, or migration.

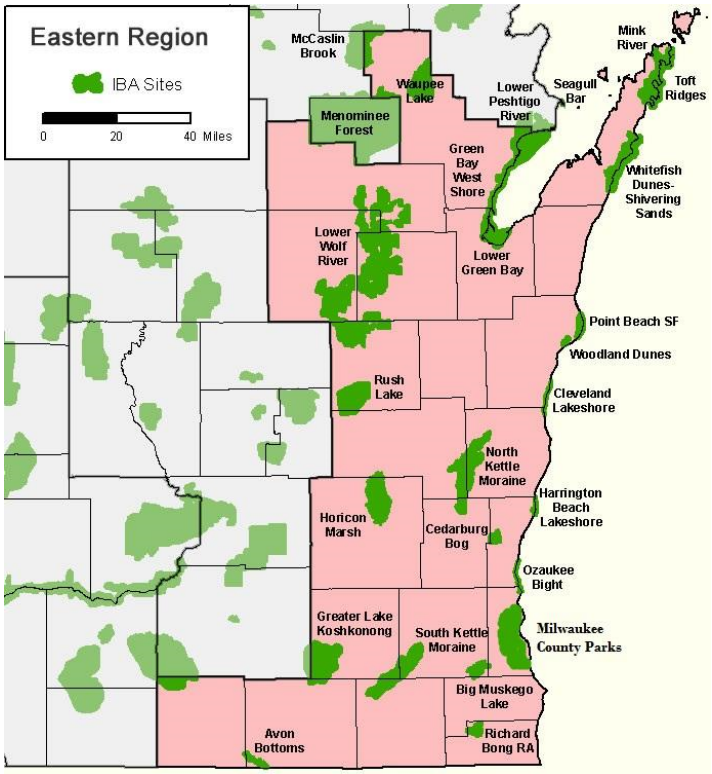


Figure 30. Important Bird Areas (IBAs) in Wisconsin's eastern region (Wisconsin Bird Conservation Partnership n.d.b).

Table 30 lists bird species recorded within each component of the proposed Green Bay Reserve. Methods of data collection include standardized survey methods (e.g., point counts, transects), citizen science observations, and historic records. In general, larger sites (e.g., Lower Bay Component) have more species records than smaller sites.

Lower Green Bay records are taken from Howe et al. (2018). Peshtigo Component records derive from e-bird files (n.d.) of the Peshtigo harbor area over the past 10 years. Sturgeon Bay records are limited to June observations within the Crossroads and Strawberry Creek landscapes (Grimm 2021).

Table 30. Birds Recorded Within Each Component of the Proposed Green Bay Reserve.

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Acadian flycatcher	*Empidonax virescens*	x		
Alder flycatcher	*Empidonax alnorum*	x		x
American avocet	*Recurvirostra americana*	x		
American bittern	*Botaurus lentiginosus*	x	x	
American black duck	*Anas rubripes*	x		
American coot	*Fulica americana*	x		
American crow	*Corvus brachyrhynchos*	x	x	x
American golden plover	*Pluvialis dominica*	x		
American goldfinch	*Spinus tristis*	x	x	x
American kestrel	*Falco sparverius*	x	x	
American redstart	*Setophaga ruticilla*	x	x	x
American robin	*Turdus migratorius*	x	x	x
American tree sparrow	*Spizella arborea*	x		
American white pelican	*Pelecanus erythrorhynchos*	x	x	x
American wigeon	*Anas americana*	x		
American woodcock	*Scolopax minor*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Arctic tern	*Sterna paradisaea*	x		
Baird's sandpiper	*Calidris bairdii*	x		
Bald eagle	*Haliaeetus leucocephalus*	x	x	
Baltimore oriole	*Icterus galbula*	x	x	x
Bank swallow	*Riparia riparia*	x	x	
Barn swallow	*Hirundo rustica*	x	x	
Barred owl	*Strix varia*	x		
Bay-breasted warbler	*Setophaga castanea*	x		
Belted kingfisher	*Megaceryle alcyon*	x	x	x
Black scoter	*Melanitta americana*	x		
Black tern	*Chlidonias niger*	x		
Black-and-white warbler	*Mniotilta varia*	x	x	x
Black-bellied plover	*Pluvialis squatarola*	x		
Black-bellied whistling duck	*Dendrocygna autumnalis*	x		
Black-billed cuckoo	*Coccyzus erythropthalmus*	x		
Blackburnian warbler	*Setophaga fusca*	x		
Black-capped chickadee	*Poecile atricapillus*	x	x	x
Black-crowned night heron	*Nycticorax nycticorax*	x		
Black-legged kittiwake	*Rissa tridactyla*	x		
Black-necked stilt	*Himantopus mexicanus*	x		
Blackpoll warbler	*Setophaga striata*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Black-throated blue warbler	*Setophaga caerulescens*	x		
Black-throated green warbler	*Setophaga virens*	x	x	x
Blue jay	*Cyanocitta cristata*	x	x	x
Blue-gray gnatcatcher	*Polioptila caerulea*	x	x	
Blue-headed vireo	*Vireo solitarius*	x		
Blue-winged teal	*Anas discors*	x	x	
Blue-winged warbler	*Vermivora cyanoptera*	x	x	x
Bobolink	*Dolichonyx oryzivorus*	x		x
Bohemian waxwing	*Bombycilla garrulus*	x		
Bonaparte's gull	*Chroicocephalus philadelphia*	x		
Brewer's blackbird	*Euphagus cyanocephalus*	x		
Broad-winged hawk	*Buteo platypterus*	x		x
Brown creeper	*Certhia americana*	x		x
Brown thrasher	*Toxostoma rufum*	x	x	x
Brown-headed cowbird	*Molothrus ater*	x	x	x
Buff-bellied pipit	*Anthus rubescens*	x		
Buff-breasted sandpiper	*Tryngites subruficollis*	x		
Bufflehead	*Bucephala albeola*	x		
Cackling goose	*Branta hutchinsii*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Canada goose	*Branta canadensis*	x	x	x
Canada warbler	*Cardellina canadensis*	x	x	x
Canvasback	*Aythya valisineria*	x		
Cape May warbler	*Setophaga tigrina*	x		
Carolina wren	*Thryothorus ludovicianus*	x		
Caspian tern	*Hydroprogne caspia*	x	x	x
Cattle egret	*Bubulcus ibis*	x		
Cedar waxwing	*Bombycilla cedrorum*	x	x	x
Cerulean warbler	*Setophaga cerulea*	x		
Chestnut-sided warbler	*Setophaga pensylvanica*	x	x	x
Chimney swift	*Chaetura pelagica*	x	x	x
Chipping sparrow	*Spizella passerina*	x	x	x
Clay-colored sparrow	*Spizella pallida*	x		x
Cliff swallow	*Petrochelidon pyrrhonota*	x		
Common eider	*Somateria mollissima*	x		
Common gallinule	*Gallinula galeata*	x		
Common goldeneye	*Bucephala clangula*	x		
Common grackle	*Quiscalus quiscula*	x	x	x
Common loon	*Gavia immer*	x		
Common merganser	*Mergus merganser*	x		
Common nighthawk	*Chordeiles minor*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Common raven	*Corvus corax*	x		x
Common redpoll	*Acanthis flammea*	x		
Common tern	*Sterna hirundo*	x		
Common yellowthroat	*Geothlypis trichas*	x	x	x
Connecticut warbler	*Oporornis agilis*	x		
Cooper's hawk	*Accipiter cooperii*	x	x	
Dark-eyed junco	*Junco hyemalis*	x		
Dickcissel	*Spiza americana*	x		
Double-crested cormorant	*Phalacrocorax auritus*	x	x	
Downy woodpecker	*Picoides pubescens*	x	x	x
Dunlin	*Calidris alpina*	x		
Eared grebe	*Podiceps nigricollis*	x		
Eastern bluebird	*Sialia sialis*	x	x	x
Eastern kingbird	*Tyrannus tyrannus*	x	x	x
Eastern meadowlark	*Sturnella magna*	x		x
Eastern phoebe	*Sayornis phoebe*	x	x	
Eastern screech owl	*Megascops asio*	x		
Eastern towhee	*Pipilo erythrophthalmus*	x	x	x
Eastern whip-poor-will	*Antrostomus vociferus*	x		
Eastern wood pewee	*Contopus virens*	x	x	x
European starling	*Sturnus vulgaris*	x	x	

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Field sparrow	*Spizella pusilla*	x	x	x
Forster's tern	*Sterna forsteri*	x		
Fox sparrow	*Passerella iliaca*	x		
Franklin's gull	*Leucophaeus pipixcan*	x		
Gadwall	*Anas strepera*	x		
Glaucous gull	*Larus hyperboreus*	x		
Golden-crowned kinglet	*Regulus satrapa*	x		
Golden-winged warbler	*Vermivora chrysoptera*	x		
Grasshopper sparrow	*Ammodramus savannarum*	x		x
Gray catbird	*Dumetella carolinensis*	x	x	x
Gray-cheeked thrush	*Catharus minimus*	x	x	
Great black-backed gull	*Larus marinus*	x		
Great blue heron	*Ardea herodias*	x	x	x
Great crested flycatcher	*Myiarchus crinitus*	x		x
Great egret	*Ardea alba*	x	x	
Great horned owl	*Bubo virginianus*	x		
Greater scaup	*Aythya marila*	x		
Greater yellowlegs	*Tringa melanoleuca*	x		
Green heron	*Butorides virescens*	x	x	x
Green-winged teal	*Anas carolinensis*	x	x	

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Hairy woodpecker	*Picoides villosus*	x	x	
Henslow's sparrow	*Ammodramus henslowii*	x		
Hermit thrush	*Catharus guttatus*	x	x	x
Herring gull	*Larus smithsonianus*	x	x	x
Hooded merganser	*Lophodytes cucullatus*	x		
Hooded warbler	*Setophaga citrina*	x		
Horned grebe	*Podiceps auritus*	x		
Horned lark	*Eremophila alpestris*	x		
House finch	*Haemorhous mexicanus*	x		x
House sparrow	*Passer domesticus*	x		
House wren	*Troglodytes aedon*	x	x	x
Hudsonian godwit	*Limosa haemastica*	x		
Iceland gull	*Larus glaucoides*	x		
Indigo bunting	*Passerina cyanea*	x	x	x
Kentucky warbler	*Geothlypis formosa*	x		
Killdeer	*Charadrius vociferus*	x		x
King rail	*Rallus elegans*	x		
Lapland longspur	*Calcarius lapponicus*	x		
Lark sparrow	*Chondestes grammacus*	x		
Lazuli bunting	*Passerina amoena*	x		
Le Conte's sparrow	*Ammodramus leconteii*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Least bittern	*Ixobrychus exilis*	x		
Least flycatcher	*Empidonax minimus*	x	x	
Least sandpiper	*Calidris minutilla*	x		
Lesser black-backed gull	*Larus fuscus*	x		
Lesser scaup	*Aythya affinis*	x		
Lesser yellowlegs	*Tringa flavipes*	x		
Lincoln's sparrow	*Melospiza lincolnii*	x		
Little gull	*Hydrocoloeus minutus*	x		
Loggerhead shrike	*Lanius ludovicianus*	x		
Long-billed dowitcher	*Limnodromus scolopaceus*	x		
Long-tailed duck	*Clangula hyemalis*	x		
Louisiana waterthrush	*Seiurus motacilla*		x	
Magnolia warbler	*Setophaga magnolia*	x		x
Mallard	*Anas platyrhynchos*	x	x	x
Marbled godwit	*Limosa fedoa*	x		
Marsh wren	*Cistothorus palustris*	x	x	
Merlin	*Falco columbarius*	x	x	
Mourning dove	*Zenaida macroura*	x	x	x
Mourning warbler	*Geothlypis philadelphia*	x	x	x
Mute swan	*Cygnus olor*	x		
Nashville warbler	*Oreothlypis ruficapilla*	x	x	x

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Northern cardinal	*Cardinalis cardinalis*	x		x
Northern flicker	*Colaptes auratus*	x	x	x
Northern harrier	*Circus cyaneus*	x	x	
Northern parula	*Setophaga americana*	x		x
Northern pintail	*Anas acuta*	x		
Northern rough-winged swallow	*Stelgidopteryx serripennis*	x		
Northern saw-whet owl	*Aegolius acadicus*	x		
Northern shoveler	*Anas clypeata*	x		
Northern shrike	*Lanius excubitor*	x		
Northern waterthrush	*Parkesia noveboracensis*	x	x	x
Olive-sided flycatcher	*Contopus cooperi*	x		
Orange-crowned warbler	*Oreothlypis celata*	x		
Orchard oriole	*Icterus spurius*	x		
Osprey	*Pandion haliaetus*	x	x	x
Ovenbird	*Seiurus aurocapilla*	x	x	x
Pacific loon	*Gavia pacifica*	x		
Palm warbler	*Setophaga palmarum*	x	x	
Parasitic jaeger	*Stercorarius parasiticus*	x		
Pectoral sandpiper	*Calidris melanotos*	x		
Peregrine falcon	*Falco peregrinus*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Philadelphia vireo	*Vireo philadelphicus*	x		
Pied-billed grebe	*Podilymbus podiceps*	x	x	
Pileated woodpecker	*Dryocopus pileatus*	x	x	x
Pine grosbeak	*Pinicola enucleator*	x		
Pine siskin	*Spinus pinus*	x		
Pine warbler	*Setophaga pinus*	x	x	
Piping plover	*Charadrius melodus*	x		
Prairie warbler	*Setophaga discolor*	x		
Prothonotary warbler	*Protonotaria citrea*	x		
Purple finch	*Haemorhous purpureus*	x		x
Purple martin	*Progne subis*	x	x	
Red crossbill	*Loxia curvirostra*	x		
Red knot	*Calidris canutus*	x		
Red phalarope	*Phalaropus fulicarius*	x		
Red-bellied woodpecker	*Melanerpes carolinus*	x	x	x
Red-breasted merganser	*Mergus serrator*	x		
Red-breasted nuthatch	*Sitta canadensis*	x	x	x
Red-eyed vireo	*Vireo olivaceus*	x	x	x
Redhead	*Aythya americana*	x		
Red-headed woodpecker	*Melanerpes erythrocephalus*	x	x	

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Red-necked grebe	*Podiceps grisegena*	x		
Red-necked phalarope	*Phalaropus lobatus*	x		
Red-shouldered hawk	*Buteo lineatus*	x	x	
Red-tailed hawk	*Buteo jamaicensis*	x		x
Red-throated loon	*Gavia stellata*	x		
Red-winged blackbird	*Agelaius phoeniceus*	x	x	x
Ring-billed gull	*Larus delawarensis*	x	x	
Ring-necked duck	*Aythya collaris*	x		
Ring-necked pheasant	*Phasianus colchicus*	x	x	
Rock pigeon	*Columba livia*	x	x	
Rose-breasted grosbeak	*Pheucticus ludovicianus*	x	x	x
Ross's goose	*Chen rossii*	x		
Rough-legged hawk	*Buteo lagopus*	x		
Ruby-crowned kinglet	*Regulus calendula*	x	x	
Ruby-throated hummingbird	*Archilochus colubris*	x		
Ruddy duck	*Oxyura jamaicensis*	x		
Ruddy turnstone	*Arenaria interpres*	x		
Ruffed grouse	*Bonasa umbellus*	x		x
Rusty blackbird	*Euphagus carolinus*	x		
Sanderling	*Calidris alba*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Sandhill crane	*Grus canadensis*	x	x	x
Savannah sparrow	*Passerculus sandwichensis*	x		
Scarlet tanager	*Piranga olivacea*	x	x	x
Sedge wren	*Cistothorus platensis*	x	x	
Semipalmated plover	*Charadrius semipalmatus*	x		
Semipalmated sandpiper	*Calidris pusilla*	x		
Sharp-shinned hawk	*Accipiter striatus*	x		
Short-billed dowitcher	*Limnodromus griseus*	x		
Short-eared owl	*Asio flammeus*	x		
Snow bunting	*Plectrophenax nivalis*	x		
Snow goose	*Chen caerulescens*	x		
Snowy egret	*Egretta thula*	x		
Snowy owl	*Bubo scandiacus*	x		
Solitary sandpiper	*Tringa solitaria*	x		
Song sparrow	*Melospiza melodia*	x	x	x
Sora	*Porzana carolina*	x	x	
Spotted sandpiper	*Actitis macularius*	x		x
Spotted towhee	*Pipilo maculatus*	x		
Stilt sandpiper	*Calidris himantopus*	x		
Summer tanager	*Piranga rubra*	x		
Surf scoter	*Melanitta perspicillata*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Swainson's thrush	*Catharus ustulatus*	x		
Swamp sparrow	*Melospiza georgiana*	x	x	
Tennessee warbler	*Oreothlypis peregrina*	x		
Thayer's gull	*Larus thayeri*	x		
Townsend's solitaire	*Myadestes townsendi*	x		
Tree swallow	*Tachycineta bicolor*	x	x	x
Tricolored heron	*Egretta tricolor*	x		
Trumpeter swan	*Cygnus buccinator*	x		
Tufted titmouse	*Baeolophus bicolor*	x		
Tundra swan	*Cygnus columbianus*	x		
Turkey vulture	*Cathartes aura*	x	x	
Upland sandpiper	*Bartramia longicauda*	x		
Varied thrush	*Ixoreus naevius*	x		
Veery	*Catharus fuscescens*	x	x	
Vesper sparrow	*Pooecetes gramineus*	x		
Virginia rail	*Rallus limicola*	x		
Warbling vireo	*Vireo gilvus*	x	x	x
Western meadowlark	*Sturnella neglecta*	x		
Whimbrel	*Numenius phaeopus*	x		
White ibis	*Eudocimus albus*	x		
White-breasted nuthatch	*Sitta carolinensis*	x	x	

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
White-crowned sparrow	*Zonotrichia leucophrys*	x	x	
White-rumped sandpiper	*Calidris fuscicollis*	x		
White-throated sparrow	*Zonotrichia albicollis*	x	x	x
White-winged crossbill	*Loxia leucoptera*	x		
White-winged dove	*Zenaida asiatica*	x		
White-winged scoter	*Melanitta deglandi*	x		
Wild turkey	*Meleagris gallopavo*	x	x	x
Willet	*Tringa semipalmata*	x		
Willow flycatcher	*Empidonax traillii*	x		
Wilson's phalarope	*Phalaropus tricolor*	x		
Wilson's snipe	*Gallinago delicata*	x		
Wilson's warbler	*Cardellina pusilla*	x	x	
Winter wren	*Troglodytes hiemalis*	x		x
Wood duck	*Aix sponsa*	x	x	
Wood thrush	*Hylocichla mustelina*	x	x	x
Yellow warbler	*Setophaga petechia*	x	x	
Yellow-bellied flycatcher	*Empidonax flaviventris*	x		
Yellow-bellied sapsucker	*Sphyrapicus varius*	x	x	
Yellow-billed cuckoo	*Coccyzus americanus*	x		x
Yellow-crowned night heron	*Nyctanassa violacea*	x		

Common Name	Scientific Name	Lower Bay	Peshtigo	Sturgeon Bay
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	x		
Yellow-rumped warbler	*Setophaga coronata*	x	x	x
Yellow-throated vireo	*Vireo flavifrons*	x	x	

* *Lower Bay records are for the Lower Bay and Fox River area of concern.*

5.1.3.2 Special-Status Species and Habitats

Multiple federal- and state-listed species are known or expected to occur within some portion of the project area. According to the final report for the *Lower Green Bay and Fox River Area of Concern Habitat Restoration Plan and Path Toward Delisting Project* (Howe et al. 2018), 112 state-listed species are known or expected to occur within the area of concern. Per the U.S. Fish and Wildlife Service's Information for Planning and Consultation tool (n.d.), an additional 13 species listed or proposed for listing under the Endangered Species Act are known or expected to occur within the proposed reserve's components. Table 31 lists endangered, threatened, or special concern species found in the project area.

Table 31. Federal- and State-Listed Endangered, Threatened, and Special Concern Species in the Project Area.

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
American bullfrog	*Lithobates catesbeianus*	Amphibians	N/A	Special Concern
Common mudpuppy	*Necturus maculosus*	Amphibians	N/A	Special Concern
Northern leopard frog	*Lithobates pipiens*	Amphibians	Species of Concern	Special Concern
Hine's emerald dragonfly	*Somatochlora hineana*	Arthropods	Endangered	Endangered
Monarch butterfly	*Danaus plexippus*	Arthropods	Proposed Threatened	N/A
Hairy-necked tiger beetle	*Cicindela hirticollis rhodensis*	Arthropods	N/A	Endangered

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Northern blue butterfly	*Lycaeides idas*	Arthropods	N/A	Endangered
Regal fritillary	*Speyeria idalia*	Arthropods	Species of Concern	Endangered
Rusty patched bumble bee	*Bombus affinis*	Arthropods	Endangered	Special Concern
Acadian flycatcher	*Empidonax virescens*	Birds	N/A	Threatened
American bittern	*Botaurus lentiginosus*	Birds	N/A	Special Concern
American black duck	*Anas rubripes*	Birds	N/A	Special Concern
American golden plover	*Pluvialis dominica*	Birds	N/A	Special Concern
American white pelican	*Pelecanus erythrorhynchos*	Birds	N/A	Special Concern
American woodcock	*Scolopax minor*	Birds	N/A	Special Concern
Bald eagle	*Haliaeetus leucocephalus*	Birds	N/A	Special Concern
Black tern	*Chlidonias niger*	Birds	Species of Concern	Endangered
Black-billed cuckoo	*Coccyzus erythropthalmus*	Birds	N/A	Special Concern
Black-crowned night heron	*Nycticorax nycticorax*	Birds	N/A	Special Concern
Black-necked stilt	*Himantopus mexicanus*	Birds	N/A	Special Concern
Black-throated blue warbler	*Setophaga caerulescens*	Birds	N/A	Special Concern

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Blue-winged teal	*Anas discors*	Birds	N/A	Special Concern
Blue-winged warbler	*Vermivora cyanoptera*	Birds	N/A	Special Concern
Brown thrasher	*Toxostoma rufum*	Birds	N/A	Special Concern
Buff-breasted sandpiper	*Tryngites subruficollis*	Birds	N/A	Special Concern
Canada warbler	*Cardellina canadensis*	Birds	N/A	Special Concern
Canvasback	*Aythya valisineria*	Birds	N/A	Special Concern
Cape May warbler	*Setophaga tigrina*	Birds	N/A	Special Concern
Caspian tern	*Hydroprogne caspia*	Birds	N/A	Endangered
Cattle egret	*Bubulcus ibis*	Birds	N/A	Special Concern
Cerulean warbler	*Setophaga cerulea*	Birds	N/A	Threatened
Common gallinule	*Gallinula galeata*	Birds	N/A	Special Concern
Common goldeneye	*Bucephala clangula*	Birds	N/A	Special Concern
Common nighthawk	*Chordeiles minor*	Birds	N/A	Special Concern
Common tern	*Sterna hirundo*	Birds	Species of Concern	Endangered
Connecticut warbler	*Oporornis agilis*	Birds	N/A	Special Concern
Dickcissel	*Spiza americana*	Birds	N/A	Special Concern

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Dunlin	*Calidris alpina*	Birds	N/A	Special Concern
Eastern meadowlark	*Sturnella magna*	Birds	N/A	Special Concern
Eastern whip-poor-will	*Antrostomus vociferus*	Birds	N/A	Special Concern
Field sparrow	*Spizella pusilla*	Birds	N/A	Special Concern
Forster's tern	*Sterna forsteri*	Birds	N/A	Endangered
Golden-winged warbler	*Vermivora chrysoptera*	Birds	Species of Concern	Special Concern
Grasshopper sparrow	*Ammodramus savannarum*	Birds	N/A	Special Concern
Great black-backed gull	*Larus marinus*	Birds	N/A	Special Concern
Great egret	*Ardea alba*	Birds	N/A	Threatened
Henslow's sparrow	*Ammodramus henslowii*	Birds	Species of Concern	Threatened
Hooded warbler	*Setophaga citrina*	Birds	N/A	Threatened
Horned grebe	*Podiceps auritus*	Birds	N/A	Special Concern
Hudsonian godwit	*Limosa haemastica*	Birds	N/A	Special Concern
Kentucky warbler	*Geothlypis formosa*	Birds	N/A	Threatened
King rail	*Rallus elegans*	Birds	N/A	Special Concern

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Lark sparrow	*Chondestes grammacus*	Birds	N/A	Special Concern
Le Conte's sparrow	*Ammodramus leconteii*	Birds	N/A	Special Concern
Least bittern	*Ixobrychus exilis*	Birds	N/A	Special Concern
Least flycatcher	*Empidonax minimus*	Birds	N/A	Special Concern
Lesser scaup	*Aythya affinis*	Birds	N/A	Special Concern
Loggerhead shrike	*Lanius ludovicianus*	Birds	N/A	Endangered
Northern harrier	*Circus cyaneus*	Birds	N/A	Special Concern
Northern pintail	*Anas acuta*	Birds	N/A	Special Concern
Peregrine falcon	*Falco peregrinus*	Birds	N/A	Endangered
Philadelphia vireo	*Vireo philadelphicus*	Birds	N/A	Special Concern
Piping plover	*Charadrius melodus*	Birds	Endangered	Endangered
Prothonotary warbler	*Protonotaria citrea*	Birds	N/A	Special Concern
Purple martin	*Progne subis*	Birds	N/A	Special Concern
Red crossbill	*Loxia curvirostra*	Birds	N/A	Special Concern
Red knot	*Calidris canutus*	Birds	Threatened	N/A
Redhead	*Aythya americana*	Birds	N/A	Special Concern

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Red-headed woodpecker	*Melanerpes erythrocephalus*	Birds	N/A	Special Concern
Red-necked grebe	*Podiceps grisegena*	Birds	N/A	Endangered
Red-shouldered hawk	*Buteo lineatus*	Birds	N/A	Threatened
Ruby-crowned kinglet	*Regulus calendula*	Birds	N/A	Special Concern
Ruddy duck	*Oxyura jamaicensis*	Birds	N/A	Special Concern
Rusty blackbird	*Euphagus carolinus*	Birds	N/A	Special Concern
Short-billed dowitcher	*Limnodromus griseus*	Birds	N/A	Special Concern
Short-eared owl	*Asio flammeus*	Birds	N/A	Special Concern
Snowy egret	*Egretta thula*	Birds	N/A	Special Concern
Solitary sandpiper	*Tringa solitaria*	Birds	N/A	Special Concern
Swainson's thrush	*Catharus ustulatus*	Birds	N/A	Special Concern
Upland sandpiper	*Bartramia longicauda*	Birds	N/A	Threatened
Vesper sparrow	*Pooecetes gramineus*	Birds	N/A	Special Concern
Western meadowlark	*Sturnella neglecta*	Birds	N/A	Special Concern
whimbrel	*Numenius phaeopus*	Birds	N/A	Special Concern
White-winged crossbill	*Loxia leucoptera*	Birds	N/A	Special Concern

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Whooping crane	*Grus americana*	Birds	Experimental Population, non-essential	Special Concern
Willow flycatcher	*Empidonax traillii*	Birds	N/A	Special Concern
Wilson's phalarope	*Phalaropus tricolor*	Birds	N/A	Special Concern
Wilson's warbler	*Cardellina pusilla*	Birds	N/A	Special Concern
Wood thrush	*Hylocichla mustelina*	Birds	N/A	Special Concern
Yellow-billed cuckoo	*Coccyzus americanus*	Birds	N/A	Special Concern
Yellow-crowned night heron	*Nyctanassa violacea*	Birds	N/A	Threatened
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Birds	N/A	Special Concern
American eel	*Anguilla rostrata*	Fish	N/A	Special Concern
Banded killifish	*Fundulus diaphanus*	Fish	N/A	Special Concern
Lake sturgeon	*Acipenser fulvescens*	Fish	N/A	Special Concern
Longear sunfish	*Lepomis megalotis*	Fish	N/A	Threatened
River redhorse	*Moxostoma carinatum*	Fish	N/A	Threatened
American water shrew	*Sorex palustris*	Mammals	N/A	Special Concern
Big brown bat	*Eptesicus fuscus*	Mammals	N/A	Threatened

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Canada lynx	*Lynx canadensis*	Mammals	Threatened	N/A
Gray wolf	*Canis lupus*	Mammals	Endangered	N/A
Little brown bat	*Myotis lucifugus*	Mammals	N/A	Threatened
Northern flying squirrel	*Glaucomys sabrinus*	Mammals	N/A	Special Concern
Northern long-eared bat	*Myotis septentrionalis*	Mammals	Endangered	Threatened
Prairie vole	*Microtus ochrogaster*	Mammals	N/A	Special Concern
Silver-haired bat	*Lasionycteris noctivagans*	Mammals	N/A	Special Concern
Tricolored bat	*Perimyotis subflavus*	Mammals	Endangered	Threatened
Woodland jumping mouse	*Napaeozapus insignis*	Mammals	N/A	Special Concern
Woodland vole	*Microtus pinetorum*	Mammals	N/A	Special Concern
Salamander mussel	*Simpsonaias ambigua*	Mussels	Proposed Endangered	Threatened
American searocket	*Cakile edentula lacustris*	Plants	N/A	Special Concern
Butternut	*Juglans cinerea*	Plants	N/A	Special Concern
Common marsh bedstraw	*Galium palustre*	Plants	N/A	Endangered
Dwarf lake iris	*Iris lacustris*	Plants	Threatened	Threatened

Common Name	Scientific Name	Taxon	Federal Status	State Status (WI)
Pitcher's thistle	*Cirsium pitcheri*	Plants	Threatened	Threatened
Snow trillium	*Trillium nivale*	Plants	N/A	Threatened
Blanding's turtle	*Emydoidea blandingii*	Reptiles	N/A	Special Concern
Butler's garter snake	*Thamnophis butleri*	Reptiles	N/A	Special Concern
Eastern ribbon snake	*Thamnophis sauritus*	Reptiles	N/A	Endangered
Queen snake	*Regina septemvittata*	Reptiles	N/A	Endangered
Wood turtle	*Glyptemys insculpta*	Reptiles	N/A	Threatened

5.1.3.3 Invasive Species

An invasive species is a non-native organism that causes ecological or economic harm in its new environment. Since the early 1800s, 185 aquatic invasive species have entered the Great Lakes, with the first recorded in Green Bay in the 1890s (Wisconsin Sea Grant 2013). Introduction of invasive species has since increased exponentially. Invasive species have largely been introduced—intentionally and unintentionally—by human activities over time. Common vectors for introduction of aquatic invasive species include accidental escape, aquarium releases, ballast water, development of canals connecting two previously unconnected water bodies, and "hitchhiking" on boats, nets, or other equipment. Within Green Bay, established and destructive invasive species include common reed (*Phragmites australis*), Eurasian watermilfoil (*Myriophyllum spicatum*), purple loosestrife (*Lythrum salicaria*), curly-leaf pondweed (*Potamogeton crispus*), common carp (*Cyprinus carpio*), rainbow smelt (*Osmerus mordax*), sea lamprey (*Petromyzon marinus*), alewife (*Alosa pseudoharengus*), white perch (*Monroe americana*), round goby (*Neogobius melanostomus*), ruffe (*Gymnocephalus cernuus*), spiny waterflea (*Bythotrephes cederstroemi*), fishhook Waterflea (*Cercopagis pengoi*), zebra mussel (*Dreissena polymorpha*), quagga mussel (*Dreissena bugensis*), European frogbit (*Hydrocharis morsus-ranae*), starry stonewort (*Nitellopsis obtuse*), freshwater golden clam (*Corbicula fluminea)*, Chinese mystery snail, banded mystery snail (*Callinina georgiana*), flowering rush (*Butomus umbellatus*), and bloody red shrimp (*Hemimysis anomala*). For detailed information on the origins, impacts, and control mechanisms for these species, please reference Wisconsin Sea Grant's 2013 *State of the Bay* report and more recent reports from the Wisconsin Department of Natural Resources (Qualls, Harris, and Harris 2013).

5.2 Human Environment

5.2.1 Prehistoric, Historic, and Current Human Uses

5.2.1.1 Prehistoric Setting

The geography of northeastern Wisconsin and the proposed Green Bay Reserve was formed about 12,000 years ago during the final part of the Wisconsin Glaciation. The initial Wisconsin Glaciation period began about 100,000 years ago when the Laurentide ice sheet covered North America. The ice sheet entered the area of present-day Wisconsin about 30,000 years ago (Clayton et al. 2006). Through multiple warming and cooling episodes, the ice sheet advanced and retreated over present-day northern and eastern Wisconsin. Glacial geologists classify the Laurentide ice sheet components entering Wisconsin as semi-independent glacial lobes (Mickelson and Attig 2017). The geography of the proposed Green Bay Reserve site was primarily shaped by multiple episodes of the Green Bay Lobe's southern advancement and northern retreat.

The Green Bay Lobe's westernmost marginal ridges formed north-south moraines across central Wisconsin's Marathon, Portage, and Waushara counties (Mickelson and Attig 2017). Its eastern border is better known as the Niagara Escarpment (fig. 31). The prominent, erosion-resistant Niagara Escarpment consists of steep, nearly vertical ridges forming the Bay of Green Bay's eastern shoreline. It extends south along Lake Winnebago into Illinois and northeast along the southern border of Michigan's Upper Peninsula, crossing Ontario, Canada, and New York's Niagara Falls (Stieglitz 2016).

Between the Green Bay Lobe's western and eastern borders, the glacier's heavy weight and its episodic advancements and retreats eroded and smoothed underlying rock to create a subtle northeastern slope (Mickelson and Attig 2017). The final retreat of the Green Bay Lobe about 12,000 years ago shaped the Green Bay and Fox River lowlands and the Bay of Green Bay. A combination of the northeasterly slope created by the glacier's final retreat and the Niagara Escarpment along the Bay of Green Bay's eastern border allowed a tremendous amount of glacial melt to pool and create the lowlands, Bay of Green Bay, and the entire proposed Green Bay Reserve project area.

5.2.1.2 Tribal Lifeways

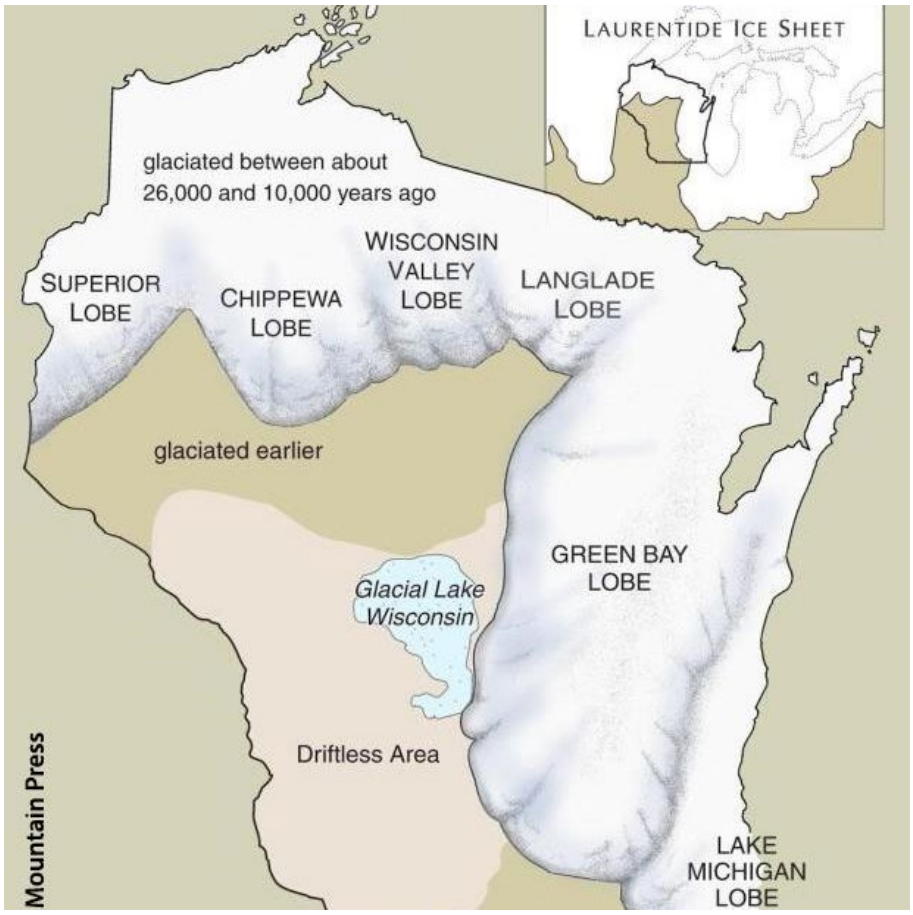


Figure 31. Wisconsin glaciation and Niagara Escarpment lobes (Ham 2023).

5.2.1.2.1 A Brief History of Wisconsin's First Peoples

Paleo-Indians

Archeologists use the term *Paleo-Indian* to refer to the first human inhabitants of the Americas. In accordance with the Wisconsin Historical Society's historical essay, *A Short History of Wisconsin*, Paleo-Indians resided in present-day Wisconsin between 10,000 and 6500 BCE. They hunted wooly mammoths, mastodon, and bison and foraged wild foods for subsistence. Archaeologists have found stone and copper tools from 5000 BCE throughout the state (n.d.a).

Late Woodland Indians, the Effigy Mound Builders

According to the Wisconsin Historical Society (n.d.b),

> Between 700 BCE and 1 CE, pottery, domesticated plants, and the practice of building earthen burial mounds were introduced to Wisconsin. These changes created the beginning of the Woodland Tradition. However, life remained relatively stable until the beginning of the Late Woodland stage, between 600 and 900 CE. During this period two important innovations — the bow and arrow and corn horticulture — swept across the region. Within a span of only a couple centuries, a new and distinct culture arose in Wisconsin. Archaeologists call it "Effigy Mound" culture. The name is inspired by the unique burial mounds constructed by the native communities of southern Wisconsin. Some effigies are in the form of birds, bear, deer, spirit animals or people. Other mounds are abstract, such as combinations of embankments with dome-shaped mounds. . . . During this period, community members also began to harvest corn, prepare fields and process wild nuts, fish, and mussels for winter storage.
>
> These surpluses, combined with the ease of bow hunting, fueled a rise in population, which reduced the need to move from place to place. To accommodate larger populations, the Mound Cultures started building pole-frame wigwams for housing. By 900 CE, some communities in eastern Wisconsin had begun to settle in semipermanent villages.

Mississippian Culture and Aztalan

Around 1000 CE, individuals from Cahokia, a large community located near present-day St. Louis, settled in northern Illinois and, eventually, Wisconsin. Per the Wisconsin Historical Society (n.d.c),

> Archaeologists call their culture "Middle Mississippian." . . . Cahokia gave rise to a number of small communities across the upper Midwest. Residents engaged in corn agriculture, pottery production, and trade with their Woodland neighbors. The Middle Mississippians soon created a vast trade network that moved valuable items across the continent and exposed Woodland peoples to Middle Mississippian culture. Some northern Mississippian outposts were in Wisconsin. The largest were located at the modern city of Trempealeau and Aztalan on the Crawfish River. . . . By approximately 1200 CE, Aztalan and Trempealeau were abandoned. Near the same time, Cahokia slipped into decline. These cultures evolved into the new Mississippian culture known as Oneota. The new civilization began to expand across the Midwest, giving rise to many of the tribal groups known today.

Specifically, the Menominee, Ho-Chunk (Winnebago), and Dakota (Eastern Sioux) are thought to be descendants of the Oneota.

5.2.1.2.2 Historic Wisconsin Indian Period and Arrival of Europeans

Other tribes began to migrate into modern-day Wisconsin in the sixteenth and seventeenth centuries, including the Ojibwe (Chippewa), who migrated from the eastern Great Lakes around 1500, and the Sauk, Meskwaki (Fox), Potawatomi, Mascouten, Kickapoo, Ottawa, Miami, and Huron, who emigrated from Canada, New York, Ohio, and Michigan as a result of the Iroquois Wars in the mid-1600s (Wisconsin Historical Society n.d.a). The Oneota population and culture declined rapidly, likely driven by epidemic disease, rising regional conflict, and other factors.

In 1634, Frenchman Jean Nicolet became the first recorded European to land on the shores of Wisconsin. Nicolet voyaged across Lake Michigan and landed on the southeastern shore of the Door Peninsula in Green Bay. Records of his travel include the first written account of the existence of Indigenous peoples in Wisconsin, specifically the Ho-Chunk and Potawatomi. Other records maintain a strong presence of Menominee living along

the western shore of Green Bay (Mason 1986). Menominee legend says that their foundational culture hero, Me'napus, and all great game animals were born in this region. Nicolet's arrival into Wisconsin, specifically to the Bay of Green Bay, began what is referred to as the *Historic period* in Wisconsin's history. The Bay of Green Bay and its surrounding region in northeastern Wisconsin hosted significant and entwined environmental and economic events during the Historic period.

The location of Nicolet's arrival in Wisconsin, often referred to as "Red Banks," is thought to be about 12 miles northeast of the present-day City of Green Bay (Holand 1925). Nicolet and the Huron people who traveled with him arrived at the mouth of Green Bay seeking a meeting with the Ho-Chunk people. At Red Banks, they encountered a large settlement of roughly 4,000 to 5,000 people; while some accounts describe this as a multi-tribal site, it was more than likely a Potawatomi village (Holand 1925). Records of European travels through Lake Michigan and along the Bay indicate the presence of Potawatomi, Menominee, and Sauk villages across the Door Peninsula. It is believed the Ho-Chunk, known as "People of the Sea" and whom Nicolet was traveling to meet, warred with these groups in pursuit of land on the peninsula and forced these groups to push westward toward the southern and western sides of the Bay and along the Fox River. Unfortunately, the Ho-Chunk people, who were eventually found by Nicolet, appeared to have suffered a severe decline in population, likely caused by European diseases; and no Early Historic Ho-Chunk (Winnebago) village has ever been found on the Door Peninsula (Mason 1986).

For a long period during the early seventeenth century, the Door Peninsula, waters of Green Bay, and western waters of Lake Superior and Lake Michigan funneled Early Historic Indigenous peoples and European travelers westward toward the Mississippi River, southward toward Illinois, and northward to French Quebec. The route has been referred to as the "Grand Traverse" (Mason 1986). Along that journey, Rock Island, located at the mouth of Green Bay, played an important role, as Indigenous peoples hosted trade and other activities with French Jesuit missionaries. Nicolet traveled the route across northern Lake Michigan and into Green Bay desiring to find the Ho-Chunk people, who were thought to be the initial trade managers among Wisconsin's Indigenous groups, while the Huron people, native to areas in modern-day Quebec, originally mediated trade of Indigenous and European goods across northern Michigan and southern Quebec and into Wisconsin. Wars among North American Indigenous groups reduced the Huron's role as trade mediators in the early to mid-seventeenth century, opening up the Grand Traverse to more French travelers. In 1671, the first Jesuit mission, St. Francis Xavier, was established in Wisconsin at the southern foot of Green Bay, likely along the Fox River in present-day De Pere, by French missionary Father Claude-Jean Allouez. In 1673, a French Jesuit missionary, Father Jacque Marquette, and a fur trader, Louis Jolliet, journeyed from southern Lake Michigan to Green Bay, visiting the St. Francis Xavier church before continuing along the Fox River and eventually confirming the southward flow of the Mississippi River. Their journey across the modern-day state of Wisconsin and through the proposed project area initiated a 4,000-mile network of trading posts across the area. By 1684, the French established Fort La Baye in the present-day City of Green Bay. The fort was a military stronghold and a critical economic center for trading beaver fur and European goods among Indigenous groups and the French in modern-day northeastern Wisconsin.

The French maintained control of Fort La Baye until 1760, when the French surrendered Montreal and New France to the British. The British renamed the fort and economic center Fort Edward Augustus. The current City of Green Bay remained a primary site for the British fur trade. In the War of 1812, the British ceded control of the fort to the United States. A new fort, Fort Howard, was constructed in 1815 and served as the center of Green Bay society until the 1850s. Throughout French, British, and American governance, the Menominee, Oneida, Fox, and other Tribal nations maintained a significant presence in northeastern Wisconsin. In the 1830s, at least 12 Menominee villages were located along the shores of Green Bay. In 1838, the United States established the Oneida Reservation slightly southeast of the Bay of Green Bay for the Oneida people. Notably, Indigenous presence had an impact on the economic activities in and around the Bay of Green Bay, including Menominee Chief Oshkosh's vital role in sustainable forestry practices. Following the 1854 treaty that

established the Menominee Reservation in Wisconsin, Chief Oshkosh taught selective cutting and rotational harvesting to the Menominee people, which allowed the forests to regenerate before subsequent timber harvests (Cartographers' Guild 1998). His methods contrasted the practice of clear-cutting timber across northern Wisconsin and helped pave the way for northeastern Wisconsin's eventual booming timber industry.

5.2.1.3 Historic Activities Impacting the Current Conditions of the Bay of Green Bay

Fur Trading

As previously mentioned, Fort La Baye existed as a military stronghold and critical economic center for the trade of beaver fur and European goods among northeastern Wisconsin's Indigenous groups and the French. By the 1730s, the trading post at Green Bay produced between 300 to 400 packs of beaver pelts annually, with a pack containing about 80 pelts (Innis 2000). To illustrate the scale of the fur trade, the Green Bay post moved approximately 192,000 pelts annually from 1754 to 1756 (Schorger 1965). Though seldom viewed through the lens of ecological impact (but see Kay 1977), the removal of beavers from a landscape can significantly affect surface and groundwater flows as well as the movement of sediment and nutrients within watersheds.

Logging

As beavers were decimated from northeastern Wisconsin and much of North America, economic activity turned to the timber industry. Logging in the Green Bay region began in the late 1700s with the earliest sawmills in present-day Wisconsin built in the same area as the proposed project area. There is some debate among historical sources as to where, when, and by whom the first sawmill was built in the region. By the early 1800s, several sawmills were operating along the shores or rivers of Lower Green Bay (Bebow-Reinhard 2022; Forest History Association of Wisconsin 1982; Wisconsin Historical Society 1856).

The priorities for early logging and sawmill operations were likely the lumber supply for local building construction needs and land-clearing for row-crop, small-field agriculture. The abundance of highly valued white pine (*Pinus strobus*) in the upper watersheds of the western tributaries flowing to Green Bay—particularly the Oconto, Peshtigo, and Menominee Rivers—led to the rapid expansion of extractive logging throughout the region. By the mid- to late 1800s, these tributaries, along with smaller-order streams feeding these major tributaries, were subjected to multiple morphological alterations (e.g., channel straightening or realignments, bottom scouring, in-stream boulder removal, bank clearing) to facilitate the transport of cut logs downstream during the spring log drives to mills at the rivers' mouths.

Northeast Wisconsin delivered large quantities of pine down the Menominee, Peshtigo, and Wolf Rivers to city mills near the river mouths by the mid- to late 1800s. These mills deposited sawdust in the adjacent rivers, creating areas with high biological oxygen demand (BOD) conditions at the river mouths. During this time, railroad tracks were being laid along the western shore of Green Bay to allow access to land with valuable hardwood stands; these hardwoods could not be transported by the same river log drives as pines. Burning logging slash to clear land following harvest was a standard part of logging operations in pine country, where small, scattered brush fires were common. Between 1899 and 1905, Wisconsin led the nation in lumber production. The lumber industry shaped the economy in and around northeastern Wisconsin. Milling centers; paper mills; wood door, trim, and blinds manufacturers; barrel and casket makers; and other wood product manufacturers lined the shores of Green Bay between 1860 and 1905. Today, the City of Green Bay, De Pere, and cities along the Fox River (south of the project area) remain major paper- and fiber-based packaging manufacturing centers (see section 5.2.3.5 for more information).

Fisheries

Prior to European settlement, regional lakes provided sustenance, transportation, and trade for Indigenous peoples (Bogue 2001). Following European settlement, the lakes sustained fisheries that initially supported local markets and later supported regional, national, and international markets as preservation and transportation

systems were developed. Green Bay fisheries were initially developed without regulatory oversight, leading to exploitation that paid little heed to the cultural and biological impacts on the lakes or their surrounding drainage basins (Molton, Brenden, and Bence 2013). Driven by intended and accidental introductions of exotic species (Snyder et al. 2013) and physical or qualitative alterations in aquatic habitats, particularly at the mouths of major tributaries (Hayes et al. 2018), most Great Lake fisheries—and to varying degrees Green Bay fisheries—underwent dramatic and sometimes catastrophic changes (Molton, Brenden, and Bence 2013). For more information on current commercial fisheries operations in the Bay of Green Bay, see section 5.2.3.7.

5.2.1.4 Cultural and Historical Resources

As described throughout section 5.2.1, the Bay of Green Bay hosted many significant prehistoric and historic events and activities, shaping the human and natural environment of present-day northeastern Wisconsin. This section provides detailed information about existing prehistoric and historic archeological sites and architectural structures, along with shipwrecks and lighthouses located within the Bay of Green Bay. Additional details are also provided about the history of Indigenous peoples in and around the present-day project area. Combined, this information details the rich regional cultural history that shaped the Bay of Green Bay and continues in the proposed project area today.

5.2.1.4.1 Archeological Sites, Architectural Structures, and Historic Places

The Wisconsin Historical Society is the state agency responsible for collecting, preserving, and sharing historical records and stories. The agency is home to the State Historic Preservation Office, which is a repository for collecting, managing, and preserving information about historical buildings, archaeological sites, burial sites, and archaeological surveys within the state (Wisconsin Historical Society n.d.d). These data are made available through the Wisconsin Historical Preservation Database. According to data retrieved from the database, 33 known archeological sites and 15 known architectural sites exist within the proposed Green Bay Reserve. One site, the Peshtigo Harbor Light, was listed on the National Register of Historic Places in 2007 and is located at the proposed reserve site. This lighthouse, built in 1936, and is located offshore, approximately 3.3 miles southeast of Peshtigo Point.

5.2.1.4.2 Point au Sable and Wequiock Creek

Point au Sable and Wequiock Creek hold historical significance for regional Indigenous groups and are notable sites of early European activity. Both Point au Sable and Wequiock Creek are located in the proposed Green Bay Reserve's Lower Bay Component. Most historical content included in this section was sourced from a report, *Documentation of Archeological Sites and Properties: A Baseline Study of the Environs Associated with the Wequiock and Savoch Acquisition Parcels* (2022), prepared by First Nations archeologist Dr. David F. Overstreet for the Northeast Wisconsin Land Trust.

While Nicolet's exact landing location is unknown, evidence suggests that the Ho-Chunk, Menominee, and Potawatomi had established villages in this area at the time of his landfall (Overstreet 2022). Both the Ho-Chunk and Menominee peoples consider the Green Bay area as the place of their creation, with the Ho-Chunk on the eastern shore at Red Banks and the Menominee on the western shore at the mouth of the Menominee River (Overstreet 2022). The Potawatomi have a complex history of eastern-to-western movement across the Midwest, but the historical writings of T.T. Brown reference an important Potawatomi settlement at the tip of Point au Sable (Collins, Brown, and Hess 1933). The settlement's location has not been confirmed (Overstreet 2022). Oral traditions also note the involvement of the Potawatomi people during the Beaver Wars from the early to late 1600s that included intertribal warfare over resources and trade agreements with the French.

In addition to the Ho-Chunk and Potawatomi, many other Tribal nations were present in the region at various times or drawn to the locality for economic and ceremonial purposes or to partake in the region's abundant natural resources and surrounding landscape (Overstreet 2022).

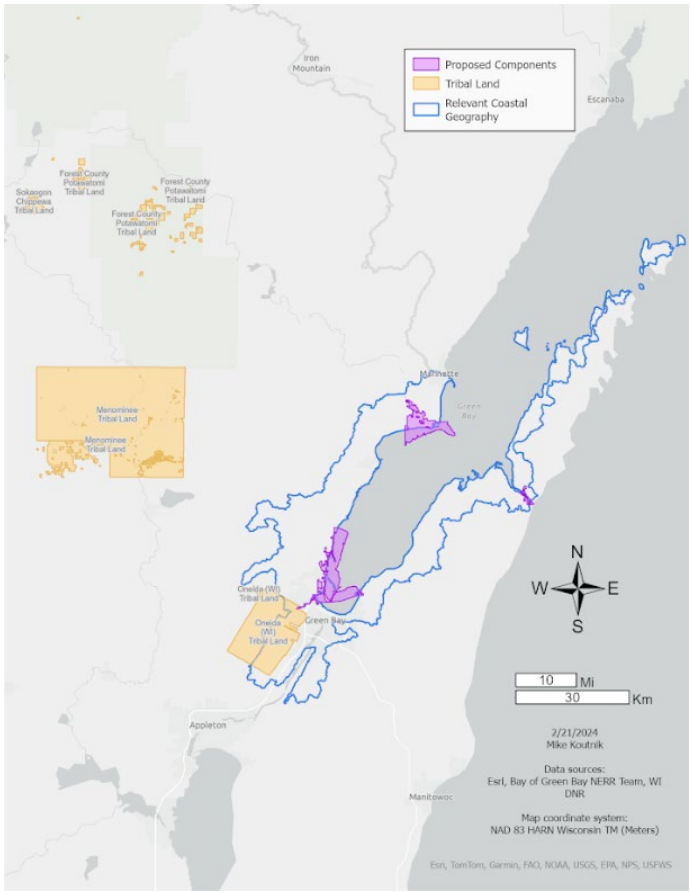


Figure 32. Tribal lands within northeastern Wisconsin and their proximity to the proposed National Estuarine Research Reserve components.

The Oneida Nation also has strong ties to the land near the southwestern tip of Green Bay. Several Indigenous groups, including the Oneida, were displaced from their ancestral lands in New York and Ontario in the early nineteenth century. The Oneida, an Iroquoian-speaking people of the Haudenosaunee "People of the Longhouse" Confederacy (Loew 2013), also historically known as the Iroquois Confederacy or Six Nations, are known as the Onyote (people of the standing stone). The Oneida people began relocating to Wisconsin in 1838 (Overstreet 2022). The Treaty with the Oneida in 1838 established the 65,400-acre Oneida Indian Reservation along Duck Creek, which empties into Green Bay. The Oneida have lived on this land for nearly 200 years and now call it their home. Figure 32 shows all reservation land areas in northeastern Wisconsin.

Today, Point au Sable is entirely owned and managed by the University of Wisconsin–Green Bay. This 191-acre natural area is located on a prominent peninsula along the eastern shore of Lower Green Bay and represents one of the Bay's few unmodified estuarine wetlands. Wequiock Creek Natural Area is a 76-acre parcel acquired in 2019 through a partnership with the Northeast Wisconsin Land Trust, University of Wisconsin–Green Bay, and Town of Scott.

5.2.1.5 Lighthouses and Shipwrecks

Documenting the lighthouses and shipwrecks in and around Green Bay is essential, given the region's rich history of exploration. Travel via the Great Lakes, through the Bay and to multiple rivers beyond, led to westward movement toward the Mississippi River. In addition to exploration, the Bay's lighthouses and cargo ships have played a critical role in regional economic activities, such as the transport of timber and other commodities. Today, many of the Bay's lighthouses are treasured local historical sites that draw tourists and residents alike, especially during the warmer outdoor recreational season. Local historical societies and advocacy groups also collaborate to memorialize significant shipwrecks involving loss of life.

Lighthouses

According to property records from the Wisconsin Historical Society, 11 lighthouses (listed below) stand within the project area. These lighthouses are located along Wisconsin's Green Bay coastline and within the open waters of the Bay (fig. 33).

- Chambers Island Lighthouse, Gibraltar, 1868
- Eagle Bluff Lighthouse, Gibraltar, 1868
- Grassy Island Range Lights, Green Bay, 1872
- Green Bay Harbor Entrance Light, Lake Michigan, 1936
- Long Tail Point Light, Suamico, 1848
- Pensaukee Harbor Light, Pensaukee, unknown
- Peshtigo Reef Light, Lake Michigan, 1936
- Plum Island Life-saving and Light Station, Washington, 1896
- Plum Island Range Rear Light, Washington, 1889
- Potawatomi Lighthouse, Washington, 1858
- Sherwood Point Light Station, Nasewaupee, 1883

Shipwrecks

According to records retrieved from *wisconsinshipwrecks.org*, a joint initiative between the Wisconsin Historical Society's Maritime Preservation Program and the Wisconsin Sea Grant Institute, 94 known shipwreck sites are located within the Bay of Green Bay (Wisconsin Sea Grant and Wisconsin Historical Society n.d.).
Figure 33 shows the location of each shipwreck site. *Wisconsinshipwrecks.org* provides details about each of the shipwrecks (listed) within the Wisconsin waters of Green Bay. Each ship name is presented with the year it was built and its vessel type. Most of these shipwrecks took place in the Bay's northern waters and along the shores of Door County.

- *Adriatic* (1889) schooner-barge
- *Advance* (1871) barge
- *Agnes Arnold* (1864) tug
- *Agnes Behrman* (1883) scow-schooner
- *America* (1912) oil screw
- *Ardent* (1857) schooner
- *Augustus* (1885) scow-schooner
- *Bay State* (1855) schooner
- *Carrington* (1853) schooner
- *Cecilia Hill* (1896) steam screw

- *Charles A. Eddy* (1889) steam screw
- *City of Kalamazoo* (1893) steamer
- *Cleveland* (1860) steam screw
- *Dan Hayes* (1868) scow-schooner
- *Denmark* (1846) schooner
- *Dollie M.* (1893) schooner
- *E.C.L.* (1855) bark
- *E.G. Crosby* (1903) steam screw
- *Ebenezer* (1890) scow-schooner
- *Ella Doak* (1868) scow-schooner
- *Ellen Couture* (unknown) schooner
- *Emerald* (1869) schooner-barge
- *Emmanuel* (1890) schooner
- *Empire State* (1862) barge
- *Erie L. Hackley* (1882) steam screw
- *Etta* (1800s) sloop
- *Farrand H. Williams* (1882) scow-schooner
- *Fleetwing* (1867) schooner
- *Fountain City* (1857) steam screw
- *Four Brothers* (1870) schooner
- *Francis IV* (1922) gas screw
- *G.L. Newman* (1855) bark
- *George* (1891) scow-schooner
- *George R. Roberts* (1847) schooner
- *Green Bay Sloop* sloop
- *Hanover* (1852) schooner
- *Hustler* (1893) gas schooner
- *Ida Corning* (1881) barge
- *Iver Lawson* (1869) schooner
- *J.K. Stack* (1875) schooner
- *J.S. Williams* (1868) schooner
- *James H. Johnson* (1882) steam paddle
- *James Reid* (1863) tug
- *Japan* (1853) schooner
- *Jennibel* (1863) schooner
- *Jenny* (1889) scow-schooner
- *Joseph L. Hurd* (1869) barge
- *Kate Hinchman* (1862) schooner
- *Kittie Laurie* (1872) schooner
- *Libbie Nau* (1867) schooner
- *Lilly Amoit* (1873) gas schooner
- *Little Harbor Launch* (unknown) launch
- *Lucia A. Simpson* (1875) schooner
- *Luna* (1862) schooner
- *Maria* (1866) scow-schooner
- *Mariner* (1854) schooner

- *Mary Elizabeth* (1844) schooner
- *Mary Newton* (1869) tug
- *Meridian* (1848) schooner
- *Mueller* (1887) steam screw
- *Norma* (1867) schooner
- *Norman* (1883) schooner
- *North Shore* (1894) steam screw
- *Oak Leaf* (1866) barge
- *Oak Orchard* (1887) scow-schooner
- *Ontario* (1846) brig
- *Petoskey* (1888) steam screw
- *Petrel* (1885) schooner
- *Petrus* (unknown) scow
- *Pride* (1866) schooner
- Pup (1894) barge
- *Red River* (unknown) scow
- *Reindeer* (1863) tug
- *Robert Holland* (1872) steam screw
- *Sardinia* (1856) schooner
- *Sidney O. Neff* (1890) steam screw
- *Sophia Lawrence* (1882) scow-schooner
- *Starlight* (1897) gas schooner
- *Sydney C. McLouth* (1880) steam screw
- *Thomas C. Wilson* (1868) schooner
- Unidentified wreckage tug
- *Union* (1867) schooner
- Unknown schooner
- *Vermillion* (1887) steam screw
- *Veto* (1879) schooner
- *W.C. Tillson* (1876) steam paddle
- *W.L. Brown* (1880) steam screw
- *Webster Batchelder* (1880) tug
- *Whirlwind* (unknown) schooner
- *Willard A. Smith* (1875) schooner
- *William Finch* (1878) scow-schooner
- *William M. Arbuckle* (1854) schooner
- *Wisconsin* (1882) schooner-barge
- *Free Trader* (1860) schooner

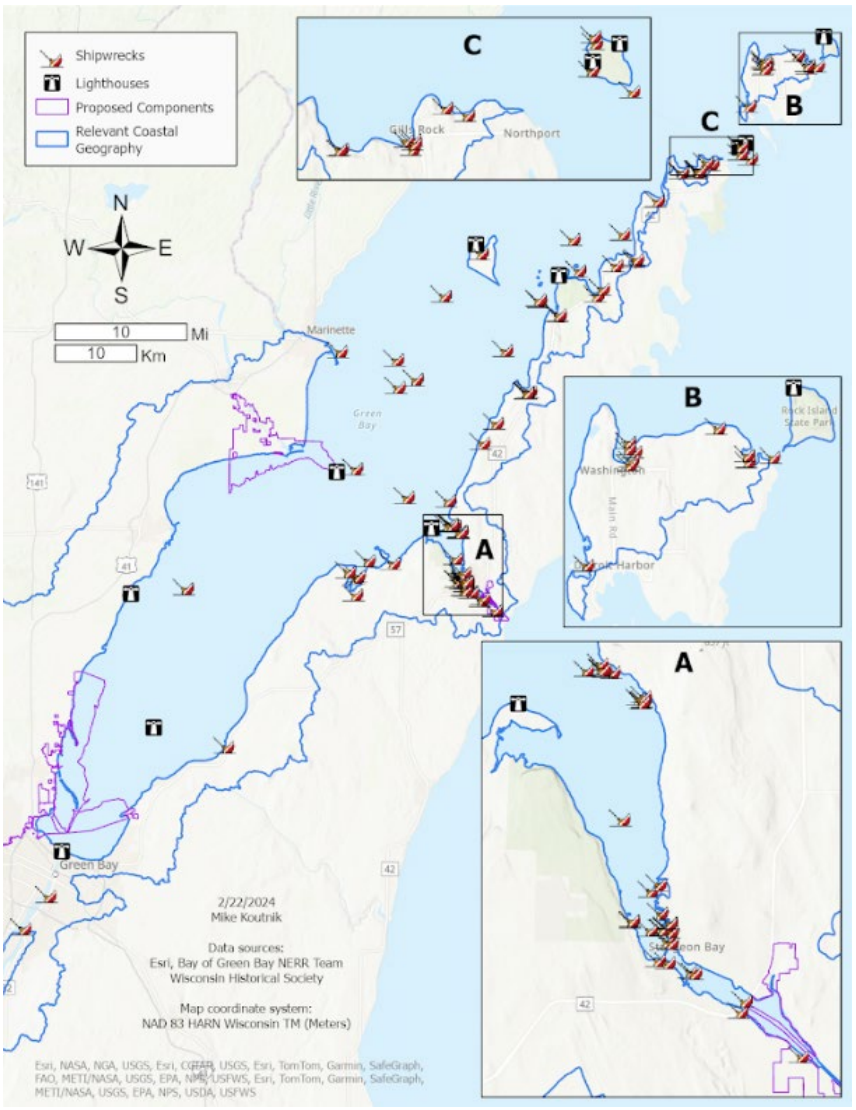


Figure 33. Map of lighthouses and shipwreck sites within the proposed project area.

5.2.2 Human and Economic Setting

Demographic data for the proposed project area are derived from the U.S. Census Bureau's American Community Survey (ACS) 2021 One-Year Estimate Data Profiles. ACS data for the five Wisconsin counties surrounding the Bay of Green Bay are included since the reserve's impact would extend beyond the project area itself. Demographic data are provided for five counties: Brown, Door, Kewaunee, Marinette, and Oconto.

5.2.2.1 Population

Population and Physical Size

The total population of the five Wisconsin counties surrounding the Bay of Green Bay is 400,250 across 6,769 square miles. The population density is approximately 132 people per square mile. The total number of households is 169,121, and the most populous center is the City of Green Bay, with a total population of 107,395. Table 32 describes the area and population details of each county surrounding the Bay of Green Bay (U.S. Census Bureau 2021a; U.S. Census Bureau 2021b).

Table 32. Counties Within the Bay of Green Bay Project Area, by Population and Area.

County	Total Area and Total Water Area (sq mi)		Population	Households	Median Age
Brown	616	86	269,591	110,225	38
Door	2,370	1,888	29,713	15,414	53
Kewaunee	1,084	742	20,535	8,530	44
Marinette	1,550	151	41,720	18,021	48
Oconto	1,149	151	38,691	16,931	47
TOTAL	6,769	3,018	400,250	169,121	46 (average)

Gender and Age

The population of the five Wisconsin counties surrounding the Bay of Green Bay have a nearly equal number of males (50.48%) and females (49.52%). The median age is 46 years. Approximately 22 percent of the population is 19 or younger; 45 percent are between 20 and 59 years old; and 30 percent are 60 or older (U.S. Census Bureau 2021b; U.S. Census Bureau 2021c).

Race and Ethnicity

Communities within the project area lack significant racial or ethnic diversity, with 92 percent of the total population identifying as white alone. Brown County, which houses the City of Green Bay and a portion of the proposed reserve's Lower Bay Component, is most diverse. Door and Oconto counties have a higher percentage of American Indians (1–2.1%) than the average American Indian population across the United States (0.8%). Table 33 provides race demographic data for each county (U.S. Census Bureau 2022).

Table 33. Race Demographics for the Bay of Green Bay Project Area, by Percentage.

County	White	Black or African American	American Indian or Alaska Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Two or More Races
Brown	80.0	2.6	2.1	3.2	0.0	3.5	8.6
Door	92.9	0.2	0.7	1.1	0.0	0.1	4.9
Kewaunee	93.4	0.0	0.1	1.3	0.0	1.5	3.7
Marinette	94.2	0.1	0.6	0.3	0.0	0.8	3.9
Oconto	93.4	0.2	1.0	0.2	0.0	1.5	3.7

Nationality

Approximately 97 percent of the population within the five-county region are U.S.-born residents. Among the three percent of residents born outside of the United States, about 50 percent originate from Latin America, followed by Europe (22%), Asia (20%), and smaller proportions from Africa, Oceania, and Northern America.

5.2.2.2 Employment

According to the U.S. Census Bureau's 2017 American Communities Survey 5-Year Estimate Data Profile for the five-county region, approximately 205,000 residents aged 16 or older are in the labor force. The regional labor force comprises private-wage and salaried workers (82%), government employees (11%), and self-employed individuals (7%). The average unemployment rate is 4.54 percent, and the median household income in 2017 inflation-adjusted dollars is $54,862 (U.S. Census Bureau 2017). Table 34 provides county-specific unemployment and income statistics.

Table 34. Employment and Income for the Bay of Green Bay Project Area.

County	**Median Household Income** (in 2017 inflation-adjusted dollars)	**Unemployment Rate (%)**
Brown	$56,775	4.4
Door	$56,494	4.6
Kewaunee	$60,320	3.5
Marinette	$44,958	5.7
Oconto	$55,762	4.5
Average	$54,862	4.54

Source: 2017 American Communities Survey 5-year estimates

Historically and today, northeastern Wisconsin is known for its strong manufacturing economy. Workers in the manufacturing sector represent nearly a quarter (23%) of the regional workforce, followed by those in the education and health services (19.4%) and trade, transportation, and utilities (17.7%) sectors. Table 35 lists employment by industry (State of Wisconsin Department of Workforce Development 2023).

Table 35. Employment (%) by Industry for the Bay of Green Bay Project Area (2021).*

Industry	Brown	Door	Kewaunee	Marinette	Oconto	Average
Construction	4.7	5.2	6.6	3.7	5.2	5.1
Education and Health Services	21.5	17.2	17.3	19	21.8	19.4
Financial Activities	7.2	2.7	2.5	2.6	2.0	3.4
Information	1.0	1.1	0.0	0.6	0.4	0.6
Leisure and Hospitality	9.5	22	7.3	9.1	8.1	11.2
Manufacturing	17.7	16	26.1	31.7	24.8	23.26
Natural Resources and Mining	0.6	1.5	16.5	2.9	5.3	5.36
Other Services	2.3	4.3	0.0	2.2	1.9	2.14
Professional and Business Services	11.7	4.8	4.0	4.0	3.9	5.68
Public Administration	3.0	6.6	4.7	5.2	9.9	5.8
Trade, Transportation, and Utilities	20.8	18.6	13.3	19.1	16.7	17.7

**Gray denotes the three largest workforces by industry.*

Notable large, regional employers are listed below, along with the number of people employed by each. This list includes employers that support the region's largest workforces, create a significant local economic impact, and represent the region's industrial landscape.

- Bellin Health and ThedaCare (healthcare; 1,863 local employees)
- Schneider National (transportation; 3,599 local employees)
- Schreiber Foods (food manufacturing; 10,000 employees globally)
- American Foods Group (food manufacturing; 1,377 local employees)
- Georgia-Pacific Corporation (manufacturing; 3,590 local employees)
- Fincantieri Bay Shipbuilding (construction; 1,385 local employees)
- Multi-Color Corporation (manufacturing; 13,000 employees nationally)
- Humana (insurance; 2,700 local employees)
- Associated Bank (financial; 4,200 local employees)

According to NOAA's Economics: National Ocean Watch data, in 2021 alone, the ocean economy, which is defined as all economic sectors dependent on the oceans and Great Lakes, supported more than 11,500 jobs in the five counties surrounding the Bay of Green Bay (2023).

5.2.2.3 Regional Economics

The employment and workforce statistics provided in section 5.2.4.3 focus on higher-level census data and provide a holistic look at the entire five-county region that borders the proposed reserve's project area. According to an economic assessment completed by NewNorth, the region's five largest industries by economic output are (1) manufacturing; (2) food and beverage; (3) transportation and logistics; (4) pulp, paper, and converting; and (5) energy, power, and control, followed by aerospace and biohealth (New North n.d.a; New North n.d.b).

- Manufacturing: The region has 2.8 times more manufacturing operation outlets than the national average; 2,100 business locations contribute $22.2 billion to the regional economy.
- Food and Beverage: With an emphasis on farming and ranching, packaging and filling-machine operations, dairy processing, and farm workers, more than 1,000 food and agricultural processing and other businesses contribute $7.01 billion to the regional economy.
- Transportation and Logistics: The region ranks 18th in the United States for its concentration of transportation and logistics companies. More than 1,100 business locations contribute $2.5 billion to the regional economy. The region is home to two international airports and three commercial ports (i.e., the Port of Green Bay, Port of Marinette, and a third limited-cargo port in Sturgeon Bay).
- Pulp, Paper, and Converting: Wisconsin is the no. 1 producer of paper and paper products in the United States, and the region hosts the largest concentration of paper-producing locations. The regional industry supports about 15,000 direct and 44,000 indirect workers and contributes $3.0 billion to the regional economy.
- Energy, Power, and Control: Approximately 22,000 industry jobs from over 850 business locations contribute $4.5 billion to the regional economy. The workforce generally includes electricians, assemblers and fabricators, industrial and mechanical engineers, and electronic assemblers.

According to NOAA's Economics: National Ocean Watch data, in 2021 alone, the ocean economy within the five-county region generated over $880 million in gross domestic product (2023).

5.2.3 Current Human Uses

5.2.3.1 Tourism and Recreation

Northeastern Wisconsin's significant tourism industry and recreational offerings are integrated and inextricably intertwined with the region's natural environment. As early as the late 1800s, Door County—home to the proposed Sturgeon Bay Component—was marketed to wealthy urbanites from the Chicago area as a "healthy and scenic getaway" (Cartographers' Guild 1998). The Door peninsula includes eight state parks and natural areas featuring bluffs and beaches and offers year-round outdoor recreational opportunities such as boating, kayaking, canoeing, hunting, fishing, hiking, cross-country skiing, snowmobiling, wildlife viewing, and birding.

The City of Sturgeon Bay hosts a 13.8-mile segment of the Ice Age National Scenic Trail, a thousand-mile footpath that highlights the state's natural areas for hikers and wildlife and bird enthusiasts. Each year, 2.5 million visitors travel to the Door Peninsula, where 22 percent of the county's labor force (about 3,335 jobs) is employed by the leisure and hospitality industry (Rogers 2023).

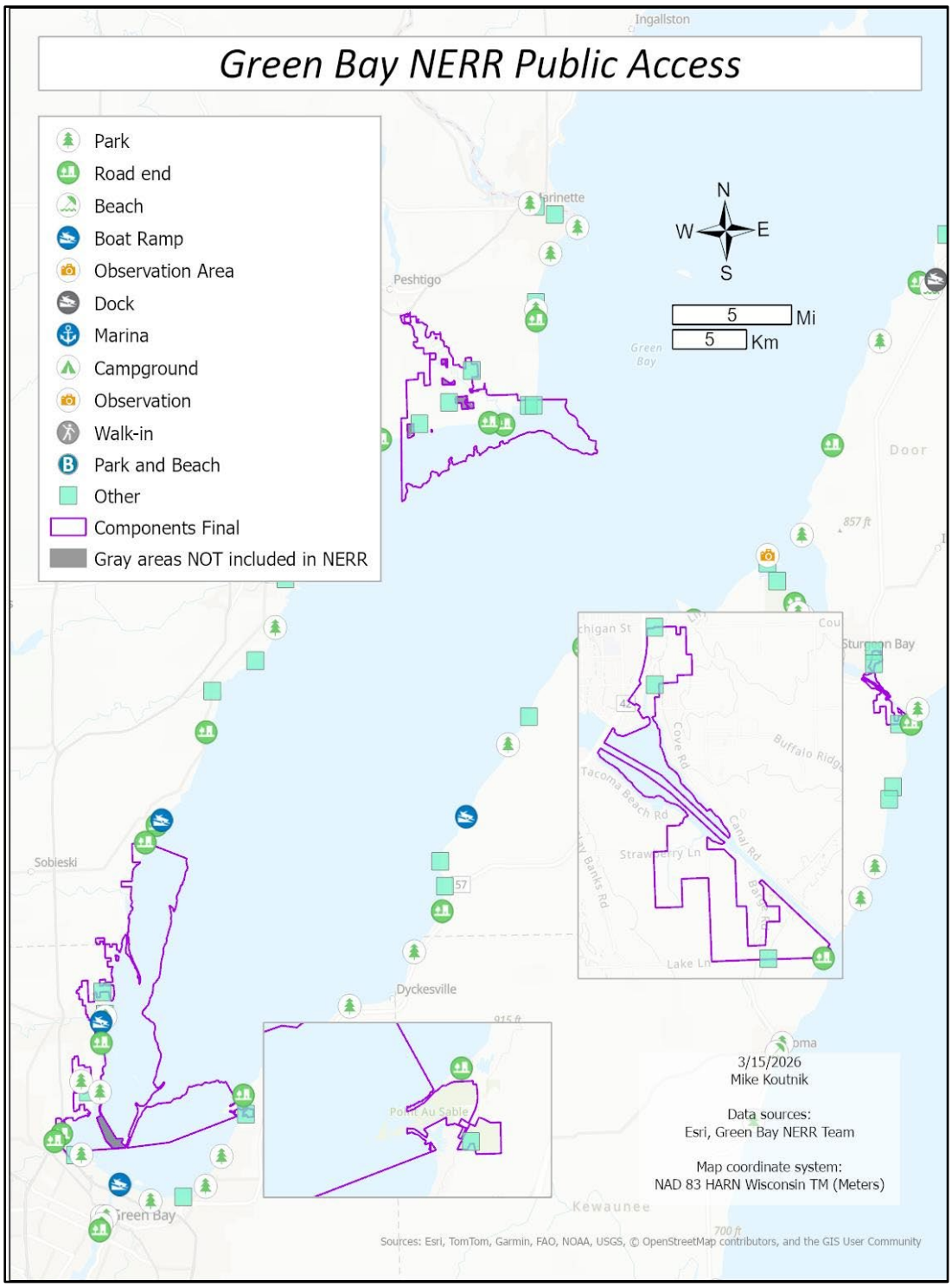


Figure 34. Map of public access facilities adjacent to the Green Bay estuary.

Beyond the Door Peninsula, Green Bay, its shoreline, and the surrounding areas offer recreational opportunities for both residents and tourists. The warmer months cater to recreational activities like boating, fishing, camping, hiking, and golf. Figure 34 shows more than 50 parks, four public beaches, seven public boat docks, two public marinas, and four public observation areas within the proposed reserve's project area. In the colder months, the area offers fall and winter outdoor activities such as hunting, snowshoeing, cross-country skiing, and snowmobiling. Hundreds of miles of trails are dedicated to snowmobiling, cross-country skiing, snowshoeing, and snowbiking. As examples, the Barkhausen Waterfowl Preserve, Neshota Park, and Reforestation Camp in Brown County offer 34 miles of cross-country trails; Oconto County offers 480 miles of snowmobile trails, and Marinette County has 11 groomed trails for winter snowshoeing and cross-country skiing, as well as hundreds of miles of snowmobile trails.

Brown and Door counties, in particular, also offer a few tourism hot spots. Examples of non-outdoor, recreational tourist attractions in the area include Lambeau Field and Titletown, Green Bay Botanical Gardens, Bay Beach Amusement Park, NEW Zoo and Adventure Park, Neville Public Museum, Children's Museum of Green Bay, National Railroad Museum, Door County Maritime Museum, and the Peninsula Players Theater.

5.2.3.2 Education

There are 103 public school districts within a 90-mile driving radius of the proposed reserve's project area. These school districts serve a population of 330,000 K-12 students. Of the five Wisconsin counties that surround the Bay of Green Bay, Brown County (and City of Green Bay) is home to the largest number of schools (i.e., 85 elementary school, middle school, high school, or combined school buildings). Comparatively, the rural surrounding counties of Door, Kewaunee, Marinette, and Oconto host a combined total of 62 school buildings. Table 36 describes K-12 and college and university student enrollment, as well as educational attainment levels for the five-county region (U.S. Census Bureau 2022).

Table 36. Education Characteristics for the Bay of Green Bay Project Area (2022).

County	K-12 Enrollment	College or Graduate School Enrollment	Bachelor's Degree or Higher (%)
Brown	64,083	15,199	32.5
Door	5,133	1,105	34.4
Kewaunee	4,352	691	19.3
Marinette	7,963	1,304	17.7
Oconto	7,633	1,269	17.1
Total	89,164	19,568	24.2 (average)

The region's student demographics are characterized as a dichotomy between Brown County's populated communities and the four rural counties within the reserve's project area. Brown County is home to the Green Bay Area Public School District (GBPS). The district's student population of 18,922 is more than the eight other districts within the five-county region combined. About 60 percent of GBPS students are defined as economically disadvantaged per their eligibility for the state's school meal program. Twenty-three percent of students in the eight other districts are defined as economically disadvantaged. The state average is approximately 41 percent. The Green Bay Area Public School District also reports a distinct racial and ethnic composition compared to other nearby districts; it is the only majority-minority district in the region. Most GBPS students live directly

adjacent to the proposed reserve's Lower Bay Component. Less than 15 percent of students in other regional districts identify with a racial or ethnic minority group. Table 37 provides student race demographics for public school districts located between 0 and 30 minutes (driving radius) from the proposed reserve components (Wisconsin Department of Public Instruction 2023).

Table 37. K-12 Student Demographics for the Bay of Green Bay Project Area, by Percentage (2022–23).

School District	American Indian or Native Alaskan	Asian	Black or African American	Hispanic or Latinx	Native Hawaiian or Pacific Islander	Two or More Races	White
Wrightstown Community	1.0	0.8	0.8	7.6	0.3	4.1	85.3
Denmark	0.4	0.5	0.7	5.4	0.0	3.0	89.9
De Pere	0.6	2.7	1.4	6.2	0.0	5.2	83.9
West De Pere	3.0	4.4	2.3	5.6	0.1	6.8	77.8
Green Bay Area Public	3.4	8.4	8.6	32.8	0.1	8.2	38.6
Ashwaubenon	1.8	3.3	3.0	7.3	0.1	9.2	75.3
Pulaski Community	2.1	0.9	0.7	3.7	0.1	3.4	89.1
New Leaf Prep Academy	2.6	1.3	0.6	1.3	0.0	1.3	92.9
Howard-Suamico	0.6	2.6	1.5	4.7	0.0	5.3	85.3

Northeast Wisconsin is home to many higher education institutions. Twenty-one colleges and universities serve 19,568 undergraduate and graduate students across the region. Seven of these institutions reside in the project area: (1) University of Wisconsin–Green Bay (UWGB); (2) University of Wisconsin–Green Bay at Marinette, (3) St. Norbert College, (4) Northeast Wisconsin Technical College, (5) Rasmussen College, (6) Medical College of Wisconsin, and (7) Bellin College. All but the UWGB campus at Marinette are located in northern Brown County. The University of Wisconsin–Green Bay is the largest of these institutions. Located in the City of Green Bay, the university serves about 9,000 students (approximately 8,500 undergraduate students and 500 graduate students). The University of Wisconsin–Green Bay, the proposed reserve's lead state agency, serves as a major hub for estuarine and estuarine-related research, as well as public educational activities. The institution is known for its strong biological sciences programs, including aquatic ecology and fisheries, ecology and conservation, aquaculture, and biology for educators, in addition to its water sciences, environmental engineering technology, and environmental sciences programs. UWGB faculty lead the majority of environmental, biological, and social science research activities within and around the Green Bay estuary, and they continue to make major contributions to the academic literature, state and local research efforts, and public education regarding Bay-related issues.

The region is home to strong K-12 environmental education partnerships with public agencies and higher education institutions. Examples include a UWGB-led project in which K-12 students in Brown County grow wild rice for eventual seeding as part of a wild rice monitoring project at Point au Sable and Wequiock Creek. Also, the West Shores Interpretive Center at the L.H. Barkhausen Waterfowl Preserve hosts annual UWGB-organized estuary education field trips for local K-12 classrooms.

A well-established network of environmental education and research facilities is located in the Bay of Green Bay. The West Shores Interpretive Center is located within the Lower Bay Component of the proposed reserve. It provides year-round experiential environmental education programming and regularly hosts field experiences for K-12 students. In the Sturgeon Bay Component of the proposed reserve, the Crossroads at Big Creek operates the Collins Learning Center, which supports environmental education programs and provides laboratory space and equipment for visiting researchers. Both centers maintain strong relationships with regional schools, teachers, after-school programs, community science volunteers, and visitors and have extensive experience providing hands-on educational programs to audiences of all ages. Crossroads also maintains active monitoring programs focused on water quality, bird breeding, amphibians, bats, and northern pike while collaborating with institutions like the Shedd Aquarium on fisheries research and education initiatives. Lastly, there are numerous ongoing research and community science activities throughout the Lower Bay Component of the proposed reserve, including wild rice restoration and monitoring, coastal wetland monitoring, and avian migration studies at Point au Sable, providing opportunities to integrate research with place-based educational experiences.

5.2.3.3 Research and Monitoring

The Green Bay estuary has supported and will continue to support a rich and diverse array of research and monitoring activities. The proposed Lower Bay Component, where the Bay meets the Lower Fox River, has demonstrated a critical need for long-term environmental monitoring. As described in section 5.1.1.3.2, the proposed Lower Bay Component is currently one of 23 active EPA Great Lakes areas of concern. The now-delisted Lower Menominee River area of concern was located near the proposed Peshtigo Component.

The presence of the Lower Fox River and Green Bay area of concern, combined with the long-standing involvement of multiple colleges and universities and management agencies, has resulted in a substantial research and monitoring network throughout the Green Bay estuary. The Green Bay estuary supports an extensive and expanding network of federal and state agencies, universities, Tribal nations, local organizations, and nonprofit partners. Monitoring sites shown in figures 35 and 36 represent a collaborative network of programs managed by the U.S. Environmental Protection Agency, U.S. Geological Survey, Wisconsin Department of Natural Resources, National Oceanic and Atmospheric Administration, University of Wisconsin–Green Bay, University of Wisconsin–Milwaukee, Great Lakes Observing System, Crossroads at Big Creek, and NEW Water, along with numerous other partners.

Collectively, these programs provide critical baseline information on riverine loading, water quality, primary production, harmful algal blooms, submerged aquatic vegetation, fisheries, coastal wetland conditions, hydrodynamics, flooding, and long-term climate trends throughout the estuary and watershed.

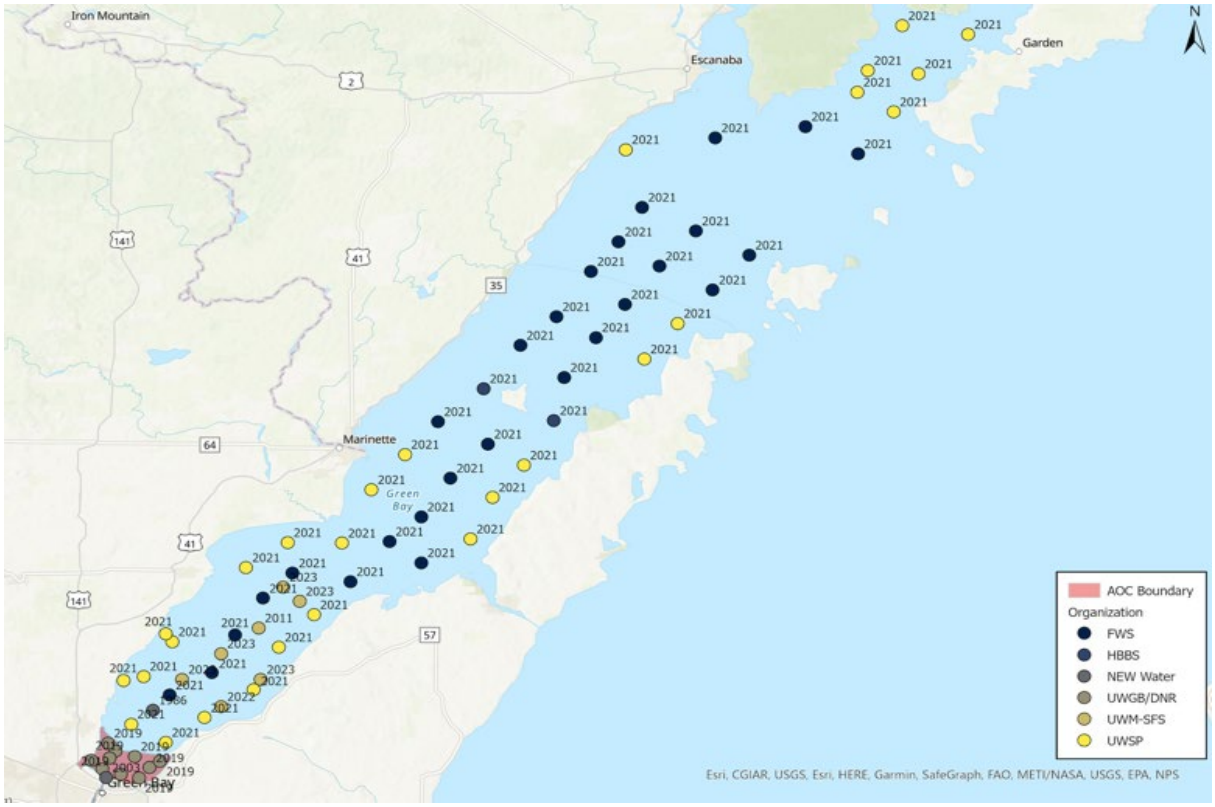


Figure 35. Known water-quality monitoring stations, with dates of most recent monitoring effort, within the Green Bay estuary (2024).

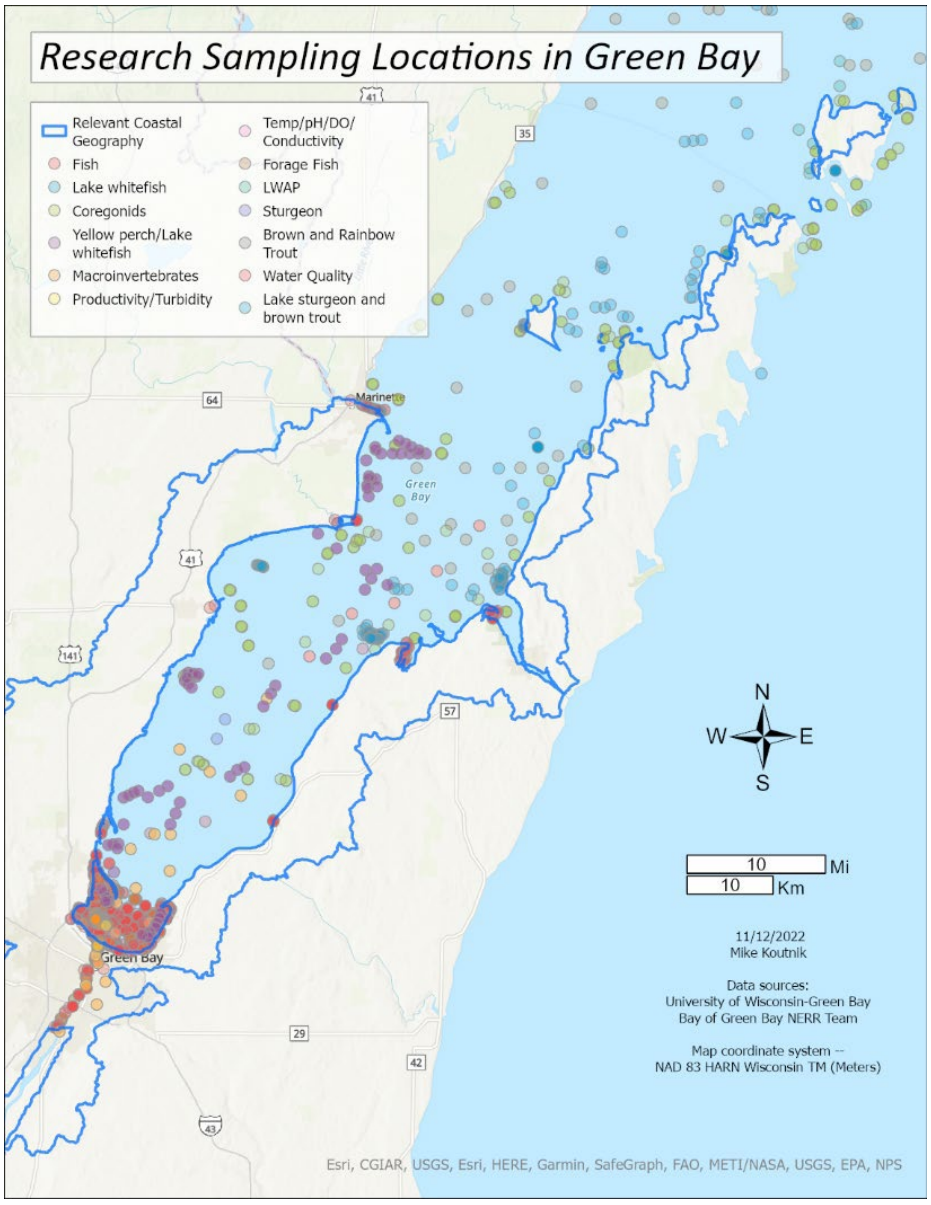


Figure 36. Sampling parameters and locations within the Green Bay estuary.

Understanding dynamics at the land-water interface is essential for understanding the influence of the Green Bay estuary on the larger Green Bay–Lake Michigan ecosystem. Physical, chemical, and biological processes occur across a broad range of spatial and temporal scales, from small-scale turbulence and sediment processes to large-scale hydrodynamic circulation, ice cover, and climate-driven variability. Long-term monitoring efforts throughout the estuary provide the information necessary to characterize these processes, support ecosystem modeling, and inform management decisions.

Examples of established, long-term water-quality monitoring programs include:

NEW Water's Aquatic Monitoring Program (AMP). NEW Water, the Green Bay Metropolitan Sewerage District, leads one of the region's most extensive water-quality monitoring efforts. NEW Water provides wastewater treatment and conveyance services to 15 municipalities located along the southern shoreline of Green Bay and within the Lower Fox River watershed. The organization has maintained its aquatic monitoring program since 1986. The program currently includes 34 water-quality sampling sites extending from the Lower Fox River and Lower Green Bay northward to the Sturgeon Bay area. Measurements of nutrients, contaminants, dissolved oxygen, temperature, light, suspended solids, algal concentrations, and other physical and chemical parameters are collected on a regular basis at these sites. NEW Water also operates two monitoring buoys; one buoy is located near the mouth of the Fox River, and the other buoy is located approximately seven miles north of the river mouth. These stations collect near real-time data from May through October, including water temperature, conductivity, dissolved oxygen, pH, total algae, phosphate concentrations, air temperature, wind speed, and wind direction (NEW Water n.d.a; NEW Water n.d.b; NEW Water n.d.c; NEW Water 2015). Data from NEW Water's long-term monitoring program provide important baseline water quality data about the Bay of Green Bay.

Wisconsin Department of Natural Resources' Lower Fox River Basin Volunteer Monitoring Program. The Wisconsin Department of Natural Resources also conducts extensive monitoring around the Bay of Green Bay. For example, the department administers the Lower Fox River Basin Volunteer Monitoring Program to support water quality monitoring throughout the watershed. This citizen-science water-quality monitoring program was established in 2015 to assist with monitoring goals outlined in the Lower Fox River Total Maximum Daily Load plan and to evaluate its implementation. Through this program, trained volunteers collect monthly surface water samples at 20 monitoring sites located on 16 tributary streams between May and October. Samples are analyzed by the Wisconsin State Laboratory of Hygiene for total phosphorus, total suspended solids, dissolved reactive phosphorus, and total nitrogen. Additional field measurements include streamflow and turbidity. Only one of the monitoring sites, Wequiock Creek at Nicolet Drive, is located within the proposed reserve's boundaries. However, all monitored streams ultimately discharge into the Lower Fox River and Green Bay, providing important information on watershed conditions affecting estuarine water quality (Wisconsin Department of Natural Resources n.d.a).

Several additional monitoring programs provide important baseline water quality and meteorological information about the Green Bay estuary. A buoy-based observing system operated by the University of Wisconsin–Green Bay and University of Wisconsin–Madison is part of NOAA's Integrated Ocean Observing System through the Great Lakes Observing System; this system provides continuous observations of meteorological and water quality conditions. Additional real-time water quality monitoring is supported through an expanding network of low-cost sensor arrays operated collaboratively by the University of Wisconsin–Green Bay, University of Wisconsin–Madison, and Cellcom. The U.S. Geological Survey manages a network of river-monitoring stations throughout the watershed, while NOAA maintains water level gauges at locations in Green Bay and Sturgeon Bay and in Menominee, Michigan. Together, these monitoring systems create an extensive observation network that supports research, management, and decision-making for the estuary.

In addition to these and other baseline monitoring efforts, many other organizations conduct research and monitoring activities throughout the Bay of Green Bay. For example, the U.S. Environmental Protection Agency's research vessel, the R/V *Lake Guardian*, conducts water quality sampling throughout the Great Lakes, visiting each lake on a five-year cycle. Its monitoring includes sampling stations in Green Bay as part of the Cooperative Science and Monitoring Initiative, a binational effort with Canada under the Great Lakes Water Quality Agreement.

The northern portion of Green Bay is included in Lake Michigan's Cooperative Science and Monitoring Initiative surveys, and data generated through these efforts contribute to understanding baseline environmental conditions and long-term trends throughout the estuary. University researchers from the University of Wisconsin–Green Bay, University of Wisconsin–Madison, and other institutions also conduct monitoring activities throughout the estuary, often through grant-funded research projects.

Polyfluoroalkyl substances (PFAS) monitoring is another important water-quality monitoring activity within the Green Bay region. The Wisconsin Department of Natural Resources conducts PFAS monitoring to inform fish consumption advisories, drinking water advisories, and resource management decisions. Monitoring sites occur near the proposed Peshtigo Component and within the Lower Fox River watershed. Sampling includes analysis of both water and fish tissue.

Fish monitoring and fisheries research are also conducted throughout the estuary, including within the proposed reserve boundaries. Approximately 160 sampling locations support active and historical research projects focused on walleye, lake whitefish, muskellunge, northern pike, lake sturgeon, and white sucker. These collaborative efforts by the Wisconsin and Michigan Departments of Natural Resources, the Wisconsin Cooperative Fishery Research Unit, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, and university researchers include evaluating spawning behavior, habitat use, population dynamics, and habitat restoration effectiveness in support of sustainable fisheries management.

Long-term coastal wetland monitoring is another important component of the Green Bay estuary's research network. Since 2011, the University of Wisconsin–Green Bay's Cofrin Center for Biodiversity has participated in the binational Great Lakes Coastal Wetland Monitoring Program, a collaborative effort among sixteen institutions across the United States and Canada. More than 50 coastal wetland monitoring sites are located throughout the Green Bay estuary, including 18 sites within the proposed reserve's boundaries. These sites are monitored regularly for birds, amphibians, fish, vegetation, and aquatic invertebrates and provide baseline information on wetland condition and ecosystem change. Additional long-term monitoring and mapping efforts, including the Great Lakes Coastal Wetland Mapping Program led by Michigan Technological University's Research Institute, provide information on wetland extent, habitat change, and invasive species distribution, including phragmites, and thereby support wetland conservation and restoration throughout the estuary.

Numerous terrestrial and coastal habitat monitoring efforts are also underway within and adjacent to the proposed reserve. The Crossroads at Big Creek Nature Area maintains active monitoring programs focused on breeding birds, amphibians, and bats; water quality; fisheries; and northern pike. Recent collaborations between the Crossroads and Shedd Aquarium have expanded monitoring efforts focused on fish spawning and migration. The Oneida Bird Monitoring Project, a partnership among the Oneida Nation, Northeastern Wisconsin Audubon, Audubon Great Lakes, and University of Wisconsin–Green Bay, monitors migratory waterfowl, shorebirds, and breeding birds on restoration lands near the southern boundary of the proposed reserve. Green Bay's coastal wetlands have been identified by Audubon Great Lakes as one of the most important coastal wetland regions in the Great Lakes for marsh bird conservation, and all three proposed reserve components include shoreline areas identified as priorities for conservation or restoration.

Research and monitoring activities occur in each of the three proposed components. The relatively undisturbed habitats of the Peshtigo Component support long-term coastal wetland monitoring and research focused on migratory birds, native fish populations, and wild rice habitats. The Lower Bay Component supports numerous active studies, including investigations of wild rice ecology at Sensiba and Barkhausen, avian migration and feeding ecology at Point au Sable, and long-term monitoring of coastal wetlands in the Suamico River area, Little Tail Point, Dead Horse Bay, Peters Marsh, Peats Lake, and Atkinson Marsh. Many of these projects also support educational and community science initiatives, including wild rice restoration and monitoring programs for K-12 students. Research at Point au Sable and Wequiock Creek is regularly conducted by UWGB faculty and students, facilitated by the university's close proximity to the Lower Bay Component.

Research conducted within the boundaries of the proposed Green Bay Reserve has contributed substantially to scientific understanding of the Green Bay ecosystem. A special issue of the *Journal of Great Lakes Research* highlighted a broad range of studies conducted throughout the estuary, including investigations of coastal wetlands, fisheries, benthic ecology, food web dynamics, harmful algal blooms, hypoxia, biogeochemical processes, and restoration science (Klump et al. 2018).

5.2.3.4 Transportation, Navigation, and Infrastructure

Similar to how the waters of Green Bay were historically used to transport timber and other commodities in and out of central and northern Wisconsin, the Bay remains a key transportation resource for economic activity today.

As mentioned in section 5.2.2.3, three ports within the Bay of Green Bay (i.e., Port of Green Bay, Port of Sturgeon Bay, and Port of Marinette) contribute significantly to the local and regional economy. The Port of Green Bay and its managing entity, the Brown County Port & Resource Recovery Department, play a pivotal role in economic activity in the region. The Port of Green Bay is Lake Michigan's westernmost port and offers the shortest, most direct route for shipments between the Midwest and the rest of the world. The port provides modern, state-of-the-art facilities, which facilitate economical cargo handling and safe navigation. Trucking lines provide overnight delivery within a 400-mile radius, and major railroads and highway infrastructure connect the port with the central region of the United States. The port is also just five miles east of the Austin Straubel International Airport, which currently flies directly to Atlanta, Chicago, Denver, Detroit, Fort Myers, Las Vegas, Minneapolis, Orlando, and Phoenix. According to the Port of Green Bay's 2022 Annual Report, the port supports over 1,289 jobs, resulting in $82 million in personal income and $147 million in economic impact for Brown County annually.

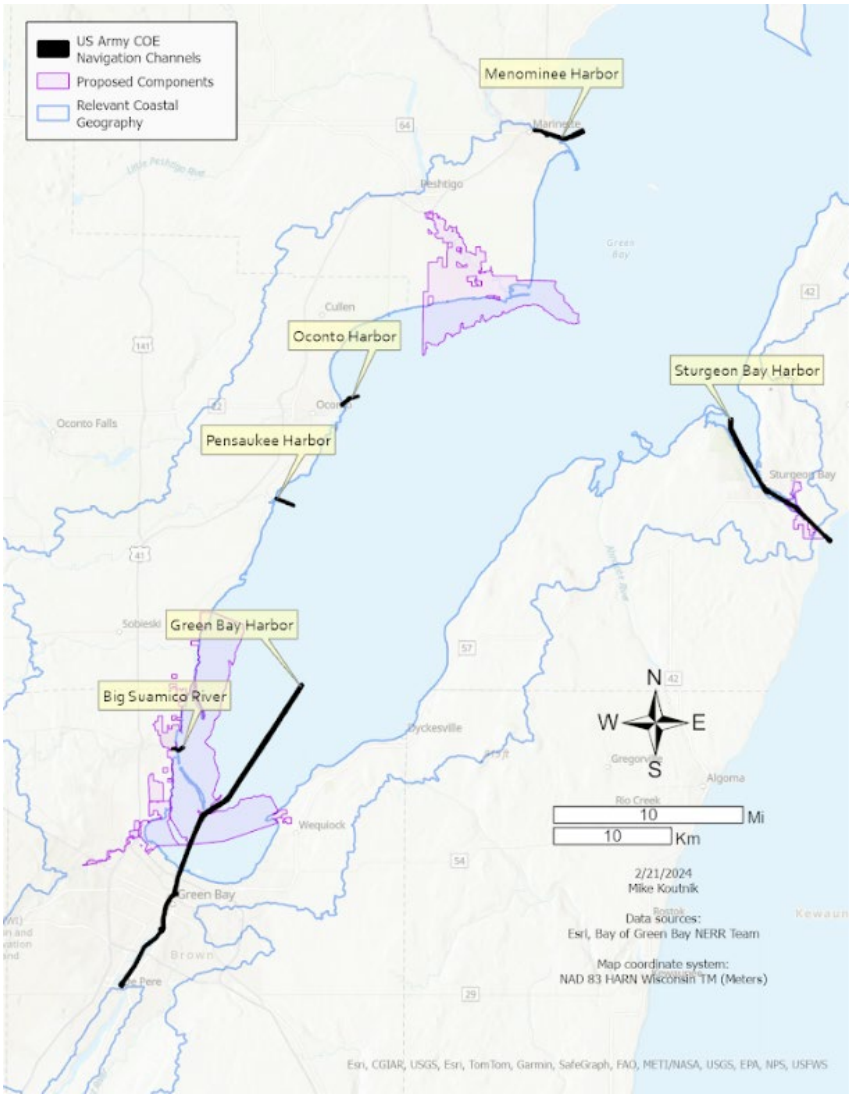


Figure 37. Map of Green Bay navigation channels and harbors.

The Brown County Port & Resource Recovery Department is a long-time land management partner, including for environmental stewardship, in the Lower Bay area. The department is currently involved in multiple projects related to land use in the Lower Bay, which include:

- Renovation of the decommissioned Pulliam Power Plant Site. The department seeks to purchase and renovate the PCB-contaminated site. The refurbished site would be the first modern port terminal added to the Bay in several decades. The department has received federal and state funding to partially support the work and is currently completing an environmental assessment of the site.
- Renard Island Master Plan. In 1977, Brown County and the U.S. Army Corps of Engineers executed a memorandum of agreement to construct the Renard Island Confined Disposal Facility in Green Bay for disposal of material generated from annual maintenance dredging in the Green Bay Harbor and navigation channel. The island received dredged materials from 1978–1997, and a final cap was placed in 2015 (Brown County Port & Resource Recovery Department 2019). The Brown County Port & Resource Recovery Department received ownership of the island from the U.S. Army Corps of Engineers

in 2017 and proceeded to develop a master plan for its future use. The department has established goals to meet the objectives of the plan over the next decade.

- Cat Island Restoration Project. The wetlands found in Lower Green Bay were historically protected by a chain of barrier islands called the Cat Island Chain. During a period of high water in the mid-1970s, this naturally occurring chain of barrier islands suffered severe erosion when struck by a series of storms during ice breakup (Brown County Port & Resource Recovery Department 2018). The Cat Island Restoration Project calls for the reconstruction of three barrier islands in the Lower Bay using beneficially reused, fine sands–dredged material from the outer Lower Bay harbor navigation channel. This reconstruction will provide 272 acres of habitat for shorebirds, waterfowl, amphibians, turtles, invertebrates, and furbearing mammals. The Brown County Port & Resource Recovery Department is a managing partner, along with the U.S. Army Corps of Engineers and Wisconsin Department of Natural Resources (Port of Green Bay n.d.).

Green Bay is the second most heavily dredged port in the Great Lakes. The port's 14-mile-long shipping channel that extends north toward Marinette is dredged annually. The port is dredged to a depth of 26 feet for 11.5 miles upstream from the entrance channel (U.S. Army Corps of Engineers 2023). Dredged material is currently placed in either the Bay Port disposal facility under an agreement with the Brown County Port & Resource Recovery Department or in the Cat Island Dredged Material Disposal Facility. Removal of dredged materials historically played an important role in the removal of PCBs from the Fox River. Today, the department works closely with the Wisconsin Department of Natural Resources and the U.S. Environmental Protection Agency on continued PCB-monitoring, as well as identifying advanced beneficial reuse applications for the dredged materials, such as the Cat Island Restoration Project. Figure 37 shows a map of the port's navigation channel.

The Port of Sturgeon Bay also uses a more lightly dredged shipping channel. This channel allows large vessels to enter the port for repairs (also identified in fig. 37). This port is dredged every five years to a depth of 23 feet at the entrance channel and 20 feet in the turning basin at Sturgeon Bay. Dredged sediment is deposited at a privately owned combined disposal facility (U.S. Army Corps of Engineers 2022).

5.2.3.5 Industry and Manufacturing

As described in section 5.2.2.3, the Bay of Green Bay is home to various industries, including but not limited to food and agricultural processing, paper production, and manufacturing.

According to the U.S. Department of Agriculture's Meat, Poultry and Egg Product Inspection Directory, 12 establishments produce meat, poultry, or egg products regulated by the agency's Food Safety Inspection Service within or adjacent to the proposed project area. These facilities are concentrated within the City of Green Bay (U.S. Department of Agriculture 2026). Meat- and poultry-processing facilities discharge nutrients into receiving waters, which contributes to eutrophication (U.S. Environmental Protection Agency 2023). Wastewater discharged from meat- and poultry-processing facilities is regulated under the Wisconsin Pollution Discharge Elimination System (Wisconsin Department of Natural Resources n.d.r). For a more in-depth discussion about the impacts of excess nutrients on water quality in the Bay of Green Bay, please see section 5.1.1.3.1.

As described in section 5.2.1.3., the Lower Fox River proved an ideal location for paper production due to its proximity to lumber areas that could supply the wood pulp needed to make paper. After 1900, pulp and paper mills flourished along the Lower Fox River. As national demand for paper products increased, rapid expansion followed. The Lower Fox River and Bay of Green Bay remain a major center for paper production. According to the U.S. Environmental Protection Agency's ECHO tool, over 25 paper and pulp mills are in eight Wisconsin counties containing portions of the Lower Fox River or adjacent to the Bay of Green Bay (U.S. Environmental Protection Agency n.d.b). One contaminant of special concern is PCBs (polychlorinated biphenyls), which are created from the processing of carbonless paper in mills along the Lower Fox River. PCBs entered the river from many sources, but the largest deposits of contaminated sediments were traceable to local paper-recycling mills.

In 2020, following several large financial settlements with parties responsible for contributing to PCB discharges into the river, 4.9 million cubic meters (6.5 million cubic yards) of PCB-contaminated sediment were removed (dredged) from the river bed of the Fox River (Allen and Campbell 2023). Additional information on the history of pollution and pollution control in the Fox River can be found in Summers (2006) and Wozniak (1996).

In the HUC-12 watersheds immediately adjacent to Wisconsin's Bay of Green Bay, 19 facilities manufacture, process, use, import, or dispose of chemicals subject to Toxic Substances Control Act regulations. Regulated facilities within the Bay of Green Bay produce, store, or sell a variety of goods, such as paper products; chemicals; resin and synthetic rubber; lime; ferrous and nonferrous metal products (including metal recycling); electric power generation; coal, ore, and other minerals; asphalt paving mixture, fuel, and petroleum; paint and coatings; car parts; and fire protection products (U.S. Environmental Protection Agency n.d.b).

As noted in section 5.1.1.2.1, per- and polyfluoroalkyl substances (PFAS) refer to a large class of chemicals found in a wide variety of consumer products and industrial applications. These chemicals have been detected in fish throughout the Green Bay system and its tributaries by the Wisconsin Department of Natural Resources. A recent study found that a plume of per- and polyfluoroalkyl substances (PFAS) from an industrial source has made its way into Green Bay through the movement of groundwater (Harrington 2023). This contamination was traced to fire-products training facilities in the Marinette and Peshtigo areas, which were previously identified as sources of PFAS contamination in groundwater and private drinking water wells in the area.

5.2.3.6 Military

The City of Green Bay has an important military heritage as home to a former federal fort, Fort Howard (1816–1852). Today, the city and surrounding areas include an Army National Guard facility in the City of Green Bay, the Naval Reserve Center in Ashwaubenon (south of the proposed Lower Bay Component), the U.S. Defense Logistics Agency in the City of Green Bay, and multiple U.S. Coast Guard units. The Port of Sturgeon Bay, which is near the proposed reserve's Sturgeon Bay Component, is home to three U.S. Coast Guard units: Coast Guard Station Sturgeon Bay, Marine Safety Detachment Sturgeon Bay, and Coast Guard Cutter *Mobile Bay*.

Coast Guard Station Sturgeon Bay comprises two units: Station Sturgeon Bay and Station Washington Island. Together, the stations maintain about 30 active-duty and reserve personnel who conduct search and rescue, law enforcement, ice rescue, and maritime environmental protection. Their coverage spans Washington Island, Green Bay, and Lake Michigan's western shore from Point aux Barques south to Sturgeon Bay. Station (Small) Washington Island is a seasonal station located 50 miles north of Station Sturgeon Bay and operational from May through September.

Marine Safety Detachment (MSD) Sturgeon Bay is a multi-mission unit responsible for executing the U.S. Coast Guard's key missions under the U.S. Department of Homeland Security: Port Safety and Security, Marine Environmental Protection, and Commercial Vessel Safety. Approximately 10 active-duty personnel protect the busiest and most dynamic port in Wisconsin and perform tasks ranging from conducting port security patrols, processing vessel arrivals, inspecting U.S. and foreign commercial vessels, and conducting waterfront facility exams for federal regulatory compliance. Its area of responsibility includes 21 facilities, including several oil transfer facilities. In an average year, the MSD Area of Responsibility (AOR) receives 150 foreign vessel arrivals, 80 of which arrive from European and South American ports, with the remainder arriving from Canadian ports. The MSD Area of Responsibility for maritime inspection extends 35 nautical miles offshore and includes all navigable waters of western Lake Michigan, from Kenosha, Wisconsin, to Thompson, Michigan (just west of Manistique, Michigan), covering over 300 miles of coastline.

Coast Guard Cutter *Mobile Bay* is the third of nine 140-foot icebreaking tugs built by the U.S. Coast Guard. The cutter is ported in Sturgeon Bay. *Mobile Bay* conducts its icebreaking missions from mid-December through mid-April in the northern Great Lakes, operating primarily in the Green Bay, Straits of Mackinac, and St. Mary's River. Its other missions include maritime law enforcement, search and rescue, environmental pollution response, and homeland security.

All three of these Coast Guard units generally focus their support services for commercial navigation purposes.

5.2.3.7 Commercial Fishing

Commercial fishing in the Bay of Green Bay is limited, primarily targeting lake whitefish. Yellow perch are also harvested, though current quantities support only localized, seasonal distribution. Other species available for commercial licenses are rainbow smelt and round whitefish (menominee); however, these species have not been commercially fished for many years. While the lake whitefish population has fluctuated dramatically over the last two decades, recent documentation of recolonization in the Bay—rather than northern Lake Michigan—allows for larger commercial harvests from the Bay. Still, the 2022–23 lake whitefish commercial quota for lower Green Bay is limited to 12.5 percent (569,788 lbs) of the overall Wisconsin harvest limit (Schmidt 2023). Lake whitefish distribution remains largely local to Door County and the greater Green Bay area. The largest commercial fishing companies in the Green Bay area include Lindal Fisheries in Sturgeon Bay, Bailey’s Harbor Fish Company and Hickey Bros. Fisheries in Bailey’s Harbor (Door County), and Maricque Family Fisheries in Suamico. These fisheries mainly catch and sell lake whitefish and a small number of yellow perch locally or regionally.

Some Wisconsin Department of Natural Resources–restricted commercial fishing areas do overlap the proposed reserve’s waters (fig. 38). Specifically, restricted fishing areas exist along the western shore of the proposed Lower Bay Component and along the shoreline of the proposed Sturgeon Bay Component (Schmidt 2023).

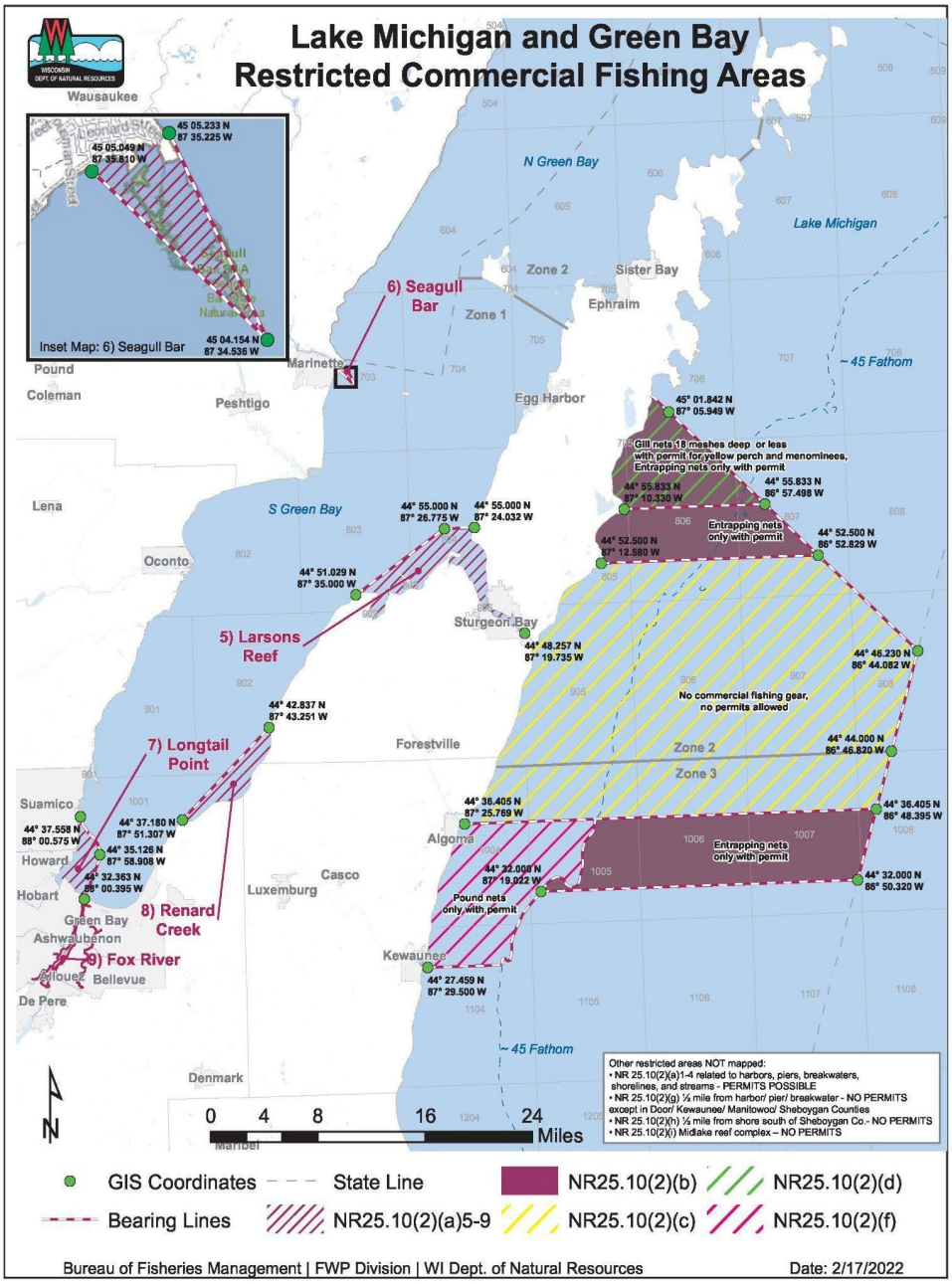


Figure 38. Restricted commercial fishing areas of Lake Michigan and Green Bay.

5.2.3.8 Recreational Fishing and Hunting

5.2.3.8.1 Recreational Fishing

Fishing is a year-round activity for outdoor recreational enthusiasts in the Green Bay region. The Wisconsin Department of Natural Resources, in partnership with the Great Lakes Indian Fish and Wildlife Commission, leads or manages all fish-stocking efforts in Green Bay. The department documents sport fishery in the Wisconsin waters of Lake Michigan and Green Bay from March through November. According to the department's 2023 Lake Michigan Management Report, anglers spent an estimated 2.4 million hours on the Wisconsin waters of Lake Michigan and Green Bay in 2022. Recreational anglers are most likely to catch yellow perch and walleye. In 2022, yellow perch and walleye recorded the highest estimated harvests in these waters, at 156,880 and 133,000, respectively (Schmidt 2023).

SPECIES	RAMP	MOORED	CHARTER	PIER	SHORE	STREAM	TOTAL
Coho salmon	44,409	15,497	39,579	565	1,859	2,783	**104,692**
Chinook salmon	46,871	24,087	35,100	1,427	1,439	11,224	**120,148**
Rainbow trout	9,340	7,639	10,937	79	297	7,012	**35,304**
Brown trout	2,760	464	968	264	1,024	3,533	**9,013**
Brook trout	0	0	0	0	0	8	**8**
Lake trout	6,318	4,834	11,803	84	28	0	**23,067**
Northern pike	5,071	0	0	106	255	68	**5,500**
Smallmouth bass	2,152	4,630	0	457	168	201	**7,608**
Yellow perch	127,968	16,558	0	2,647	5,528	4,179	**156,880**
Walleye	113,288	4,387	0	82	69	15,413	**133,239**
TOTAL	**358,177**	**78,096**	**98,387**	**5,711**	**10,667**	**44,421**	**595,459**

Figure 39. Sport harvest by fishery type and species for Wisconsin's Lake Michigan and Green Bay in 2022.

Over the past 20 years, the area's lake whitefish population has increased considerably, fostering the development of a strong recreational fishery (Schmidt 2023). Significantly smaller numbers of the following species are also commonly fished in the Bay of Green Bay: coho salmon, chinook salmon, rainbow trout, lake trout, brown trout, brook trout, muskellunge, northern pike, white perch, and smallmouth bass. Figure 39 provides additional information on the estimated recreational fishery harvests in Wisconsin's Lake Michigan and Green Bay (Schmidt 2023).

The Wisconsin Department of Natural Resources provides safe-eating guidelines for fish caught in Wisconsin. The department's recommendations are based on ongoing monitoring of fish for PCBs and PFOs. Year-round freshwater fishing by local residents and tourists contributes to the regional economy. According to Winden et al. (n.d.), 91 percent of Green Bay–area angler survey respondents indicated ownership of a powerboat, kayak, canoe, rowboat, or sailboat. The median total cost of all fishing gear for each respondent was $29,000. On average, respondents took 30 fishing trips in the Green Bay region annually, at a total cost of about $700 per trip. The report concluded that recreational sport fishing in the Green Bay region generates an economic impact of $264.3 million, creates annual state and local tax revenues of $14.8 million, and supports over 2,711 full-time jobs.

Fishing tournaments are another popular outdoor recreational activity for Bay of Green Bay–area residents and tourists. Green Bay is highly sought for walleye tournaments by The Walleye Federation. In 2023, the Bass Pro Shops and Cabela's National Team Championship tournament took place in Marinette, Wisconsin (The Walleye Federation 2022). Sturgeon Bay is home to the largest Wisconsin smallmouth bass tournament each spring. A 2018 sport fisheries report found that local anglers participate in about three local fishing tournaments each year (Winden et al. n.d.).

5.2.3.8.2 Recreational Hunting

Wisconsin is nationally recognized as a premier state for hunting white-tailed deer. White-tailed deer hunting remains a quintessential cultural pastime among northeastern Wisconsin residents. The 2025 nine-day, statewide gun season harvest totaled 183,098 deer, with 12,888 deer coming from the proposed reserve's five-county region (Wisconsin Department of Natural Resources n.d.u).

All five counties within the proposed reserve's boundaries are located in a Wisconsin Department of Natural Resources–designated Central Farmland Deer Management Zone (fig. 40). Oconto and Marinette, the two northernmost counties in the area, often compete for a top-five or top-ten spot for most deer harvested in the Central Farmland zone, which comprises 35 central and northeastern Wisconsin counties. The 2025 gunned deer harvest totals for each county in the five-county area were 2,238 deer for Door County; 3,718 deer for Oconto County; 4,020 deer for Marinette County; 1,637 deer for Kewaunee County; and 1,275 deer for Brown County (Wisconsin Department of Natural Resources n.d.u).

Each Wisconsin county has a County Deer Management Council that leads decision-making about deer herd management plans. Oconto, Brown, and Door counties have current county deer management goals to decrease the local deer population (Wisconsin Department of Natural Resources n.d.b; Wisconsin Department of Natural Resources n.d.c; Wisconsin Department of Natural Resources n.d.k; Wisconsin Department of Natural Resources n.d.l).

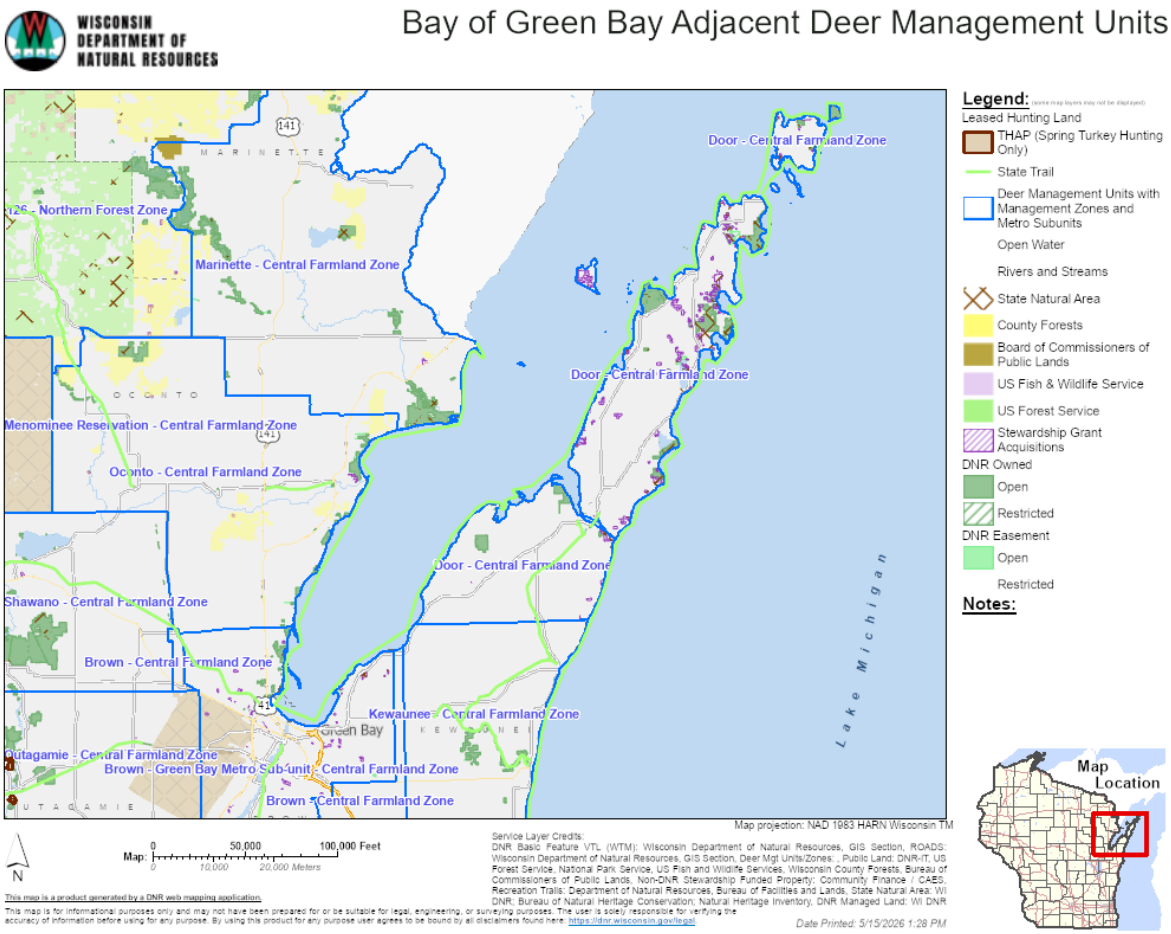


Figure 40. The Wisconsin Department of Natural Resources' Bay of Green Bay–adjacent deer management units.

Kewaunee County has a goal of maintaining their current deer population while Marinette County does not currently have a deer population goal (Wisconsin Department of Natural Resources n.d.f). Herd population goals are relevant to the proposed reserve because large deer populations can negatively impact forest habitats. Deer enjoy eating deciduous saplings, such as maples, oaks, and birch. When deer populations become too large, their constant browsing of the forest understory kills many saplings, reducing the forest's ability to mature (Kelly 2019). Compounding negative impacts include the loss of bird habitat and an increase in invasive weeds.

In addition to white-tailed deer hunting, hunting and trapping of small game (e.g., rabbit, racoon, snowshoe hare, fox, squirrel, ruffed grouse), big game (e.g., bear, wolf, turkey), furbearers (e.g., beaver, weasel, bobcat, mink), and waterfowl (e.g., mallard, Canada goose, coot) are also permitted throughout the state (Wisconsin Department of Natural Resources n.d.w; Frater and Rees Lohr n.d.; Finger et al. n.d.). Waterfowl are the second most hunted animal in the estuary. Hunting is allowed on much of the land and waters included within the proposed Green Bay Reserve boundaries. Hunting and trapping in the state follow seasonal restrictions and are subject to state licensing and regulations in accordance with WDNR management.

5.2.3.9 Agriculture

As a major land use in Northeast Wisconsin, agricultural production significantly impacts the water quality in the estuary and watershed of Green Bay. Wisconsin is known as “America’s Dairyland” because it produces more cheese than any other U.S. state. Statewide milk production is second only to California. The Bay of Green Bay region contributes much to the state’s dairy economy. Agricultural land use heavily supports both cattle and calf production, as well as production of forage and corn as animal feed. Figure 41 maps the 2023 permits for large concentrated animal feeding operations (CAFOs) in the five-county area and beyond. These operations contain greater than 1,000 animals. Thirty-five of these facilities operate in the three counties that border the lower Green Bay and its eastern shoreline. The region’s largest crops are forage (hay) and corn for animal feed. In addition to dairy production, Door County also hosts a significant fruit orchard cash crop industry. In total, 799,886 acres of land across the five-county area are used for agricultural production purposes. Table 43 describes agricultural activity in the five-county area of the proposed reserve per the most recent (2017) U.S. Department of Agriculture Census of Agriculture County Profiles (USDA 2019).

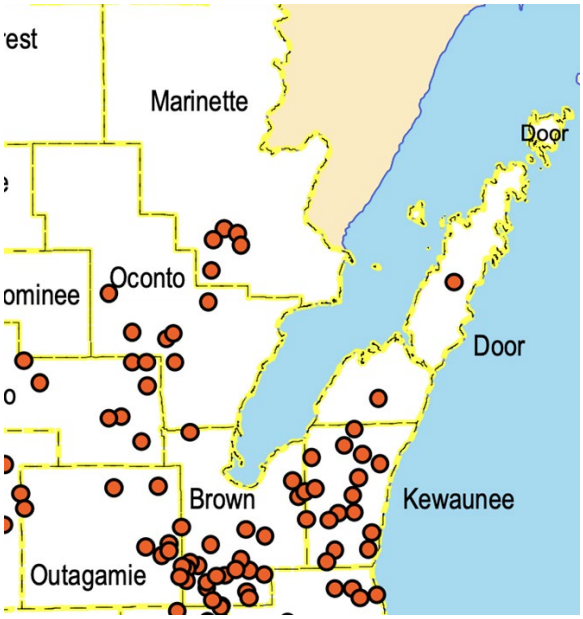


Figure 41. Concentrated animal feeding operations permitted by the Wisconsin Pollutant Discharge Elimination System.

Table 38. Agricultural Activity Within the Bay of Green Bay.

County	No. of Farms	Farmland (Acres)	Cattle Livestock Inventory	Top Crops by Acreage	Cropland (%); Pastureland (%); Woodland (%)
Brown	975	192,007	125,470	Forage (hay), corn for silage, soybeans for beans	87; 4; 5
Door	626	114,508	21,079	Forage (hay), soybeans for beans, corn for grain	79; 4; 12
Kewaunee	655	170,405	107,438	Forage (hay), corn for silage, corn for grain	86; 2; 8
Marinette	515	133,068	43,068	Forage (hay), corn for grain, corn for silage	67; 5; 21
Oconto	834	189,898	46,998	Forage (hay), corn for grain, soybeans for beans	75; 6; 14

Given the region's large dairy industry, agriculture is the largest source of nonpoint pollution in northeastern Wisconsin (University of Wisconsin–Madison n.d.). Lower Green Bay is the ultimate recipient of most of these pollutants. In 2012, the total maximum daily load (TMDL) and watershed management plan for the Lower Fox River basin and Lower Green Bay identified baseline sources for total phosphorus (TP) and total suspended solids (TSS). The study looked at total loading from the three prominent nearby river basins (Lower Fox River, Upper Fox River including Lake Winnebago, and the Wolf River), as well as specific sources from the Lower Fox River basin (The Cadmus Group, Inc. 2012). The study identified agriculture as the primary source for both total phosphorus and total suspended solids in Lower Green Bay.

The Lower Fox River basin provides a direct route for agricultural runoff to enter Lower Green Bay. The river originates at the outlet of Lake Winnebago and flows northeast for 39 miles before emptying into Green Bay. Land use in this watershed is 50 percent agriculture, 35 percent urban, and 15 percent natural forest areas and wetlands. There are 14 impaired waters in the Lower Fox River basin, including Lower Green Bay, that are polluted by excess total phosphorus and total suspended solids, impairing use by fish and other aquatic life in these water bodies. While agricultural runoff is not the only source of total phosphorus and total suspended solids, it is the largest (Wisconsin Department of Natural Resources 2015). Excess total phosphorus and total suspended solids adversely affects human, animal, and wildlife health due to water quality issues, such as nuisance algae growth, oxygen depletion, warmer water temperatures, reduced aquatic vegetation, and degraded habitat. Green Bay waters act as an outsized contributor of nutrients to Lake Michigan, with Lake Michigan receiving one third of its nutrient load from the Bay.

Today, the Wisconsin Department of Natural Resources manages the Lower Fox River TMDL project. The project's goals are to (1) reduce excess algal growth, (2) increase water clarity in Lower Green Bay, (3) increase growth of beneficial submerged aquatic vegetation in Lower Green Bay, (4) increase dissolved oxygen (DO) levels, and (5) restore degraded habitat (Wisconsin Department of Natural Resources 2015). Specifically, the

project seeks to lower TP and TSS loadings in the Lower Fox River basin by 59 percent and 55 percent, respectively. As part of that project, the University of Wisconsin–Madison Division of Extension manages the Great Lakes Restoration Initiative–funded Lower Fox Demonstration Farms Network. The network provides funding and pairs environmental professionals with local producers to identify and implement on-farm conservation practices that are feasible in Northeast Wisconsin to restore soil health, reduce runoff pollution, and improve water quality. Additional partners on the project include the Natural Resources Conservation Service, NEW Water, Brown County, and Outagamie County. The TMDL target for agriculture in the Lower Fox River basin is a TP reduction of 196,748 pounds and a TSS reduction of 55,570,968 pounds.

In addition to the Lower Fox Demonstration Farms Network, the Great Lakes Restoration Initiative similarly supports the Door-Kewaunee Watershed and Green Bay West Shore Demonstration Farms Network. This financial and technical support helps agricultural producers within these watersheds to implement on-farm conservation practices that reduce phosphorus and sediment in local water sources flowing into the Bay and Great Lakes (Natural Resources Conservation Service 2022).

While agricultural land use in the region heavily supports the state dairy industry, Door County also supports a regionally significant fruit orchard cash crop industry, including a robust cherry industry. The area's late spring, delayed by Green Bay and Lake Michigan, slows budburst in cherries, reducing potential frost damage to fruit blossoms (Goode 2008). The higher elevation and slopes also reduce problematic frost that typically form in lower valley areas; therefore, the best Door County cherry production sites tend to exist in northern Door County, where the elevation along the Niagara Escarpment is higher. Door County is the highest producer of cherries among all Wisconsin counties, producing just under 10 million pounds annually.

6 Environmental Consequences

Chapter 6 describes the anticipated environmental impacts of implementing each of the action alternatives, as well as the no action alternative, presented in chapter 4. These potential impacts apply to the affected environment described in chapter 5. This impact analysis discusses the reasonably foreseeable effects of each alternative, including unavoidable adverse impacts and aggregate effects (sections 6.2, 6.3, and 6.4), relationships between the proposed action and other applicable plans (section 6.5), the relationship between short-term uses and long-term productivity (section 6.6), and the irreversible and irretrievable commitment of resources (section 6.7). Table 39 defines terms used to identify intensities and durations of potential effects throughout this chapter.

Although the proposed Green Bay National Estuarine Research Reserve's management plan would largely involve administrative actions, designation and approval would be followed by reserve operations, with associated education, research, training, stewardship, and monitoring opportunities and activities. Annually appropriated federal funds, along with matching funds provided by the University of Wisconsin–Green Bay and other partners, would support the reserve's daily operations. Current uses of public and land trust land and waters within the proposed reserve's boundaries would continue to be managed under existing authorities, and land ownership would remain unchanged. The environmental impacts of designating the Green Bay Reserve and implementing its management plan are expected to be mostly beneficial, resulting in positive social, cultural, economic, and ecological effects; however, designation and implementation of the proposed reserve may also result in relatively minor adverse impacts (see sections 6.2 and 6.3). From a national perspective, approval of the proposed action establishes the 31st National Estuarine Research Reserve. The proposed Green Bay Reserve would fill a gap in the National Estuarine Research Reserve System, supporting a more complete network of estuarine systems that represents the array of biologically and geomorphologically diverse estuaries found in the United States and its territories.

At the time of publication, the draft management plan for the proposed reserve does not identify any specific, future facility-construction projects. Instead, if the proposed reserve were designated, existing office, laboratory, education, and storage spaces would be utilized. In its initial years of operations, the proposed reserve—if designated—and its Reserve Advisory Committee would evaluate needs and opportunities for future facilities and pursue feasible solutions to enhance or develop facilities for short- and long-term needs. Per the proposed reserve's draft management plan, information gleaned through this effort would be summarized in a long-term facility strategy.

Any future plans for facility expansion, restoration projects, habitat manipulations, land acquisitions, or reserve boundary changes would be included in subsequent management plans for the proposed reserve; these plans are subject to review and approval by NOAA's Office for Coastal Management, require updates every five years, and are released to solicit public comments. This recurring process provides many opportunities for review and discussion before new reserve-related projects are undertaken. Finally, any reserve-led projects which receive federal funding from the Office for Coastal Management (e.g., the annual operations award or competitively selected procurement, acquisition, and construction awards) would be subject to the National Environmental Policy Act and, therefore, would be reviewed by the Office for Coastal Management in accordance with applicable mandates (e.g., environmental and historic preservation laws, applicable executive orders, and other regulations, including Reserve System regulations) prior to implementation. In general, development of future facilities should be designed to minimize adverse impacts to sensitive environments and species.

6.1 Affected Resources and Potential Effects

The National Environmental Policy Act (NEPA) requires federal agencies to prepare an environmental impact statement for any action that may significantly affect the quality of the human environment. While NOAA does not anticipate any significant environmental effects from the designation of the proposed Green Bay National Estuarine Research Reserve, federal regulations at 15 C.F.R. § 921.13 require NOAA to prepare a draft and final environmental impact statement for each reserve designation.

Effects or *impacts* refer to reasonably foreseeable changes to the human environment that have a close causal relationship to the proposed action or alternatives. Effects can be ecological (e.g., natural resources and the components, structures, and functioning of affected ecosystems), aesthetic, historical, cultural, economic (e.g., employment), social, or health-related. Effects analyzed under NEPA may be beneficial, adverse, or both, relative to these values. To determine if reasonably foreseeable effects are significant, the decision-maker analyzes the potentially affected environment and the degree of those effects.

When evaluating the potentially affected environment, the decision-maker should consider, as appropriate to the specific action, the geographic area and the national, regional, and local contexts. This chapter assesses past, present, and reasonably foreseeable effects. Section 6.4 further examines potential aggregate effects of significant future environmental stressors or conditions, including climate change, changes in land use and development, and invasive species. For this analysis, the potential impacts, both beneficial and adverse, have been evaluated using the criteria or characteristics identified in table 39.

Table 39. Evaluation Criteria and Characteristics for Environmental Consequences.

Effect and Impact Categorization	**Description**
Type of Effect	
Direct	Effects from a proposed action that occur at the same time and same place.
Indirect	Effects from a proposed action that occur later in time, at some distance from the project, or due to cause and effect relationships.
Impact Severity	
Negligible	The impact level on the resource is difficult to detect. If the impact(s) on the resource or environment is detectable, the changes would present little to no noticeable difference.
Minor	Impacts on the resource or environment is small but detectable.
Moderate	Impacts on the resource or environment is detectable and apparent.
Major	Impacts on the resource or environment is detectable and substantial.

6.2 Natural Environment

6.2.1 Physical Environment

6.2.1.1 Weather and Climate

Table 40. Weather and Climate Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Weather and climate	No direct or indirect impacts (beneficial or adverse) are expected.	Indirect, negligible impacts (beneficial) may occur due to increased awareness of environmental change.	Same as Alternative A

No Action Alternative

Under this alternative, no direct or indirect impacts (beneficial or adverse) on weather and climate are expected because actions in the area of the proposed reserve have negligible impacts on the daily weather and overall climate of the region. Future changes to weather and climate are expected to be the result of larger regional and global factors that are independent of local conditions and changes.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on weather and climate in the Bay of Green Bay. Future changes to weather and climate are expected to be the result of larger regional and global factors that are independent of local conditions and changes. While precise ecosystem responses to future climate scenarios cannot be predicted, the proposed Green Bay Reserve would provide opportunities to learn from and manage novel ecosystems emerging in the Great Lakes estuaries. Furthermore, the proposed reserve's education and monitoring programs could raise awareness of changing weather and climate conditions and their implications, potentially leading to individual behavioral shifts with minor indirect benefits. These minor benefits will have a negligible impact relative to previously mentioned global factors.

6.2.1.2 Water (Hydrosphere)

6.2.1.2.1 Water Quality

Table 41. Water Quality Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Water quality	Potential manipulation and restoration activities may alter nutrient levels in receiving waters. Temporary, moderate increases can occur in sedimentation from upland and estuarine habitat manipulations or restorations that remain ongoing from projects related to the area of concern and other restoration activities. Beneficial, long-term improvements to water filtration, infiltration, and retention of soils can occur as a result of these activities.	Minor indirect impacts (beneficial) may result from the proposed reserve's research, education, training, and stewardship programs.	Same as Alternative A

No Action Alternative

The Bay of Green Bay is undergoing significant and long-term restoration projects under the U.S. Environmental Protection Agency's Area of Concern designation, including various restoration projects aimed at removing beneficial use impairments related to water quality. The Bay of Green Bay will remain subject to federal, state, and local regulations aiming to maintain or improve water quality in the estuary and its contributing waters. While there may be short-term, moderate increases in sedimentation during restoration, long-term water quality improvements will occur due to improved water filtration capacity of wetlands fringing the Bay, retention of soils, and overall improvement to shoreline habitat aiming to improve water quality in the Bay. These efforts will continue regardless of reserve designation.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on Bay of Green Bay water quality; however, minor indirect impacts (beneficial) to water quality will result from the activities of the proposed Green Bay Reserve following its designation. Specifically, the reserve's proposed water-quality monitoring program and related research and its educational, training, and stewardship initiatives could raise awareness of water quality within the Bay of Green Bay. Furthermore, any reserve-led assistance with direct land management activities could conceivably have positive benefits on local water quality.

For example, the draft management plan for the proposed reserve poses collaborating with landowning partners and watershed organizations to support restoration planning, best management practices, and green infrastructure projects that reduce sediment and nutrient loading to the Bay and working with regional partners

to explore and implement innovative approaches for improving estuarine resilience, including shoreline sediment management, watershed scenario planning, and beneficial reuse of dredged materials. Because Alternatives A and B fundamentally comprise the same components with only minor variations, the expected impact of either alternative is virtually identical.

6.2.1.2.2 Hydrology

Table 42. Hydrology Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Hydrology	No direct or indirect measurable impacts (beneficial or adverse) are expected on the hydrology of the proposed areas.	Minor indirect impacts (beneficial) may result from the proposed reserve's research, education, and stewardship programs.	Same as Alternative A

No Action Alternative

No direct or indirect measurable impacts (beneficial or adverse) are expected on the hydrology (e.g., water levels, water circulation patterns, Bay of Green Bay tributary network, inland open waters, groundwater) of the area. Future changes to the hydrology of the Bay of Green Bay and its contributing watersheds will be the result of larger climate- or land use–related changes in the watersheds upstream of the Green Bay estuary or open water coastal areas of the Bay of Green Bay.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any direct impacts (beneficial or adverse) on the hydrology of the Bay of Green Bay, its contributing watersheds, or the proposed Green Bay Reserve components. Future direct, measurable changes to the Green Bay hydrologic system will be the result of larger climate- or land use–related changes in the watersheds upstream of the Green Bay estuary or coastal areas of the proposed Green Bay Reserve.

However, minor, localized, beneficial impacts to the surface and possibly groundwater hydrology are expected to result from activities of the proposed Green Bay Reserve following its designation. Research, educational programs, and assistance with direct land management activities could conceivably have positive benefits on local hydrological patterns and processes at each proposed reserve component. For example, the Green Bay Reserve's draft management plan proposes support for restoration projects that improve connectivity between streams, wetlands, and the Bay, including culvert removal, stream restoration, shoreline improvements, and habitat enhancement, aiding the development and application of hydrodynamic and landscape modeling tools that improve understanding of coastal habitat interactions and water exchange across the estuary and exploring training and knowledge exchange opportunities that highlight approaches for restoring and stewarding connections between urban watersheds, tributaries, wetlands, and the open waters of Green Bay. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.2.2 Biological Environment

6.2.2.1 Upland and Terrestrial Habitats

Table 43. Upland and Terrestrial Habitat Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Upland and terrestrial habitats	Negligible direct or indirect impacts (beneficial or adverse) are expected on upland and terrestrial habitats.	Minor indirect impacts (beneficial) may result from the added financial and staff capacity of the proposed reserve.	Same as Alternative A

No Action Alternative

Negligible direct or indirect impacts (beneficial or adverse) are expected on the upland and terrestrial habitats within the Bay of Green Bay. Small, localized land management activities (e.g., trail building, trail maintenance, invasive species control, habitat restoration) by partners will continue and would have minor impacts on the integrity or function of upland and terrestrial habitats. Future major direct impacts to upland and terrestrial habitats would be the result of larger climate- or land use–related changes or the introduction of a highly impactful invasive species in the watersheds surrounding the Bay of Green Bay.

Alternatives A and B

Land within the proposed Green Bay Reserve would continue to be managed by existing landholding partners under either action alternative. Like the no action alternative, reserve designation is expected to have negligible direct impacts (beneficial or adverse) on the upland and terrestrial habitats surrounding the Bay of Green Bay. Small, localized disturbances related to routine, partner-led land management activities (e.g., trail building, trail maintenance, invasive species control, habitat restoration) will continue regardless of reserve designation; these activities are expected to have minor impacts on the integrity or environmental functioning of existing upland and terrestrial habitats.

Minor, localized impacts (beneficial) would result from the proposed Green Bay Reserve's activities following its designation. Specifically, the proposed reserve would provide additional support to landholding partners in managing upland and terrestrial habitats. After a reserve is designated, the lead state partner can access annual funding from NOAA to support reserve operations, including hiring staff to implement reserve-led stewardship programs. Hiring a dedicated stewardship coordinator supports on-the-ground restoration efforts led by the proposed reserve's landholding partners. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.2.2.2 Riparian and Freshwater Habitats

Table 44. Riparian and Freshwater Habitat Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Riparian and freshwater habitats	Negligible direct or indirect impacts (beneficial or adverse) are expected on riparian and freshwater habitats.	Minor indirect impacts (beneficial) may result from research, stewardship, education programs, and additional staff and financial capacity provided by the proposed reserve.	Same as Alternative A

No Action Alternative

Negligible direct or indirect impacts (beneficial or adverse) are expected on the riparian and freshwater habitats within the Bay of Green Bay. Riparian and freshwater habitats would continue to be protected and managed by the existing landholding partners. Historical and ongoing environmental degradation would continue to adversely impact the riparian and freshwater habitats of the Bay of Green Bay, both directly and indirectly.

Alternatives A and B

Like the no action alternative, the riparian and freshwater habitats within the proposed Green Bay Reserve would continue to be directly or indirectly impacted by historical and ongoing conditions that currently degrade the health of areas within the proposed reserve's boundaries. Minor, localized impacts (beneficial) are expected to result from reserve activities. Specifically, the reserve is expected to increase mitigation and restoration research, stewardship, and outreach programs and projects. Furthermore, it would provide additional staff and financial capacity to support landholding partners with aquatic and freshwater habitat management. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.2.2.3 Estuarine Environment

Table 45. Estuarine Environment Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Estuarine environment	No direct or indirect measurable impacts (beneficial or adverse) are expected on the estuarine environment.	Minor indirect impacts (beneficial) may result from research, education programs, stewardship programs, and additional staff and financial capacity provided by the proposed reserve.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) are expected on the estuarine environment (i.e., the Bay of Green Bay tributaries proposed for inclusion in the proposed Green Bay Reserve and the land cover characteristics of their watersheds). Future impacts on the estuarine environment would be the result of larger climate- or land use–related changes in the region.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on the estuarine environment. Future direct impacts on the estuarine environment would be the result of larger climate- or land use–related changes within the watersheds and upstream of the proposed Green Bay Reserve.

Minor, localized impacts (beneficial) would result from the proposed Green Bay Reserve's activities following designation. Research, education, and stewardship programs, as well as reserve staff assistance with direct land management activities, could conceivably have positive benefits on the estuarine environment. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.2.3 Living Resources

6.2.3.1 Flora – All Habitats

Table 46. Flora Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Flora	Negligible direct or indirect impacts (beneficial or adverse) are expected to flora.	Minor indirect impacts (beneficial) may result from research, education programs, stewardship programs, and additional staff and financial capacity provided by the proposed reserve.	Same as Alternative A

No Action Alternative

Existing landholding partners would continue to protect and manage the areas within the proposed Green Bay Reserve. Historical and ongoing environmental degradation would persist in adversely affecting local flora, both directly and indirectly.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on flora within the proposed Green Bay Reserve. Rather, the diversity, composition, viability, and climate resilience of flora would continue to be directly or indirectly impacted by historical and ongoing conditions. Minor, localized impacts (beneficial) could result from reserve activities following designation; specifically, the reserve will support existing and create new restoration research, stewardship, and outreach programs and projects. Furthermore, the proposed reserve would provide additional staff and financial capacity to support landholding partners with habitat management. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.2.3.2 Fauna – All Habitats

Table 47. Fauna Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Fauna	Negligible direct or indirect impacts (beneficial or adverse) are expected to fauna.	Negligible indirect (beneficial) impacts are expected due to increased awareness of estuarine fauna.	Same as Alternative A

No Action Alternative

Existing landholding partners would continue to protect and manage the areas within the proposed Green Bay Reserve. Historical and ongoing environmental degradation would persist in adversely affecting local fauna, both directly and indirectly.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on fauna within the proposed Green Bay Reserve. Historical and ongoing environmental degradation would persist in adversely affecting the population viability, overall diversity and composition, and climate resilience of fauna. Negligible, localized indirect impacts (beneficial) could result from reserve activities following designation; specifically, the reserve's education and outreach programs could raise awareness of estuarine fauna, possibly leading to improved stewardship in the Bay of Green Bay. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.2.3.3 Special-Status Species and Habitats (e.g., Federal- and State-Listed Endangered, Threatened, and Special Concern Species and Habitats)

Table 48. Special-Status Species and Habitats Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Special-status species and habitats	Direct and indirect impacts (adverse) are expected to continue due to historical and ongoing threats to special-status species and habitats.	Minor, indirect impacts (beneficial) could result from the proposed reserve's programs raising awareness of special-status species and habitats.	Same as Alternative A

No Action Alternative

Existing landholding partners would continue to protect and manage the areas within the proposed Green Bay Reserve, including the protection, conservation, and restoration of special-status species and habitats on their land. However, historical and ongoing threats would persist in adversely impacting special-status species and habitats, both directly and indirectly.

Alternatives A and B

Like the no action alternative, special-status species and habitats under either action alternative would continue to be directly or indirectly impacted by historical and ongoing environmental degradation that affects the health of the Bay of Green Bay. Minor, localized indirect impacts (beneficial) could result from the proposed reserve's activities following its designation; specifically, the reserve's stewardship, education, and outreach programs could raise awareness of special-status species and habitats, possibly leading to improved stewardship in the Bay of Green Bay. Furthermore, the proposed Green Bay Reserve would provide additional staff and financial capacity to support landholding partners with habitat management, which could directly benefit sensitive species and habitats. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3 Human Environment

6.3.1 Cultural and Historic Setting

6.3.1.1 Cultural Resources (e.g., Historic and Prehistoric Archaeological and Architectural Sites and Lighthouses and Shipwrecks)

Table 49. Cultural Resources Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Historic and prehistoric archeological and architectural sites	None	Minor indirect impacts (beneficial) are expected due to greater awareness of cultural and historical sites for preservation, education, and research and relationship-building with Tribal partners and communities.	Same as Alternative A
Lighthouses and shipwrecks	None	Minor indirect impacts (beneficial) are expected due to greater awareness of sites for preservation or tourism opportunities.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to the area's cultural and historical resources are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay and its surrounding land. Future impacts to cultural and historical resources would be the result of local or regional funding for preservation or research efforts, independent of a National Estuarine Research Reserve designation.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on cultural or historical resources within the proposed Green Bay Reserve. Instead, multiple potential impacts (minor, indirect, and beneficial) could result from the proposed reserve's activities following its designation. For example, the proposed reserve's draft management plan includes significant environmental education opportunities for students and the general public that could showcase the many cultural and historical resources (e.g., archeological and architectural sites, lighthouses, and shipwrecks) in and around Green Bay. These educational opportunities could raise awareness of these resources, possibly leading to beneficial environmental stewardship or preservation efforts. Promotion of these resources could also increase tourism and other economic activity or environmental stewardship for the natural areas around these sites. The reserve's draft management plan also proposes outreach and collaboration with Tribal nations in the region for both environmental education and stewardship activities. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.2 Human and Economic Setting

6.3.2.1 Population

Table 50. Human Population Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Population	None	Minor indirect impacts (beneficial and adverse) are anticipated due to potential population growth, as reserve activities enhance the natural environment and increase the area's appeal.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to the population are anticipated. Future population changes could result from local, regional, or national changes to economic, quality-of-life, or political factors.

Alternatives A and B

Like the no action alternative, reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on the population surrounding the Bay of Green Bay. However, under both action alternatives, minor indirect impacts (beneficial) are anticipated due to reserve activities following its designation. Impacts could include minor, long-term population growth as the proposed Green Bay Reserve creates a healthier natural environment in northeastern Wisconsin, thereby promoting more outdoor recreation and creating a more desirable place to live. Related potential benefits include increased and improved access to the shoreline through construction of boardwalks, improved trails, and other accessibility features, promoting a healthier lifestyle through increased physical activity. Conversely, Alternative A or B could also create minor indirect impacts (adverse), namely increased cost of living due to the area's desirability. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.2.2 Employment

Table 51. Employment Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Employment	None	Negligible direct and indirect impacts (beneficial) are anticipated due to immediate reserve staff hiring and longer-term growth in employment opportunities related to natural resources, outdoor recreation, tourism, and research.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to area employment are anticipated. Future changes in employment may be driven by local, regional, or national economic or political shifts, as well as broader external factors.

Alternatives A and B

Reserve designation under either action alternative is expected to have negligible direct and indirect impacts (beneficial). The initial hiring of several core staff members, including a manager, an education coordinator, and a research coordinator to implement the programs and activities described in the draft management plan, would have the most direct and immediate impact on local employment.

Long term, the proposed reserve's efforts to address current watershed, water quality, and natural habitat issues; facilitate a better understanding of environmental stewardship practices; and develop environmental awareness among local residents, businesses, and land managers could lead to future employment opportunities in natural resources, recreation, tourism, and university-led research. Overall, these beneficial impacts on local employment are expected to be negligible and indirect over the long term. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.2.3 Regional Economics

Table 52. Regional Economic Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Regional economics	None	Negligible indirect impacts (beneficial) are anticipated due to increased tourism and outdoor recreational activities.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to the regional economy are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to regional economics could result from local, regional, or national economic or political factors, as well as broader external factors.

Alternatives A and B

Reserve designation under either action alternative is not expected to have any measurable direct impacts (beneficial or adverse) on the regional economy. However, under both action alternatives, negligible indirect impacts (beneficial) could result from reserve activities following its designation. The proposed reserve's enhanced emphasis on Bay of Green Bay water quality and its surrounding natural areas could revitalize aquatic and land areas and, therefore, create beneficial long-term growth for outdoor recreation businesses (e.g., camping, hiking, fishing, boating, kayaking) and associated tourism businesses in leisure and hospitality. A greater number of researchers and students involved in reserve programming could also generate negligible increases in local business patronage. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3 Current Human Uses

6.3.3.1 Tourism and Recreation

Table 53. Tourism and Recreation Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Tourism and recreation	None	Minor indirect impacts (beneficial) are anticipated due to enhanced stewardship of natural areas and associated growth in tourism and outdoor recreational activities.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to the tourism industry and recreation activities are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to the tourism industry and outdoor recreation could result from local or regional efforts by organizations seeking to boost local and regional tourism and outdoor recreational activities.

Alternatives A and B

Reserve designation under either action alternative is not expected to result in any measurable direct impacts (beneficial or adverse) on the area's tourism industry or recreational activities. However, under both action alternatives, minor indirect impacts (beneficial) could result from reserve activities following its designation. Enhanced stewardship of natural areas, focused trail restoration and improvements, the creation of water-access points, and increased public accessibility to natural areas could attract more visitors and increase local and regional tourism and outdoor recreational activities. Designating the Green Bay Reserve could also attract more nonlocal visitors by increasing public knowledge of the area's outdoor recreational opportunities at a regional and national level.

Any increase in nonlocal visitors potentially increases vehicular traffic, thereby increasing air pollution. These potential secondary impacts (adverse) are expected to be negligible. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3.2 Education

Table 54. Education Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Education	None	Moderate direct and indirect impacts (beneficial) are anticipated from K-12 and public environmental education activities led by the reserve, as well as expanded research opportunities conducted by local higher education institutions in partnership with the reserve.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to education are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to local environmental education opportunities would be made by existing school districts or organizations that provide environmental education.

Alternatives A and B

Under either action alternative, Green Bay Reserve designation is expected to have moderate direct and indirect impacts (beneficial) on environmental education.

In the short term, designating the reserve would enable hiring an education coordinator to immediately expand regional environmental education. Over the long term, the reserve aims to execute the draft management plan's goals to broaden education and interpretation focused on the natural and cultural value of the Green Bay estuary and its watershed. Education-related objectives include empowering communities to adapt to climate change and changing water levels in the Bay of Green Bay, improving understanding of watershed inputs and water quality outputs, demonstrating connections between upland actions and nearshore and open water impacts, and developing K-12 estuary education programs that share historical connections, contemporary quality-of-life benefits, and future social opportunities. Through these initiatives, the reserve would deliver immediate and long-term regional benefits by expanding environmental education opportunities. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3.3 Research and Monitoring

Table 55. Research and Monitoring Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Research and monitoring	None	Moderate direct and indirect impacts (beneficial) are expected due to greater collaboration among organizations conducting research and monitoring activities, as well as expanded data collection, monitoring activities, and research opportunities.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to research and monitoring opportunities are anticipated. Existing landowners would continue to protect and monitor the Bay of Green Bay area. Future changes to regional research and monitoring activities would be made by existing state and local agencies, higher education institutions, and nonprofit organizations.

Alternatives A and B

Under either action alternative, Green Bay Reserve designation is expected to have moderate direct and indirect impacts (beneficial) on research and monitoring efforts in the Bay of Green Bay. Following designation, the reserve would hire a research coordinator, adding immediate capacity to the community of scientists supporting research and monitoring in the area. In the years following its designation, the reserve would add to the Reserve System's unprecedented nationwide effort to collect long-term water quality, biotic, physical and land use, and habitat change information by establishing monitoring stations and eventually implementing the System-Wide Monitoring Program. The reserve would also implement the activities described in its draft management plan, which includes several goals, objectives, and actions specific to data collection, monitoring, and reporting efforts. Research-related objectives proposed in the draft management plan include enhancing the data-informed decision-making capacity of coastal communities as they build resilience to and prepare for climate change impacts and fluctuating Great Lakes water levels, monitoring key ecosystem inputs (e.g., sediment and nutrient loading) and associated ecosystem states (e.g., dissolved oxygen levels), identifying key connections and risks to these connections between terrestrial and aquatic ecosystems within the Green Bay estuary, and understanding factors limiting or promoting the successful restoration of diverse, predominantly native biotic communities in the Bay, its wetlands, and its tributaries. These research and monitoring efforts will directly and significantly benefit the management of the existing area of concern and influence longer-term outcomes related to historical pollution within the region's watershed. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3.4 Transportation, Navigation, and Infrastructure

Table 56. Transportation, Navigation, and Infrastructure Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Transportation, navigation, and infrastructure	None	Negligible indirect impacts (beneficial) are expected from increased tourism and education-related visits to the region.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to transportation, navigation, or infrastructure conditions are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to regional transportation, navigation, and infrastructure would be made by federal, state, and local government agencies that currently manage transportation, navigation, and infrastructure activities.

Alternatives A and B

Similar to the no action alternative, reserve designation under either action alternative is not expected to have any direct impacts (beneficial or adverse) to the region's transportation, navigation, and infrastructure network. However, under either action alternative, the proposed reserve's activities are expected to have negligible indirect impacts (beneficial) following designation. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

Transportation: Implementation of the proposed Green Bay Reserve's education programming results in increased school bus traffic to locations throughout the area. These increases in vehicular traffic are expected to have negligible, adverse impacts on local air quality and no impact on existing transportation opportunities and infrastructure.

Navigation: The proposed designation is nonregulatory; therefore, it does not interfere with or inhibit shipping or recreational boat traffic or management of existing navigation channels. In fact, the proposed boundaries include a 10-mile buffer around the Green Bay and Sturgeon Bay shipping channels. Due to the potential for increased water quality monitoring via buoys throughout the Bay, an increase (negligible) in small boat traffic on the Bay could occur. This traffic is not expected to change existing navigation opportunities.

Infrastructure: The designation of the proposed reserve is not expected to impact the normal, day-to-day operations or economic activities related to the Port of Green Bay, Port of Sturgeon Bay, or Port of Marinette (Wisconsin or Menominee, Michigan). Reserve designation could have a negligible, beneficial long-term impact on the Renard Island Master Plan and Cat Island Restoration Project, which both seek to positively impact Lower Bay water quality and land habitat by adding capacity to support implementation.

6.3.3.5 Industry and Manufacturing

Table 57. Manufacturing Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Manufacturing	None	Negligible indirect impacts (adverse) are expected due to enhanced collection and tracking of water quality parameters related to industrial or manufacturing activities.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to industry and manufacturing are anticipated. Existing landowners would continue to protect and manage the area. Future changes to regional industrial and manufacturing activities would be made by existing or new private ventures or federal, state, regional, or local regulatory agencies.

Alternatives A and B

Similar to the no action alternative, reserve designation under either action alternative is not expected to have any direct impacts (beneficial or adverse) to the region's industrial or manufacturing environment. Furthermore, reserve designation is not expected to alter the status quo of activities performed by any of the industrial and manufacturing facilities within the region; research reserves are nonregulatory entities that do not impose limits on private activities. However, under either action alternative, the reserve's activities following designation could have negligible indirect impacts (adverse) on industrial and manufacturing activities in the Bay of Green Bay. Following designation, the reserve will collect, track, and report water quality parameters that could be related to industrial and manufacturing activities. These data could be used by city, county, regional, or state governments to impose regulations on industrial or manufacturing activities, thereby increasing business costs. Due to an existing, robust water-quality monitoring network within the Bay of Green Bay, any impacts of long-term water quality monitoring conducted by the proposed reserve are expected to be negligible. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3.6 Military

Table 58. Military Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Military	None	Negligible indirect impacts (beneficial) are expected from enhanced education to U.S. Coast Guard units regarding environmental stewardship of the Bay.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to the military are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to regional military activities would be made by government agencies that currently manage military operations.

Alternatives A and B

Similar to the no action alternative, reserve designation under either action alternative is not expected to have any direct impacts (beneficial or adverse) to existing military operations or infrastructure. However, under either action alternative, the reserve's activities following designation may have negligible indirect impacts (beneficial) on military activities in the region. The proposed Green Bay Reserve and its programs are not expected to alter the status quo of activities performed by any military entities adjacent to the proposed reserve. Negligible beneficial impacts could occur if U.S. Coast Guard personnel engage in proposed Green Bay Reserve–managed environmental stewardship or educational activities. This scenario could ultimately lead these personnel to institute activities or processes that better support water quality or shoreline habitat in the Bay as these activities and processes relate to their respective Coast Guard occupational activities. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3.7 Commercial Fishing

Table 59. Commercial Fishing Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Commercial fishing	None	Minor indirect impacts (beneficial) are expected from potential growth in commercial fishing operations due to improved water quality and increased fish stocks.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to commercial fishing activities are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to regional commercial fishing activities would be made by existing or new private or public ventures related to commercial fishing or by state or regional regulatory agencies responsible for Green Bay fish-stock management.

Alternatives A and B

Reserve designation under either action alternative is not expected to have any direct impact (beneficial or adverse) on commercial fishing. Under either action alternative, the reserve's activities following designation are anticipated to have minor indirect impacts (beneficial) on commercial fishing activities in the Green Bay estuary. Enhanced water-quality parameter data collection and tracking by the reserve could lead to enhanced water quality in the Bay of Green Bay. These activities could prove beneficial for the propagation of Green Bay fish species. Larger fish stocks could lead to increased harvests of whitefish, perch, and other species, benefiting regional commercial fishing operations. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3.8 Recreational Fishing and Hunting

Table 60. Recreational Fishing and Hunting Impacts.

Resource	No Action Alternative	Alternative A	Alternative B – Revised Nominated Site
Recreational fishing	None	Minor indirect impacts (beneficial) are expected from potential growth in recreational fishing due to improved water quality in the Bay yielding increased fish populations.	Same as Alternative A
Recreational hunting	None	Minor indirect impacts (beneficial) are expected from enhanced environmental stewardship of land used for hunting.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to recreational fishing and hunting activities are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to regional recreational fishing and hunting activities would be made by state or regional government agencies responsible for management or regulation of regional fishing and hunting activities or by existing or new private or public ventures that operate businesses related to recreational fishing or hunting.

Alternatives A and B

Similar to the no action alternative, reserve designation under either action alternative is not expected to have any direct impact (beneficial or adverse) on recreational fishing and hunting activities around the Bay of Green Bay.

Recreational Fishing: Under either action alternative, the reserve's activities following designation could have minor, indirect impacts (beneficial) on recreational fishing activities in the Bay of Green Bay. Enhanced water-quality parameter data collection and tracking by the reserve could lead to enhanced water quality in the Bay of Green Bay. These activities could be beneficial for the propagation of Green Bay fish species. Larger fish stocks could lead to increased recreational harvests of whitefish, perch, and other species.

Recreational Hunting: Under either action alternative, the reserve's activities following designation could have minor indirect impacts (beneficial) on recreational hunting activities around the Bay of Green Bay. The reserve's stewardship and education programs could lead to minor, localized improvements to freshwater, riparian, terrestrial, and upland habitats relied upon by large and small game species, furbearers, and waterfowl. Consequently, recreational hunting conditions could improve on the proposed reserve's land where hunting is currently allowed. Designation of the reserve does not alter the availability or extent of hunting lands within the proposed reserve components. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.3.3.9 Agriculture

Table 61. Agriculture Impacts.

Resource	No Action Alternative	Alternative A – Nominated Site	Alternative B – Revised Nominated Site
Agriculture	None	Minor indirect impacts (adverse) are expected from enhanced collection and tracking of water quality parameters related to agricultural runoff and the implications of that data on regional agricultural practices and the watershed.	Same as Alternative A

No Action Alternative

No direct or indirect impacts (beneficial or adverse) to agricultural activities are anticipated. Existing landowners would continue to protect and manage the Bay of Green Bay area. Future changes to agricultural activities, particularly changes related to agricultural runoff as a source of nonpoint pollution and current efforts to meet total maximum daily load (TMDL) goals, would be made by state or regional government agencies or nonprofit organizations responsible for regional land use management or existing projects intended to meet TMDL goals.

Alternatives A and B

Reserve designation under either action alternative is not expected to have any direct impacts (beneficial or adverse) on agricultural activities around the Bay of Green Bay. However, under either action alternative, the reserve's activities following designation could have minor indirect impacts (adverse) on agricultural activities. Specifically, designating the reserve could attract greater attention to agricultural runoff as the largest contributor to water quality challenges in the Lower Fox River Basin and Lower Green Bay. Similarly, enhanced data collection, tracking, and reporting of water quality parameters related to agricultural runoff could be used by city, county, or regional governments to impose regulations on agricultural producers, thereby increasing costs for agricultural production businesses. This indirect impact would be due to the reserve's long-term monitoring activities. Because Alternatives A and B fundamentally comprise the same proposed components with only minor variations, the expected impact of either alternative is virtually identical.

6.4 Aggregate Effects

Per the Council on Environmental Quality's *Memorandum for Heads of Federal Agencies and Departments: Implementation of the National Environmental Policy Act* dated February 19, 2025, federal agencies should analyze the reasonably foreseeable effects of the proposed action (Scarlett 2025). These effects may include the aggregated effects of the proposed action when added to other past, present, and reasonably foreseeable future actions. As such, this draft environmental impact statement analyzes these aggregate effects to determine the likelihood of any significant adverse impacts on the environment. While sections 6.2 and 6.3 analyze a full range of direct and indirect impacts of the proposed action, this section focuses on aggregate effects of the proposed action combined with future substantial environmental stressors that are not connected to the proposed project but are reasonably foreseeable to occur, change, or exacerbate in the future.

Although reserve designation and approval of the reserve's management plan are largely administrative actions, these actions would be followed by reserve operations, with associated education, research, training, stewardship, and monitoring opportunities and activities. As summarized in sections 6.2 and 6.3 and under all analyzed alternatives, designating the reserve and subsequently implementing its activities are not expected to

significantly or adversely impact—either directly or indirectly—the environment. Many of the adverse effects are expected to be negligible to minor in intensity, whereas most beneficial effects are expected to have minor to moderate impacts, especially at the local level.

Information available at the time of this analysis indicates that a variety of threats and stressors will continue to impact natural resources and human communities in and surrounding the Bay of Green Bay. The most acute of these is climate change, followed by contaminants, nutrients, and sediments; invasive species; development; and hydrologic modifications. These threats and stressors will impact the Bay of Green Bay regardless of whether the proposed reserve is designated. A brief description of the most significant threats and stressors facing the Bay of Green Bay follows, along with an analysis of the combined effects of those threats and stressors with the proposed reserve designation on aspects of the natural and human environment. Discussion of the most significant threats and stressors facing the Bay of Green Bay is based in part on Wenger and Harris's *Green Bay Ecosystem and Assessment of Climate Change Impacts* (2010) and the Wisconsin Initiative on Climate Change Impacts' *Potential Climate Change Impacts on the Bay of Green Bay: An Assessment Report* (2010).

6.4.1 Climate Change

As described in chapter 5, regional climatic conductions are expected to shift from a cold winter–warm summer climate with no dry season to a cold winter–hot summer climate with no dry season (Beck et al. 2018). Climate models project that Wisconsin will receive slightly more precipitation in more frequent and intense rainfall events, especially in early spring (Wisconsin Initiative on Climate Change Impacts 2011). Climate models also predict winter precipitation over Wisconsin to increase by about 10 percent by the middle of the century (Wisconsin Initiative on Climate Change Impacts n.d.b). These changes in temperature and precipitation could exacerbate existing problems in the Bay of Green Bay. For example, when rain falls on frozen ground, the manure spread on fields and salt spread on roads are readily transported into waterways and wetlands, causing harm to wetland plants and worsening water quality (Wisconsin Initiative on Climate Change Impacts n.d.a). In addition, the predicted warmer and wetter winters, with longer and more frequent freeze-thaw periods, lack of winter ice cover, and more frequent and intense precipitation events in summer and fall, could lead to increased coastal erosion.

High-pressure and low-pressure weather systems generally move across the Bay of Green Bay in a west-to-east direction, with wind direction and strength dependent on the location, speed, and intensity of the weather system. Research into wind direction and speed over the Great Lakes indicates a shift in both summer wind direction (Waples and Klump 2002) and intensity (Jabbari et al. 2021) over recent decades. Wind direction and wind-induced wave power affect both water movement (e.g., seiche events) and nearshore stability in the shallow estuarine systems of the Bay. Waples and Klump (2002) suggest that the shifting average wind field over Green Bay could result in decreased inflow of cold, hypoxic Lake Michigan water through the northern mouth of Green Bay, leading to warmer waters and increased benthic microbial metabolism in the Bay.

Increased evapotranspiration during growing seasons is also predicted, resulting in drying of soils and lower groundwater recharge amounts and durations. Species composition changes, both from native species migrations into and out of the area and immigration and establishment of new non-native invasive species benefiting from warming temperatures and a longer growing season, could also occur (Wisconsin Initiative on Climate Change Impacts n.d.a). Based on regional and Great Lakes–specific climate change assessments (Wisconsin Initiative on Climate Change Impacts 2021; Hall, Stuntz, and Abrams 2008; Kling et al. 2003; Wittman 2008), species shifts are expected in both the watershed of the Bay of Green Bay and the coastal wetland and estuarine systems. For example, future forests and surrounding lands will likely experience declines in currently dominant species, such as northern white cedar, paper birch, quaking aspen, and sugar maple. Likewise, species forecasted to increase in or migrate into the forests of northeastern Wisconsin include black oak, swamp white

oak, white oak, shagbark hickory, and black cherry. In addition, in Green Bay itself, fish expected to decline include cool-water species, such as northern pike, yellow perch, and walleye. Species projected to increase include those more adapted to warm-water conditions, such as bluegill, largemouth bass, white bass, and smallmouth bass.

The Bay of Green Bay will obviously be impacted by changing climatic conditions. While it is not possible to predict or forecast precise ecosystem responses to any future scenario, the proposed Green Bay Reserve would provide opportunities to learn and share knowledge through documentation, investigation, and management of the novel ecosystems that will arise in the Great Lakes estuaries under a changing climate. As noted in section 6.2, the designation of the proposed reserve is not expected to have any direct impact (beneficial or adverse) on climate conditions around the Bay of Green Bay. Following designation, the reserve's education and monitoring programs could raise awareness of changing climatic conditions and potentially spur voluntary beneficial behavior changes.

However, given that changing climate conditions are being observed globally and are driven by factors outside of the reserve's control, the reserve's localized activities will ultimately have a negligible impact on the Bay of Green Bay's climate. As a result, the expected aggregate effects of climate change and the proposed reserve designation are not significant.

6.4.2 Contaminants, Nutrients, and Sediments

As detailed in chapter 5, the historical activities of paper and pulp mills have contributed to an accumulation of contaminants, such as PCBs and PFOS, within the sediments of the Bay of Green Bay. Despite past and extensive ongoing efforts to address legacy contaminants (e.g., federal, state, and local efforts to delist beneficial use impairments associated with the Lower Fox River and Green Bay area of concern, the Lower Fox River and Green Bay Superfund site cleanup, restoration projects supported by the Natural Resource Damage Assessment process), the Bay of Green Bay will continue to be impacted by these contaminants for the reasonably foreseeable future. For example, fish tissue will need 10–30 years for recovery despite complete cleanup of PCB contamination at the Lower Fox River Superfund site in 2020 (U.S. Environmental Protection Agency n.d.c). In addition, while research on the fate and transport of PFAS is still ongoing, these substances have been described as "exceptionally resistant to degradation" and linger in the environment for prolonged periods of time (Wisconsin Department of Natural Resources 2020b).

Furthermore, historical and ongoing agricultural activities and development substantially drive sedimentation and subsequent nutrient pollution within the Bay of Green Bay. As of 2026, all major tributaries to the Bay of Green Bay are listed on the Clean Water Act 303(d) impaired waters list by the U.S. Environmental Protection Agency and Wisconsin Department of Natural Resources. Lower Green Bay is impaired by excessive phosphorus and sediment loading from the Fox River. The smaller tributaries of Duck Creek, the Suamico River, the Pensaukee River, and the Little Suamico River, which empty along Green Bay's southwestern shore, are also considered impaired for excessive sediment and nutrients. Big Creek and Strawberry Creek, the estuarine systems located within the Sturgeon Bay Component of the proposed Green Bay Reserve, are also on the impaired waters list. Excess sediment and nutrient loading contribute to nuisance algae growth, areas of severe oxygen depletion in Lower Green Bay, reduced water clarity and submerged aquatic vegetation, and generally degraded fish and wildlife habitat. While the existing Lower Fox River total maximum daily load implementation plans calls for a 59-percent reduction in total phosphorus loadings and a 55-percent reduction in total suspended sediments from the watershed, attainment of these goals is not expected until 2040 (Wisconsin Department of Natural Resources n.d.i).

Legacy contamination, nutrient pollution, and excess sediment loading are expected to impact water quality within the Bay of Green Bay for the foreseeable future. While it is not possible to predict or forecast precisely the impact or ecosystem responses to any current or future mitigation efforts, the proposed Green Bay Reserve would provide opportunities to monitor the Bay of Green Bay as the Bay recovers from the impacts of legacy contaminants, nutrient pollution, and sedimentation and share lessons learned. As described in section 6.2, the designation of the proposed Green Bay Reserve itself is not anticipated to have any direct impacts (beneficial or adverse) on water quality. Following designation, the reserve may have minor indirect impacts (beneficial) through implementation of its water-quality monitoring program and its related research, education, training, and stewardship initiatives. As a result, the expected aggregate effects of contaminants, nutrient pollution and sediment loading, and the proposed reserve designation are not significant.

6.4.3 Invasive Species

As summarized in chapter 5, more than 185 invasive species have been introduced to the Great Lakes region since the early 1800s. Within the Bay of Green Bay, many invasive species are well-established and adversely impact ecological conditions. For example, common carp (*Cyprinus carpio*), which are widespread throughout the Great Lakes region, degrade aquatic habitats by uprooting and consuming aquatic macrophytes. Aquatic macrophytes provide critical habitat for native fish species and provide food for waterfowl. This fish species also degrades water quality by stirring up sediments while feeding, which in turn, decreases water clarity and impacts internal nutrient cycling (Great Lakes Fishery Commission n.d.; U.S. Geological Survey 2026b). Zebra mussels (*Dreissena polymorpha*) and quagga mussels (*D. bugensis*) are other key examples of invasive species that are degrading ecological conditions in the Bay of Green Bay. In the shallow, productive waters of the Bay, these mussels are able to coexist. They are capable of consuming profound amounts of phytoplankton, which has cascading impacts on the food web of the waterbodies they invade. Zebra and quagga mussel invasion can also drastically increase water clarity, potentially impacting aquatic plant community composition and water temperatures (U.S. Geological Survey 2026a; U.S. Geological Survey 2026c). Once established, invasive species are notoriously difficult to eradicate. As such, existing invasive species will continue to impact the Bay of Green Bay for the reasonably foreseeable future.

According to its draft management plan, the proposed reserve anticipates conducting research, developing educational resources on the impact of invasive species, and evaluating restoration strategies to support native species recovery. While it is not possible to predict or forecast precisely the impact or ecosystem responses to any current or future invasive species introduction, the activities of the proposed Green Bay Reserve are expected to have a minor indirect impact (beneficial) by providing opportunities to learn and share knowledge gained through education, monitoring, research, and stewardship of the Bay of Green Bay. Therefore, the expected aggregate effects of invasive species and the proposed reserve designation are not significant.

6.4.4 Development and Hydromodification

As summarized in chapter 5, the watersheds that abut the Bay of Green Bay have been subject to large-scale land use changes over time due to human activity (namely, timber harvest, intensive agriculture, and development). Within the last 100 years, an estimated 60 percent of Green Bay's coastal marshes have been converted to agricultural land, filled, or developed (Wisconsin Initiative on Climate Change Impacts 2010). To support the conversion of wetlands into other land use types, hydrologic modifications are often made to create land suitable for agricultural use or development. For example, rivers and streams may be straightened, deepened, widened, dammed, or even relocated to control flooding or improve drainage. These hydrologic modifications can alter stream velocities, water temperatures, and sediment erosion, transport, and deposition patterns, which can degrade water quality and in-stream habitat. Dams, in particular, can impede and entirely

block fish passage (U.S. Environmental Protection Agency 2007). Finally, dike installation can disconnect coastal wetlands from surface waters, which disrupts the benefits they provide (Carter et al. 2022).

The conversion of forest, wetland, or other types of open space to development also augments how much and how quickly water flows over the landscape. Per the U.S. Environmental Protection Agency's *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (1993), pervious spaces, such as vegetated and open forested areas, are converted to land uses that typically have increased areas of impervious surface (e.g., rooftops, roads, parking lots, sidewalks). This urbanization decreases the infiltrative capacity of the ground, resulting in increased runoff volumes, peak flow rates, and pollutant loading. From 1970 to 2020, the population in coastal counties across the United States increased by approximately 46 percent (National Oceanic and Atmospheric Administration n.d.a). A natural consequence of this boost in coastal population is increased development. This trend holds true for the five counties surrounding the Bay of Green Bay, where an additional 56 square miles of land were converted to developed land cover types between 1975 and 2021 (table 62).

Table 62. Land Cover Data Aggregated for Brown, Door, Kewaunee, Marinette, and Oconto Counties.

Land Cover	1975 (mi^2)	Lost (mi^2)	Gained (mi^2)	2021 (mi^2)	Net Change (mi^2)
Developed, high-intensity	41.61	0	25.73	67.33	25.73
Developed, low-intensity	152.03	-1.54	21.47	171.96	19.93
Developed, open space	20.1	-3.19	14.41	31.32	11.22
Grassland/ herbaceous	30.8	-10.81	30.27	50.26	19.46
Agriculture	1252.59	-51.95	15.16	1215.79	-36.78
Forested	1178.81	-64.2	35.24	1149.86	-28.96
Scrub/shrub	177.13	-39.86	31.53	168.81	-8.31
Woody wetland	798.02	-14.31	4.6	788.3	-9.72
Emergent wetland	89.92	-6.25	13.77	97.45	7.53
Bare land	10.87	-2.88	7.23	15.21	4.35
Open water	787.53	-8.85	4.4	783.08	-4.45

Source: NOAA Coastal Change Analysis Program

As discussed in section 6.3, the Green Bay Reserve is not expected to develop any on-the-ground facilities during the initial five-year period following its designation. Instead, the reserve will repurpose existing office, laboratory, meeting, and storage space on the University of Wisconsin–Green Bay campus. Existing facilities at the Manitowoc and Sheboygan campuses may also be used periodically for equipment storage, staging, or program support activities as operational needs arise. Reliance on existing facilities is expected to minimize new construction during the reserve's initial years of operation and would not contribute to the conversion trends of open space by development.

In the early years following designation, reserve staff will create a comprehensive facilities development plan to evaluate long-term facility needs and identify opportunities to support Green Bay Reserve programs and operations. Future facility development may include the use of shared spaces with landowning partners and other collaborating organizations. Facility planning would consider operational requirements for research,

monitoring, education, stewardship, and training and engagement activities while emphasizing compatibility with existing land uses, resource protection objectives, and public access considerations.

Future plans for facility development or expansion will be included in the Green Bay Reserve's subsequent management plans, which are updated every five years and subject to NOAA review and approval. This recurring process provides many opportunities for review and discussion before new reserve-related construction projects are undertaken. In addition, all future construction or acquisition projects proposed by the reserve using NOAA funds would be subject to NEPA and environmental compliance evaluations at the time of funding. While it is not possible to predict or forecast precisely the impact of any future facilities development, the proposed Green Bay Reserve and NOAA would implement appropriate measures to mitigate the impacts on the terrestrial environment prior to construction.

Development and hydrologic modifications within the watershed will impact the Bay of Green Bay for the reasonably foreseeable future. Where and how development and hydromodification occurs will continue to be guided by state, county, and local regulations. As previously stated, the proposed Green Bay National Estuarine Research Reserve is not a regulatory entity and designation of a national reserve does not impact the use or development of private property. While reserve designation in itself is not anticipated to have any direct impact (beneficial or adverse) on the Bay of Green Bay, any future facilities development activities conducted by the reserve in the years following designation could have negligible indirect impacts (adverse) on the environment. Potential impacts associated with future reserve facilities could include temporary disturbances related to site preparation, construction activities, increased human use, and associated infrastructure development. These activities could result in localized effects. When compared to all other development and hydrologic modifications occurring within the Bay of Green Bay, these effects will have no measurable impact. Finally, the proposed Green Bay Reserve, through its research, training, and stewardship programs, could also provide minor indirect impacts (beneficial) by providing local coastal decision-makers and environmental professionals with science-based tools, information, and planning approaches that support resilient estuaries and coastal communities. As a result, the expected aggregate effects of development and hydromodification are not significant.

6.5 Relationship to Other Applicable State, Regional, and Local Plans and Policies

Establishment of the proposed Green Bay Reserve would not conflict with—and would largely complement—the objectives of federal, state, regional, or local land use plans, policies, or controls for areas within the proposed boundaries. The draft management plan describes the activities to take place in and around the proposed reserve and the authorities that govern those uses (appendix 1). All areas that constitute the proposed Green Bay Reserve are currently under public or land trust ownership. If designated, these entities would enter a voluntary multi-partner memorandum of understanding (MOU; included in the draft management plan's appendix). This MOU would describe the roles and responsibilities of each party within the administrative boundary of the proposed Green Bay Reserve. If designated, reserve staff would coordinate with landowning partners within reserve boundaries to address any issues that may arise after designation. Any advice provided or action taken by reserve staff or signatory parties to the memorandum of understanding is expected to be consistent with Reserve System, local, state, and federal policies, regulations, and statutes as well as the roles and responsibilities detailed in the MOU agreement. Green Bay Reserve staff would regularly meet with the future Reserve Advisory Committee, various strategic partners, and key community leaders to share ideas, promote efficiencies, and resolve conflicts. Using a collaborative process, the reserve's staff and its partners would ensure proper implementation of the reserve's management plan. The following paragraphs summarize some of the state, regional, and local plans that apply to the proposed reserve components. Chapter 5 of the draft management plan presents a comprehensive listing of the state and local authorities and plans.

STATE MANAGEMENT

Most areas within the proposed Green Bay Reserve are owned and managed by the Wisconsin Department of Natural Resources. As a result, existing state laws, regulations, management plans, and conservation strategies will continue to provide the primary framework for management of reserve resources following designation. The proposed reserve would not alter ownership, regulatory authority, or the management responsibilities of participating agencies. Reserve programs and activities would be implemented in a manner consistent with existing state management objectives and authorities.

Several state planning documents and programs provide guidance for management of land and waters within the proposed reserve boundaries. The *Green Bay Planning Group Master Plan* serves as the principal management framework for many Wisconsin Department of Natural Resources properties located along the western shore of Green Bay, including several units within the proposed reserve boundaries. Additional guidance is provided by the Northern Lake Michigan Coastal Regional Master Plan, the Rapid Ecological Assessment for the Green Bay West Shores Wildlife Area, the State Natural Areas Strategy, the Wisconsin Wildlife Action Plan, the Lower Green Bay West Shore Habitat Management Restoration Plan, and the Wisconsin Land Legacy Report. Together, these plans establish priorities for habitat conservation, species protection, ecological restoration, public access, recreation, scientific research, and long-term stewardship of ecologically significant coastal habitats.

State management of reserve land is further guided by programs and regulations intended to protect sensitive natural resources. Several areas within the proposed reserve are designated State Natural Areas and managed under Wisconsin Administrative Code NR 45, which restricts activities that could degrade ecological integrity or interfere with scientific monitoring. In addition, the *Conservation Blueprint for the Fox, Wolf, and Green Bay Region* and statewide climate adaptation and conservation planning efforts provide complementary guidance for wetland protection, watershed management, climate resilience, and habitat restoration. Reserve activities are intended to complement and support these existing state priorities while contributing additional research, monitoring, education, and stewardship capacity.

LOCAL MANAGEMENT

The proposed Green Bay Reserve includes land owned and managed by counties, municipalities, universities, nonprofit conservation organizations, and other partners. These entities would retain ownership and management authority over their respective properties following designation. Existing comprehensive plans, park and recreation plans, zoning ordinances, conservation easements, land trust stewardship commitments, and organizational management policies would continue to guide management decisions within the reserve boundaries.

Local government partners manage several important conservation and public access areas within the proposed reserve. Brown County manages the Barkhausen Waterfowl Preserve and Fort Howard Paper Foundation Wildlife Area under its Comprehensive Outdoor Recreation Plan, emphasizing habitat protection, environmental education, and compatible recreation. The City of Green Bay manages the Ken Euers Nature Area as a restored coastal wetland and natural area protected through local zoning and dedicated to conservation, environmental education, and passive recreation. The Village of Howard manages the Duck Creek Conservation Corridor under shoreland-wetland, floodplain, and conservancy zoning regulations that restrict development, protect wetlands and wildlife habitat, and support restoration and public access. Portions of the Lower Bay Component are also influenced by restoration priorities established through the Lower Fox River and Green Bay area of concern program.

Several nonprofit organizations and the University of Wisconsin System provide long-term stewardship of conservation lands within the proposed reserve. The Northeast Wisconsin Land Trust, Door County Land Trust, and Crossroads at Big Creek manage properties under organizational missions focused on the permanent protection of natural resources, habitat restoration, environmental education, and scientific research. These properties are protected through a combination of fee ownership, conservation-oriented deed restrictions, accreditation standards, stewardship endowments, and organizational policies that emphasize long-term conservation and compatible public use. Collectively, these frameworks provide durable protections for coastal wetlands, forests, streams, and other ecologically significant habitats within the proposed reserve.

6.6 Irreversible and Irretrievable Commitment of Resources

The National Environmental Policy Act requires an analysis of the extent to which the proposed action's direct and indirect effects would commit operational resources to uses that cannot be recovered or that future generations would be unable to reverse. A resource commitment is considered irreversible when impacts from its use will limit future use options and the change cannot be reversed, reclaimed, or repaired. Irreversible commitments generally occur to nonrenewable resources, such as minerals or cultural resources, or those that are renewable only over long spans of time, such as soil productivity. A resource commitment is considered irretrievable when the use or consumption of the resource is neither renewable nor recoverable for use by future generations until reclamation is successfully applied. Irretrievable commitments generally apply to the loss of production, harvest, or natural resources and are not necessarily irreversible.

The designation of the proposed Green Bay National Estuarine Research Reserve and implementation of its draft management plan (appendix 1) would result in few irreversible or irretrievable commitments of resources. The action alternatives would require minor commitments of both renewable and nonrenewable energy and material resources for the management, research, education, and outreach activities associated with designation and operation of the proposed Green Bay Reserve. Designation of a reserve is also expected to result in a commitment of resources, staff time, and funds associated with reserve activities. Nonrenewable resources that would be used during these activities include fuel, water, power, and other necessary resources to implement and operate a reserve. Ongoing operational funding is needed to plan, manage, and implement the proposed reserve. These operational funds become irretrievable once spent. Also, to the extent that any buildings or permanent infrastructure are installed in support of the proposed reserve's operations, those efforts would effectively irretrievably commit resources unless the infrastructure were removed or the reserve were de-designated.

Under the no action alternative, the staff time invested in analyzing and planning for potential reserve designation and implementation would not fulfill the purpose and need for the proposed action. A team of individuals prepared the draft management plan for the proposed reserve, staff at NOAA thoroughly evaluated the proposed designation, the report preparers drafted this environmental impact statement, and staff affiliated with several proposed partners contributed time, effort, and information in support of a reserve designation. However, partner actions to further habitat manipulation and restoration activities, or associated education and outreach, could continue even under the no-action scenario. In addition, limited environmental change is anticipated or permitted—other than minor disturbances associated with research—by the National Estuarine Research Reserve program. Landholding partners would advise staff on operation and management of the proposed Green Bay Reserve. Each partner has a vested interest in the reserve due to landownership, existing activities, or conservation of natural resources.

This partnership is voluntary and executed through a multi-party memorandum of understanding that provides structure for the long-term support of the proposed Green Bay Reserve; however, any partner could withdraw from the partnership. The multiparty memorandum of understanding details the relationships among partners and each partner's commitment to the proposed reserve. It was developed by the signatories and is available in the draft management plan.

Commercial uses of the Bay of Green Bay are expected to continue under current regulatory authorities, and these activities are not tied directly to the proposed Green Bay Reserve's implementation or management. Regardless of whether a reserve is designated, landholding partners are expected to continue stewardship and oversight within the proposed reserve components, though without the coordination and resources provided by the proposed Green Bay Reserve. If designated, the Office for Coastal Management's annual operations funding awarded to the reserve could lead to irreversible or irretrievable commitments of resources in the Bay of Green Bay.

6.7 Local Short-Term Uses of the Environment and Long-Term Productivity

The National Environmental Policy Act requires consideration of the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity. Overall, short-term environmental uses related to the action alternatives are expected to improve the health and quality of the affected natural and human environment by (1) enhancing scientific understanding of the Bay of Green Bay's ecological functioning, (2) expanding public education and outreach opportunities related to the Green Bay estuary, and (3) providing future Green Bay Reserve staff support to landholding partners managing properties proposed for inclusion within the reserve boundary. Most adverse effects from designating a reserve would be minor and are expected to occur alongside long-term benefits to the overall health and productivity of the Bay of Green Bay.

The long-term productivity associated with designating the proposed reserve relies on the goals of the Green Bay Reserve and its draft management plan. To achieve these goals, the reserve will collaborate with landowning partners, Tribal nations, federal and state agencies, nonprofit organizations, and local communities to advance stewardship initiatives that improve water quality, restore and monitor priority habitats, strengthen shoreline and wetland resilience, and promote the use of best management practices. The proposed Green Bay Reserve's research, monitoring, education, training, and stewardship efforts should substantially improve the long-term management of the Bay of Green Bay by encouraging scientific investigations that improve informed decision-making, developing place-based education and training programs that inspire and educate the community, and creating opportunities to practice and promote stewardship.

Under the no action alternative, short-term improvements to the overall health and quality of the environment, as well as the long-term productivity of the area (as indicated by enhanced environmental services), would be less pronounced. Although ongoing activities by landholding partners are expected to provide some of these benefits without a reserve designation, these benefits would not be as significant as those realized under the action alternatives without the coordinating function and resources provided by the Reserve System. Other foreseeable unavoidable adverse environmental effects are unlikely to result from the designation of the Green Bay National Estuarine Research Reserve. Additional NEPA compliance will be conducted when federal funds are provided by NOAA for subsequent management plan implementation.

7 List of Federal Permits, Licenses, or Other Authorizations and NEPA Certifications

In addition to NEPA compliance, the Office for Coastal Management complies with several other environmental and administrative review requirements, including those listed below, as part of evaluating the proposed action to designate the Green Bay National Estuarine Research Reserve. The compliance status for each of these requirements is provided in appendix 5.

Clean Air Act

Clean Water Act

Coastal Barrier Resources Act

Coastal Zone Management Act

Endangered Species Act

Farmland Protection Policy Act

Fish and Wildlife Coordination Act

Migratory Bird Treaty Act and Executive Order 13186

National Historic Preservation Act

National Marine Sanctuaries Act

Rivers and Harbors Act

Executive Order 11988 – Floodplain Management

Executive Order 11990 – Protection of Wetlands

Executive Order 13112 – Invasive Species

Executive Order 13158 – Marine Protected Areas

Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments

7.2 Certification Related to Page Limits: *To be completed in the final Environmental Impact Statement*

7.3 Certification Related to Deadlines: *To be completed in the final Environmental Impact Statement*

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Funding support

Support for the University of Wisconsin–Green Bay's contributions to this report was provided by The Pew Charitable Trusts, the Wisconsin Coastal Management Program, and the Fund for Lake Michigan.

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Appendices

Appendix 1: Proposed Green Bay Reserve Draft Management Plan

Appendix 2: CZMA and Reserve System Regulations

SUBCHAPTER B—OCEAN AND COASTAL RESOURCE MANAGEMENT

PART 921—NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM REGULATIONS

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APPENDIX I TO PART 921—BIOGEOGRAPHIC CLASSIFICATION SCHEME

APPENDIX II TO PART 921—TYPOLOGY OF NATIONAL ESTUARINE RESEARCH RESERVES

AUTHORITY: Section 315 of the Coastal Zone Management Act, as amended (16 U.S.C. 1461).

SOURCE: 58 FR 38215, July 15, 1993, unless otherwise noted.

Subpart A—General

§ 921.1 Mission, goals and general provisions.

(a) The mission of the National Estuarine Research Reserve Program is the establishment and management, through Federal-state cooperation, of a national system (National Estuarine Research Reserve System or System) of estuarine research reserves (National Estuarine Research Reserves or Reserves) representative of the various regions and estuarine types in the United States. National Estuarine Research Reserves are established to provide opportunities for long-term research, education, and interpretation.

(b) The goals of the Program are to:

(1) Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources;

(2) Address coastal management issues identified as significant through coordinated estuarine research within the System;

(3) Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;

(4) Promote Federal, state, public and private use of one or more Reserves within the System when such entities conduct estuarine research; and

(5) Conduct and coordinate estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas.

(c) National Estuarine Research Reserves shall be open to the public to the extent permitted under state and Federal law. Multiple uses are allowed to the degree compatible with each Reserve's overall purpose as provided in the management plan (see §921.13) and consistent with paragraphs (a) and (b) of this section. Use levels are set by the state where the Reserve is located and analyzed in the management plan. The Reserve management plan shall describe the uses and establish priorities among these uses. The plan shall identify uses requiring a state permit, as well as areas where uses are encouraged or prohibited. Consistent with resource protection and research objectives, public access and use may be restricted to certain areas or components within a Reserve.

(d) Habitat manipulation for research purposes is allowed consistent with the following limitations. Manipulative research activities must be specified in the management plan, be consistent with the mission and goals of the program (see paragraphs (a) and (b) of this section) and the goals and objectives set forth in the Reserve's management plan, and be limited in nature and extent to the minimum manipulative activity necessary to accomplish the stated research objective. Manipulative research activities with a significant or long-term impact on Reserve resources require the prior approval of the state and the National Oceanic and Atmospheric Administration (NOAA). Manipulative research activities which can reasonably be expected to have a significant adverse impact on the estuarine resources and habitat of a Reserve, such that the activities themselves or their resulting short- and long-term consequences compromise the representative character and integrity of a Reserve, are prohibited. Habitat manipulation for resource management purposes is prohibited except as specifically approved by NOAA as: (1) A restoration activity consistent with paragraph (e) of this section; or (2) an activity necessary for the protection of public health or the preservation of other sensitive resources which have been listed or are eligible for protection under relevant Federal or state authority (e.g., threatened/endangered species or significant historical or cultural resources) or if the manipulative activity is a long-term pre-existing use (*i.e.,* has occurred prior to designation) occurring in a buffer area. If habitat manipulation is determined to be necessary for the protection of public health, the preservation of sensitive resources, or if the manipulation is a long-term pre-existing use in a buffer area, then these activities shall be specified in the Reserve management plan in accordance with §921.13(a)(10) and shall be limited to the reasonable alternative which has the least adverse and shortest term impact on the representative and ecological integrity of the Reserve.

(e) Under the Act an area may be designated as an estuarine Reserve only if the area is a representative estuarine ecosystem that is suitable for long-term research. Many estuarine areas have undergone some ecological change as a result of human activities (e.g., hydrological changes, intentional/unintentional species composition changes—introduced and exotic species). In those areas proposed or designated as National Estuarine Research Reserves, such changes may have diminished the representative character and integrity of the site. Although restoration of degraded areas is not a primary purpose of the System, such activities may be permitted to improve the representative character and integrity of a Reserve. Restoration activities must be carefully planned and approved by NOAA through the Reserve management plan. Historical research may be necessary to determine the ''natural'' representative state of an estuarine area (*i.e.,* an estuarine ecosystem minimally affected by

human activity or influence). Frequently, restoration of a degraded estuarine area will provide an excellent opportunity for management oriented research.

(f) NOAA may provide financial assistance to coastal states, not to exceed, per Reserve, 50 percent of all actual costs or $5 million whichever amount is less, to assist in the acquisition of land and waters, or interests therein. NOAA may provide financial assistance to coastal states not to exceed 70 percent of all actual costs for the management and operation of, the development and construction of facilities, and the conduct of educational or interpretive activities concerning Reserves (see subpart I). NOAA may provide financial assistance to any coastal state or public or private person, not to exceed 70 percent of all actual costs, to support research and monitoring within a Reserve. Notwithstanding any financial assistance limits established by this Part, when financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, such assistance may be used to pay 100 percent of all actual costs of activities carrier out with this assistance, as long as such funds are available. Predesignation, acquisition and development, operation and management, special research and monitoring, and special education and interpretation awards are available under the National Estuarine Reserve Program. Predesignation awards are for site selection/feasibility, draft management plan preparation and conduct of basic characterization studies. Acquisition and development awards are intended primarily for acquisition of interests in land, facility construction and to develop and/or upgrade research, monitoring and education programs. Operation and management awards provide funds to assist in implementing, operating and managing the administrative, and basic research, monitoring and education programs, outlined in the Reserve management plan. Special research and monitoring awards provide funds to conduct estuarine research and monitoring projects with the System. Special educational and interpretive awards provide funds to conduct estuarine educational and interpretive projects within the System.

(g) Lands already in protected status managed by other Federal agencies, state or local governments, or private organizations may be included within National Estuarine Research Reserves only if the managing entity commits to long-term management consistent with paragraphs (d) and (e) of this section in the Reserve management plan. Federal lands already in protected status may not comprise a majority of the key land and water areas of a Reserve (see § 921.11(c)(3)).

(h) To assist the states in carrying out the Program's goals in an effective manner, NOAA will coordinate a research and education information exchange throughout the National Estuarine Research Reserve System. As part of this role, NOAA will ensure that information and ideas from one Reserve are made available to others in the System. The network will enable Reserves to exchange information and research data with each other, with universities engaged in estuarine research, and with Federal, state, and local agencies. NOAA's objective is a system-wide program of research and monitoring capable of addressing the management issues that affect long-term productivity of our Nation's estuaries.

[58 FR 38215, July 15, 1993, as amended at 62 FR 12540, Mar. 17, 1997; 63 FR 26717, May 14, 1998]

§ 921.2 Definitions.

(a) *Act* means the Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 *et seq*.

(b) *Assistant Administrator* means the Assistant Administrator for Ocean Services and Coastal Zone Management or delegee.

(c) *Coastal state* means a state of the United States, in or bordering on, the Atlantic, Pacific, or Arctic Ocean, the Gulf of Mexico, Long Island Sound, or one or more of the Great Lakes. For the purposes of these regulations the term also includes Puerto Rico, the Virgin Islands, Guam, the Commonwealth of the Northern Marianas Islands, the Trust Territories of the Pacific Islands, and American Samoa (see 16 U.S.C. 1453(4)).

(d) *State agency* means an instrumentality of a coastal state to whom the coastal state has delegated the authority and responsibility for the creation and/or management/operation of a National Estuarine Research Reserve. Factors indicative of this authority may include the power to receive and expend funds on behalf of the Reserve, acquire and sell or convey real and personal property interests, adopt rules for the protection of the Reserve, enforce rules applicable to the Reserve, or develop and implement research and education programs for the reserve. For the purposes of these regulations, the terms ''coastal state'' and ''State agency'' shall be synonymous.

(e) *Estuary* means that part of a river or stream or other body of water having unimpaired connection with the open sea, where the sea water is measurably diluted with fresh water derived from land drainage. The term also includes estuary-type areas with measurable freshwater influence and having unimpaired connections with the open sea, and estuary-type areas of the Great Lakes and their connecting waters (see 16 U.S.C. 1453(7)).

(f) *National Estuarine Research Reserve* means an area that is a representative estuarine ecosystem suitable for long-term research, which may include all of the key land and water portion of an estuary, and adjacent transitional areas and uplands constituting to the extent feasible a natural unit, and which is set aside as a natural field laboratory to provide long-term opportunities for research, education, and interpretation on the ecological relationships within the area (see 16 U.S.C. 1453(8)) and meets the requirements of 16 U.S.C. 1461(b). This includes those areas designated as National Estuarine Sanctuaries or Reserves under section 315 of the Act prior to enactment of the Coastal Zone Act Reauthorization Amendments of 1990 and each area subsequently designated as a National Estuarine Research Reserve.

§ 921.3 National Estuarine Research Reserve System biogeographic classification scheme and estuarine typologies.

(a) National Estuarine Research Reserves are chosen to reflect regional differences and to include a variety of ecosystem types. A biogeographic classification scheme based on regional variations in the nation's coastal zone has been developed. The biogeographic classification scheme is used to ensure that the National Estuarine Research Reserve System includes at least one site from each region. The estuarine typology system is utilized to ensure that sites in the System reflect the wide range of estuarine types within the United States.

(b) The biogeographic classification scheme, presented in appendix I, contains 29 regions. Figure 1 graphically depicts the biogeographic regions of the United States.

(c) The typology system is presented in appendix II.

§ 921.4 Relationship to other provisions of the Coastal Zone Management Act, and to the Marine Protection, Research and Sanctuaries Act.

(a) The National Estuarine Research Reserve System is intended to provide information to state agencies and other entities involved in addressing coastal management issues. Any coastal state, including those that do not have approved coastal management programs under section 306 of the Act, is eligible for an award under the National Estuarine Research Reserve Program (see § 921.2(c)).

(b) For purposes of consistency review by states with a federally approved coastal management program, the designation of a National Estuarine Research Reserve is deemed to be a Federal activity, which, if directly affecting the state's coastal zone, must be undertaken in a manner consistent to the maximum extent practicable with the approved state coastal management program as provided by section 1456(c)(1) of the Act, and implementing regulations at 15 CFR part 930, subpart C. In accordance with section 1456(c)(1) of the Act and the applicable regulations NOAA will be responsible for certifying that designation of the Reserve is consistent with the state's approved coastal management program. The state must concur with or object to the certification. It is recommended that the lead state agency for Reserve designation consult, at the

earliest practicable time, with the appropriate state officials concerning the consistency of a proposed National Estuarine Research Reserve.

(c) The National Estuarine Research Reserve Program will be administered in close coordination with the National Marine Sanctuary Program (Title III of the Marine Protection, Research and Sanctuaries Act, as amended, 16 U.S.C. 1431–1445), also administered by NOAA. Title III authorizes the Secretary of Commerce to designate discrete areas of the marine environment as National Marine Sanctuaries to protect or restore such areas for their conservation, recreational, ecological, historical, research, educational or esthetic values. National Marine Sanctuaries and Estuarine Research Reserves may not overlap, but may be adjacent.

Subpart B—Site Selection, Post Site Selection and Management Plan Development

§ 921.10 General.

(a) A coastal state may apply for Federal financial assistance for the purpose of site selection, preparation of documents specified in § 921.13 (draft management plan (DMP) and environmental impact statement (EIS)), and the conduct of limited basic characterization studies. The total Federal share of this assistance may not exceed $100,000. Federal financial assistance for preacquisition activities under § 921.11 and § 921.12 is subject to the total $5 million for which each Reserve is eligible for land acquisition. Notwithstanding the above, when financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, such assistance may be used to pay 100 percent of all actual costs of activities carried out with this assistance, as long as such funds are available. In the case of a biogeographic region (see appendix I) shared by two or more coastal states, each state is eligible for Federal financial assistance to establish a separate National Estuarine Research Reserve within their respective portion of the shared biogeographic region. Each separate National Estuarine Research Reserve is eligible for the full complement of funding. Financial assistance application procedures are specified in subpart I.

(b) In developing a Reserve program, a state may choose to develop a multiple-site Reserve reflecting a diversity of habitats in a single biogeographic region. A multiple-site Reserve allows the state to develop complementary research and educational programs within the individual components of its multi-site Reserve. Multiple-site Reserves are treated as one Reserve in terms of financial assistance and development of an overall management framework and plan. Each individual site of a proposed multiple-site Reserve shall be evaluated both separately under § 921.11(c) and collectively as part of the site selection process. A coastal state may propose to establish a multiple-site Reserve at the time of the initial site selection, or at any point in the development or operation of the Reserve. If the state decides to develop a multiple-site National Estuarine Research Reserve after the initial acquisition and development award is made for a single site, the proposal is subject to the requirements set forth in § 921.33(b). However, a state may not propose to add one or more sites to an already designated Reserve if the operation and management of such Reserve has been found deficient and uncorrected or the research conducted is not consistent with the Estuarine Research Guidelines referenced in § 921.51. In addition, Federal funds for the acquisition of a multiple-site Reserve remain limited to $5,000,000 (see § 921.20). The funding for operation of a multiple-site Reserve is limited to the maximum allowed for any one Reserve per year (see § 921.32(c)) and preacquisition funds are limited to $100,000 per Reserve. Notwithstanding the above, when financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, such assistance may be used to pay 100 percent of all actual costs of activities carrier out with this assistance, as long as such funds are available.

[58 FR 38215, July 15, 1993, as amended at 63 FR 26717, May 14, 1998]

§ 921.11 Site selection and feasibility.

(a) A coastal state may use Federal funds to establish and implement a site selection process which is approved by NOAA.

(b) In addition to the requirements set forth in subpart I, a request for Federal funds for site selection must contain the following programmatic information:

(1) A description of the proposed site selection process and how it will be implemented in conformance with the biogeographic classification scheme and typology (§ 921.3);

(2) An identification of the site selection agency and the potential management agency; and

(3) A description of how public participation will be incorporated into the process (see § 921.11(d)).

(c) As part of the site selection process, the state and NOAA shall evaluate and select the final site(s). NOAA has final authority in approving such sites. Site selection shall be guided by the following principles:

(1) The site's contribution to the biogeographical and typological balance of the National Estuarine Research Reserve System. NOAA will give priority consideration to proposals to establish Reserves in biogeographic regions or subregions or incorporating types that are not represented in the system. (see the biogeographic classification scheme and typology set forth in § 921.3 and appendices I and II);

(2) The site's ecological characteristics, including its biological productivity, diversity of flora and fauna, and capacity to attract a broad range of research and educational interests. The proposed site must be a representative estuarine ecosystem and should, to the maximum extent possible, be an estuarine ecosystem minimally affected by human activity or influence (see § 921.1(e)).

(3) Assurance that the site's boundaries encompass an adequate portion of the key land and water areas of the natural system to approximate an ecological unit and to ensure effective conservation. Boundary size will vary greatly depending on the nature of the ecosystem. Reserve boundaries must encompass the area within which adequate control has or will be established by the managing entity over human activities occurring within the Reserve. Generally, Reserve boundaries will encompass two areas: Key land and water areas (or ''core area'') and a buffer zone. Key land and water areas and a buffer zone will likely require significantly different levels of control (see § 921.13(a)(7)). The term ''key land and water areas'' refers to that core area within the Reserve that is so vital to the functioning of the estuarine ecosystem that it must be under a level of control sufficient to ensure the long-term viability of the Reserve for research on natural processes. Key land and water areas, which comprise the core area, are those ecological units of a natural estuarine system which preserve, for research purposes, a full range of significant physical, chemical and biological factors contributing to the diversity of fauna, flora and natural processes occurring within the estuary. The determination of which land and water areas are ''key'' to a particular Reserve must be based on specific scientific knowledge of the area. A basic principle to follow when deciding upon key land and water areas is that they should encompass resources representative of the total ecosystem, and which if compromised could endanger the research objectives of the Reserve. The term *buffer zone* refers to an area adjacent to or surrounding key land and water areas and essential to their integrity. Buffer zones protect the core area and provide additional protection for estuarine-dependent species, including those that are rare or endangered. When determined appropriate by the state and approved by NOAA, the buffer zone may also include an area necessary for facilities required for research and interpretation. Additionally, buffer zones should be established sufficient to accommodate a shift of the core area as a result of biological, ecological or geomorphological change which reasonably could be expected to occur. National Estuarine Research Reserves may include existing Federal or state lands already in a protected status where mutual benefit can be enhanced. However, NOAA will not approve a site

for potential National Estuarine Research Reserve status that is dependent primarily upon the inclusion of currently protected Federal lands in order to meet the requirements for Reserve status (such as key land and water areas). Such lands generally will be included within a Reserve to serve as a buffer or for other ancillary purposes; and may be included, subject to NOAA approval, as a limited portion of the core area;

(4) The site's suitability for long-term estuarine research, including ecological factors and proximity to existing research facilities and educational institutions;

(5) The site's compatibility with existing and potential land and water uses in contiguous areas as well as approved coastal and estuarine management plans; and

(6) The site's importance to education and interpretive efforts, consistent with the need for continued protection of the natural system.

(d) Early in the site selection process the state must seek the views of affected landowners, local governments, other state and Federal agencies and other parties who are interested in the area(s) being considered for selection as a potential National Estuarine Research Reserve. After the local government(s) and affected landowner(s) have been contacted, at least one public meeting shall be held in the vicinity of the proposed site. Notice of such a meeting, including the time, place, and relevant subject matter, shall be announced by the state through the area's principal newspaper at least 15 days prior to the date of the meeting and by NOAA in the FEDERAL REGISTER.

(e) A state request for NOAA approval of a proposed site (or sites in the case of a multi-site Reserve) must contain a description of the proposed site(s) in relationship to each of the site selection principals (§ 921.11(c)) and the following information:

(1) An analysis of the proposed site(s) based on the biogeographical scheme/typology discussed in § 921.3 and set forth in appendices I and II;

(2) A description of the proposed site(s) and its (their) major resources, including location, proposed boundaries, and adjacent land uses. Maps are required;

(3) A description of the public participation process used by the state to solicit the views of interested parties, a summary of comments, and, if interstate issues are involved, documentation that the Governor(s) of the other affected state(s) has been contacted. Copies of all correspondence, including contact letters to all affected landowners must be appended;

(4) A list of all sites considered and a brief statement of the reasons why a site was not preferred; and

(5) A nomination of the proposed site(s) for designation as a National Estuarine Research Reserve by the Governor of the coastal state in which the state is located.

(f) A state proposing to reactivate an inactive site, previously approved by NOAA for development as an Estuarine Sanctuary or Reserve, may apply for those funds remaining, if any, provided for site selection and feasibility (§ 921.11a)) to determine the feasibility of reactivation. This feasibility study must comply with the requirements set forth in § 921.11 (c) through (e).

§ 921.12 Post site selection.

(a) At the time of the coastal state's request for NOAA approval of a proposed site, the state may submit a request for funds to develop the draft management plan and for preparation of the EIS. At this time, the state may also submit a request for the remainder of the predesignation funds to perform a limited basic characterization of the physical, chemical and biological characteristics of the site approved by NOAA necessary for providing EIS information to NOAA. The state's request for these post site selection funds must be accompanied by the information specified in subpart I and, for draft management plan development and EIS information collection, the following programmatic information:

(1) A draft management plan outline (see § 921.13(a) below); and

(2) An outline of a draft memorandum of understanding (MOU) between the state and NOAA detailing the Federal-state role in Reserve management during the initial period of Federal funding and expressing the

state's long-term commitment to operate and manage the Reserve.

(b) The state is eligible to use the funds referenced in § 921.12(a) after the proposed site is approved by NOAA under the terms of § 921.11.

§ 921.13 Management plan and environmental impact statement development.

(a) After NOAA approves the state's proposed site and application for funds submitted pursuant to § 921.12, the state may begin draft management plan development and the collection of information necessary for the preparation by NOAA of an EIS. The state shall develop a draft management plan, including an MOU. The plan shall set out in detail:

(1) Reserve goals and objectives, management issues, and strategies or actions for meeting the goals and objectives;

(2) An administrative plan including staff roles in administration, research, education/interpretation, and surveillance and enforcement;

(3) A research plan, including a monitoring design;

(4) An education/interpretive plan;

(5) A plan for public access to the Reserve;

(6) A construction plan, including a proposed construction schedule, general descriptions of proposed developments and general cost estimates. Information should be provided for proposed minor construction projects in sufficient detail to allow these projects to begin in the initial phase of acquisition and development. A categorical exclusion, environmental assessment, or EIS may be required prior to construction;

(7)(i) An acquisition plan identifying the ecologically key land and water areas of the Reserve, ranking these areas according to their relative importance, and including a strategy for establishing adequate long-term state control over these areas sufficient to provide protection for Reserve resources to ensure a stable environment for research. This plan must include an identification of ownership within the proposed Reserve boundaries, including land already in the public domain; the method(s) of acquisition which the state proposes to use—acquisition (including less-than-fee simple options) to establish adequate long-term state control; an estimate of the fair market value of any property interest—which is proposed for acquisition; a schedule estimating the time required to complete the process of establishing adequate state control of the proposed research reserve; and a discussion of any anticipated problems. In selecting a preferred method(s) for establishing adequate state control over areas within the proposed boundaries of the Reserve, the state shall perform the following steps for each parcel determined to be part of the key land and water areas (control over which is necessary to protect the integrity of the Reserve for research purposes), and for those parcels required for research and interpretive support facilities or buffer purposes:

(A) Determine, with appropriate justification, the minimum level of control(s) required [e.g., management agreement, regulation, less-than-fee simple property interest (e.g., conservation easement), fee simple property acquisition, or a combination of these approaches]. This does not preclude the future necessity of increasing the level of state control;

(B) Identify the level of existing state control(s);

(C) Identify the level of additional state control(s), if any, necessary to meet the minimum requirements identified in paragraph (a)(7)(i)(A) of this section;

(D) Examine all reasonable alternatives for attaining the level of control identified in paragraph (a)(7)(i)(C) of this section, and perform a cost analysis of each; and

(E) Rank, in order of cost, the methods (including acquisition) identified in paragraph (a)(7)(i)(D) of this section.

(ii) An assessment of the relative cost-effectiveness of control alternatives shall include a reasonable estimate of both short-term costs (e.g., acquisition of property interests, regulatory program development including associated enforcement costs, negotiation, adjudication, etc.) and long-term costs (e.g., monitoring, enforcement,

adjudication, management and coordination). In selecting a preferred method(s) for establishing adequate state control over each parcel examined under the process described above, the state shall give priority consideration to the least costly method(s) of attaining the minimum level of long-term control required. Generally, with the possible exception of buffer areas required for support facilities, the level of control(s) required for buffer areas will be considerably less than that required for key land and water areas. This acquisition plan, after receiving the approval of NOAA, shall serve as a guide for negotiations with landowners. A final boundary for the reserve shall be delineated as a part of the final management plan;

(8) A resource protection plan detailing applicable authorities, including allowable uses, uses requiring a permit and permit requirements, any restrictions on use of the research reserve, and a strategy for research reserve surveillance and enforcement of such use restrictions, including appropriate government enforcement agencies;

(9) If applicable, a restoration plan describing those portions of the site that may require habitat modification to restore natural conditions;

(10) If applicable, a resource manipulation plan, describing those portions of the Reserve buffer in which long-term pre-existing (prior to designation) manipulation for reasons not related to research or restoration is occurring. The plan shall explain in detail the nature of such activities, shall justify why such manipulation should be permitted to continue within the reserve buffer; and shall describe possible effects of this manipulation on key land and water areas and their resources;

(11) A proposed memorandum of understanding (MOU) between the state and NOAA regarding the Federal-state relationship during the establishment and development of the National Estuarine Research Reserve, and expressing a long-term commitment by the state to maintain and manage the Reserve in accordance with section 315 of the Act, 16 U.S.C. 1461, and applicable regulations. In conjunction with the MOU, and where possible under state law, the state will consider taking appropriate administrative or legislative action to ensure the long-term protection and operation of the National Estuarine Research Reserve. If other MOUs are necessary (such as with a Federal agency, another state agency or private organization), drafts of such MOUs must be included in the plan. All necessary MOU's shall be signed prior to Reserve designation; and

(12) If the state has a federally approved coastal management program, a certification that the National Estuarine Research Reserve is consistent to the maximum extent practicable with that program. See §§ 921.4(b) and 921.30(b).

(b) Regarding the preparation of an EIS under the National Environmental Policy Act on a National Estuarine Research Reserve proposal, the state and NOAA shall collect all necessary information concerning the socioeconomic and environmental impacts associated with implementing the draft management plan and feasible alternatives to the plan. Based on this information, the state will draft and provide NOAA with a preliminary EIS.

(c) Early in the development of the draft management plan and the draft EIS, the state and NOAA shall hold a scoping meeting (pursuant to NEPA) in the area or areas most affected to solicit public and government comments on the significant issues related to the proposed action. NOAA will publish a notice of the meeting in the FEDERAL REGISTER at least 15 days prior to the meeting. The state shall be responsible for publishing a similar notice in the local media.

(d) NOAA will publish a FEDERAL REGISTER notice of intent to prepare a draft EIS. After the draft EIS is prepared and filed with the Environmental Protection Agency (EPA), a Notice of Availability of the draft EIS will appear in the FEDERAL REGISTER. Not less than 30 days after publication of the notice, NOAA will hold at least one public hearing in the area or areas most affected by the proposed national estuarine research reserve. The hearing will be held no sooner than 15 days after appropriate notice of the meeting has been given in the principal news media by the state and in the FEDERAL REGISTER by NOAA. After a 45-day

comment period, a final EIS will be prepared by the state and NOAA.

Subpart C—Acquisition, Development and Preparation of the Final Management Plan

§ 921.20 General.

The acquisition and development period is separated into two major phases. After NOAA approval of the site, draft management plan and draft MOU, and completion of the final EIS, a coastal state is eligible for an initial acquisition and development award(s). In this initial phase, the state should work to meet the criteria required for formal research reserve designation; e.g., establishing adequate state control over the key land and water areas as specified in the draft management plan and preparing the final management plan. These requirements are specified in § 921.30. Minor construction in accordance with the draft management plan may also be conducted during this initial phase. The initial acquisition and development phase is expected to last no longer than three years. If necessary, a longer time period may be negotiated between the state and NOAA. After Reserve designation, a state is eligible for a supplemental acquisition and development award(s) in accordance with § 921.31. In this post-designation acquisition and development phase, funds may be used in accordance with the final management plan to construct research and educational facilities, complete any remaining land acquisition, for program development, and for restorative activities identified in the final management plan. In any case, the amount of Federal financial assistance provided to a coastal state with respect to the acquisition of lands and waters, or interests therein, for any one National Estuarine Research Reserve may not exceed an amount equal to 50 percent of the costs of the lands, waters, and interests therein or $5,000,000, whichever amount is less, except when the financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, in which case the assistance may be used to pay 100 percent of all actual costs of activities carrier out with this assistance, as long as such funds are available.

[58 FR 38215, July 15, 1993, as amended at 62 FR 12540, Mar. 17, 1997; 63 FR 26717, May 14, 1998]

§ 921.21 Initial acquisition and development awards.

(a) Assistance is provided to aid the recipient prior to designation in:

(1) Acquiring a fee simple or less-than-fee simple real property interest in land and water areas to be included in the Reserve boundaries (see § 921.13(a)(7); § 921.30(d));

(2) Minor construction, as provided in paragraphs (b) and (c) of this section;

(3) Preparing the final management plan; and

(4) Initial management costs, e.g., for implementing the NOAA approved draft management plan, hiring a Reserve manager and other staff as necessary and for other management-related activities. Application procedures are specified in subpart I.

(b) The expenditure of Federal and state funds on major construction activities is not allowed during the initial acquisition and development phase. The preparation of architectural and engineering plans, including specifications, for any proposed construction, or for proposed restorative activities, is permitted. In addition, minor construction activities, consistent with paragraph (c) of this section also are allowed. The NOAA-approved draft management plan must, however, include a construction plan and a public access plan before any award funds can be spent on construction activities.

(c) Only minor construction activities that aid in implementing portions of the management plan (such as boat ramps and nature trails) are permitted during the initial acquisition and development phase. No more than five (5) percent of the initial acquisition and development award may be expended on such activities. NOAA must make a specific determination, based on the final EIS, that the construction activity will not be detrimental to the environment.

(d) Except as specifically provided in paragraphs (a) through (c) of this section, construction projects, to be funded in whole or in part under an acquisition and development award(s), may not be initiated until the Reserve receives formal designation (see § 921.30). This requirement has been adopted to ensure that substantial progress in establishing adequate state control over key land and water areas has been made and that a final management plan is completed before major sums are spent on construction. Once substantial progress in establishing adequate state control/acquisition has been made, as defined by the state in the management plan, other activities guided by the final management plan may begin with NOAA's approval.

(e) For any real property acquired in whole or part with Federal funds for the Reserve, the state shall execute suitable title documents to include substantially the following provisions, or otherwise append the following provisions in a manner acceptable under applicable state law to the official land record(s):

(1) Title to the property conveyed by this deed shall vest in the [recipient of the award granted pursuant to section 315 of the Act, 16 U.S.C. 1461 or other NOAA approved state agency] subject to the condition that the designation of the [name of National Estuarine Reserve] is not withdrawn and the property remains part of the federally designated [name of National Estuarine Research Reserve]; and

(2) In the event that the property is no longer included as part of the Reserve, or if the designation of the Reserve of which it is part is withdrawn, then NOAA or its successor agency, after full and reasonable consultation with the State, may exercise the following rights regarding the disposition of the property:

(i) The recipient may retain title after paying the Federal Government an amount computed by applying the Federal percentage of participation in the cost of the original project to the current fair market value of the property;

(ii) If the recipient does not elect to retain title, the Federal Government may either direct the recipient to sell the property and pay the Federal Government an amount computed by applying the Federal percentage of participation in the cost of the original project to the proceeds from the sale (after deducting actual and reasonable selling and repair or renovation expenses, if any, from the sale proceeds), or direct the recipient to transfer title to the Federal Government. If directed to transfer title to the Federal Government, the recipient shall be entitled to compensation computed by applying the recipient's percentage of participation in the cost of the original project to the current fair market value of the property; and

(iii) Fair market value of the property must be determined by an independent appraiser and certified by a responsible official of the state, as provided by Department of Commerce regulations at 15 CFR part 24, and Uniform Relocation Assistance and Real Property Acquisition for Federal and Federally assisted programs at 15 CFR part 11.

(f) Upon instruction by NOAA, provisions analogous to those of § 921.21(e) shall be included in the documentation underlying less-then-fee-simple interests acquired in whole or part with Federal funds.

(g) Federal funds or non-Federal matching share funds shall not be spent to acquire a real property interest in which the state will own the land concurrently with another entity unless the property interest has been identified as a part of an acquisition strategy pursuant to § 921.13(7) which has been approved by NOAA prior to the effective date of these regulations.

(h) Prior to submitting the final management plan to NOAA for review and approval, the state shall hold a public meeting to receive comment on the plan in the area affected by the estuarine research reserve. NOAA will publish a notice of the meeting in the FEDERAL REGISTER at least 15 days prior to the public meeting. The state shall be responsible for having a similar notice published in the local newspaper(s).

Subpart D—Reserve Designation and Subsequent Operation

§ 921.30 Designation of National Estuarine Research Reserves.

(a) The Under Secretary may designate an area proposed for designation by the Governor of the state in which it is located, as a National Esturaine Research Reserve if the Under Secretary finds:

(1) The area is a representative estuarine ecosystem that is suitable for long-term research and contributes to the biogeographical and typological balance of the System;

(2) Key land and water areas of the proposed Reserve, as identified in the management plan, are under adequate state control sufficient to provide long-term protection for reserve resources to ensure a stable environment for research;

(3) Designation of the area as a Reserve will serve to enhance public awareness and understanding of estuarine areas, and provide suitable opportunities for public education and interpretation;

(4) A final management plan has been approved by NOAA;

(5) An MOU has been signed between the state and NOAA ensuring a long-term commitment by the state to the effective operation and implementation of the area as a National Estuarine Research Reserve;

(6) All MOU's necessary for reserve management (*i.e.*, with relevant Federal, state, and local agencies and/or private organizations) have been signed; and

(7) The coastal state in which the area is located has complied with the requirements of subpart B.

(b) NOAA will determine whether the designation of a National Estuarine Research Reserve in a state with a federally approved coastal zone management program directly affects the coastal zone. If the designation is found to directly affect the coastal zone, NOAA will make a consistency determination pursuant to §307(c)(1) of the Act, 16 U.S.C. 1456, and 15 CFR part 930, subpart C. See §921.4(b). The results of this consistency determination will be published in the FEDERAL REGISTER when the notice of designation is published. See §921.30(c).

(c) NOAA will publish the notice of designation of a National Estuarine Research Reserve in the FEDERAL REGISTER. The state shall be responsible for having a similar notice published in the local media.

(d) The term *state control* in §921.30(a)(3) does not necessarily require that key land and water areas be owned by the state in fee simple. Acquisition of less-than-fee simple interests e.g., conservation easements) and utilization of existing state regulatory measures are encouraged where the state can demonstrate that these interests and measures assure adequate long-term state control consistent with the purposes of the research reserve (see also §§921.13(a)(7); 921.21(g)). Should the state later elect to purchase an interest in such lands using NOAA funds, adequate justification as to the need for such acquisition must be provided to NOAA.

§ 921.31 Supplemental acquisition and development awards.

After National Estuarine Research Reserve designation, and as specified in the approved management plan, a coastal state may request a supplemental acquisition and/or development award(s) for acquiring additional property interests identified in the management plan as necessary to strengthen protection of key land and water areas and to enhance long-term protection of the area for research and education, for facility and exhibit construction, for restorative activities identified in the approved management plan, for administrative purposes related to acquisition and/or facility construction and to develop and/or upgrade research, monitoring and education/interpretive programs. Federal financial assistance provided to a National Estuarine Research Reserve for supplemental development costs directly associated with facility construction (*i.e.*, major construction activities) may not exceed 70 percent of the total project cost, except when the financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, in which case the assistance may be used to pay 100

percent of the costs. NOAA must make a specific determination that the construction activity will not be detrimental to the environment. Acquisition awards for the acquisition of lands or waters, or interests therein, for any one reserve may not exceed an amount equal to 50 percent of the costs of the lands, waters, and interests therein of $5,000,000, whichever amount is less, except when the financial assistance is provided from amounts recovered as result of damage to natural resources located in the coastal zone, in which case the assistance may be used to pay 100 percent of all actual costs of activities carrier out with this assistance, as long as such funds are available. In the case of a biogeographic region (see appendix I) shared by two or more states, each state is eligible independently for Federal financial assistance to establish a separate National Estuarine Research Reserve within their respective portion of the shared biogeographic region. Application procedures are specified in subpart I. Land acquisition must follow the procedures specified in §§ 921.13(a)(7), 921.21(e) and (f) and 921.81.

[58 FR 38215, July 15, 1993, as amended at 62 FR 12540, Mar. 17, 1997; 63 FR 26717, May 14, 1998]

§ 921.32 Operation and management: Implementation of the management plan.

(a) After the Reserve is formally designated, a coastal state is eligible to receive Federal funds to assist the state in the operation and management of the Reserve including the management of research, monitoring, education, and interpretive programs. The purpose of this Federally funded operation and management phase is to implement the approved final management plan and to take the necessary steps to ensure the continued effective operation of the Reserve.

(b) State operation and management of the Reserves shall be consistent with the mission, and shall further the goals of the National Estuarine Research Reserve program (see § 921.1).

(c) Federal funds are available for the operation and management of the Reserve. Federal funds provided pursuant to this section may not exceed 70 percent of the total cost of operating and managing the Reserve for any one year, except when the financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, in which case the assistance may be used to pay 100 percent of the costs. In the case of a biogeographic region (see Appendix I) shared by two or more states, each state is eligible for Federal financial assistance to establish a separate Reserve within their respective portion of the shared biogeographic region (see § 921.10).

(d) Operation and management funds are subject to the following limitations:

(1) Eligible coastal state agencies may apply for up to the maximum share available per Reserve for that fiscal year. Share amounts will be announced annually by letter from the Sanctuary and Reserves Division to all participating states. This letter will be provided as soon as practicable following approval of the Federal budget for that fiscal year.

(2) No more than ten percent of the total amount (state and Federal shares) of each operation and management award may be used for construction-type activities.

[58 FR 38215, July 15, 1993, as amended at 62 FR 12541, Mar. 17, 1997]

§ 921.33 Boundary changes, amendments to the management plan, and addition of multiple-site components.

(a) Changes in the boundary of a Reserve and major changes to the final management plan, including state laws or regulations promulgated specifically for the Reserve, may be made only after written approval by NOAA. NOAA may require public notice, including notice in the FEDERAL REGISTER and an opportunity for public comment before approving a boundary or management plan change. Changes in the boundary of a Reserve involving the acquisition of properties not listed in the management plan or final EIS require public notice and the opportunity for comment; in certain cases, a categorical exclusion, an environmental assessment and possibly an environmental impact statement may be required.

NOAA will place a notice in the FEDERAL REGISTER of any proposed changes in Reserve boundaries or proposed major changes to the final management plan. The state shall be responsible for publishing an equivalent notice in the local media. See also requirements of §§ 921.4(b) and 921.13(a)(11).

(b) As discussed in § 921.10(b), a state may choose to develop a multiple-site National Estuarine Research Reserve after the initial acquisition and development award for a single site has been made. NOAA will publish notice of the proposed new site including an invitation for comments from the public in the FEDERAL REGISTER. The state shall be responsible for publishing an equivalent notice in the local newspaper(s). An EIS, if required, shall be prepared in accordance with section § 921.13 and shall include an administrative framework for the multiple-site Reserve and a description of the complementary research and educational programs within the Reserve. If NOAA determines, based on the scope of the project and the issues associated with the additional site(s), that an environmental assessment is sufficient to establish a multiple-site Reserve, then the state shall develop a revised management plan which, concerning the additional component, incorporates each of the elements described in § 921.13(a). The revised management plan shall address goals and objectives for all components of the multi-site Reserve and the additional component's relationship to the original site(s).

(c) The state shall revise the management plan for a Reserve at least every five years, or more often if necessary. Management plan revisions are subject to (a) above.

(d) NOAA will approve boundary changes, amendments to management plans, or the addition of multiple-site components, by notice in the FEDERAL REGISTER. If necessary NOAA will revise the designation document (findings) for the site.

Subpart E—Ongoing Oversight, Performance Evaluation and Withdrawal of Designation

§ 921.40 Ongoing oversight and evaluations of designated National Estuarine Research Reserves.

(a) The Sanctuaries and Reserve Division shall conduct, in accordance with section 312 of the Act and procedures set forth in 15 CFR part 928, ongoing oversight and evaluations of Reserves. Interim sanctions may be imposed in accordance with regulations promulgated under 15 CFR part 928.

(b) The Assistant Administrator may consider the following indicators of non-adherence in determining whether to invoke interim sanctions:

(1) Inadequate implementation of required staff roles in administration, research, education/interpretation, and surveillance and enforcement. Indicators of inadequate implementation could include: No Reserve Manager, or no staff or insufficient staff to carry out the required functions.

(2) Inadequate implementation of the required research plan, including the monitoring design. Indicators of inadequate implementation could include: Not carrying out research or monitoring that is required by the plan, or carrying out research or monitoring that is inconsistent with the plan.

(3) Inadequate implementation of the required education/interpretation plan. Indicators of inadequate implementation could include: Not carrying out education or interpretation that is required by the plan, or carrying out education/interpretation that is inconsistent with the plan.

(4) Inadequate implementation of public access to the Reserve. Indicators of inadequate implementation of public access could include: Not providing necessary access, giving full consideration to the need to keep some areas off limits to the public in order to protect fragile resources.

(5) Inadequate implementation of facility development plan. Indicators of inadequate implementation could include: Not taking action to propose and budget for necessary facilities, or not undertaking necessary construction in a timely manner when funds are available.

(6) Inadequate implementation of acquisition plan. Indicators of inadequate implementation could include: Not pursuing an aggressive acquisition program with all available funds for that purpose, not requesting promptly additional funds when necessary, and evidence that adequate long-term state control has not been established over some core or buffer areas, thus jeopardizing the ability to protect the Reserve site and resources from offsite impacts.

(7) Inadequate implementation of Reserve protection plan. Indicators of inadequate implementation could include: Evidence of non-compliance with Reserve restrictions, insufficient surveillance and enforcement to assure that restrictions on use of the Reserve are adhered to, or evidence that Reserve resources are being damaged or destroyed as a result of the above.

(8) Failure to carry out the terms of the signed Memorandum of Understanding (MOU) between the state and NOAA, which establishes a long-term state commitment to maintain and manage the Reserve in accordance with section 315 of the Act. Indicators of failure could include: State action to allow incompatible uses of state-controlled lands or waters in the Reserve, failure of the state to bear its fair share of costs associated with long-term operation and management of the Reserve, or failure to initiate timely updates of the MOU when necessary.

§ 921.41 Withdrawal of designation.

The Assistant Administrator may withdraw designation of an estuarine area as a National Estuarine Research Reserve pursuant to and in accordance with the procedures of section 312 and 315 of the Act and regulations promulgated thereunder.

Subpart F—Special Research Projects

§ 921.50 General.

(a) To stimulate high quality research within designated National Estuarine Research Reserves, NOAA may provide financial support for research projects which are consistent with the Estuarine Research Guidelines referenced in § 921.51. Research awards may be awarded under this subpart to only those designated Reserves with approved final management plans. Although research may be conducted within the immediate watershed of the Reserve, the majority of research activities of any single research project funded under this subpart may be conducted within Reserve boundaries. Funds provided under this subpart are primarily used to support management-related research projects that will enhance scientific understanding of the Reserve ecosystem, provide information needed by Reserve management and coastal management decision-makers, and improve public awareness and understanding of estuarine ecosystems and estuarine management issues. Special research projects may be oriented to specific Reserves; however, research projects that would benefit more than one Reserve in the National Estuarine Reserve Research System are encouraged.

(b) Funds provided under this subpart are available on a competitive basis to any coastal state or qualified public or private person. A notice of available funds will be published in the FEDERAL REGISTER. Special research project funds are provided in addition to any other funds available to a coastal state under the Act. Federal funds provided under this subpart may not exceed 70 percent of the total cost of the project, consistent with § 921.81(e)(4) (''allowable costs''), except when the financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, in which case the assistance may be used to pay 100 percent of the costs.

[58 FR 38215, July 15, 1993, as amended at 62 FR 12541, Mar. 17, 1997]

§ 921.51 Estuarine research guidelines.

(a) Research within the National Estuarine Research Reserve System shall be conducted in a manner consistent with Estuarine Research Guidelines developed by NOAA.

(b) A summary of the Estuarine Research Guidelines is published in the FEDERAL REGISTER as a part of the notice of available funds discussed in § 921.50(c).

(c) The Estuarine Research Guidelines are reviewed annually by NOAA. This review will include an opportunity

for comment by the estuarine research community.

§ 921.52 Promotion and coordination of estuarine research.

(a) NOAA will promote and coordinate the use of the National Estuarine Research Reserve System for research purposes.

(b) NOAA will, in conducting or supporting estuarine research other than that authorized under section 315 of the Act, give priority consideration to research that make use of the National Estuarine Research Reserve System.

(c) NOAA will consult with other Federal and state agencies to promote use of one or more research reserves within the National Estuarine Research Reserve System when such agencies conduct estuarine research.

Subpart G—Special Monitoring Projects

§ 921.60 General.

(a) To provide a systematic basis for developing a high quality estuarine resource and ecosystem information base for National Estuarine Research Reserves and, as a result, for the System, NOAA may provide financial support for basic monitoring programs as part of operations and management under § 921.32. Monitoring funds are used to support three major phases of a monitoring program:

(1) Studies necessary to collect data for a comprehensive site description/characterization;

(2) Development of a site profile; and

(3) Formulation and implementation of a monitoring program.

(b) Additional monitoring funds may be available on a competitive basis to the state agency responsible for Reserve management or a qualified public or private person or entity. However, if the applicant is other than the managing entity of a Reserve that applicant must submit as a part of the application a letter from the Reserve manager indicating formal support of the application by the managing entity of the Reserve. Funds provided under this subpart for special monitoring projects are provided in addition to any other funds available to a coastal state under the Act. Federal funds provided under this subpart may not exceed 70 percent of the total cost of the project, consistent with § 921.81(e)(4) (''allowable costs''), except when the financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, in which case the assistance may be used to pay 100 percent of the costs.

(c) Monitoring projects funded under this subpart must focus on the resources within the boundaries of the Reserve and must be consistent with the applicable sections of the Estuarine Research Guidelines referenced in § 921.51. Portions of the project may occur within the immediate watershed of the Reserve beyond the site boundaries. However, the monitoring proposal must demonstrate why this is necessary for the success of the project.

[58 FR 38215, July 15, 1993, as amended at 62 FR 12541, Mar. 17, 1997]

Subpart H—Special Interpretation and Education Projects

§ 921.70 General.

(a) To stimulate the development of innovative or creative interpretive and educational projects and materials to enhance public awareness and understanding of estuarine areas, NOAA may fund special interpretive and educational projects in addition to those activities provided for in operations and management under § 921.32. Special interpretive and educational awards may be awarded under this subpart to only those designated Reserves with approved final management plans.

(b) Funds provided under this subpart may be available on a competitive basis to any state agency. However, if the applicant is other than the managing entity of a Reserve, that applicant must submit as a part of the application a letter from the Reserve manager indicating formal support of the application by the managing entity of the Reserve. These funds are provided in addition to any other funds available to a coastal state under the Act. Federal funds provided under this subpart may not exceed 70 percent of the total cost of the project, consistent with § 921.81(e)(4) (''allowable costs''),

except when the financial assistance is provided from amounts recovered as a result of damage to natural resources located in the coastal zone, in which case the assistance may be used to pay 100 percent of the costs.

(c) Applicants for education/interpretive projects that NOAA determines benefit the entire National Estuarine Research Reserve System may receive Federal assistance of up to 100% of project costs.

[58 FR 38215, July 15, 1993, as amended at 62 FR 12541, Mar. 17, 1997]

Subpart I—General Financial Assistance Provisions

§ 921.80 Application information.

(a) Only a coastal state may apply for Federal financial assistance awards for preacquisition, acquisition and development, operation and management, and special education and interpretation projects under subpart H. Any coastal state or public or private person may apply for Federal financial assistance awards for special estuarine research or monitoring projects under subpart G. The announcement of opportunities to conduct research in the System appears on an annual basis in the FEDERAL REGISTER. If a state is participating in the national Coastal Zone Management Program, the applicant for an award under section 315 of the Act shall notify the state coastal management agency regarding the application.

(b) An original and two copies of the formal application must be submitted at least 120 working days prior to the proposed beginning of the project to the following address: Sanctuaries and Reserves Division Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, 1825 Connecticut Avenue, NW., suite 714, Washington, DC 20235. Application for Federal Assistance Standard Form 424 (Non-construction Program) constitutes the formal application for site selection, post-site selection, operation and management, research, and education and interpretive awards. The Application for Federal Financial Assistance Standard Form 424 (Construction Program) constitutes the formal application for land acquisition and development awards. The application must be accompanied by the information required in subpart B (predesignation), subpart C and § 921.31 (acquisition and development), and § 921.32 (operation and management) as applicable. Applications for development awards for construction projects, or restorative activities involving construction, must include a preliminary engineering report, a detailed construction plan, a site plan, a budget and categorical exclusion check list or environmental assessment. All applications must contain back up data for budget estimates (Federal and non-Federal shares), and evidence that the application complies with the Executive Order 12372, ''Intergovernmental Review of Federal Programs.'' In addition, applications for acquisition and development awards must contain:

(1) State Historic Preservation Office comments;

(2) Written approval from NOAA of the draft management plan for initial acquisition and development award(s); and

(3) A preliminary engineering report for construction activities.

§ 921.81 Allowable costs.

(a) Allowable costs will be determined in accordance with applicable OMB Circulars and guidance for Federal financial assistance, the financial assistant agreement, these regulations, and other Department of Commerce and NOAA directives. The term ''costs'' applies to both the Federal and non-Federal shares.

(b) Costs claimed as charges to the award must be reasonable, beneficial and necessary for the proper and efficient administration of the financial assistance award and must be incurred during the award period.

(c) Costs must not be allocable to or included as a cost of any other Federally-financed program in either the current or a prior award period.

(d) General guidelines for the non-Federal share are contained in Department of Commerce Regulations at 15 CFR part 24 and OMB Circular A–110.

Copies of Circular A–110 can be obtained from the Sanctuaries and Reserves Division; 1825 Connecticut Avenue, NW., suite 714; Washington, DC 20235. The following may be used in satisfying the matching requirement:

(1) *Site selection and post site selection awards.* Cash and in-kind contributions (value of goods and services directly benefiting and specifically identifiable to this part of the project) are allowable. Land may not be used as match.

(2) *Acquisition and development awards.* Cash and in-kind contributions are allowable. In general, the fair market value of lands to be included within the Reserve boundaries and acquired pursuant to the Act, with other than Federal funds, may be used as match. However, the fair market value of real property allowable as match is limited to the fair market value of a real property interest equivalent to, or required to attain, the level of control over such land(s) identified by the state and approved by the Federal Government as that necessary for the protection and management of the National Estuarine Research Reserve. Appraisals must be performed according to Federal appraisal standards as detailed in Department of Commerce regulations at 15 CFR part 24 and the Uniform Relocation Assistance and Real Property Acquisition for Federal land Federally assisted programs in 15 CFR part 11. The fair market value of privately donated land, at the time of donation, as established by an independent appraiser and certified by a responsible official of the state, pursuant to 15 CFR part 11, may also be used as match. Land, including submerged lands already in the state's possession, may be used as match to establish a National Estuarine Research Reserve. The value of match for these state lands will be calculated by determining the value of the benefits foregone by the state, in the use of the land, as a result of new restrictions that may be imposed by Reserve designation. The appraisal of the benefits foregone must be made by an independent appraiser in accordance with Federal appraisal standards pursuant to 15 CFR part 24 and 15 CFR part 11. A state may initially use as match land valued at greater than the Federal share of the acquisition and development award. The value in excess of the amount required as match for the initial award may be used to match subsequent supplemental acquisition and development awards for the National Estuarine Research Reserve (see also §921.20). Costs related to land acquisition, such as appraisals, legal fees and surveys, may also be used as match.

(3) *Operation and management awards.* Generally, cash and in-kind contributions (directly benefiting and specifically identifiable to operations and management), except land, are allowable.

(4) *Research, monitoring, education and interpretive awards.* Cash and in-kind contributions (directly benefiting and specifically identifiable to the scope of work), except land, are allowable.

§921.82 Amendments to financial assistance awards.

Actions requiring an amendment to the financial assistance award, such as a request for additional Federal funds, revisions of the approved project budget or original scope of work, or extension of the performance period must be submitted to NOAA on Standard Form 424 and approved in writing.

APPENDIX I TO PART 921—BIOGEOGRAPHIC CLASSIFICATION SCHEME

Acadian

1. Northern of Maine (Eastport to the Sheepscot River.)
2. Southern Gulf of Maine (Sheepscot River to Cape Cod.)

Virginian

3. Southern New England (Cape Cod to Sandy Hook.)
4. Middle Atlantic (Sandy Hook to Cape Hatteras.)
5. Chesapeake Bay.

Carolinian

6. North Carolinas (Cape Hatteras to Santee River.)
7. South Atlantic (Santee River to St. John's River.)
8. East Florida (St. John's River to Cape Canaveral.)

West Indian

9. Caribbean (Cape Canaveral to Ft. Jefferson and south.)
10. West Florida (Ft. Jefferson to Cedar Key.)

Louisianian

11. Panhandle Coast (Cedar Key to Mobile Bay.)
12. Mississippi Delta (Mobile Bay to Galveston.)
13. Western Gulf (Galveston to Mexican border.)

Californian

14. Southern California (Mexican border to Point Conception.)
15. Central California (Point Conception to Cape Mendocino.)
16. San Francisco Bay.

Columbian

17. Middle Pacific (Cape Mendocino to the Columbia River.)
18. Washington Coast (Columbia River to Vancouver Island.)
19. Puget Sound.

Great Lakes

20. Lake Superior (including St. Mary's River.)
21. Lakes Michigan and Huron (including Straits of Mackinac, St. Clair River, and Lake St. Clair.)
22. Lake Erie (including Detroit River and Niagara Falls.)
23. Lake Ontario (including St. Lawrence River.)

Fjord

24. Southern Alaska (Prince of Wales Island to Cook Inlet.)
25. Aleutian Island (Cook Inlet Bristol Bay.)

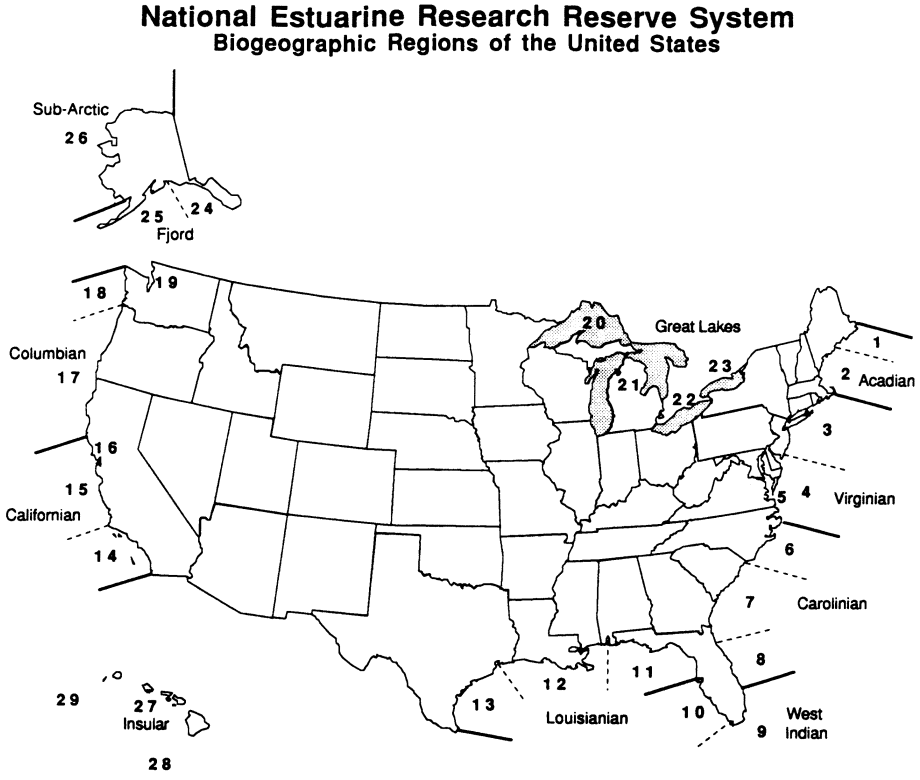
Sub-Arctic

26. Northern Alaska (Bristol Bay to Damarcation Point.)

Insular

27. Hawaiian Islands.
28. Western Pacific Island.
29. Eastern Pacific Island.

FIGURE 1



APPENDIX II TO PART 921—TYPOLOGY OF NATIONAL ESTUARINE RESEARCH RESERVES

This typology system reflects significant differences in estuarine characteristics that are not necessarily related to regional location. The purpose of this type of classification is to maximize ecosystem variety in the selection of national estuarine reserves. Priority will be given to important ecosystem types as yet unrepresented in the reserve system. It should be noted that any one site may represent several ecosystem types or physical characteristics.

Class I—Ecosystem Types

Group I—Shorelands

A. Maritime Forest-Woodland. That have developed under the influence of salt spray. It can be found on coastal uplands or recent features such as barrier islands and beaches, and may be divided into the following biomes:

1. Northern coniferous forest biome: This is an area of predominantly evergreens such as the sitka spruce (Picea), grand fir (Abies), and white cedar (Thuja), with poor development of the shrub and herb leyera, but high annual productivity and pronounced seasonal periodicity.

2. Moist temperate (Mesothermal) coniferous forest biome: Found along the west coast of North America from California to Alaska, this area is dominated by conifers, has relatively small seasonal range, high humidity with rainfall ranging from 30 to 150 inches, and a well-developed understory of vegetation with an abundance of mosses and other moisture-tolerant plants.

3. Temperate deciduous forest biome: This biome is characterized by abundant, evenly distributed rainfall, moderate temperatures which exhibit a distinct seasonal pattern,

well-developed soil biota and herb and shrub layers, and numerous plants which produce pulpy fruits and nuts. A distinct subdivision of this biome is the pine edible forest of the southeastern coastal plain, in which only a small portion of the area is occupied by climax vegetation, although it has large areas covered by edaphic climax pines.

4. Broad-leaved evergreen subtropical forest biome: The main characteristic of this biome is high moisture with less pronounced differences between winter and summer. Examples are the hammocks of Florida and the live oak forests of the Gulf and South Atlantic coasts. Floral dominants include pines, magnolias, bays, hollies, wild tamarine, strangler fig, gumbo limbo, and palms.

B. Coast shrublands. This is a transitional area between the coastal grasslands and woodlands and is characterized by woody species with multiple stems and a few centimeters to several meters above the ground developing under the influence of salt spray and occasional sand burial. This includes thickets, scrub, scrub savanna, heathlands, and coastal chaparral. There is a great variety of shrubland vegetation exhibiting regional specificity:

1. Northern areas: Characterized by Hudsonia, various erinaceous species, and thickets of Myricu, prunus, and Rosa.

2. Southeast areas: Floral dominants include Myrica, Baccharis, and Iles.

3. Western areas: Adenostoma, arcotyphylos, and eucalyptus are the dominant floral species.

C. Coastal grasslands. This area, which possesses sand dunes and coastal flats, has low rainfall (10 to 30 inches per year) and large amounts of humus in the soil. Ecological succession is slow, resulting in the presence of a number of seral stages of community development. Dominant vegetation includes mid-grasses (5 to 8 feet tall), such as Spartina, and trees such as willow (Salix sp.), cherry (Prunus sp.), and cottonwood (Pupulus deltoides.) This area is divided into four regions with the following typical strand vegetation:

1. Arctic/Boreal: Elymus;
2. Northeast/West: Ammophla;
3. Southeast Gulf: Uniola; and
4. Mid-Atlantic/Gulf: Spartina patens.

D. Coastal tundra. This ecosystem, which is found along the Arctic and Boreal coasts of North America, is characterized by low temperatures, a short growing season, and some permafrost, producing a low, treeless mat community made up of mosses, lichens, heath, shrubs, grasses, sedges, rushes, and herbaceous and dwarf woody plants. Common species include arctic/alpine plants such as Empetrum nigrum and Betula nana, the lichens Cetraria and Cladonia, and herbaceous plants such as Potentilla tridentata and Rubus chamaemorus. Common species on the coastal beach ridges of the high arctic desert include Bryas intergrifolia and Saxifrage oppositifolia. This area can be divided into two main subdivisions:

1. Low tundra: Characterized by a thick, spongy mat of living and undecayed vegetation, often with water and dotted with ponds when not frozen; and

2. High Tundra: A bare area except for a scanty growth of lichens and grasses, with underlaying ice wedges forming raised polygonal areas.

E. Coastal cliffs. This ecosystem is an important nesting site for many sea and shore birds. It consists of communities of herbaceous, graminoid, or low woody plants (shrubs, heath, etc.) on the top or along rocky faces exposed to salt spray. There is a diversity of plant species including mosses, lichens, liverworts, and ''higher'' plant representatives.

GROUP II—TRANSITION AREAS

A. Coastal marshes. These are wetland areas dominated by grasses (Poacea), sedges (Cyperaceae), rushes (Juncaceae), cattails (Typhaceae), and other graminoid species and is subject to periodic flooding by either salt or freshwater. This ecosystem may be subdivided into: (a) Tidal, which is periodically flooded by either salt or brackish water; (b) nontidal (freshwater); or (c) tidal freshwater. These are essential habitats for many important estuarine species of fish and invertebrates as well as shorebirds and waterfowl and serve important roles in shore stabilization, flood control, water purification, and nutrient transport and storage.

B. Coastal swamps. These are wet lowland areas that support mosses and shrubs together with large trees such as cypress or gum.

C. Coastal mangroves. This ecosystem experiences regular flooding on either a daily, monthly, or seasonal basis, has low wave action, and is dominated by a variety of salt-tolerant trees, such as the red mangrove (Rhizophora mangle), black mangrove (Avicennia Nitida), and the white mangrove (Laguncularia racemosa.) It is also an important habitat for large populations of fish, invertebrates, and birds. This type of ecosystem can be found from central Florida to extreme south Texas to the islands of the Western Pacific.

D. Intertidal beaches. This ecosystem has a distinct biota of microscopic animals, bacteria, and unicellular algae along with macroscopic crustaceans, mollusks, and worms with a detritus-based nutrient cycle. This area also includes the driftline communities found at high tide levels on the beach. The dominant organisms in this ecosystem include crustaceans such as the mole crab (Emerita), amphipods (Gammeridae), ghost crabs (Ocypode), and bivalve mollusks such

as the coquina (Donax) and surf clams (Spisula and Mactra.)

E. Intertidal mud and sand flats. These areas are composed of unconsolidated, high organic content sediments that function as a short-term storage area for nutrients and organic carbons. Macrophytes are nearly absent in this ecosystem, although it may be heavily colonized by benthic diatoms, dinoflaggellates, filamintous blue-green and green algae, and chaemosynthetic purple sulfur bacteria. This system may support a considerable population of gastropods, bivalves, and polychaetes, and may serve as a feeding area for a variety of fish and wading birds. In sand, the dominant fauna include the wedge shell Donax, the scallop Pecten, tellin shells Tellina, the heart urchin Echinocardium, the lug worm Arenicola, sand dollar Dendraster, and the sea pansy Renilla. In mud, faunal dominants adapted to low oxygen levels include the terebellid Amphitrite, the boring clam Playdon, the deep sea scallop Placopecten, the Quahog Mercenaria, the echiurid worm Urechis, the mud snail Nassarius, and the sea cucumber Thyone.

F. Intertidal algal beds. These are hard substrates along the marine edge that are dominated by macroscopic algae, usually thalloid, but also filamentous or unicellular in growth form. This also includes the rocky coast tidepools that fall within the intertidal zone. Dominant fauna of these areas are barnacles, mussels, periwinkles, anemones, and chitons. Three regions are apparent:

1. Northern latitude rocky shores: It is in this region that the community structure is best developed. The dominant algal species include Chondrus at the low tide level, Fucus and Ascophylium at the mid-tidal level, and Laminaria and other kelplike algae just beyond the intertidal, although they can be exposed at extremely low tides or found in very deep tidepools.

2. Southern latitudes: The communities in this region are reduced in comparison to those of the northern latitudes and possesses algae consisting mostly of single-celled or filamentour green, blue-green, and red algae, and small thalloid brown algae.

3. Tropical and subtropical latitudes: The intertidal in this region is very reduced and contains numerous calcareous algae such as Porolithon and Lithothamnion, as well and green algae with calcareous particles such as Halimeda, and numerous other green, red, and brown algae.

GROUP III—SUBMERGED BOTTOMS

A. Subtidal hardbottoms. This system is characterized by a consolidated layer of solid rock or large pieces of rock (neither of biotic origin) and is found in association with geomorphological features such as submarine canyons and fjords and is usually covered with assemblages of sponges, sea fans, bivalves, hard corals, tunicates, and other attached organisms. A significant feature of estuaries in many parts of the world is the oyster reef, a type of subtidal hardbottom. Composed of assemblages of organisms (usually bivalves), it is usually found near an estuary's mouth in a zone of moderate wave action, salt content, and turbidity. If light levels are sufficient, a covering of microscopic and attached macroscopic algae, such as keep, may also be found.

B. Subtidal softbottoms. Major characteristics of this ecosystem are an unconsolidated layer of fine particles of silt, sand, clay, and gravel, high hydrogen sulfide levels, and anaerobic conditions often existing below the surface. Macrophytes are either sparse or absent, although a layer of benthic microalgae may be present if light levels are sufficient. The faunal community is dominated by a diverse population of deposit feeders including polychaetes, bivalves, and burrowing crustaceans.

C. Subtidal plants. This system is found in relatively shallow water (less than 8 to 10 meters) below mean low tide. It is an area of extremely high primary production that provides food and refuge for a diversity of faunal groups, especially juvenile and adult fish, and in some regions, manatees and sea turtles. Along the North Atlantic and Pacific coasts, the seagrass Zostera marina predominates. In the South Atlantic and Gulf coast areas, Thalassia and Diplanthera predominate. The grasses in both areas support a number of epiphytic organisms.

Class II—Physical Characteristics

GROUP I—GEOLOGIC

A. Basin type. Coastal water basins occur in a variety of shapes, sizes, depths, and appearances. The eight basic types discussed below will cover most of the cases:

1. Exposed coast: Solid rock formations or heavy sand deposits characterize exposed ocean shore fronts, which are subject to the full force of ocean storms. The sand beaches are very resilient, although the dunes lying just behind the beaches are fragile and easily damaged. The dunes serve as a sand storage area making them chief stabilizers of the ocean shorefront.

2. Sheltered coast: Sand or coral barriers, built up by natural forces, provide sheltered areas inside a bar or reef where the ecosystem takes on many characteristics of confined waters-abundant marine grasses, shellfish, and juvenile fish. Water movement is reduced, with the consequent effects pollution being more severe in this area than in exposed coastal areas.

3. Bay: Bays are larger confined bodies of water that are open to the sea and receive strong tidal flow. When stratification is pronounced the flushing action is augmented by

river discharge. Bays vary in size and in type of shorefront.

4. Embayment: A confined coastal water body with narrow, restricted inlets and with a significant freshwater inflow can be classified as an embayment. These areas have more restricted inlets than bays, are usually smaller and shallower, have low tidal action, and are subject to sedimentation.

5. Tidal river: The lower reach of a coastal river is referred to as a tidal river. The coastal water segment extends from the sea or estuary into which the river discharges to a point as far upstream as there is significant salt content in the water, forming a salt front. A combination of tidal action and freshwater outflow makes tidal rivers well-flushed. The tidal river basin may be a simple channel or a complex of tributaries, small associated embayments, marshfronts, tidal flats, and a variety of others.

6. Lagoon: Lagoons are confined coastal bodies of water with restricted inlets to the sea and without significant freshwater inflow. Water circulation is limited, resulting in a poorly flushed, relatively stagnant body of water. Sedimentation is rapid with a great potential for basin shoaling. Shores are often gently sloping and marshy.

7. Perched coastal wetlands: Unique to Pacific islands, this wetland type found above sea level in volcanic crater remnants forms as a result of poor drainage characteristics of the crater rather than from sedimentation. Floral assemblages exhibit distinct zonation while the faunal constituents may include freshwater, brackish, and/or marine species. EXAMPLE: Aunu's Island, American Samoa.

8. Anchialine systems: These small coastal exposures of brackish water form in lava depressions or elevated fossil reefs have only a subsurface connection in the ocean, but show tidal fluctuations. Differing from true estuaries in having no surface continuity with streams or ocean, this system is characterized by a distinct biotic community dominated by benthis algae such as Rhizoclonium, the mineral encrusting Schiuzothrix, and the vascular plant Ruppia maritima. Characteristic fauna which exhibit a high degree of endemicity, include the mollusks Theosoxus neglectus and Tcariosus. Although found throughout the world, the high islands of the Pacific are the only areas within the U.S. where this system can be found.

B. Basin structure. Estuary basins may result from the drowning of a river valley (coastal plains estuary), the drowning of a glacial valley (fjord), the occurrence of an offshore barrier (bar-bounded estuary), some tectonic process (tectonic estuary), or volcanic activity (volcanic estuary).

1. Coastal plains estuary: Where a drowned valley consists mainly of a single channel, the form of the basin is fairly regular forming a simple coastal plains estuary. When a channel is flooded with numerous tributaries an irregular estuary results. Many estuaries of the eastern United States are of this type.

2. Fjord: Estuaries that form in elongated steep headlands that alternate with deep U-shaped valleys resulting from glacial scouring are called fjords. They generally possess rocky floors or very thin veneers of sediment, with deposition generally being restricted to the head where the main river enters. Compared to total fjord volume river discharge is small. But many fjords have restricted tidal ranges at their mouths due to sills, or upreaching sections of the bottom which limit free movement of water, often making river flow large with respect to the tidal prism. The deepest portions are in the upstream reaches, where maximum depths can range from 800m to 1200m while sill depths usually range from 40m to 150m.

3. Bar-bounded estuary: These result from the development of an offshore barrier such as a beach strand, a line of barrier islands, reef formations a line of moraine debris, or the subsiding remnants of a deltaic lobe. The basin is often partially exposed at low tide and is enclosed by a chain of offshore bars of barrier islands broken at intervals by inlets. These bars may be either deposited offshore or may be coastal dunes that have become isolated by recent seal level rises.

4. Tectonic estuary: These are coastal indentures that have formed through tectonic processes such as slippage along a fault line (San Francisco Bay), folding or movement of the earth's bedrock often with a large inflow of freshwater.

5. Volcanic estuary: These coastal bodies of open water, a result of volcanic processes are depressions or craters that have direct and/or subsurface connections with the ocean and may or may not have surface continuity with streams. These formations are unique to island areas of volcanic orgin.

C. Inlet type. Inlets in various forms are an integral part of the estuarine environment as they regulate to a certain extent, the velocity and magnitude of tidal exchange, the degree of mixing, and volume of discharge to the sea.

1. Unrestricted: An estuary with a wide unrestricted inlet typically has slow currents, no significant turbulence, and receives the full effect of ocean waves and local disturbances which serve to modify the shoreline. These estuaries are partially mixed, as the open mouth permits the incursion of marine waters to considerable distances upstream, depending on the tidal amplitude and stream gradient.

2. Restricted: Restrictions of estuaries can exist in many forms: Bars, barrier islands, spits, sills, and more. Restricted inlets result in decreased circulation, more pronounced longitudinal and vertical salinity gradients, and more rapid sedimentation. However, if

the estuary mouth is restricted by depositional features or land closures, the incoming tide may be held back until it suddenly breaks forth into the basin as a tidal wave, or bore. Such currents exert profound effects on the nature of the subtrate, turbidity, and biota of the estuary.

3. Permanent: Permanent inlets are usually opposite the mouths of major rivers and permit river water to flow into the sea.

4. Temporary (Intermittent): Temporary inlets are formed by storms and frequently shift position, depending on tidal flow, the depth of the sea, and sound waters, the frequency of storms, and the amount of littoral transport.

D. Bottom composition. The bottom composition of estuaries attests to the vigorous, rapid, and complex sedimentation processes characteristic of most coastal regions with low relief. Sediments are derived through the hydrologic processes of erosion, transport, and deposition carried on by the sea and the stream.

1. Sand: Near estuary mouths, where the predominating forces of the sea build spits or other depositional features, the shore and substrates of the estuary are sandy. The bottom sediments in this area are usually coarse, with a graduation toward finer particles in the head region and other zones of reduced flow, fine silty sands are deposited. Sand deposition occurs only in wider or deeper regions where velocity is reduced.

2. Mud: At the base level of a stream near its mouth, the bottom is typically composed of loose muds, silts, and organic detritus as a result of erosion and transport from the upper stream reaches and organic decomposition. Just inside the estuary entrance, the bottom contains considerable quantities of sand and mud, which support a rich fauna. Mud flats, commonly built up in estuarine basins, are composed of loose, coarse, and fine mud and sand, often dividing the original channel.

3. Rock: Rocks usually occur in areas where the stream runs rapidly over a steep gradient with its coarse materials being derived from the higher elevations where the stream slope is greater. The larger fragments are usually found in shallow areas near the stream mouth.

4. Oyster shell: Throughout a major portion of the world, the oyster reef is one of the most significant features of estuaries, usually being found near the mouth of the estuary in a zone of moderate wave action, salt content, and turbidity. It is often a major factor in modifying estuarine current systems and sedimentation, and may occur as an elongated island or peninsula oriented across the main current, or may develop parallel to the direction of the current.

GROUP II—HYDROGRAPHIC

A. Circulation. Circulation patterns are the result of combined influences of freshwater inflow, tidal action, wind and oceanic forces, and serve many functions: Nutrient transport, plankton dispersal, ecosystem flushing, salinity control, water mixing, and more.

1. Stratified: This is typical of estuaries with a strong freshwater influx and is commonly found in bays formed from ''drowned'' river valleys, fjords, and other deep basins. There is a net movement of freshwater outward at the top layer and saltwater at the bottom layer, resulting in a net outward transport of surface organisms and net inward transport of bottom organisms.

2. Non-stratified: Estuaries of this type are found where water movement is sluggish and flushing rate is low, although there may be sufficient circulation to provide the basis for a high carrying capacity. This is common to shallow embayments and bays lacking a good supply of freshwater from land drainage.

3. Lagoonal: An estuary of this type is characterized by low rates of water movement resulting from a lack of significant freshwater influx and a lack of strong tidal exchange because of the typically narrow inlet connecting the lagoon to the sea. Circulation whose major driving force is wind, is the major limiting factor in biological productivity within lagoons.

B. Tides. This is the most important ecological factor in an estuary as it affects water exchange and its vertical range determines the extent of tidal flats which may be exposed and submerged with each tidal cycle. Tidal action against the volume of river water discharged into an estuary results in a complex system whose properties vary according to estuary structure as well as the magnitude of river flow and tidal range. Tides are usually described in terms of the cycle and their relative heights. In the United States, tide height is reckoned on the basis of average low tide, which is referred to as datum. The tides, although complex, fall into three main categories:

1. Diurnal: This refers to a daily change in water level that can be observed along the shoreline. There is one high tide and one low tide per day.

2. Semidiurnal: This refers to a twice daily rise and fall in water that can be observed along the shoreline.

3. Wind/Storm tides: This refers to fluctuations in water elevation to wind and storm events, where influence of lunar tides is less.

C. Freshwater. According to nearly all the definitions advanced, it is inherent that all estuaries need freshwater, which is drained from the land and measurably dilutes seawater to create a brackish condition. Freshwater enters an estuary as runoff from the

land either from a surface and/or subsurface source.

1. Surface water: This is water flowing over the ground in the form of streams. Local variation in runoff is dependent upon the nature of the soil (porosity and solubility), degree of surface slope, vegetational type and development, local climatic conditions, and volume and intensity of precipitation.

2. Subsurface water: This refers to the precipitation that has been absorbed by the soil and stored below the surface. The distribution of subsurface water depends on local climate, topography, and the porosity and permeability of the underlying soils and rocks. There are two main subtypes of surface water:

a. Vadose water: This is water in the soil above the water table. Its volume with respect to the soil is subject to considerable fluctuation.

b. Groundwater: This is water contained in the rocks below the water table, is usually of more uniform volume than vadose water, and generally follows the topographic relief of the land being high hills and sloping into valleys.

GROUP III—CHEMICAL

A. Salinity. This reflects a complex mixture of salts, the most abundant being sodium chloride, and is a very critical factor in the distribution and maintenance of many estuarine organisms. Based on salinity, there are two basic estuarine types and eight different salinity zones (expressed in parts per thousand-ppt.)

1. Positive estuary: This is an estuary in which the freshwater influx is sufficient to maintain mixing, resulting in a pattern of increasing salinity toward the estuary mouth. It is characterized by low oxygen concentration in the deeper waters and considerable organic content in bottom sediments.

2. Negative estuary: This is found in particularly arid regions, where estuary evaporation may exceed freshwater inflow, resulting in increased salinity in the upper part of the basin, especially if the estuary mouth is restricted so that tidal flow is inhibited. These are typically very salty (hyperhaline), moderately oxygenated at depth, and possess bottom sediments that are poor in organic content.

3. Salinity zones (expressed in ppt):

a. Hyperhaline—greater than 40 ppt.

b. Euhaline—40 ppt to 30 ppt.

c. Mixhaline—30 ppt to 0.5 ppt.

(1) Mixoeuhaline—greater than 30 ppt but less than the adjacent euhaline sea.

(2) Polyhaline—30 ppt to 18 ppt.

(3) Mesohaline—18 ppt to 5 ppt.

(4) Oligohaline—5 ppt to 0.5 ppt.

d. Limnetic: Less than 0.5 ppt.

B. pH Regime: This is indicative of the mineral richness of estuarine waters and falls into three main categories:

1. Acid: Waters with a pH of less than 5.5.

2. Circumneutral: A condition where the pH ranges from 5.5 to 7.4.

3. Alkaline: Waters with a pH greater than 7.4.

PART 922—NATIONAL MARINE SANCTUARY PROGRAM REGULATIONS

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922.42 Allowed activities.
922.43 Prohibited or otherwise regulated activities.
922.44 Emergency regulations.
922.45 Penalties.
922.46 Response costs and damages.
922.47 Pre-existing authorizations or rights and certifications of pre-existing authorizations or rights.
922.48 National Marine Sanctuary permits—application procedures and issuance criteria.

Appendix 3: Letters Initiating the Green Bay Reserve Designation Process

Tony Evers
Office of the Governor | State of Wisconsin

March 25, 2019

Dr. Timothy Gallaudet, Acting Undersecretary of Commerce for Oceans and Atmosphere
National Oceanic and Atmospheric Administration
1401 Constitution Avenue, NW
Washington, D.C. 20230

RE: Green Bay Ecosystem National Estuarine Research Reserve Site Selection

Dear Dr. Gallaudet:

I am pleased to notify your office of Wisconsin's interest in establishing a National Estuarine Research Reserve (NERR) in our Green Bay coastal area of Lake Michigan. The Green Bay ecosystem is the largest freshwater estuary in the world, in the largest reservoir of freshwater on the planet, the vitality of which are critical to the current and future prosperity of the city of Green Bay, Door County, and the broader region. We share with the NERR System a vision of creating a "living laboratory" where scientists, educators, and community partners use place-based research to create distinct educational resources, to facilitate local stewardship, and to support the local economic health afforded by our estuarine-based natural resources.

Green Bay itself is a unique body of water, stretching from the tip of Door County to the headwaters of the Fox and Wolf Rivers. The Bay contains some of the most beautiful and extensively used waters within the entire Great Lakes basin, and represents a tremendous asset for the State of Wisconsin and its citizens – for recreation, fishing, transportation and maritime commerce. It is also an intensely interesting system in terms of its underlying dynamics, the understanding of which have applicability across estuarine systems throughout the world. Designation of Green Bay as a National Estuarine Research Reserve would highlight Wisconsin's leadership in applied environmental stewardship and bring much needed attention to the Great Lakes. Wisconsin sits on nearly ~20% of the world's surface freshwater and 90% of the nation's supply that will increasingly become the envy of regions not so blessed. The Green Bay ecosystem supports a robust tourism industry, with Brown and Door Counties alone generating nearly a billion dollars in visitor spending in 2015 alone. The visitor center and outreach activities associated with a Green Bay ecosystem NERR will provide an additional year-round draw for tourists, and a highly visible location for the NERR System. The initiatives and activities led by a Green Bay ecosystem NERR will enhance place-based identity, contributing directly to talent recruitment and retention efforts for skilled millennials who are seeking the quality of life opportunities supported by a healthy natural resource base. Green Bay will, I predict, quickly become a hallmark reserve within the national system, emphasizing our ability to balance natural resource stewardship with sound agricultural practices, progressive urban design, and responsible industry.

The state of Wisconsin formally seeks federal funds, technical assistance and commitment to guide our state through the site selection process. The University of Wisconsin-Green Bay, working closely with the Wisconsin Coastal Management Program in the Department of Administration, the University of Wisconsin-Milwaukee, and local community partners will serve as the lead agency for establishing a NERR. The University of Wisconsin-Green Bay has and continues to serve as a leader in in research, stewardship, and restoration activities within the Green Bay ecosystem.

Tony Evers

Office of the Governor | State of Wisconsin

I invite you to visit Wisconsin's Green Bay ecosystem to gain firsthand experience of this internationally important estuarine system. I am confident that NERR designation will increase awareness of the value of this resource to the nation, and foster a sense of immense pride for this natural resource treasure among the citizens of Wisconsin.

I look forward to working with you and your staff on this exciting project. Thank you.

Sincerely,



Tony Evers

Governor of Wisconsin

cc: Wisconsin Congressional Delegation

Gary L. Miller, Chancellor

University of Wisconsin-Green Bay

UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary of Commerce
for Oceans and Atmosphere
Washington, D.C. 20230

JUL 19 2019

The Honorable Tony Evers
Governor
State of Wisconsin
Office of the Governor
P.O. Box 7863
Madison, WI 53707

Dear Governor Evers:

Thank you for your recent letter regarding your support to establish a National Estuarine Research Reserve System in the Green Bay coastal area of Lake Michigan.

The National Oceanic and Atmospheric Administration (NOAA) recognizes the importance of partnerships as well as the economic and ecological value provided by estuarine ecosystems, which includes the importance of reserve programs for research, monitoring, education, and stewardship for local communities. NOAA's National Ocean Service manages the site designation process, and the program lead is Erica Seiden. She can be reached at (240) 533-0781 or Erica.Seiden@noaa.gov. Ms. Seiden has been in contact with Matt Dornbush from the University of Wisconsin-Green Bay and will coordinate next steps with the University.

We look forward to providing both technical assistance and broad capabilities for the site selection process. If you have any further questions, please contact Wendy Lewis, Director of NOAA's Office of Legislative and Intergovernmental Affairs, at (202) 482-4981.

Sincerely,

Neil A. Jacobs, Ph.D.
Assistant Secretary of Commerce for
Environmental Observation and Prediction
Performing the Duties of
Under Secretary of Commerce
for Oceans and Atmosphere

THE ADMINISTRATOR

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Appendix 4: Comments Submitted During the Scoping Phase

Comment 1:

- Commenter: Anonymous
- Date: 02/03/2024
- Comment: Climate change is only going to make the Great Lakes and surrounding ecosystem more important for the future of the region. Protecting and studying it needs to be a priority, not just for the people who live in the area but for all of North America.

Comment 2:

- Commenter: Chris Ritchie
- Date: 02/03/2024
- Comment: I'm all in favor of this, let's protect our environments.

Comment 3:

- Commenter: Nathan Brandel
- Date: 02/03/2024
- Comment: Please move forward with this. While restoration may be highly unlikely due to forever chemicals, invasive species, and physical removal of natural habitat, hopefully we can learn what not to do.

Comment 4:

- Commenter: Robert Howe
- Date: 03/19/2024
- Comment: Proposed areas are excellent! They all include "subsystems" that exhibit estuarine properties such as mixing of bay water with inflows from adjacent watersheds. Important topics for research reserve include (1) system responses to changing water levels and (2) complications caused by invasive species. Wet meadow component of the coastal estuarine environment in Green Bay (and Great Lakes in general) is being displaced by invasive phragmites and other undesirable invasives.

Comment 5:

- Commenter: Chip McDonald
- Date: 03/19/2024
- Comment: With outreach, education, and access being core objectives, will proximity to underserved populations be considered? Specifically for development of the programs offered and outreach center.

Comment 6:

- Commenter: Deborah Jorgensen
- Date: 03/21/2024
- Comment: Dear Bridget, I would just like to say that I am very excited to see the natural area sites of the NEER near our property is promoting stewardship of these lands. I have, over the years, been trying to bring attention to the tenderness of this area to no avail. I have contacted numerous conservation entities; local, county, and state departments; and the DNR. We are very blessed to have in our area numerous birds (turkeys, geese, eagles, hawks, owls, egrets, sandhill cranes, ducks, pelicans, and many songbirds), frogs, snakes, weasels, raccoons, rabbits, fox, coyotes, deer, possum, chipmunks, and squirrels. Since the rise of the Bay over the past 5 years we have also blessed with fish in the area

streams and ponds. My complaint has been that the allowance of airboat traffic in these areas have caused a lot of upheaval in the nesting of these creatures. The football field's bright lights and the loud noises from the turbines late at night and [in the] wee early morning hours have caused a lot of distress to the wildlife. I hear the cries of the native birds as these boats are allowed in such tender areas especially during nesting season. These vehicles have gotten stuck in the mucky low areas and damage the plants, such as cattails, as a result. I have been trying to get this area monitored for no motors but have been told I have no rights to do that. It is frustrating that as a property owner I do not have the "right" to protect wildlife. I am hoping that with the advent of this venture, you may be able to do so. I am very appreciative of your time and good luck with the NERR. Sincerely yours, Deborah A. Jorgensen

Comment 7:

- Commenter: Richard Spotts
- Date: 03/26/2024
- Comment: As a former long-time Wisconsin resident, I strongly support and applaud this proposed NERR designation. This proposed designation is reasonable, necessary, and in the public interest. I commend those who are working to advance this designation. I urge NOAA to promptly approve and implement this designation. Thank you very much.

Comment 8:

- Commenter: Amanda Smith
- Date: 03/28/2024
- Comment: If designated, I believe the NERR should focus on land acquisition within the Brown Co. NERR boundary area. This would allow for complementary efforts to occur within or near the Lower Green Bay Fox River Area of Concern. Additionally, it could set things up for success in terms of site selection for future facilities like a NERR headquarters. Siting facilities like a headquarters building in Brown Co. is important for logistical reasons (central location to field sites, partners etc.) but also to encompass the estuary in its entirety, which starts in the City of Green Bay and other Brown Co. municipality lands.

Comment 9:

- Commenter: WI DNR
- Date: 03/28/2024
- Comment: If designated, I believe it is important for the NERR's research agenda to prioritize European frog-bit, which is a relatively new NR40 Prohibited Species to the Bay, has recently been documented in many of the proposed NERR natural areas, and is predicted to spread to more suitable habitat within the NERR boundary. Ongoing response efforts are being implemented by numerous partners and the partnership of the NERR would help bolster those efforts.

Comment 10:

- Commenter: Krystle McClain (US EPA, Region 5)
- Date: 04/15/2024
- Comment:

  DEVELOPMENT OF THE DRAFT MANAGEMENT PLAN

  - According to information on UW-Green Bay's website2, "A site for the visitor and education center will be determined later in the designation process. The location of the visitor center does not need to be located within a candidate site area or within the boundaries of the reserve, post-designation." EPA has reviewed NOAA's National Estuarine Research Reserve System Regulations and specifically 15 CFR § 921.13 (Management Plan and Environmental Impact Statement Development), which calls for

development of a Draft Management Plan and collection of information to be used to inform the forthcoming DEIS.

- NOAA's regulations state, in 15 CFR § 921.13(a)(6), the Draft Management Plan shall set out, in detail, "A construction plan, including a proposed construction schedule, general descriptions of proposed developments and general cost estimates. Information should be provided for proposed minor construction projects in sufficient detail to allow these projects to begin in the initial phase of acquisition and development. A categorical exclusion, environmental assessment, or EIS may be required prior to construction."
- While EPA does not have any comments to offer on the ecological locations selected to be within the boundary of the proposed NERR, the construction of a visitor and education center may result in impacts to the natural and human environment. Scoping information was not clear if the forthcoming Draft Management Plan will provide alternatives or a specific site for a proposed visitor and education center or how and when impacts associated with the visitor center will be analyzed under NEPA.
- Recommendations for the DEIS: When releasing the forthcoming DEIS for public review and comment, also release the Draft Management Plan with the DEIS for review and comment. Clarify how NOAA intends to analyze any impacts associated with construction of any buildings, infrastructure, or parking associated with education, outreach, or access to NERR sites.

ENERGY EFFICIENCY AND ENVIRONMENTAL BEST PRACTICES

- Energy efficient design and material selection for construction projects associated with the NERR can reduce operations costs and promote a high-quality work environment, while also protecting the environment. Recycling construction debris also preserves valuable landfill space and makes use of materials that have high embodied energy.
- Recommendations for the DEIS: NOAA should consider committing to the following:
  - Achieving Leadership in Energy & Environmental Design (LEED) certification at the platinum level (or design for net-zero energy usage) for all new buildings associated with the project. Best practices for energy efficiency and sustainable building design can include the use of energy-efficient building materials, such as south-facing skylights and windows, motion sensored lighting, solar, wind, and/or geothermal power, and Energy Star certified windows and doors. In addition to reducing the overall environmental footprint, green building certification programs promote health by encouraging practices that protect indoor air quality. At a minimum, EPA encourages NOAA to commit to analyze the strengths and feasibility of these strategies;
  - Constructing proposed roads, parking lots, sidewalks, or other surfaces slated for driving or walking using permeable pavement or porous pavers to reduce runoff;
  - Identifying and implementing opportunities for additional green stormwater management practices. Opportunities include, but are not limited to, green roofs, bioswales, and rain gardens;
  - Ensuring areas around all new buildings associated with the project which are not planned for operations be considered for conversion to native habitats, increasing the area which can be beneficially used for wildlife, stormwater infiltration or detention, and aesthetics, among other functions;
  - Discussing to what extent NOAA will require energy efficiency measures, greenhouse gas reductions, and other sustainability measures, per Executive Order 13693;
  - Incorporating electric vehicle charging stations in new parking areas and designating priority parking spots for carpools and low emission vehicles;
  - Committing to recycle a high percentage of construction and demolition debris; and
  - Replacing raw materials with recycled materials for infrastructure components. Options include, but are not limited to:

- Using recycled materials to replace carbon-intensive Portland Cement in concrete as "supplementary cementitious material;"
- Using tire-derived aggregate in lightweight embankment fill and retaining wall backfill; and
- Using recycled materials in pavement applications, such as crushed recycled concrete, recycled asphalt pavement, and rubberized asphalt concrete. Also, in some circumstances, demolished onsite asphalt can be re-used (e.g., cold in-place recycling or full depth reclamation).

ENVIRONMENTAL JUSTICE AND CHILDREN'S HEALTH

- NOAA should analyze if construction, operation, and maintenance of the proposed NERR will impact communities with environmental justice (EJ) concerns. Our recommendations below suggest opportunities to further analyze, disclose, and reduce such impacts.
- Recommendations for the DEIS:
  - Identify the presence of low-income and/or minority communities within the project area(s) and within the broader area(s) that could experience environmental impacts from the proposed project. Disclose demographic information and summarize input from community members; o Describe past activities and future plans to engage minority populations, low-income populations, and Tribes during the environmental review and planning phase, and, if the project commences, during construction and operations;
  - Evaluate the impacts of this proposal on low-income and/or minority communities and sensitive receptors (e.g., children, people with asthma, etc.);
  - Include an analysis and conclusion regarding whether the Proposed Action or any action alternatives may have disproportionately high and adverse impacts on low income or minority communities, as specified in CEQ's Environmental Justice Guidance;
  - Consider any disproportionate, non-project-related pollution exposures that communities of concern may already be experiencing, as well as any disproportionate non-pollution stressors that may make the communities susceptible to pollution, such as health conditions, other social determinants of health, and disproportionate vulnerability related to climate change;
  - Identify measures to (1) ensure meaningful community engagement, (2) minimize adverse community impacts, and (3) avoid disproportionate impacts to communities with EJ concerns;
  - Use census-tract-level information to initially help locate communities with EJ concerns. For initial screening, use EPA's EJSCREEN5 mapping tool;
  - In conducting the EJ analysis, utilize resources such as the Promising Practices Report6 and the Community Guide to EJ and NEPA Methods to appropriately engage in meaningful, targeted, community outreach, analyze impacts, and advance environmental justice principles through NEPA implementation;
  - Consider cumulative environmental impacts to minority populations, low-income populations, Tribes, and indigenous peoples in the project area within the environmental justice analysis and disclose conclusions on those impacts;
  - Provide an analysis and findings as to whether the Proposed Project and all alternatives, including the No Action Alternative, would likely have disproportionate adverse impacts on minority populations, low-income populations, or Tribes. Identify what those impacts may be and include measures in the DEIS that NOAA will take to avoid, minimize, or mitigate impacts; and
  - Establish material hauling routes away from places where children live, learn, and play, to the extent feasible. Consider homes, schools, daycares, and playgrounds. In addition to air quality benefits, careful routing may protect children from vehicle-pedestrian accidents. Identify potential material hauling routes in the DEIS.

CLIMATE CHANGE

- Executive Order 14008: Tackling the Climate Crisis at Home and Abroad states, "The United States and the world face a profound climate crisis. We have a narrow moment to pursue action…to avoid the most catastrophic impacts of that crisis and to seize the opportunity that tackling climate change presents." The U.S. Global Change Research Program's National Climate Assessment provides data and scenarios that may be helpful in assessing trends in temperature, precipitation, and frequency and severity of storm events.
- Construction of any new buildings would directly release greenhouse gas (GHG) emissions during construction from trucks hauling materials, workers' vehicles, and operation of construction equipment. It is important for the DEIS to fully quantify and adequately disclose the impacts of the GHG emissions from the No Action alternative and all action alternatives and discuss the implications of those emissions in light of science-based policies established to avoid the worsening impacts of climate change.
- In addition, estimates of the social cost of greenhouse gases (SC-GHG9) are informative for assessing the impacts of GHG emissions. SC-GHG estimates allow analysts to monetize the societal value of changes in GHG emissions from actions that have small, or marginal, impacts on cumulative global emissions. Estimates of the social cost of carbon (SC-CO2) and other greenhouse gases (e.g., social cost of methane (SC-CH4)) have been used for over a decade in Federal government analyses. Quantification of anticipated GHG releases and associated SC-GHG comparisons among all alternatives (including the No Action Alternative scenarios) within the DEIS would inform project decision-making and provide clear support for implementing all practicable measures to minimize GHG emissions and releases.
- On January 9, 2023, the Council on Environmental Quality (CEQ) published interim guidance to assist Federal agencies in assessing and disclosing climate change impacts during environmental reviews10. CEQ developed this guidance in response to Executive Order 13990 - Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis. This interim guidance was effective immediately. CEQ indicated that agencies should use this interim guidance to inform the NEPA review for all new proposed actions and may use it for evaluations in process, as agencies deem appropriate, such as informing the consideration of alternatives or helping address comments raised through the public comment process. EPA recommends the DEIS apply the interim guidance as appropriate, to ensure robust consideration of potential climate impacts, mitigation, and adaptation issues.
- Recommendations for the DEIS: NOAA should apply the interim guidance as appropriate, to ensure robust consideration of potential climate impacts, mitigation, and adaptation issues.
- Additional recommendations are as follows:
  - Emissions & SC-GHG Disclosure and Analysis
    - Include a detailed discussion of the project's reasonably-foreseeable direct and indirect GHG emissions in the context of actions necessary to achieve Wisconsin's policies and GHG emission reduction goals11 as well as national policy and GHG emission reduction goals over the anticipated project lifetime, including the U.S. 2030 Paris targets and the 2050 goal for net-zero energy emissions.
    - Quantify estimates of all direct and indirect GHG emissions12 from the proposed project over its anticipated lifetime for all alternatives, including the No Action Alternative, broken out by GHG type. Include and analyze potential upstream and downstream GHG emissions.
    - Use SC-GHG estimates to disclose and consider the climate damages from net changes in direct and indirect emissions of CO2 and other GHGs resulting from the proposed project. To do so, EPA recommends a breakdown of estimated net GHG emission changes by individual gas, rather than relying on CO2-equivalent (CO2e) estimates, and then monetize the climate impacts associated with each GHG using the corresponding social cost estimate (i.e., monetize CH4 emissions changes expected to occur with the social cost of methane (SC-CH4) estimate for

emissions).13 When applying SC-GHG estimates, just as with tools to quantify emissions, USGS should disclose the assumptions (e.g., discount rates) and uncertainties associated with such analysis and the need for updates over time to reflect evolving science and economics of climate impacts.
    - Use comparisons of GHG emissions and SC-GHG across alternatives to inform project decision-making.
- Resilience and Adaptation:
    - Describe changing climate conditions (i.e., temperatures and frequency and severity of storm events) and assess how such changes could impact the proposed project and the environmental impacts of the proposed project and alternatives.
    - Incorporate robust climate resilience and adaptation considerations into (1) project design and engineering; (2) construction oversight; (3) commitments for protective measures related to stormwater and erosion; and (4) routine monitoring during operations. The DEIS should describe how NOAA has addressed such considerations and provide a rationale for any reasonable alternatives to enhance resilience that were not adopted or discussed in detail.
- Reduction and Mitigation:
    - Identify practices to reduce and mitigate GHG emissions; include commitments to do so in the DEIS. We recommend NOAA consider practices in the enclosed Construction Emission Control Checklist.

OTHER COMMENTS

- The Federal Register NOI stated that all comments received during the scoping period will be posted online for public viewing. However, the NOI did not state how NOAA plans to respond to comments.
- Recommendations for the DEIS: In the DEIS, create an appendix to include all comments received during the DEIS comment period – including any applicable transcripts of comments from the public, and all comment letters received. For all government agency letters received, include NOAA's responses to specific comments from each letter. EPA also recommends that the appendix include all correspondence sent to and received from the resource agencies regarding the project.

Appendix 5: Compliance with Other Environmental Review Requirements

NOAA's Office for Coastal Management complied with the National Environmental Policy Act (NEPA) and several other environmental and administrative review requirements, including those listed below, as part of its evaluation of the proposed action to designate the Green Bay National Estuarine Research Reserve. If the Office for Coastal Management decides to award funding to the reserve, the office will conduct any additional environmental reviews required by law at that time.

Clean Air Act

The Clean Air Act (42 U.S.C. § 7401 *et seq*.) directs the U.S. Environmental Protection Agency to establish air emission standards to safeguard public health and the environment. Nationwide attainment and maintenance of National Ambient Air Quality Standards (NAAQS) is the fundamental goal. Primary NAAQS are designed to protect human health. Secondary NAAQS are designed to protect the public welfare (e.g., to prevent damage to soils, crops, vegetation, water, visibility, and property). 42 U.S.C. § 7506(c) prohibits federal agencies from licensing, permitting, or approving any activity that does not conform to an approved state implementation plan issued to enforce the standards.

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not affect the environment in ways regulated by the Clean Air Act. As such, no further compliance action is planned at this time.

Clean Water Act

The Clean Water Act (33 U.S.C. § 1251 *et seq*.) is the principal federal law governing pollution control and water quality of the nation's waterways. Section 404, administered jointly by the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency, authorizes a permit program for the discharge of dredged or fill material into navigable waters. Section 401 (Louisiana Water Quality Certification Program), administered by the Louisiana Department of Environmental Quality and the U.S. Environmental Protection Agency, requires applicants for federal licenses or permits for activities that may result in a discharge of pollution into navigable waters to obtain a certification of compliance with applicable water quality standards and goals from the appropriate state (or a waiver from the state).

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not affect the environment in ways regulated by the Clean Water Act. As such, no further compliance action is planned at this time.

Coastal Barrier Resources Act

The Coastal Barrier Resources Act (CBRA; 16 U.S.C. §§ 3501–3508) encourages the conservation of hurricane-prone, biologically rich coastal barriers by restricting federal expenditures that encourage development, such as federal flood insurance. The Coastal Barrier Resources Act designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts and made these areas ineligible for most new federal expenditures and financial assistance. The Coastal Barrier Improvement Act of 1990 (Pub. L. No. 101– 591) reauthorized the Coastal Barrier Resources Act; expanded the system to include undeveloped coastal barriers along the Florida Keys, Great Lakes, Puerto Rico, and U.S. Virgin Islands; and added a new category of coastal barriers to the system. The new category, "otherwise protected areas," includes undeveloped coastal barriers that are within the boundaries of an area established under federal, state, or local law or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes.

Compliance: There are three CBRA units in the proposed Green Bay Reserve boundaries:

1. **Peshtigo Point Unit WI-03 and Dyers Slough Unit WI-04**: The Peshtigo Point Unit WI-03 and Dyers Slough Unit WI-04 are both within the Peshtigo Component of the proposed Green Bay Reserve. A map of this system unit can be found at *https://www.fws.gov/sites/default/files/documents/55-003B.pdf*.
2. **Point au Sable Unit WI-02**: The Point au Sable Unit WI-02 is located within the Lower Bay Component of the proposed reserve. A map of this system unit can be found at *https://www.fws.gov/sites/default/files/documents/55-002B.pdf*.

The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not develop coastal areas in ways regulated by the Coastal Barrier Resources Act. As such, no further compliance action is planned at this time. Should the Office for Coastal Management decide to award funding to the proposed reserve, the office would conduct any additional required environmental reviews at that time.

Coastal Zone Management Act

The goal of the Coastal Zone Management Act (CZMA; 16 U.S.C. § 1451 *et seq*.) is to preserve, protect, develop, and—where possible—restore and enhance the nation's coastal resources. Under the Coastal Zone Management Act, NOAA's Office for Coastal Management supports implementation of federally approved, state coastal management programs. Section 307 of the Coastal Zone Management Act, known as the "federal consistency" provision, requires any federal action inside or outside the state's coastal zone that affects any land or water use or natural resources of the coastal zone to be consistent with the enforceable policies of an approved state coastal management program. The federal consistency regulations at 15 C.F.R. § 930 set forth detailed timeframes and procedures that must be followed. Subpart C of the regulations provides that for all federal agency activities, inside or outside the coastal zone, the federal agency must submit a Consistency Determination to the state if the federal agency determines the activity may have reasonably foreseeable effects on the state's coastal uses or resources. Per 15 C.F.R. § 930.34(a)(1), federal agency activities must be consistent to the maximum extent practicable with the enforceable policies of the state's coastal management program. If there are no reasonably foreseeable effects, the federal agency may be required to provide a negative determination to the state. See 15 C.F.R. § 930.35.

Compliance: Pursuant to Section 307(c)(1) of the Coastal Zone Management Act, 16 U.S.C. § 1457(c)(1), and the implementing regulations promulgated at 15 C.F.R. § 921.4(b), the Office for Coastal Management will submit a Consistency Determination to the Wisconsin Coastal Management Program for the designation of the Green Bay National Estuarine Research Reserve and approval of the state-developed management plan.

Endangered Species Act

The Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. § 1531 *et seq*.), provides for the conservation of species endangered or threatened throughout all or a significant portion of their range and for the conservation of the ecosystems on which they depend. The Endangered Species Act directs all federal agencies to work to conserve endangered and threatened species and use their authorities to further ESA purposes. Under the Endangered Species Act, NOAA Fisheries and the U.S. Fish and Wildlife Service (in this subsection, collectively, "the Services") publish lists of endangered, threatened, candidate, and other species with special status.

Section 7(a)(2) of the Endangered Species Act states that each federal agency shall, in consultation with the Secretary, ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of ESA Critical Habitat for those species. The Endangered Species Act requires action agencies to consult or confer with the Services when

there is discretionary federal involvement or control over the action. When a federal agency's action "may affect" a protected species or its ESA Critical Habitat, that agency is required to consult with NOAA Fisheries or the U.S. Fish and Wildlife Service. Informal consultation with the Services is sufficient for actions that "may affect but are not likely to adversely affect" listed species or federally designated ESA Critical Habitats. This finding can be made only if all reasonably expected effects of the proposed action would be beneficial, insignificant, or discountable. An action agency shall confer with the Services if the action is likely to jeopardize the continued existence of a proposed species or result in the destruction or adverse modification of proposed ESA Critical Habitat. Formal consultation with the Services and preparation of a biological assessment are required for actions that "may affect and are likely to adversely affect" listed species or federally designated ESA Critical Habitats. An action agency shall confer with the Services if the action is likely to jeopardize the continued existence of a proposed species or result in the destruction or adverse modification of proposed ESA Critical Habitat.

Compliance: The Office for Coastal Management concluded that the federal action to designate the Green Bay National Estuarine Research Reserve would— in and of itself—have no effect on protected species or ESA Critical Habitat. The Green Bay Reserve is expected to have long-term, minor beneficial impacts on federally listed endangered or threatened species and ESA Critical Habitat by contributing to habitat enhancement, improving scientific knowledge associated with protected species, and encouraging the protection of federal- and state- listed species. However, future activities conducted under the Green Bay Reserve's Final Management Plan will be evaluated to assess their potential to adversely affect protected species and ESA Critical Habitat. ESA consultation with the U.S. Fish and Wildlife Service will occur whenever federally listed endangered or threatened species or ESA Critical Habitat may be or are likely to be adversely affected, consistent with procedures outlined in the ESA federal consultation regulations at 50 C.F.R. § 402.14.

Farmland Protection Policy Act

The Farmland Protection Policy Act (Pub. Law 98-98; 7 U.S.C. § 4201 *et seq*.) is intended to minimize the impact of federal programs on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that—to the extent possible—federal programs are administered to be compatible with state and local units of government and private programs and policies to protect farmland. Federal agencies are required to develop and review their policies and procedures to implement the Farmland Protection Policy Act every two years. The Farmland Protection Policy Act does not authorize the federal government to regulate the use of private or nonfederal land or, in any way, affect the property rights of owners. For purposes of the Farmland Protection Policy Act, farmland includes prime farmland, unique farmland, and land of statewide or local importance.

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would neither occur on farmland nor convert farmland to nonagricultural use. As such, no further compliance steps are planned at this time.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 U.S.C. § 661 et seq.) provides for interagency consultation, particularly consultation with the U.S. Fish and Wildlife Service and the appropriate state wildlife agency, when federal agencies plan to conduct activities involving the impoundment, diversion, deepening, control, or modification of a body of water for any purpose, with only two exceptions. Interagency consultation allows federal agencies to incorporate recommended conservation measures intended to reduce potential project impacts on fish, wildlife, and the aquatic and terrestrial plant species upon which those species depend.

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not affect the environment in ways regulated by the Fish and Wildlife Coordination Act. As such, no further compliance steps are planned at this time.

Migratory Bird Treaty Act and Executive Order 13186

The Migratory Bird Treaty Act (16 U.S.C. § 715 *et seq*.) implements the nation's commitment to bilateral treaties or conventions with Great Britain, Canada, Japan, Russia, and Mexico for the protection of shared migratory bird resources. The Migratory Bird Treaty Act makes unlawful for anyone to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird or any part, nest, or egg or any such bird, unless authorized under a permit issued by the Secretary of the Interior. The Migratory Bird Treaty Act also regulates scientific collection and possession of migratory birds for educational purposes. Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*, directs federal agencies taking actions that have or are likely to have a measurable negative effect on migratory bird populations to develop (within two years of the action) a memorandum of understanding with the U.S. Fish and Wildlife Service that promotes the conservation of migratory bird populations.

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay Reserve would not negatively affect any migratory bird. As such, no further compliance steps are planned at this time.

National Historic Preservation Act

The National Historic Preservation Act of 1966 (NHPA; 54 U.S.C. § 300101 *et seq*.) requires federal agencies to take into account the effects of their undertakings on historic properties in accordance with regulations issued by the Advisory Council on Historic Preservation at 36 C.F.R. § 800. The regulations require that federal agencies consult with states, Tribes, and other interested parties (consulting parties) when making their effects determinations. The regulations establish four basic steps in the NHPA 106 process: (1) determine if the undertaking is the type of activity that could affect historic properties, (2) identify historic properties in the area of potential effects, (3) assess potential adverse effects, and (4) resolve adverse effects.

Compliance: NOAA's Office for Coastal Management will complete an analysis of potential effects to historic properties as a result of designating the Green Bay National Estuarine Research Reserve and consult with the Wisconsin State Historic Preservation Office and Tribal nations, as appropriate, pursuant to Section 106 of the National Historic Preservation Act. Should the reserve be designated, the Office for Coastal Management will make determinations for individual, specific actions as to NHPA Section 106 compliance and potential consultations prior to providing subsequent funding for future activities under the Green Bay Reserve's final management plan.

National Marine Sanctuaries Act

Under the National Marine Sanctuaries Act (16 U.S.C. § 1431 *et seq*.), federal agency actions, internal or external to a national marine sanctuary, including private activities authorized by licenses, leases, or permits, that are likely to destroy, cause the loss of, or injure any sanctuary resource are subject to consultation with the Secretary of Commerce. Each federal agency proposing such an action must provide a written statement describing the action and its potential effects on sanctuary resources no later than 45 days before the final approval of the action. In addition, sanctuary permits may be required for certain actions that would otherwise be prohibited.

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not adversely affect any sanctuary resources. As such, no further compliance steps are planned at this time.

Rivers and Harbors Act

The Rivers and Harbors Act of 1899 (33 U.S.C. § 401 *et seq*.) regulates development and use of the nation's navigable waterways. Section 10 of the Rivers and Harbors Act (33 U.S.C. § 403) prohibits the unauthorized obstruction or alteration of any navigable waters of the United States. This section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters, is unlawful unless authorized by the U.S. Army Corps of Engineers. Activities requiring Section 10 permits include the construction of structures (e.g., piers, wharfs, breakwaters, bulkheads, jetties, weirs, transmission lines) and work involving dredging, disposal of dredged material, excavation, filling, or other modifications to navigable waters of the United States. Approval is required prior to permanent or temporary actions that build upon, alter, improve, move, or occupy or otherwise could affect an authorized USACE Civil Works project (33 U.S.C. § 408).

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not obstruct or alter navigable waters. As such, no further compliance steps are planned at this time.

Executive Order 11988 – Floodplain Management

Executive Order 11988 (Floodplain Management) requires federal agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of floodplains.

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve did not have the potential to affect floodplains or occupants therein nor would the action's purpose be harmed by being in a floodplain. As such, no further compliance steps are planned at this time.

Executive Order 11990 – Protection of Wetlands

Executive Order 11990 (Protection of Wetlands) requires federal agencies to avoid, to the extent possible, adverse impacts associated with occupying or modifying floodplains and wetlands and avoid floodplain or wetland development whenever there is a practical alternative.

Compliance: As part of the NEPA process, the Office for Coastal Management evaluated impacts to wetlands resulting from Green Bay National Estuarine Research Reserve designation. To comply with the executive order, the office conducted a public review and notice aimed at minimizing and avoiding impacts, as well as restoring and preserving the natural and beneficial values of wetlands. The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not have the potential to affect wetlands. As such, no further compliance steps are planned at this time.

Executive Order 13112 – Invasive Species

Executive Order 13112 (Invasive Species) prevents the introduction of invasive species; responds to and controls invasions in a cost-effective and environmentally sound manner to minimize economic, ecological, and human health implications; and provides for restoration of native species and habitat conditions in ecosystems that have been invaded. See also Executive Order 13751 (Safeguarding the Nation from the Impacts of Invasive Species; December 2016).

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not introduce invasive species nor serve to spread those species present in the action area. As such, no further compliance steps are planned at this time.

Executive Order 13158 – Marine Protected Areas

Executive Order 13158 (Marine Protected Areas) requires federal agencies to identify actions that affect natural or cultural resources that are within marine protected areas. It further requires federal agencies, in taking such actions, to avoid harm to the natural and cultural resources that are protected by marine protected areas.

Compliance: The Office for Coastal Management determined that the act of designating the Green Bay National Estuarine Research Reserve would not harm any marine protected area resources. As such, no further compliance steps are planned at this time.

Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments

Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments) requires federal agencies to establish procedures for meaningful consultation and coordination with Tribal officials in the development of federal policies that have tribal implications. NOAA implements Executive Order 13175 through the "NOAA 13175 Policy." Pursuant to the policy, NOAA offers affected federally recognized Tribes government-to-government consultation at the earliest practicable time that the government can reasonably anticipate that a proposed policy or initiative may have tribal implications. "Proposed policies" that may have tribal implications include regulations, legislative comments, proposed legislation, and other policy statements or actions. The policy provides guidance and procedures designed to ensure NOAA effectively and consistently conducts required government-to-government consultations with federally recognized Tribes. If a proposed action may have tribal implications, the office proposing the action should, at the earliest time practicable, review the NOAA 13175 Policy to determine whether tribal consultation should be initiated.

Compliance: Per Executive Order 13175, NOAA's Office for Coastal Management sent letters to the applicable federally recognized and state-recognized Tribes. These letters invited Tribes to formally engage in tribal consultations regarding the draft environmental impact statement and draft management plan for the proposed Green Bay National Estuarine Research Reserve and provide engagement opportunities on the proposed designation.

Appendix 6: Habitat Classification Scheme Used by the State of Wisconsin for the Proposed Green Bay Reserve

Understanding the habitat of the proposed boundaries is important. To derive habitat area estimates for the proposed Green Bay National Estuarine Research Reserve, four habitat layers were used by the Wisconsin Department of Natural Resources (DNR):

1) Open Waters of Estuary within Components – Clip the area of the Adjusted Estuary to include only areas within the proposed components. These data comprise the largest area classified as "open water" for habitat characterization.
2) Wetlands in Components – Clip the Wisconsin DNR Wetlands Inventory layer (WWI) with the components layer; then, erase the Open Waters of the Estuary area. The "Wetland Class" field was used to characterize habitat in areas covered by this layer. Note: This layer also includes areas classified as open water, and these areas are included in the "open water" habitat total.
3) Other Open Waters – Start with the Wisconsin DNR Lakes and Open Waters layer. Clip to include only areas in the components; then, erase any area included in the Wetlands in Component layer. The area remaining in this layer are also included in the "open water" habitat total.
4) WISCLAND (Wisconsin DNR land cover and land use data) – Where gaps remained (i.e., in the components where habitat wasn't characterized by the previous three layers), WISCLAND was used to fill those gaps. To fill the gaps using only WISCLAND data, the data were (a) clipped to each component and (b) erased in areas already covered by the three previous layers. WISCLAND provides data across four classification levels. Level 2 was used for characterizing habitat as it provides useful differentiation of habitat types while maintaining a reasonably high level of classification confidence. Learn more about and view WISCLAND data at *https://dnr.wisconsin.gov/maps/WISCLAND*.

A map of the four habitat layers can be viewed at *https://arcg.is/1aerTD0*.

One challenge in classifying habitat for the proposed components is resolving inconsistencies between the WISCLAND and Wisconsin Wetlands Inventory classification schemes. In most cases, WISCLAND classes were used for the resolved habitat classes. The following adjustments were made to resolve these classification differences:

- The Wisconsin Wetlands Inventory allows for "modifiers" within a primary wetland class field. For example, the class—in some cases—is simply "Emergent/wet meadow," while other polygons are classed as "Emergent/wet meadow," Flats/unvegetated wet soil," "Emergent/wet meadow," "Open Water," or other values. The "dominant" wetland type was used as the characterization for these polygons, meaning all three examples are characterized as "Emergent/wet meadow." WISCLAND areas classed as "Emergent/wet meadow" were included in this WWI class.
- The Wisconsin Wetlands Inventory has a class called "Forested (palustrine)." WISCLAND does not have an equivalent class. This label was adopted as an additional class in the habitat scheme.
- Any WWI polygons with a dominant class of "Scrub/Shrub" were classed as "Scrub/Shrub." WISCLAND areas classed as "Lowland Scrub/Shrub" were also included in the WWI "Scrub/Shrub" class.