Appendix 9.5: Cat Island

Written by Erin Giese and Dr. James Horn

<table>
<tr><td>Location (centroid)</td><td>Lat. 44.566961°, Lon. -88.008842°[1] (NAD 1983, UTM Zone 16N)</td></tr>
<tr><td>Total Area (ha)</td><td>152.50 ha</td></tr>
<tr><td>Area Public Land (ha)</td><td>0 ha

The Cat Island Wave Barrier is currently owned by the Brown County Port and Recovery office in Green Bay, and the U.S. Army Corps of Engineers (USACE) is actively filling the reconstructed island “cells” with shipping channel dredge material. The USACE will continue to fill these “cells” over the next 20-30 years. Because it is an active construction site and because the recently placed dredge material can behave like quick sand, it is considered to be dangerous and poses a serious safety hazard. The causeway/wave barrier is gated and locked at two locations.

Therefore, there is no public access available at this time.</td></tr>
<tr><td>Area of Habitat Types Present (ha) and Percent of Each Habitat Type</td><td>Dominant Habitat Types: These habitat types were documented during a July 2015 habitat mapping effort led by the University of Wisconsin-Green Bay Cofrin Center for Biodiversity (CCB) across the Lower Green Bay and Fox River Area of Concern (LGB&FR AOC)[2]. Habitat types within Cat Island are displayed as a static map at the bottom of this document. There is a total of 132.30 ha of natural habitat within Cat Island.

<table>
<tr><th>Habitat Type</th><th>Area (ha)</th><th>Percent</th></tr>
<tr><td>Emergent Marsh (High Energy Coastal)</td><td>0.01</td><td>0.01</td></tr>
<tr><td>Great Lakes Beach</td><td>10.83</td><td>8.18</td></tr>
<tr><td>Green Bay Open Water</td><td>121.05</td><td>91.50</td></tr>
<tr><td>Submergent Marsh</td><td>0.42</td><td>0.32</td></tr>
</table>

Disclaimer! Because this priority area is located within the Great Lakes coastal zone, the amount of habitat types can vary drastically across years and even within years (or months) due to changing Great Lakes water levels, precipitation, and seiche. Within this priority area specifically, the amounts of all habitats listed above are known to fluctuate significantly from year to year and within years. Moreover, because the Cat Island Project is an active construction site with ever-changing dredge placement, the amount of Great Lakes beach in particular will vary greatly over time. The habitat types listed above and mapped below are based on a field effort conducted in July 2015. Plants recorded in the “Natural Habitat Communities and Significant Plants” section were primarily documented in July 2015 and late summer/fall of 2016 and 2017. Great Lakes water levels were much higher in 2016 and 2017 than in July 2015.</td></tr>
<tr><td>General Description</td><td>The Cat Island Wave Barrier is a ~4.5 km long causeway that extends into the open bay of Green Bay from Peters Marsh along the southern west shore. Off the causeway/wave barrier, are three artificial island “cells” with “legs” extending off the main road/causeway[3]. Historically, there were three large barrier islands (i.e., the Cat Island Chain) that provided critical fish and wildlife habitat for birds, fish, invertebrates, and furbearers and offered a protected refugium for native plants and extensive Great Lakes beach[3]. These islands were very popular to duck hunters as well[4]. Due to</td></tr>
</table>

[1] File “AOC_PriorityAreas_v09_USE_THIS.shp”
[2] LGB&FR AOC 2015 habitat field mapping effort
[3] Brown County Port and Resource Recovery Cat Island document: https://static1.squarespace.com/static/56ec0372859fd0e272858772/t/574db48fab48de7bc23597a0/1464710289702/2014+Cat+Island+Abstract+Spring.pdf
[4] Personal communication with Thomas Erdman on 13 January 2016

	extremely high water levels in the bay, massive storms, and hardened shorelines, these islands washed away during the spring of 1973 with the exception of a few small sandy islands, including parts of Cat Island[3,5]. The huge emergent and submergent marshes of the Duck Creek Delta complex also vanished because the islands no longer provided the much needed protection and because of high sediment loads further upstream[3,5]. In the 1980s, a group of local conservationists proposed the idea of reconstructing these three barrier islands and formalized the idea in the LGB&FR AOC's 1988 Remedial Action Plan[3]. It took decades of extensive planning and acquiring funding for that idea to materialize and become a reality[3,6]. They collaborated with Brown County, Brown County Port and Resource Recovery Office, and U.S. Army Corps of Engineers (USACE) and decided to reconstruct these islands. Over time, the Cat Island Wave Barrier and island "cells" were eventually constructed by May 2013[3]. Although the project will not be fully completed for another 20-30 years, many fish and wildlife have already been documented using the relatively new dredge material, which consists of sand and clay, in the westernmost island "cell," including the federally and state endangered shorebird, the Piping Plover (*Charadrius melodus*). Piping Plovers have not been recorded nesting in lower Green Bay in over 70 years and were only previously known to nest on Longtail Point and Little Tail Point[4]. This project site is also currently considered the best shorebird migratory stopover site in the entire state of Wisconsin. While the project is far from completion, it offers many unique opportunities for wildlife managers and researchers to explore adaptive management techniques, such as constructing tern nesting platforms, testing out different nesting substrate for Piping Plovers, and restoring native submergent and emergent plants in the shadow of the wave barrier[7]. Many research projects are currently taking place as scientists and managers explore the re-establishment of submergent and aquatic plants and the responses of fish and wildlife. This project provides an excellent example of conservationists and resource managers working together to solve problems and achieve success through collaboration, communication, and identifying common ground.
Special Features	• Contains a significant amount of Great Lakes beach habitat, which is rare to both the state of WI and the LGB&FR AOC. • Provides the submergent and emergent marshes of the Duck Creek Delta and Peters Marsh wetland complexes with protection from wave action. • Provides breeding habitat for many colonial nesting birds, including American White Pelican (*Pelecanus erythrorhynchos*), Double-crested Cormorant (*Phalacrocorax auritus*), Caspian Tern (*Hydroprogne caspia*), Common Tern (*Sterna hirundo*), Herring Gull (*Larus smithsonianus*), Ring-billed Gull (*Larus delawarensis*), herons/egrets, and the federally and state endangered Piping Plover (*Charadrius melodus*). • Open water surrounding the Cat Island Wave Barrier provides habitat for many fish species. • Provides migratory shorebird habitat and is currently considered to be the most critical shorebird migratory stopover site in Wisconsin[8]. • Offers important migratory stopover habitat for waterfowl and staging habitat for swallows and blackbirds on the Great Lakes beach habitat[9]. • Provides wintering bird habitat to Snowy Owls, Snow Buntings (*Plectrophenax nivalis*), and some waterfowl.
Natural Habitat Communities and	There is nearly 11 ha of **Great Lakes beach habitat** within the boundaries of this priority area found both in the existing historic Cat Island as well as the recently

[5] Frieswyk and Zedler 2007: "Vegetation change in Great Lakes coastal wetlands: deviation from the historical cycle"
[6] U.S. Dept. of the Interior Article: https://www.doi.gov/restoration/restoring-cat-island-chain-green-bay-wisconsin
[7] UW-Sea Grant Webpage: http://www.seagrant.wisc.edu/home/Portals/0/Files/Habitats%20and%20Ecosystems/CatIslandsRept.pdf
[8] Shorebird master's project by UW-Green Bay graduate student, Tom Prestby (2016)
[9] AOC Waterfowl Surveys in 2016-2017; surveys conducted by Tom Prestby

Significant Plants (ordered in terms of ecological importance and size/amount)	deposited dredge material. The existing Cat Island that sits inside the easternmost artificial "cell" is covered almost entirely by sand with little to no vegetation and has a small pond in the southwestern corner of the island. Due to the thousands of breeding American White Pelicans and Double-crested Cormorants, which produce significant amounts of guano, very few plants can thrive on this island. In contrast, parts of the westernmost "cell," which has relatively new dredge material that is largely sand, are heavily vegetated. Cottonwood (*Populus deltoides*) saplings have taken over the western and southwestern most parts of this "cell," though a diversity of other vascular plants—65 species total, including 45 native species—were also found there in a 2017 survey, including the following native species: • American sea-rocket (*Cakile edentula* ssp. *edentula* var. *lacustris*) • Dock-leaved smartweed (*Persicaria lapathifolia*) • Swamp milkweed (*Asclepias incarnata*) • Common milkweed (*Asclepias syriaca*) • Blue vervain (*Verbena hastata*) • Common yellow-cress (*Rorippa palustris*) • Common bur-reed (*Sparganium eurycarpum*) • Common water-parsnip (*Sium suave*) • Cypress-like sedge (*Carex pseudocyperus*) Throughout the rest of this priority area is a large amount of **open water**, since this is an active, ongoing project of placing dredge material, with pockets of **submergent** and **emergent marsh**.

Significant Animals	**Birds**:
	• 233 bird species have been recorded along the Cat Island Causeway and neighboring areas, including[10]:
	  ○ One federally endangered species (Piping Plover)
	  ○ One federally threatened species (Red Knot [*Calidris canutus*])
	  ○ Two federally listed species of concern (Black Tern [*Chlidonias niger*] and Common Tern [*Sterna hirundo*])
	  ○ Seven state endangered species:
	  ▪ Black Tern, Common Tern, Caspian Tern (*Hydroprogne caspia*), Forster's Tern (*Sterna forsteri*), Peregrine Falcon (*Falco peregrinus*), Piping Plover, and Red-necked Grebe (*Podiceps grisegena*)
	  ○ Two state threatened species (Great Egret [*Ardea alba*] and Upland Sandpiper [*Bartramia longicauda*])
	  ○ 44 state listed special concern species (e.g., American White Pelican, Buff-breasted Sandpiper [*Tryngites subruficollis*], Yellow-headed Blackbird [*Xanthocephalus xanthocephalus*], Ruddy Duck [*Oxyura jamaicensis*])
	  ○ Nine International Union for Conservation of Nature-listed species as vulnerable (e.g., Long-tailed Duck [*Clangula hyemalis*]) or near threatened (e.g., Semipalmated Sandpiper [*Calidris pusilla*])
	  ○ 39 Wisconsin Wildlife Action Plan Species of Greatest Concern (e.g., Wilson's Phalarope [*Phalaropus tricolor*])
	  ○ 33 species listed under the Partners in Flight priorities from Bird Conservation Regions 12 and 23 and Continental Watch List species
	  ○ Seven species listed as regional priorities from the North American Waterfowl Management Plan
	  ○ Several species are currently known to breed at this priority area, including[11,12]:
	  ▪ American White Pelican

[10] LGB&FR AOC comprehensive biota database: file "AOCBiota_DB_ShareableVersion_20171210.accdb"
[11] Wisconsin Breeding Bird Atlas II Project: https://wsobirds.org/atlas
[12] Personal communication with Thomas Prestby

	▪ Double-crested Cormorant ▪ Ring-billed Gull ▪ Herring Gull ▪ Caspian Tern ▪ Common Tern (only on artificial nesting platforms) ▪ Forster's Tern (only on artificial nesting platforms) ▪ Piping Plover ▪ Black-crowned Night-Heron (*Nycticorax nycticorax*) ▪ Spotted Sandpiper (*Actitis macularius*) ▪ Killdeer (*Charadrius vociferus*) o The waters surrounding the Cat Island Wave Barrier are also used by thousands of staging waterfowl during spring and fall migration[9] o Swallows use the open Great Lakes beach habitat and causeway for foraging and staging habitat shortly after the breeding season and during migration o >30 shorebird species use the open mud flats and edges of the causeway for foraging and stopover habitat[8] **Fish**: • Although >80 fish species have been recorded in the pelagic zone of the lower bay, some of which may use areas near Cat Island, only a few official records are available at this time. Species that use the bay, include[10]: o One federally endangered species: chinook salmon (*Oncorhynchus tshawytscha*) o Three state special concern species, including: American eel (*Anguilla rostrata*), banded killifish (*Fundulus diaphanus*), and lake sturgeon (*Acipenser fulvescens*) o One International Union for Conservation of Nature-listed species as vulnerable (bloater [*Coregonus hoyi*]) and one as endangered (American eel) o Two globally list species (G3 = vulnerable): redside dace (*Clinostomus elongatus*) and lake sturgeon (*Acipenser fulvescens*) **Mammals**: • Within the past two years, coyote (*Canis latrans*), red fox (*Vulpes vulpes*), and muskrat (*Ondatra zibethicus*) have been seen along the Cat Island Wave Barrier and neighboring waters. American mink (*Neovison vison*) has been found ~100 m north of the second locked, gate[10,12]. **Anurans**: • Five anuran (frog/toad) species have been recorded[10]: o American toad (*Bufo americanus*), eastern gray treefrog (*Hyla versicolor*), northern leopard frog (*Lithobates pipiens*), spring peeper (*Pseudacris crucifer*), and American bullfrog (*Lithobates catesbeianus*) o Northern leopard frog is both a federal and state species of special concern. American bullfrog is a state species of special concern **Mollusks**: • A few snails have been reported at Cat Island from the following taxonomic groups[10]: o Genus: *Fossaria*, *Promenetus*, *Pseudosuccinea*, and *Stagnicola* o Family: Lymnaeidae, Physidae, and Planorbidae **Arthropods**: • Several insects have been recorded using the Cat Island Wave Barrier and neighboring areas, including[10]: o Hairy-necked tiger beetle (*Cicindela hirticollis rhodensis*), which is state endangered

	○ Slender spreadwing (*Lestes rectangularis*) ○ Lance-tipped darner (*Aeshna constricta*) ○ White-faced meadowhawk (*Sympetrum obtrusum*) ○ Familiar bluet (*Enallagma civile*) ○ Common green darner (*Anax junius*) ○ Beetles of families Hydrophilidae and Dytiscidae **Diatoms**: • Over 80 species of diatoms have been found near this priority area[10]
Habitat Quality	Overall, the ecological quality of the Great Lakes beach habitat is relatively low. While native plants have colonized the westernmost "cell" in the newly placed dredge material, cottonwood has rapidly taken over large stretches of this beach. Regular management is needed to handle both the cottonwood as well as other invasives that have been reported here, such as the common reed (*Phragmites australis*) and hybrid cattail (*Typha* × *glauca*).
Significant Invasive Species Issues	**Invasive Plant Species**: Of the 65 vascular plant species documented in a 2017 survey, 20 are introduced (not native), including several species with strong invasive potential. Each of the following species outcompetes and crowds out native plants[10]: • Common reed (*Phragmites australis*) • Hybrid cattail (*Typha* × *glauca*) • Purple loosestrife (*Lythrum salicaria*) • Common mouse-ear chickweed (*Cerastium fontanum*) • Narrowleaf hawk's-beard (*Crepis tectorum*) • Prickly sow-thistle (*Sonchus asper*) • Small peppergrass (*Lepidium densiflorum*) • White poplar (*Populus alba*) **Other Plant Issues**: Cottonwood saplings and other early successional species have taken over the western and southwestern most parts of this "cell," thus preventing other more desirable Great Lakes beach plants, such as American sea-rocket, from establishing. **Invasive Animal Species**: • *Birds*: Although five invasive birds have been reported at or near this priority area, these species pose little to no threat to native birds nesting along the Cat Island Wave Barrier since a completely different native group of birds nest there. These invasives are also closely associated with humans near development or agricultural areas[10]. No management is needed. ○ European Starling (*Sturnus vulgaris*) ○ House Sparrow (*Passer domesticus*) ○ Mute Swan (*Cygnus olor*), it is possible that they may destroy submerged aquatic plants ○ Ring-necked Pheasant (*Phasianus colchicus*) ○ Rock Pigeon (*Columba livia*) • *Fish*: Recorded in the pelagic zone of the lower bay[10]. ○ Alewife (*Alosa pseudoharengus*)[13] ▪ Poses a threat to native fish species by consuming zooplankton and disturbing the natural food web; not currently being managed. ○ Common carp (*Cyprinus carpio*)[14]

[13] Fuller, P., E. Maynard, D. Raikow, J. Larson, A. Fusaro, and M. Neilson. 2016. *Alosa pseudoharengus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=490 Revision Date: 9/25/2015. Accessed 17 Oct 2016.

[14] Nico, L., E. Maynard, P.J. Schofield, M. Cannister, J. Larson, A. Fusaro, and M. Neilson. 2016. *Cyprinus carpio*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=4 Revision Date: 7/15/2015. Accessed 17 Oct 2016.

	▪ Destroy vegetation by uprooting plants and increasing cloudiness of water; not currently being managed. ○ Rainbow smelt (*Osmerus mordax*)[15] ▪ Negatively affect uncommon to rare native fish species; not currently being managed. ○ Round goby (*Neogobius melanostomus*)[16] ▪ Prey on small native fish and eggs (e.g., darters) and outcompete similarly sized native fish; not currently being managed. ○ White perch (*Morone americana*)[17] ▪ Prey on native fish eggs, such as walleye; not currently being managed.
Management and Restoration Recommendations	• Develop and implement Cat Island Habitat and Wildlife Management Plan that addresses invasive plant species control (including native cottonwood), strategic placement of dredge material, public access restrictions, predator control, shoreline management, etc. • Construct and maintain permanent island structures for nesting colonial waterbirds, especially endangered terns. • Maintain large stretches of undisturbed Great Lakes beach habitat for disturbance-prone nesting Piping Plovers. • Continue exploring the restoration of aquatic and submergent plants in the wave shadow of the Cat Island Wave Barrier. • Conduct biotic inventories along AOC shoreline and if necessary re-establish populations of native turtle species and other beach specialists. • Develop or restore important fish spawning and nursery habitats, such as rocky reefs, gravel, cobble, woody debris, and sandy areas for shoreline fish. • Designate Cat Island as a sensitive coastal landscape. • Identify and protect safe roosting areas for wintering Snowy Owls, Snow Buntings, Bald Eagles, and others. • Create and manage intermittently flooded shoreline habitat for shorebirds on Green Bay islands and shoals. • Locate and protect heron rookeries; inform land managers and provide guidance for protection measures. • Place woody debris for fish habitat.
Reference Links and Documents	**Links**: • For more information on the Cat Island Project, please visit the following webpages: ○ Port of Green Bay website: http://www.portofgreenbay.com/cat-island-restoration-project/ ○ Abstract: https://static1.squarespace.com/static/56ec0372859fd0e272858772/t/574db48fab48de7bc23597a0/1464710289702/2014+Cat+Island+Abstract+Spring.pdf ○ Management Plan: https://static1.squarespace.com/static/56ec0372859fd0e272858772/t/574db4bc2eeb819c6640ce16/1464710333514/Final+Draft+Cat+Island+Management+Plan.pdf

[15] Fuller, P., E. Maynard, J. Larson, A. Fusaro, T.H. Makled, and M. Neilson. 2016. *Osmerus mordax*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=796 Revision Date: 9/29/2015. Accessed on 17 Oct 2016.

[16] Fuller, P., A. Benson, E. Maynard, M. Neilson, J. Larson, and A. Fusaro. 2016. *Neogobius melanostomus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=713 Revision Date: 1/7/2016. Accessed on 17 Oct 2016.

[17] Fuller, P., E. Maynard, D. Raikow, J. Larson, A. Fusaro, and M. Neilson. 2016. *Morone americana*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=777 Revision Date: 1/15/2016. Accessed on 17 Oct 2016.

	○ Operation and Maintenance Manual: https://static1.squarespace.com/static/56ec0372859fd0e272858772/t/574db456ab48de7bc23594f0/1464710259772/Cat+Island+O+and+M+Manual+Draft.pdf • 1845 Map of Green Bay, which shows the historic barrier islands: http://s3.amazonaws.com/labaye/data/1845%20Head%20Of%20Green%20Bay.pdf • 1938 and 1960 Aerial Imagery provided by the Brown County GIS Department: http://maps.gis.co.brown.wi.us/geoprime/#xmin=73606.12499999994;ymax=599938.75;ymin=573456.25;xmax=130984.87499999994 **Reference Documents**: • Bosley, T.R. 1978. Loss of wetlands on the west shore of Green Bay. Wisconsin Academy of Sciences, Arts, and Letters 66:235-245. • Dorney, J.R. 1975 The vegetation pattern around Green Bay in the 1840s as related to geology, soils, and land use by Indians with a detailed look at the Townships of Scott, Green Bay, and Suamico. Book available through the UW-Green Bay Cofrin Library Archives and Area Research Center. • Frieswyk, C.B. and J.B. Zedler. 2007. Vegetation change in Great Lakes coastal wetlands: deviation from the historical cycle. Journal of Great Lakes Research 33(2):366-380. • Howlett Jr., G.F. 1974. The rooted vegetation of west Green Bay with reference to environmental change. Master's thesis. University of Wisconsin-Green Bay. • Kupsky, B. and M. Dornbush. 2017. Cat Island and Duck Creek Delta Restoration: Restoring Green Bay Aquatic Vegetation Final Report. Final report submitted to Ducks Unlimited in January 2017. • U.S. Army Corps of Engineers. 2010. Environmental Assessment: Dredged Material Management Plan, Green Bay Harbor, Wisconsin.
Site History (e.g., original vegetation, past conservation projects)	In the early 1630s, Frenchman Jean Nicolet first arrived in lower Green Bay when it was primarily inhabited by Native American tribes[18]. Between the late 1600s and 1800s, European fur trade, duck hunting, fishing, logging, shipping, and agriculture were important early industries in lower Green Bay[19,20,21]. In the early 1800s, there were a few small settlements and farms of Europeans and Native Americans in the lower Bay[20]. Historically, there were three large barrier islands (called the Cat Island Chain) that provided critical fish and wildlife habitat for birds, fish, invertebrates, and mammals as well as refugia of native plants and extensive Great Lakes beach[3]. The most common waterfowl that historically bred in Green Bay included Blue-winged Teal (*Anas discors*), Pied-billed Grebe (*Podilymbus podiceps*), Gadwall, and Mallard (personal communication with Tom Erdman). Many different bird species nested on the islands of the Cat Island Chain, including Common Tern, Herring Gull, Ring-billed Gull, Black-crowned Night-Heron, Snowy Egret (*Egretta thula*), Cattle Egret (*Bubulcus ibis*), Gadwall (*Anas strepera*), Spotted Sandpiper, Mallard (*Anas platyrhynchos*), and Canada Goose (*Branta canadensis*; field notes from Tom Erdman, 1 June 1969 and 1995 video). Like other parts of the lower bay, the center of this barrier island chain was also used for dumping dredge spoils, as noted in the U.S. Army Corps of Engineers map from 1966[27], a relatively common practice prior to environmental laws requiring dredge spoils to be dumped in confined areas. These islands also protected a massive complex of emergent and submergent marshes in the Duck Creek Delta,

[18] Jean Nicolet: French Explorer. By The Editors of Encyclopaedia Britannica. Available: https://www.britannica.com/biography/Jean-Nicolet (accessed on 24 Oct 2016).
[19] City of Green Bay's History Webpage: http://www.ci.green-bay.wi.us/history/1800s.html (accessed on 20 Oct 2016).
[20] Excerpt from "Recollections of Green Bay in 1816-17" by James W. Biddle. Available: http://s3.amazonaws.com/labaye/data/Recollections %20of%20Green%20Bay%20in%201816-1817.pdf (accessed on 24 Oct 2016).
[21] The Early Outposts of Wisconsin: Green Bay for Two-Hundred Years, 1639-1839. Available: http://labaye.org/item/70/2810 (accessed on 25 Oct 2016).

	including Peters Marsh. The true size and extent of the marsh complex that the Cat Island Chain protected can best be appreciated by looking at 1938 and 1960 aerial imagery (provided by Brown County's online GIS portal)[22]. Overall, lower Green Bay consisted of large beds of wild rice (*Zizania* sp.) and wild celery (*Vallisneria americana*), extensive emergent marsh (*Schoenoplectus* sp., cattail), meadows, sedge meadows (*Calamagrostis canadensis*), shrub carr (e.g., *Cornus* spp., *Salix* spp.), swamps, and wet conifer forest (black spruce [*Picea mariana*], balsam fir [*Abies balsamea*])[23,24,25,26,27,28]. However, due to extremely high water levels in the bay, massive storms, and recently hardened shorelines (e.g., development), these islands washed away during the spring of 1973 with the exception of a few small sandy islands, including Cat Island[3,29]. The huge emergent and submergent marshes of the Duck Creek Delta complex also vanished because the islands no longer provided the much needed protection and due to high sediment loads further upstream[3,5]. These significant changes can easily be viewed on Brown County's 1978 aerial imagery of lower Green Bay[22]. Despite the high water and storms, remnants of Cat Island and a few other tiny islands persisted and are still present today. In the 1980s, a group of local conservationists proposed the idea of reconstructing these three barrier islands and formalized the idea in the LGB&FR AOC's 1988 Remedial Action Plan[3]. It took decades for that idea to materialize and became a reality, but it finally happened[3]. Conservationists collaborated with Brown County, Brown County Port and Resource Recovery Office, and U.S. Army Corps of Engineers (USACE) and decided to reconstruct these islands on the basis of three primary reasons[3]. Two reasons were to restore the obvious loss of island fish and wildlife habitat but also provide adequate protection from wave action in order to improve growing conditions for aquatic and submergent plants[3]. The third purpose was because the Port of Green Bay needed more storage for dredge material from the shipping channel dredging effort, and the cells from the causeway provided just that[3]. Over time, the Cat Island Wave Barrier and island "cells" were eventually constructed by May 2013 thanks to a $1.5 million initial funding opportunity through the Great Lakes Restoration Initiative[3,6]. Besides the USACE and Port of Green Bay, many partners have been involved in this project, including Brown County, Wisconsin Department of Natural Resources (WDNR), U.S. Fish and Wildlife Service (FWS), UW-Sea Grant, UW-Green Bay, Lower Fox River/Green Bay Natural Resources Trustee Council, and many port terminal operators[3]. So far, a relatively large amount of dredge material has been placed in the westernmost "cell" off the causeway though some material has also been placed in the middle cell. Although the project will not be fully completed for another 20-30 years, many fish and wildlife have already been documented using the relatively new dredge material, which

[22] Brown County's Online GIS Portal: http://maps.gis.co.brown.wi.us/geoprime/#xmin=85453.16361768021;ymax=592329.2851743905;ymin=578954.2851743905;xmax=114432.33028434687

[23] Arthur C. Neville's Map of Historic Sites on Green Bay, Wisconsin 1669-1689. Available: http://s3.amazonaws.com/labaye/data/Bay%20Settle ment%20Map%20WI%20Historical%20Bulletin%201926.pdf (accessed on 24 Oct 2016).

[24] Survey of the N.W. Lakes: East Shore of Green Bay 1843. Available: http://s3.amazonaws.com/labaye/data/1843%20East%20Shore%20of %20Green%20Bay.jpg (accessed on 24 Oct 2016).

[25] 1845 Chart of Green Bay. Available http://s3.amazonaws.com/labaye/data/1845%20Chart%20of%20Green%20Bay.pdf (accessed on 24 Oct 2016).

[26] 1820s Fox River Military Road Map to Ft. Crawford. Available: http://s3.amazonaws.com/labaye/data/1820s%20Fox%20River%20Military%20 Road%20Map%20to%20Ft.%20Crawford.pdf (accessed on 24 Oct 2016).

[27] Personal communication with Thomas Erdman.

[28] 1845 Map of western lower Green Bay. Available: http://browncounty.maps.arcgis.com/apps/StorytellingSwipe/index.html?appid=72615351ef33434e9a6a1bb5fffdbe9c&webmap=02074b6abfc44b88bfe9e96afe90a014 (accessed on 28 Oct 2016).

[29] Frieswyk and Zedler 2007: "Vegetation change in Great Lakes coastal wetlands: deviation from the historical cycle"

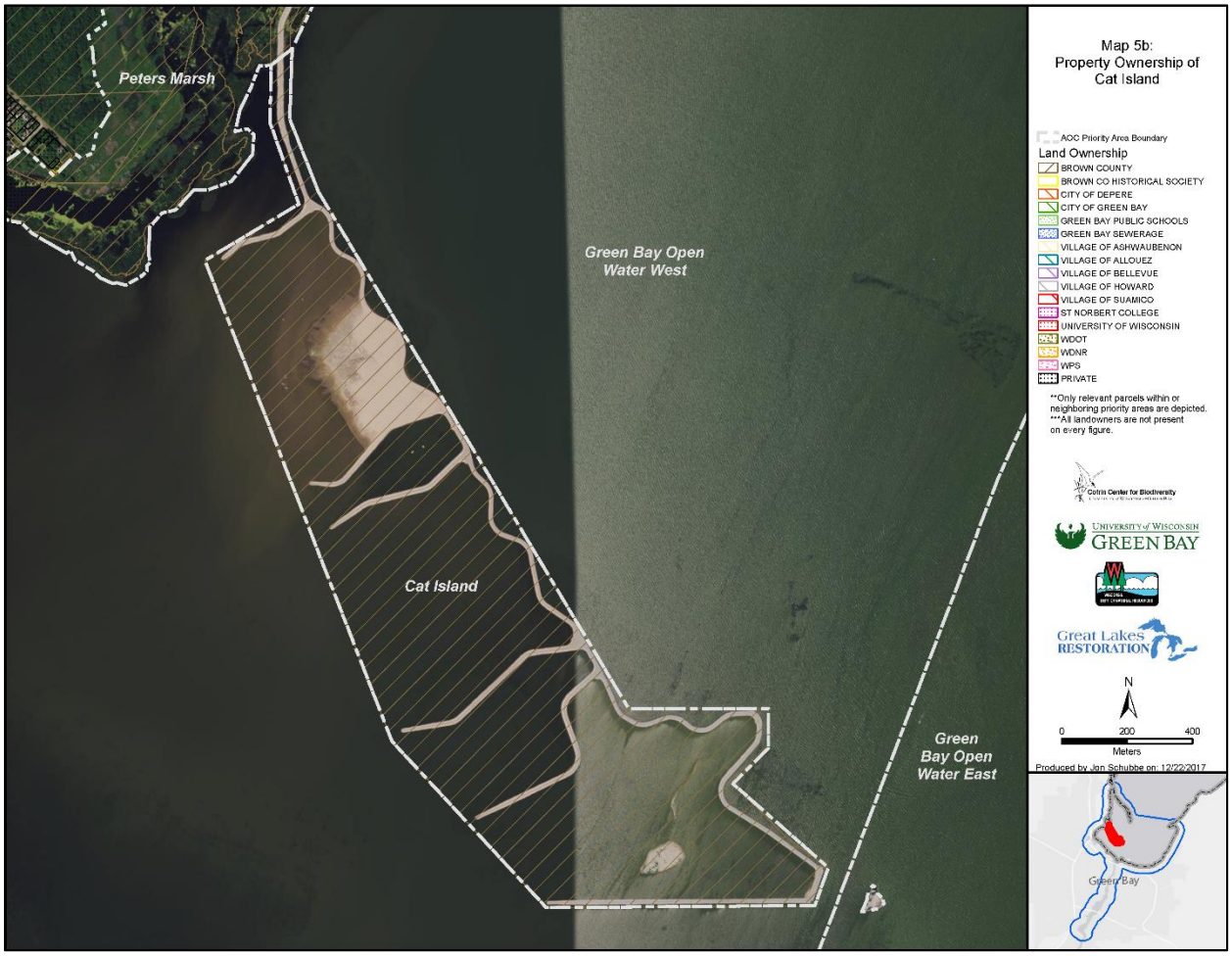
	consists of sand and clay, in the westernmost island "cell," including the federally and state endangered shorebird, the Piping Plover. Piping Plover has not been recorded nesting in lower Green Bay in over 70 years. One pair fledged four chicks from the westernmost "cell" in 2016, and four pairs nested in 2017. The FWS and WDNR organized Piping Plover nesting monitoring throughout the breeding season and enlisted many volunteers. This project site is also currently considered the best migratory shorebird stopover site in the entire state of Wisconsin with reports of >30 different shorebird species. Many diving and dabbling ducks and other waterfowl utilized the neighboring waters during migration[9]. While the project is far from completion, it offers many unique opportunities for wildlife managers and researchers to study changes and explore adaptive management techniques, such as constructing tern nesting platforms, testing out different nesting substrate for Piping Plovers, restoring native submergent and emergent plants in the shadow of the wave barrier, and possibly building fish reefs[30]. Within the past few years, the FWS, WDNR, UW-Green Bay, and others have been meeting to discuss long-term habitat and wildlife management plans, such as building permanent tern nesting structures, Piping Plover protection and predator management, vegetation management (i.e., control invasives and cottonwood), and other topics. A couple of times a year, the Cat Island Advisory Committee (CIAC) meets to discuss dredging updates, wildlife protection, research, and other topics with the USACE, Brown County, and others. The meetings are organized by Mark Walter and Dean Haen from Brown County, and so far the CIAC has written and published a public access document as well as a general management plan[31]. While dredge material has been placed in two of the three "cells," the material is by no means permanent. The backsides of the "cells" are currently open, which can cause the material to settle and move within the "cell" walls. The USACE will also need to move the material around over time. However, conservationists are working with the USACE on exploring different options for better containing the dredge material. The long-term vision of this project in terms of restoration is for each "cell" to have upland Great Lakes beach habitat that grades downwards toward the water shifting to emergent and submergent marshes. With the past several years, several research projects have taken place on the Cat Island Wave Barrier as well as in the wave shadow within the Duck Creek Delta. • Study on water quality, seed bank, and hard-stem bulrush (*Schoenoplectus acutus*) plantings in front of and behind the Cat Island Wave Barrier in 2013 by UW-Green Bay graduate student Tim Flood; major advisor: Dr. Patrick Robinson. • Aquatic plant restoration project (2015-2016) in Peters Marsh just inside the Cat Island Wave Barrier by UW-Green Bay graduate student Brianna Kupsky; major advisor: Dr. Mathew Dornbush. • The FWS coordinates an early detection and monitoring program of aquatic invasive species in Lake Michigan, and many of their sampling locations are in the LGB&FR AOC, including this priority area[32]. They survey for ichthyoplankton, carp, macroinvertebrates, and nearshore fishes[32]. • Baseline shorebird study (2013-2014) in lower Green Bay, including sites on the Cat Island Wave Barrier, by UW-Green Bay graduate student, Tom Prestby; major advisor: Dr. Robert Howe. • Establishing wild rice in the bay of Green Bay (2017-2018), including seeding in Peters Marsh; project led by Dr. Amy Carrozzino-Lyon (UW-Green Bay), Dr.

[30] UW-Sea Grant Webpage: http://www.seagrant.wisc.edu/home/Portals/0/Files/Habitats%20and%20Ecosystems/CatIslandsRept.pdf
[31] Cat Island Management Plan: https://static1.squarespace.com/static/56ec0372859fd0e272858772/t/574db4bc2eeb819c6640ce16/1464710333514/Final+Draft+Cat+Island+Management+Plan.pdf
[32] Green Bay Fish Working Group Annual Meetings on 4 January 2017

	Patrick Robinson (UW-Green Bay), Dr. Mathew Dornbush (UW-Green Bay), and Brian Glenzinski (Ducks Unlimited). • Migratory waterfowl surveys in the LGB&FR AOC, including sites on the Cat Island Wave Barrier[9]; surveys conducted by Tom Prestby; project leads: Dr. Robert Howe, Dr. Amy Wolf, and Erin Giese. • Marshbird and anuran surveys on the Cat Island Wave Barrier and Peters Marsh for the Great Lakes Coastal Wetland Monitoring Program; Dr. Robert Howe (Principal Investigator) and Erin Giese (Project Coordinator). • NEW Water collects water quality monitoring data from a station just off the easternmost "cell" next to the shipping channel. Over the next 20-30 years, new research, adaptive management, and collaborations with Brown County and the USACE will likely bring exciting new conservation opportunities and the chance to create greatly needed fish and wildlife habitat within the LGB&FR AOC.

Map of Cat Island plant communities, which are delineated based on the UW-Green Bay 2015 habitat mapping effort and 2017 submerged aquatic vegetation surveys. Map made by UW-Green Bay's Jon Schubbe.

Land ownership boundaries at Cat Island. Map made by UW-Green Bay's Jon Schubbe.



Photograph of the Cat Island Wave Barrier facing southwest towards the mouth of Duck Creek. Photograph taken by Erin Giese on 2 December 2016.

Photograph of the Cat Island Wave Barrier facing southwest, featuring the westernmost cell, which has been filled with sandy dredge material within the last few years. Photograph taken by Erin Giese on 2 December 2016.

Photograph of the Cat Island Wave Barrier facing southwest, featuring the middle “cell,” which was recently filled with dredge material and historic Cat Island in the upper left. Photograph taken by Erin Giese on 2 December 2016.

Photograph of the original Cat Island inside the easternmost “cell” of the Cat Island Wave Barrier facing east. Photograph taken by Erin Giese on 2 December 2016.

Photograph of Lone Tree Island, which is located east of the Cat Island Wave Barrier. The shipping channel is located in between the easternmost “cell” of the Cat Island Wave Barrier and Lone Tree Island. Photograph taken by Erin Giese on 2 December 2016 facing west.