

# Habitat Management for Migratory and Breeding Birds at the Cat Island Restoration Project

Final Report  
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The Cat Island Restoration project in lower Green Bay has resulted in spectacular changes in habitat for migratory and breeding birds in lower Green Bay, Wisconsin. When finished, three artificial barrier islands formed with dredge materials from the Green Bay shipping channel will provide extensive beach and shoreline habitat for dozens of bird species, including several endangered and threatened species. The causeway forming the template for these islands will indirectly enhance 1,400 acres of wetland/aquatic habitat in the delta of Duck Creek, a major tributary draining an increasingly urbanized landscape. The impacts of the Cat Island restoration project will be manifest over decades, but this project demonstrates that many benefits already are occurring.

The purpose of this project was to assess avian use of the Cat Island causeway and related habitats, including rocky shoreline and sandy or muddy beach habitat formed by dredge deposits. Information from the field surveys between 2013 and 2015 provide the basis for long term recommendations for habitat management at the Cat Island restoration project.

Specifically, we addressed the following questions? 1) What specific habitat features (water depth, substrate type, shoreline topography) are most important for migratory shorebirds and colonial water birds such as terns, herons, and egrets in lower Green Bay? 2) What habitat features and specific locations are used by nesting shore birds and colonial water birds at the newly constructed Cat Island facility? 3) How do different bird species (including gulls, cormorants, and pelicans) interact at the Cat Island facility and nearby shoals and islands? 4) How does the presence of humans (including birdwatchers) affect bird activities at the Cat Island facility? 5) Where is the best location for an observation platform for visitors? (Where will safe access to birds be greatest while simultaneously avoiding significant disturbance to nesting birds? Field surveys during 2013 documented a remarkable capacity for this system to attract and support migratory shorebirds, terns, gulls, herons, egrets, and even winter migrants. Guided by the 2013 Upper Mississippi Valley/Great Lakes regional shorebird conservation plan, UW-Green Bay graduate student Tom Prestby initiated standardized shorebird and tern surveys at 12 sites in lower Green Bay. By far the most productive site was the Cat Island restoration foundation, where Tom observed 4 tern species and 30 shorebird species, including the endangered Piping Plover (*Charadrius melodus*) and other species listed as “high peril” or “continental concern.”

Field surveys at the Cat Island causeway have continued through summer 2015. Information from these surveys will help document the Cat Island Project’s contribution to the delisting of several Beneficial Use Impairments (BUI’s) in the Lower Fox River and Green Bay AOC, including: 1) degradation of fish and wildlife populations, 2) loss of fish and wildlife habitat, and

3) degradation of aesthetics. In the latter case, aesthetics and local ecotourism opportunities may be improved significantly by the development of recreational opportunities for birdwatchers and nature enthusiasts in lower Green Bay. The 2012 Remedial Action Plan Update for the Lower Green Bay and Fox River Area of Concern lists the Cat Island Restoration as a “key project” for addressing the loss of fish and wildlife habitat BUI.



**Figure 1.** Core study area in lower Green Bay, Lake Michigan. Sites were surveyed twice per week during the spring and autumn migration periods.

In addition to results from standardized field surveys, Prestby installed remote heat-sensitive cameras at the Cat Island site during 2014 and 2015. More than 100,000 images have been recorded (Figure 2), providing information about the effects of variations in water levels and interactions between bird species using various substrates in on the causeway, dredge deposits, and previously existing shoals and islands in the vicinity of the Cat Island restoration project. These images have not been fully analyzed, but results provide several important insights, including 1) fluctuating water levels regularly expand and contract available habitat for shorebirds, pelicans, gulls, and other water birds; and 2) species interactions affect patterns of habitat use on exposed sandbars and shorelines. Certain species such as American White Pelicans displace other birds, which appear to use sandbars only when the larger species are absent.

This report presents an overview of findings, which will be described in much greater detail in the Master’s thesis of Tom Prestby, expected to be completed by December 2015.



**Figure 2.** Example of digital image taken by a remote camera on shoal near tip of Cat Island Causeway.

### **Funding:**

Funding for this project has been used primarily to cover field work by Prestby and data entry by student assistants (\$5311) plus fringe benefits (\$186) and indirect costs (\$824). Travel expenses through June 30<sup>th</sup> (\$432) have been slightly less than budgeted.

### **Deliverables and Work Accomplishments:**

Field work was completed during the final quarter of this project (April-June 2015), and data entry is near completion for bird surveys. Additional data analysis and review of photographs will continue with funding from a separate source. A preliminary final report (this document) is submitted, but this will be expanded significantly after data analysis and completion of Prestby's thesis during fall 2015.

### **Problems Encountered:**

No major problems were encountered during this reporting period.

### **Planned Tasks / Deliverables During Next Quarter:**

Prestby's thesis is scheduled for completion during fall 2015. Quantitative analysis of shorebird numbers and distribution and preparation of figures and illustrations will be expanded by the project team. An informed analysis of habitat use and recommendations for long term management of the Cat Island facility (and other areas in the Lower Green Bay and Fox River AOC) will be made available as part of the expanded final report and incorporated into Prestby's thesis.

## **Overview of Findings as of 30 June 2015**

During the final quarter of this project University of Wisconsin-Green Bay graduate students Tom Prestby and Nick Walton conducted 20-minute unlimited distance point counts at the Cat Island Wave Barrier site at 5 points per visit beginning 19 April 2015 and ending 16 June 2015. All five points were surveyed three times per week, almost always with at least one day in-between surveys. The site was visited before the start and after the end of the official survey season to track early non-shorebird migrants such as ducks and Snowy Owls and the status of summer residents including Piping Plover and Forster's and Common Terns. Similar to fall 2014, the vast majority of shorebird species detected occurred at the new dredge island in the westernmost cell. Of the 26 shorebird species documented at the site in spring 2015, 25 were detected at the dredge.

### **Effort:**

- 19 April to 16 June three times per week
  - 24 total visits
  - Approximately 50 total survey hours
- Visits before and after start and end of official survey window monitored other migrants and residents

### **Avian use of Cat Island Restoration Site:**

- 26 shorebird species were documented at site in spring 2015
- All species were detected during official point counts
- 5 Tern species were observed at site in spring 2015
- Common Terns nested at platforms constructed by U.S. Fish and Wildlife Service and Wisconsin DNR biologists.
- At least two nests with eggs were documented at time of this writing
- Forster's Terns did not nest this year at the Cat Island site; instead, they are nesting near the mouth of Duck Creek.
- Uncommon Visitors observed during this reporting period:
  - American Avocet (4 on 4/22, 1 of 5/4)
  - Piping Plover (4 total birds, 3 males which spent the whole survey season at the site)
  - Willet (1 from 6/17 to 6/24)
  - Whimbrel (1 on 5/27,5/28)
  - Marbled Godwit (4 on 5/13)
  - Red Knot (16 on 5/25)
  - Red-necked Phalarope (1 on 5/21, 5/24)

Federally Endangered/Threatened Species observed during this reporting period:

- Four total Piping Plovers documented via band combinations. One migrant of undetermined sex on 4/30, the other three were males that exhibited courtship and territorial behavior, including building of scrapes, but never attracted a female. Males arrived on 5/7, 5/10, 6/13 and all three still present 6/27. All three males regularly used the road for feeding and loafing.
- 16 Red Knots was largest flock recorded in Wisconsin since 1975 and largest ever recorded in Green Bay. Used dredge material as feeding stopover location during poor weather.
- Whooping Crane observed 6/1 and 6/17. Banded female from Necedah population. Used the dredge in the west cell as an overnight roosting location (6/17) and used adjacent Peters Marsh for feeding 6/1.

Other rare birds detected:

- Common Eider (6/12. Represents 7th record ever for WI)
- Cattle Egret (3 on 6/2)
- Little Gull (1 occasionally present 5/28-6/26)
- Franklin's Gull (5/11, 6/8)
- Arctic Tern (6/1)

Notable High Counts

- Black-bellied Plover: 16 (5/22)
- Semipalmated Plover: 17 (5/25)
- Ruddy Turnstone: 60 (5/25)
- Sanderling: 40 (5/25)
- Dunlin: 400 (5/21)
- Semipalmated Sandpiper: 380 (5/25)
- Common Tern: 500 (5/21)
- Forster's Tern: 40 (5/6,5/11)
- Caspian Tern: 70 (5/4)

Notable observations in early spring 2015:

- Snowy Owls observed 4/11-4/26. Peak of 4 on 19 April.
- 10 species of dabbling ducks detected, peak in mid-April
- 13 Species of diving ducks detected, peak near 10 April
- No mammals detected after ice-off

Other notable observations:

- Because of the significant increase in water levels, willow shoal is now almost entirely under water, meaning less shorebirds and other waterbirds (such as pelicans) used it for roosting. All Herring Gull nests on Willow shoal were washed out.
- Herring Gull nesting continuing to increase on the wave barrier. High of 28 nests on wave barrier counted on 5/30. Most later fledged young successfully.
- Canada Goose and Killdeer also nested on wave barrier.
- No species attempted to nest on new dredge island in west cell.
- Dredge in west cell hosted large loafing flocks of terns (600+), Bonaparte's Gulls (200+), dabbling ducks (300+), and American White-Pelicans (200+).
- Dredge in west cell hosted 2000+ Bank Swallows in early July.
- Vegetation beginning to sprout on dredge in late June.
- Occasional trespassing by fishermen and bird watchers was observed.



**Figure 3.** Piping Plover on Cat Island Causeway, 16 June 2015. Photo by Tom Prestby.

## Summary of Project Results

Research at the Cat Island Causeway is part of a more extensive study of spatial and temporal patterns of habitat use by shorebirds and terns in the Brown and Kewaunee County portion of the lower Green Bay. Prestby conducted standardized point counts at a strategic array of sites during spring and autumn migration periods in 2013 and 2014 (Fig. 2). The sample design included 18 points, nine on Green Bay's east shore and nine on the west shore, representing 10 general localities (five on the east shore and five on the west shore). We selected specific sample points based on public access or granted permission, historical records of shorebird use, and availability of potential shorebird habitat (Table 1). Sites represent several habitat types including coastal estuaries (near river mouths), sheltered bays, and high energy shorelines with undeveloped beach. Counts were conducted at permanent georeferenced points where views of the shoreline were maximal.

**Table 1.** Survey locations in lower Green Bay.

Point name	Shore	Lat	Long
NIC02	East	44.53695	-87.92767
NIC01	East	44.59909	-87.88048
RRIV01	East	44.66801	-87.7477
PCOM01	East	44.62012	-87.85531
DYC01	East	44.64301	-87.76382
SAB01	East	44.58333	-87.9015
SAB02	East	44.58118	-87.90827
SAB03	East	44.57699	-87.91301
SAB04	East	44.57698	-87.90275
CAT01	West	44.57695	-88.01782
CAT02	West	44.56586	-88.00539
CAT03	West	44.56357	-87.99987
CAT04	West	44.55888	-87.99626
LOT01	West	44.61989	-88.01243
LIT01	West	44.66952	-87.99871
SENS01	West	44.64038	-88.0098
SENS02	West	44.63526	-88.00939
SENS03	West	44.63074	-88.00951

Four southwestern survey points were located on the Cat Island wave barrier. This was an active construction site when the project began in in 2013 so access was sometimes limited and birds were occasionally disturbed by construction crews and vehicles. These four points were placed where shorebird foraging habitat was exposed at least occasionally (Figure 4).



**Figure 4.** Cat Island Wave barrier points. Sites surveyed 2 times per week starting July 2013.

## Methods

Site visits were scheduled randomly within each week to reduce biases associated with surveying in a predictable order (Andrei et al. 2008). Because of active construction at Cat Island, timing of surveys was not always random. Start time and end time was recorded for each visit. Even if no target birds were originally seen at a site, observers remained at each point count for a minimum of 20 minutes.

All shorebirds and terns observed from the survey point were recorded, along with distance and direction from the observer. Birds were usually in relatively small groups in open areas and relatively close to the observer, making counting or estimating numbers for all individuals reasonable. Any arrival or departure by individuals or groups was noted to the minute. Flyovers and flybys were recorded but these birds will not be included in the analysis unless they had been clearly disturbed from feeding or resting areas by the observer. Terns flying but actively feeding are an exception and will be counted and included in the subsequent analysis. A high quality spotting scope (30x power or greater) was used in all cases to help identify species.

Most surveys were conducted by the same observer (Prestby) to reduce observer bias. Additional observers were experts in shorebird identification and trained in the field by Prestby. When Prestby could not survey, Nick Walton, a UW-Green Bay graduate student who is highly skilled in shorebird identification and who was trained in the survey protocol, conducted surveys. Temperature, barometric pressure, wind speed, and wind direction were recorded at each point using a Kestrel 3500. Sky conditions were measured using estimation. Surveys were not conducted in heavy rain because these conditions likely affected bird distribution and behavior. For safety purposes no surveys were conducted when lightning was imminent.



Habitat and microhabitat were described during each survey. However, since seiche conditions and fluctuating water levels are common in Green Bay, microhabitat of each bird or flock was noted specifically. Categories used to describe local conditions included rocky shore, sand, dry mud, wet mud, mud-water film (1-2cm), shallow water (2-8cm) and deep water (8+cm), shells, and algae (Skagen & Knopf 1994). Water depth was estimated by evaluating how much of the bird's legs were under water compared to average leg length of that species. Observers estimated percent water cover, sand cover, rock cover, mud cover, and vegetation cover at the site as in Danufsky & Colwell (2003). Multiple pictures were taken at each visit of each site to monitor changes in exposed substrate and vegetation. A digital rangefinder was used to refine the boundaries of important habitats like exposed mud or shallow aquatic vegetation zones.

Point counts were conducted at each location twice per week for two years (four field seasons), plus additional surveys during spring and summer 2015. Spring surveys began 21 April 2013 and 21 April 2014, when ice and snow melt exposed potential shorebird habitat (exposed sand, rock, or mud) and persisted through 7 June 2013, 13 June 2014, and 16 June 2015, when northward shorebird migration waned. Fall migration counts began when southward shorebirds arrived (8 July in 2013 and 7 July in 2014) and ended when numbers waned (18 October in 2013 and 17 October in 2014).

Early in the fall 2013 field season, we learned that the Cat Island sites in the southwest corner of the bay were much more productive for shorebirds than the other sites. Therefore, we increased surveys of those sites to three times per week and extended the survey period of those sites until ice covered adequate shorebird habitat (13 November in 2013 and 12 November in 2014). Also, water levels increased on the bay by several inches in summer 2013, taking away exposed substrate that was seen during ground-truthing in early May at several sites. These sites (LiTail1, LoTail1, Sens3, Sens1, Sab 1, Sab2) were surveyed only once per week until water levels decreased and habitat improved later in fall when water dropped.

In spring 2014, Green Bay water levels rose more than 15 inches, drastically eliminating exposed substrate for shorebirds at some points. Because they no longer had any possible shorebird habitat, some points (LiTail1, LoTail1, Sens3, Sens1, Sab1, and Sab 2) were no longer surveyed. When water rose several more inches in summer, some points with very limited habitat (Sab3, Sab4) were surveyed once per week.

In fall 2014, a 5<sup>th</sup> count was added at Cat Island (19<sup>th</sup> overall count) to monitor fresh dredge dumpings. Surveys at this point count started on 12 August 2014 and ended on 12 November 2014. It was surveyed three times per week like the other Cat Island points.

**Table 2.** Lower Green Bay shorebird count effort

<b>Season</b>	<b>Start</b>	<b>End</b>	<b>Point Counts</b>	<b>Minutes</b>	<b>Hours</b>
Spring 2013	4/21/2013	6/7/2013	248	4960	82.68
Fall 2013	7/8/2013	11/13/2013	505	10100	168.33
Spring 2014	4/21/2013	6/13/2013	194	3880	64.67
Fall 2014	7/7/2014	11/12/2014	462	9240	154
Spring 2015	4/19/2015	6/16/2015	165	~ 3000	50
			<b>1574</b>	<b>31180</b>	<b>519.68</b>

## Results

A complete analysis and discussion of results will be completed during fall 2015 in the form of Prestby's Master's thesis at the University of Wisconsin-Green Bay. Results in this report represent a preliminary summary of findings. In the spring 2013 field season, 16 species of shorebirds and 4 species of terns were observed during point counts (Table 3). Dunlin was the shorebird species with the highest count and Killdeer was the species detected at the most locations. Caspian Tern was the tern species with the highest count and it was the tern species detected at the most locations.

**Table 3.** Spring 2013 summary data. Columns from left to right indicate species (4-letter banding code), season arrival, season departure, season high count, date of high count, location of high count (point name), and the number of points the species was observed at during the season. Sorted by high count. Species names and abbreviations are given in Appendix A.

Species	Arrival	Departure	High Count	Date High Count	High Count Loc	# Loc
DUNL	4/30/2013	6/6/2013	160	5/23/2013	Cat3	10
SESA	5/15/2013	6/6/2013	70	6/6/2013	Cat2	5
CATE	4/21/2013	6/7/2013	64	5/10/2013	Cat3	18
RUTU	5/14/2013	6/7/2013	58	5/17/2013	RRiv1	6
FOTE	4/21/2013	6/7/2013	25	5/5/2013	Cat1	12
COTE	5/3/2013	6/7/2013	23	5/23/2013	Cat3	15
BBPL	5/23/2013	6/1/2013	18	5/23/2013	Cat2	4
SAND	5/19/2013	6/1/2013	11	5/23/2013	Cat3	1
WRSA	5/23/2013	6/6/2013	11	6/6/2013	Cat3	2
LESA	5/5/2013	5/26/2013	9	5/26/2013	Cat3	4
KILL	4/21/2013	6/7/2013	6	5/31/2013	RRiv1	16
SPSA	4/27/2013	6/7/2013	6	5/17/2013	RRiv1	12
GRYE	4/25/2013	5/19/2013	3	4/25/2013	LoTail1	5
SEPL	5/26/2013	6/6/2013	3	5/26/2013	Cat3	1
BASA	5/29/2013	5/29/2013	2	5/29/2013	Cat2	2
PIPL	5/19/2013	6/1/2013	2	5/19/2013	Cat3	2
BLTE	5/29/2013	6/1/2013	1	5/29/2013	Cat2	2
LBDO	5/20/2013	5/20/2013	1	5/20/2013	RRiv1	1
RNPH	6/1/2013	6/1/2013	1	6/1/2013	Cat3	1
WISN	4/25/2013	4/25/2013	1	4/25/2013	Sens2	2

In the fall 2013 field season, 28 species of shorebirds and 4 species of terns were observed during point counts (Table 4). Semipalmated Sandpiper was the shorebird species with the highest count and Spotted Sandpiper was the species detected at the most locations. Caspian Tern was the tern species with the highest count and it was the tern species detected at the most locations.

**Table 4.** Fall 2013 summary data. Columns from left to right indicate species (4-letter banding code), season arrival, season departure, season high count, date of high count, location of high count (point name), and the number of points the species was observed at during the season. Species in the table are sorted by high count. Species names and abbreviations are given in Appendix A.

Species	Arrival	Departure	High Count	Date High Count	High Count Loc	# Loc
SESA	7/8/2013	10/6/2013	230	8/25/2013	Cat3	8
CATE	7/11/2013	10/27/2013	183	8/14/2013	Cat3	18
COTE	7/16/2013	10/17/2013	103	9/7/2013	Nic1	11
SEPL	7/22/2013	10/20/2013	80	8/25/2013	Cat3	5
LESA	7/8/2013	10/13/2013	70	8/25/2013	Cat3	11
SAND	7/8/2013	10/27/2013	64	7/27/2013	Cat3	5
FOTE	7/11/2013	10/20/2013	40	8/28/2013	Nic1	13
LEYE	7/11/2013	9/15/2013	40	8/10/2013	Cat1	9
DUNL	8/14/2013	11/1/2013	26	10/26/2013	Cat2	3
STSA	7/16/2013	9/15/2013	24	8/14/2013	Cat3	4
BASA	7/30/2013	10/13/2013	23	10/12/2013	Cat3	6
KILL	7/9/2013	10/17/2013	20	10/18/2013	RRiv1	14
SBDO	7/16/2013	8/20/2013	17	8/20/2013	Cat2	3
GRYE	7/11/2013	10/2/2013	15	8/10/2013	Cat1	6
PESA	7/16/2013	10/13/2013	13	9/15/2013	Cat3	4
SPSA	7/9/2013	10/10/2013	10	8/5/2013	Sab4	15
AMAV	7/14/2013	9/13/2013	6	7/19/2013	RRiv1	5
AMGP	8/18/2013	10/13/2013	6	10/2/2013	Cat2	4
BBPL	7/8/2013	10/13/2013	6	9/15/2013	Cat3	5
MAGO	8/11/2013	9/11/2013	6	9/11/2013	Cat3	2
RNPH	7/27/2013	9/14/2013	5	9/7/2013	Cat2	2
WISN	9/27/2013	9/27/2013	5	9/27/2013	LoTail1	1
WIPH	7/25/2013	8/14/2013	3	7/25/2013	Cat1	2
BLTE	7/11/2013	9/11/2013	2	9/11/2013	Cat4	2
WILL	7/16/2013	9/7/2013	2	9/7/2013	Dyck1	3
BBSA	8/17/2013	9/7/2013	1	8/17/2013	Cat3	1
HUGO	7/22/2013	7/22/2013	1	7/22/2013	Cat3	2
LBDO	9/14/2013	9/14/2013	1	9/14/2013	Cat4	1
REKN	7/14/2013	9/7/2013	1	7/14/2013	Cat2	3
RUTU	7/16/2013	8/5/2013	1	7/16/2013	Cat3	2
SOSA	7/11/2013	8/25/2013	1	7/11/2013	Cat1	4
WRSA	8/9/2013	8/9/2013	1	8/9/2013	Cat2	1

In the spring 2014 field season, 13 species of shorebirds and 4 species of terns were observed during point counts (Table 5). Dunlin was the shorebird species with the highest count and Spotted Sandpiper was the species detected at the most locations. Caspian Tern was the tern

species with the highest count and Caspian and Forster's Tern were the tern species detected at the most locations.

**Table 5.** Spring 2014 summary data. Columns from left to right indicate species (4-letter banding code), season arrival, season departure, season high count, date of high count, location of high count (point name), and the number of points the species was observed at during the season. Species in the table are sorted by high count. Species names and abbreviations are given in Appendix A.

Species	Arrival	Departure	High Count	Date High Count	High Count Loc	# Loc
DUNL	4/30/2014	6/13/2014	91	5/23/2014	Cat3	4
CATE	4/21/2014	6/13/2014	87	5/11/2014	Cat3	13
SESA	5/23/2014	6/13/2014	47	6/13/2014	Cat3	3
BLTE	5/12/2014	6/13/2014	36	6/13/2014	Cat1	3
COTE	4/30/2014	6/6/2014	22	5/22/2014	Nic1	10
FOTE	4/26/2014	6/13/2014	15	5/9/2014	Cat4	13
WRSA	5/16/2014	6/13/2014	12	6/13/2014	Cat3	2
RUTU	5/11/2014	6/4/2014	11	5/15/2014	RRiv1	8
BBPL	5/14/2014	6/4/2014	10	5/23/2014	Cat2	3
SAND	5/9/2014	6/13/2014	5	6/4/2014	Cat2	4
SPSA	4/30/2014	6/8/2014	5	5/12/2014	Sab3	10
KILL	4/21/2014	6/8/2014	2	4/21/2014	Sens2	5
PIPL	5/4/2014	5/14/2014	2	5/11/2014	Cat4	4
SBDO	5/16/2014	5/16/2014	2	5/16/2014	Cat4	1
GRYE	5/16/2014	5/16/2014	1	5/16/2014	Cat1	1
SEPL	5/18/2014	5/18/2014	1	5/18/2014	Cat2	1
WISN	4/21/2014	4/21/2014	1	4/21/2014	Cat1	2

In the fall 2014 field season, 26 species of shorebirds and 4 species of terns were observed during point counts (Table 6). Dunlin was the shorebird species with the highest count and Spotted Sandpiper was the species detected at the most locations. Common Tern was the tern species with the highest count and Caspian Tern was the tern species detected at the most locations.

**Table 6.** Fall 2014 summary data. Columns from left to right indicate species (4-letter banding code), season arrival, season departure, season high count, date of high count, location of high count (point name), and the number of points the species was observed at during the season. Species in the table are sorted by high count. Species names and abbreviations are given in Appendix A.

Species	Arrival	Departure	High Count	Date High Count	High Count Loc	# Loc
COTE	7/7/2014	10/13/2014	130	9/6/2014	Cat5	11
CATE	7/7/2014	10/8/2014	76	9/1/2014	Cat5	13
DUNL	7/10/2014	11/10/2014	68	10/27/2014	Cat1	5
SAND	7/14/2014	10/27/2014	51	10/8/2014	Cat5	6
BBPL	8/7/2014	10/22/2014	32	10/10/2014	Cat1	5
FOTE	7/7/2014	10/8/2014	25	7/16/2014	Cat1	7
AMGP	9/6/2014	10/29/2014	15	10/10/2014	Cat5	6
LESA	7/12/2014	9/8/2014	11	8/14/2014	Cat5	5
SESA	7/7/2014	10/20/2014	11	8/29/2014	Cat5	4
GRYE	7/7/2014	10/1/2014	9	7/12/2014	Cat2	5
MAGO	8/29/2014	9/6/2014	8	9/6/2014	Cat3	2
AMAV	7/12/2014	9/3/2014	7	8/25/2014	Cat5	3
BASA	7/28/2014	10/10/2014	7	9/6/2014	Cat1	5
STSA	8/29/2014	10/13/2014	7	10/13/2014	Cat1	2
KILL	7/7/2014	10/10/2014	6	10/10/2014	Cat1	8
PESA	8/28/2014	10/13/2014	6	9/29/2014	Cat1	3
SPSA	7/7/2014	10/15/2014	6	8/22/2014	Cat1	13
BBSA	8/25/2014	9/8/2014	5	9/6/2014	Cat5	3
SEPL	8/5/2014	9/8/2014	5	8/29/2014	Cat2	4
WILL	9/1/2014	9/1/2014	4	9/1/2014	Cat3	1
LEYE	7/23/2014	10/8/2014	3	8/16/2014	Cat5	5
RNPH	8/29/2014	8/29/2014	3	8/29/2014	Cat5	1
PIPL	7/10/2014	7/14/2014	2	7/12/2014	Cat3	2
BLTE	7/12/2014	8/29/2014	1	7/12/2014	Sens2	2
REKN	9/6/2014	9/8/2014	1	9/6/2014	Cat3	2
REPH	10/3/2014	10/6/2014	1	10/3/2014	Cat1	2
RUTU	7/25/2014	9/17/2014	1	7/25/2014	Cat1	4
SBDO	7/7/2014	9/8/2014	1	7/7/2014	Cat3	4
SOSA	8/18/2014	8/28/2014	1	8/18/2014	Sab4	2
WRSA	10/10/2014	10/10/2014	1	10/10/2014	Cat5	1

Throughout the project, 30 shorebird and 4 tern species were detected at the selected field sites. These included all three high-periled shorebird species known to migrate through the area (Piping Plover, Red Knot, and Buff-breasted Sandpiper) as well as 9 high priority conservation concern species (Solitary Sandpiper, Marbled Godwit, Hudsonian Godwit, Ruddy Turnstone, Sanderling, Dunlin, Short-billed Dowitcher, and Wilson's Phalarope). During spring 2015,

Whooping Crane (*Grus americana*) was observed at the site during early June. Another high-priority conservation concern species, Whimbrel, was detected at the Cat Island wave barrier site but individuals were not detected during formal 10 minute point count until May 2015. Red Phalarope, a very rare bird in Wisconsin, was detected in fall 2014; the observation and documentation were accepted unanimously by the Wisconsin Society for Ornithology Records Committee. Of special interest were the endangered Piping Plover and proposed-threatened Red Knot. Piping Plovers were documented during every season except fall 2013 and, in some cases, several birds were present at the same time. Band combinations were recorded and sent to appropriate staff at USFWS and other organizations. At least one unbanded plover was documented. Red Knots were documented during every season except spring 2014, including adults and juveniles.

Although we have not yet analyzed the data statistically, our results clearly show that the Cat Island wave barrier site was the most productive locality for shorebird abundance and diversity. All 30 species detected during the project were detected at this site except Wilson's Snipe, which prefers more vegetated wetland habitats. For comparison, the second-most productive site was Red River Park where only 13 shorebird species were detected. All other sites surveyed produced less than ten shorebird species over the project.

Currently, all data except results from spring 2015 have been double-entered, cross-checked, and organized for statistical analysis. Data will be evaluated and discussed in Prestby's Master's thesis, which will be defended in late fall 2015. The thesis will include 1) GIS maps predicting the highest areas of occurrence throughout the bay and 2) management recommendations for sustaining and enhancing shorebird habitat in the lower bay, especially at the Cat Island Wave Barrier restoration project. Point counts at the Cat Island Wave Barrier will continue in 2015 but will not be a part of Prestby's thesis.

### **Management Implications**

A more detailed analysis and interpretation of results from this project will be provided in the Master's thesis of Tom Prestby. However, findings from this study have clear management implications that should provide guidance for long term management of the Cat Island Restoration Site.

1. The diversity of shorebirds and colonial water birds at the Cat Island site has been nothing short of remarkable. Virtually every shorebird species known to pass through the western Great Lakes during migration has been documented at the site, and several rare species (Piping Plover, Red Knot, and others) have been observed regularly. Maintenance of quality shorebird habitat at this migratory stopover site should be high conservation priority.
2. The Cat Island Restoration site is significant not only during the usual migration periods, but also during summer (see below) and even in winter, when concentrations of Arctic species like Snowy Owl and Common Eider have been observed. Presence of these irregular species suggests that the location of this project is strategically significant for

migratory birds; as long as appropriate feeding and roosting habitat is available, the birds seem to have little trouble finding it in lower Green Bay.

3. Presence of Piping Plovers during the breeding or courtship season in all 3 years of this study reveals that the potential for nesting of this federally endangered species is very high. Maintenance of open undisturbed beach habitat will be critical for attracting nesting birds and for improving chances for nesting success.
4. Deposition of dredge spoils in 2014 provides outstanding migratory shorebird habitat and potential breeding habitat for Piping Plovers. However, vegetation already began to appear during summer 2015. Control of these plants, especially at this early stage before aggressive clones have become established, will be very important. Vegetation assessment and management should be a high priority during fall 2015. The most important consideration for migratory shorebirds is to maintain open beach habitat with little or no vegetation.
5. Artificial platforms and associated management tools like use of decoys have been successful in attracting successful nesting of both Common and Forster's Terns. Maintenance of permanent or ongoing nesting sites for these species will be opportunities for significantly enhancing populations of these state endangered species.
6. In order to minimize threats to nesting and migratory birds, barriers to immigration of potential land predators like raccoons and foxes need to be maintained. Although little evidence of predation has been observed so far, this long term threat could potentially undermine the goals of this project.
7. The high diversity and abundance of migratory birds at the Cat Island Restoration Site inevitably will lead to pressure from birdwatchers and others to visit the site. Unrestricted access clearly would lead to undesirable consequences and possibly abandonment of the site for sensitive species like Piping Plover and nesting terns. However, some type of strictly-regulated ecotourism opportunity might be possible. In combination with high concentrations of migrants at other sites like Bay Beach Wildlife Sanctuary, Point au Sable, and Sensiba Wildlife Area, lower Green Bay is a world class migratory stopover area that could be a highly desirable destination for birdwatchers during spring and fall migration periods.
8. Interactions between nesting gulls, pelicans, cormorants, and other species are important management considerations given the high concentrations of birds at the Cat Island Restoration Site and nearby shoals and islands. We hope to evaluate some of these interactions by analyzing the remote images collected during 2014 and 2015. Our preliminary findings suggest that the combination of limited space and irregular water level fluctuations might lead to important interactions among species, possibly leading to recommendations for long term habitat or population management at the Cat Island Restoration site.

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Appendix A. List of shorebird and tern species observed during this study, including 4-letter identification codes and scientific names according to the 55th AOU Supplement (Chesser et al. 2014).

<b>Code</b>	<b>Common Name</b>	<b>Scientific Name</b>
AMAV	American Avocet	<i>Recurvirostra americana</i>
AMGP	American Golden Plover	<i>Pluvialis dominica</i>
BASA	Baird's Sandpiper	<i>Calidris bairdii</i>
BBPL	Black-bellied Plover	<i>Pluvialis squatarola</i>
BBSA	Buff-breasted Sandpiper	<i>Calidris subruficollis</i>
BLTE	Black Tern	<i>Chlidonias niger</i>
CATE	Caspian Tern	<i>Hydroprogne caspia</i>
COTE	Common Tern	<i>Sterna hirundo</i>
DUNL	Dunlin	<i>Calidris alpina</i>
FOTE	Forster's Tern	<i>Sterna forsteri</i>
GRYE	Greater Yellowlegs	<i>Tringa melanoleuca</i>
HUGO	Hudsonian Godwit	<i>Limosa haemastica</i>
KILL	Killdeer	<i>Charadrius vociferus</i>
LBDO	Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>
LESA	Least Sandpiper	<i>Calidris minutilla</i>
LEYE	Lesser Yellowlegs	<i>Tringa flavipes</i>
MAGO	Marbled Godwit	<i>Limosa fedoa</i>
PIPL	Piping Plover	<i>Charadrius melodus</i>
PESA	Pectoral Sandpiper	<i>Calidris melanotos</i>
REPH	Red Phalarope	<i>Phalaropus fulicarius</i>
REKN	Red Knot	<i>Calidris canutus</i>
RNPH	Red-necked Phalarope	<i>Phalaropus lobatus</i>
RUTU	Ruddy Turnstone	<i>Arenaria interpres</i>
SAND	Sanderling	<i>Calidris alba</i>
SBDO	Short-billed Dowitcher	<i>Limnodromus griseus</i>
SEPL	Semipalmated Plover	<i>Charadrius semipalmatus</i>
SESA	Semipalmated Sandpiper	<i>Calidris pusilla</i>
SOSA	Solitary Sandpiper	<i>Tringa solitaria</i>
SPSA	Spotted Sandpiper	<i>Actitis macularia</i>
STSA	Stilt Sandpiper	<i>Calidris himantopus</i>
WILL	Willet	<i>Tringa semipalmata</i>
WIPH	Wilson's Phalarope	<i>Phalaropus tricolor</i>
WISN	Common Snipe	<i>Gallinago gallinago</i>
WRSA	White-rumped Sandpiper	<i>Calidris fuscicollis</i>