



Analysis of the
2014-2015 Audubon Coastal Bird Survey:
Mississippi



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Program Director:

Sarah Pacyna
spacyna@audubon.org

Program Biologist/Lead Investigator:

Sheri L. Glowinski, PhD
sglowinski@audubon.org

Address & Phone:

7001 Frank Griffin Road
Moss Point, MS 39563
228-285-0449

INTRODUCTION

In 2010, thousands of birds from dozens of species perished as the United States' worst environmental catastrophe, the BP Deepwater Horizon disaster unfolded. Eleven people lost their lives in this tragedy – and in addition to birds, numbers of marine species, dependent on the Gulf of Mexico's natural resources, were grievously harmed (Campagna et al. 2011). For eighty-seven days, oil flowed unabated, discharging approximately 210 million US gallons of crude oil into the Gulf of Mexico. North American shorebirds, as a whole, are experiencing pre-existing, documented declines (Morrison et al. 2001, Bart et al. 2007). For Mississippi's coastal birds, targeted conservation measures in the wake of this disaster and the ongoing challenges shorebirds already face that include threats to habitat, competition for space, human-induced disturbances, predation, reduction of prey species, and climate change (Colwell 2010, Galbraith et al. 2014), have been hindered by the lack of baseline information for the region.

In 2011, in response to the oil spill, Audubon's Pascagoula River Audubon Center developed the Audubon Coastal Bird Survey (ACBS) with the key objectives of 1) obtaining reliable data on oiled species and 2) obtaining monitoring data on any subsequent population-level changes to coastal bird species. The ACBS protocol is adapted from International Shorebird Surveys, the primary tool for understanding migratory shorebird population trends in the Western Hemisphere. The surveys employ citizen scientists to collect data and provide Audubon scientists a cost-effective mechanism to better assess threats and identify targets for species of conservation concern and to provide data on critical gaps of knowledge for this area. Prior to 2011, there were a number of breeding shorebird surveys underway for coastal Mississippi by National Audubon Society' state office, Audubon Mississippi, National Park Service, Department of Marine Resources, and Conservian, yet there were no comprehensive, year-round surveys extending outside of the breeding season (i.e., included fall and spring migrations and winter stopovers) existed. Mississippi's migratory species have a much wider geographic range throughout their life cycle, with single populations occupying habitat spanning thousands of miles between nesting, migratory, and foraging sites. For instance, juvenile shorebirds may leave nesting grounds later than adults, and without prior migratory flight experience and visual cues, fall migratory paths may differ from adult flocks (Ranalli and Ritchison 2012). Thus, surveys that extended beyond the breeding season were critical to conservation of coastal birds.

In 2013, the Department of Justice approved two plea agreements, settling criminal charges levied against British Petroleum and Transocean, and directing more than \$2.5 billion to the National Fish and Wildlife Foundation Gulf Environmental Benefit Fund to benefit natural resources impacted by this disaster. Audubon Mississippi was awarded \$1.6 million in November 2013 from this fund through the Mississippi Department of Environmental Quality to restore coastal bird populations. The Audubon Mississippi Coastal Bird Stewardship Program (AMCBSP) was instituted in June 2014 to promote the management and conservation of coastal shorebirds through citizen science, outreach, and capacity building and strategic partnerships with federal, state, and local agencies, local academic institutions and community organizations. Employing a grassroots approach to conservation, the program works to build constituents and advocates for healthy populations of shorebirds and protection of the habitats and ecosystems on which they depend. With the creation of AMCBSP, staff have also provided critical support to ensure rigor to the Audubon Coastal Bird Survey for the state.

We place an emphasis on ten bird species identified as priority species (Table 1). Five priority species (Snowy Plover, Wilson's Plover, American Oystercatcher, Least Tern, and Black Skimmer) breed on the Mississippi Gulf Coast. Five additional species (Brown Pelican, Piping Plover, Red Knot, Sanderling, and Short-billed Dowitcher) migrate through, winter in, or reside in the Gulf. Together, these species

represent different nesting and foraging strategies and use microhabitats in different ways across the span of the year. Further, several of the species are on state and/or federal Threatened and Endangered species lists. ACBS data allow for a holistic view of species diversity and abundance throughout the avian annual cycle, as well as population changes for Mississippi's coastal birds, including those of priority conservation concern. This report represents an analysis of ACBS data collected since the inception of the AMCBSP.

METHODS

Study Sites

The 2014-2015 Mississippi Coastal Bird Surveys consisted of 14 coastal mainland transects in the 3 coastal counties of Hancock, Harrison and Jackson, 3 transects total on two nearshore islands, one transect each on four barrier islands, and two transects on a single barrier island (Table 2). Most mainland transects consisted of open sand beach (constructed), mudflats and open water on the southern boundary, and open sand beach (constructed), and varying amounts of natural (shrubs, trees) and other constructed habitat (e.g., roads, walkways, seawalls) on the northern boundary. Sites varied in their surrounding land cover types (Johnson 2011), with Graveline consisting of the highest relative composition of natural habitat and those sites in Biloxi, Gulfport, and Pascagoula consisting of the highest levels of surrounding developed areas.

Survey Protocol

Three pulses were conducted annually during 2014-2015. The fall (2014) and spring (2015) pulses (August 20 - October 30 and March 20 - May 30, respectively) consisted of six surveys conducted approximately every 10 days. The winter (2015) pulse (January 10 - February 20) consisted of 3 surveys conducted approximately every 10 days. Occasionally a missed survey would be made up during the three day grace period immediately after a pulse.

One or more surveyors (typically a well-skilled birder acting as the coordinator for a particular survey site and other interested volunteers) conducted a 1-mile (with the exception of one survey, Lake Mars, which was 0.6 miles in length) walking survey in approximately one hour along an established coastal transect. All birds were identified to species, when possible, and counted within a 0.25 mile boundary on either side of the transect and at either end of the transect. Thus, an area of 0.75 mi² was surveyed at each site (.55 mi² at Lake Mars). Coordinators also recorded names of surveyors, survey start and end time, and local conditions including wind, precipitation, tide, presence of wrack, garbage, and human activity. Banded birds, oiled birds, carcasses, and other relevant observations were also noted.

Data Management

With the exception of data collected at the barrier islands, the coordinator of each site entered all data for each survey in eBird. S/he then forwarded the eBird checklist to the Coastal Bird Stewardship staff who crosschecked the data with the datasheet submitted by the site coordinator. Hardcopies of all datasheets were stored in the Coastal Bird Stewardship office. The National Park Service requested that ACBS data for the barrier islands not be entered into eBird, thus, data were maintained only in the Stewardship office.

RESULTS

Thirteen sites were surveyed during the 2014 fall pulse and 22 during each of the 2015 winter and spring pulses. A total of 256 surveys were conducted with 76 in fall, 64 in winter and 116 in spring. Variation in the number of sites surveyed per pulse and the number of surveys completed per site within a pulse varied due to volunteer scheduling issues (e.g., weather) and access (the barrier islands). Effort averaged 2.28 party-hours per survey.

Throughout the year, 183 species were detected among all the sites (Table 3) including 28 species of shorebird, 5 species of gulls, 8 species of terns, 20 species of wading birds and 19 species of waterfowl in addition to a variety of raptors and landbirds (Table 3). Throughout the sites, 143 species were detected in fall, 119 in winter and 158 in spring. In terms of species richness among the pulses, surveys conducted during spring had the highest average number of species detected (24.6 ± 10.28 SD) followed by fall (23.2 ± 8.88 SD) and winter (21.4 ± 11.53 SD). Graveline Beach was the most speciose site throughout the year with an average of $41.8 (\pm 6.46$ SD), $48.7 (\pm 7.23$ SD), and $50.8 (\pm 4.75$ SD) species detected per survey during the fall, winter and spring pulses, respectively, for a total of 127 species detected throughout the year. By comparison, the other mainland site with a natural beach, Lake Mars Ave, had an average of $22.7 (\pm 4.76$ SD) species in fall, $34.7 (\pm 2.08$ SD) in winter and $23.2 (\pm 4.36$ SD) in spring and 89 species detected throughout the year. The Menge Ave-Seal Ave. route in Pass Christian had the lowest average species richness in fall (14.0 ± 5.22 SD) and the Debuys Rd.-Cowan Rd. route in Gulfport had the lowest in both spring (15.7 ± 5.32 SD) and winter (9.3 ± 3.51 SD), but had a higher total species richness (47) than did East Ship Island and West Ship Island (both at 39).

Audubon's 10 Coastal Species of Conservation Concern – 2014-2015 Summary

American Oystercatcher: Oystercatchers were detected primarily during winter and spring with a scattering of detections during the fall pulse. Graveline, Deer Island and Singing River had the most number of surveys detecting this species. Counts were generally low, ranging from 1-30 individuals, with only a single survey in winter at Buccaneer Beach detecting 30.

Black Skimmer: Skimmers were relatively numerous during the three pulses with the three highest counts of 1,296, 977 and 963 (spring, fall and fall, respectively) all from Moses Pier.

Brown Pelican: Pelicans were detected at all sites throughout the three pulses except Ladner Pier, East Horn Island and West Ship Island with counts ranging between 1-560.

Least Tern: Least terns were present at all of the sites, primarily during April and May. Counts ranged from 1 to 829 with the highest counts being generated at the Cowan-Lorraine colony at the Debuys Rd.-Cowan Rd survey location in Gulfport.

Piping Plover: Piping Plover, a federally endangered species, was detected at five manmade mainland sites, one natural beach site and on each of the seven islands, during fall, winter and spring. Counts were generally low, ranging from 1-33, with only a single survey detecting 33 individuals, on East Ship Island.

Red Knot: Red Knot, a federally threatened species, was detected only during the month of April on four of the barrier islands in generally low numbers (1-4). However, one survey on Horn Island detected 29 individuals in April.

Sanderling: Sanderlings were present at most sites during the three pulses, with a high count of 226 in spring at East Ship Island in early spring.

Short-billed Dowitcher: Short-billed Dowitchers were detected at Bayou Caddy, Buccaneer Beach, Graveline and Deer Island during all three pulses, and occasionally throughout the pulses at the remaining sites. Counts ranged from 1-125, with the high count from the winter pulse at Buccaneer Beach.

Snowy Plover: Snowy Plover, a federally endangered species, was detected during the fall and winter pulses at one mainland site and during winter and spring pulses at all the islands except Singing River, again in small numbers (range = 1-19 individuals with only a single survey, at Sand Island, detecting 19 individuals).

Wilson's Plover: Wilson's Plover was detected only on the nearshore and barrier islands and only in small numbers (range = 1-8 individuals per survey).

The abundance of each of these species of concern at each site during each month is noted in Table 4.

DISCUSSION

The Audubon Coastal Bird Surveys were implemented in Mississippi to provide a baseline understanding of the avifaunal biodiversity using the immediately coastal areas. A minimum of four priority species was detected at each of the 22 transects surveyed during the Mississippi Audubon Coastal Bird Surveys. The barrier and nearshore islands appear to be important sites for the priority species, as the majority of the 10 priority species were detected at these locations. Additionally, the two nearshore islands (Deer and Singing River) housed a particularly diverse suite of avifauna, comparable to the most diverse mainland sites in terms of absolute species richness.

Graveline, a mainland site, housed the highest overall number of species, as well as seven of the priority species at some point during the year. Graveline contains a natural beach that is bounded by a large natural marsh to the north. Thus, the relatively large species diversity detected here is influenced by the variety of natural habitats present. The site was recently barricaded off by the Department of Environmental Quality, thus, protecting it, and the wildlife, from most vehicular traffic. Interestingly, the Lake Mars Ave site, although a natural beach similar to Graveline, did not have the same extent of species richness that Graveline does. This is likely due to a much smaller wetland at the northern boundary. Additionally, this site is not protected by a barricade and receives some amount of vehicular traffic (S. Glowinski, pers. obs.), likely impacting the ability of shorebird species, in particular, to use the shoreline successfully for activities such as breeding and loafing. In light of the active (e.g., Deer Island, Singing River Island) and potential restoration projects (e.g., Graveline) along the coast, emphasis should be placed on understanding the relationship between avian diversity and restoration practices to ensure that species of concern are not impacted negatively.

The mainland sites with the lowest overall species richness (Ladner Pier, Debuys Rd and Least Tern Area) are areas that appear to provide little natural habitat for birds (e.g., are highly managed, have little native vegetation, are largely bordered by manmade structures). These sites contained the fewest species of concern, as well. Johnson (2011), in his analysis of the ACBS data from the survey's inaugural year, found that the density of Brown Pelicans at an ACBS site was inversely related to the percent of

developed land and that for Sanderlings, density is directly related to percent beach cover surrounding the survey area. Geospatial analysis will be a valuable tool to shed light on how species respond to changing environments along the Mississippi coast (e.g., construction of buildings, regrowth of vegetation on dormant properties). Further, given that much of the managed beach is raked frequently, thereby altering the availability of wrack necessary for foraging for many shorebird species, studies should be conducted to assess the impact of this management technique on the foraging of shorebird species using these shorelines.

Limitations

Prior to the establishment of the Audubon Mississippi Coastal Bird Stewardship Program (AMCBSP), the coastal bird surveys were intended to be implemented along the entire northern Gulf of Mexico coastline (i.e., Texas, Louisiana, Mississippi, and Alabama). However, as is the nature of citizen science-based efforts, surveys were conducted irregularly and, further, had little oversight, particularly in states beyond Mississippi, where the initial funding for ACBS was focused. Therefore, the data analyzed in this report focus strictly on data collected during 2014-2015 in Mississippi.

The results of ACBS surveys should not be taken as a comprehensive assessment of the avifauna that use Mississippi's coastal areas. For example, seabirds that primarily use open water such as shearwaters have been documented casually along the coast, but were not detected during our surveys. Further, secretive marsh species (e.g., rails) are known to be present at Graveline Bayou which is covered, in part, by the transect at Graveline Beach. However, rails were not detected at this site, largely due to their secretive nature. Alternate survey techniques are necessary to fully assess the avifauna using these habitats along the coast (e.g., North American Marsh Bird Monitoring protocol, marine avifauna protocols). Additionally, the timing of the surveys at each site was determined largely by a matter of convenience; the survey coordinator chose survey times that worked with his/her schedule. Thus, the survey times within a pulse for a given transect did not necessarily correspond with the optimal time to view the maximum number of individuals of any given species (i.e., low tide, when mud flats were exposed).

Because the ACBS protocol was designed to allow researchers to assess species richness and abundance at a site in a discrete area, rather than the assessment of critical behaviors by individual birds (e.g., foraging, loafing and/or roosting) and identification of areas important for fulfillment of these behaviors, additional monitoring protocols are necessary. To quantify behavior, we recommend that systematic censuses be implemented throughout the year such that multiple stationary counts (i.e., point counts) be conducted along each existing ACBS transect. All shorebirds should be identified and counted within sight and behavior quantified (flying, running, preening, loafing, foraging, etc.) Censuses should be stratified according to tide (e.g., during low and high tides present both diurnally and nocturnally; Handel and Gill 1992; Dodd and Colwell 1996) as behavior can differ due to the amount of open mudflats available as well as between daytime and nighttime. As anthropogenic disturbance of shorebird roosting sites has been shown to increase energetic costs and enhance predation risk (Peters and Otis 2007), understanding how birds use Mississippi's coastlines is critical for conserving this group of birds.

Lastly, it should be noted that these analyses did not control for effort or account for detection probability. Link and Sauer (1999) recommend controlling for effort when variation in effort exists (e.g., in the Christmas Bird Count or the Audubon Coastal Bird Survey), thus this should be taken into consideration for analyses of population trends. While detection probability likely varies little by site among the open flat sandy areas of the sites, detection likely differs in the surrounding areas that

consist of developed areas due to differing abilities to visually detect birds. Thus, analyses should proceed carefully. It is hypothesized that observer bias is minimized as the number of observers increases, however.

Implications for Conservation

The lack of critical baseline information has hindered conservation and management of coastal birds in Mississippi. This assessment of avifauna diversity and abundance is paramount to developing stewardship and best management practices for our priority coastal waterbird species to counter current and emergent threats and will aid Audubon in prioritizing areas for conservation work.

Working to combat extant pressures, including threats to habitat; competition for space; human-induced disturbances; predation; and the reduction of prey species, will aid in the recovery of not only Gulf of Mexico dependent bird populations but Mississippi's coastal environment as well (Lambeck, 1997; Sanderson et al, 2002). Maintaining and reducing threats to stopover habitat will allow migrant birds to put on fat stores more effectively, increasing the probability that they will reach breeding and wintering locations in better condition, which increases their chances of survival and reproductive success (Morrison, 2006; Skagen, 2006).

Restoring and buoying coastal bird populations will assist in the recovery of important coastal wetland, marine, and estuarine habitats impacted by the oil spill. Waterbirds are important engineers in coastal ecosystems; they contribute to a number of ecosystem services including water quality; sediment composition; dispersal of aquatic invertebrates including crustaceans, mollusks, and annelids; change in benthic species composition and abundance; pest control such as mosquitos (and globally, aid in removing invasive species); and act as bio-indicators of the overall health of a system. They also provide cultural services with recreational (bird watching) or spiritual (religious symbols) value (Green & ElMBERG 2013).

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APPENDIX

Table 1. National Audubon Society's Gulf Coast Species of Conservation Concern

Species	Annual Status
Brown Pelican (<i>Pelecanus occidentalis</i>)	Resident
Snowy Plover (<i>Charadrius nivosus</i>)	Breeding, Migration
Wilson's Plover (<i>Charadrius wilsonia</i>)	Breeding, Migration
Piping Plover (<i>Charadrius melodus</i>)	Wintering
American Oystercatcher (<i>Haematopus palliatus</i>)	Resident
Red Knot (<i>Calidris canutus rufa</i>)	Migration, Wintering
Sanderling (<i>Calidris alba</i>)	Migration, Wintering
Short-billed Dowitcher (<i>Limnodromus griseus</i>)	Migration, Wintering
Least Tern (<i>Sternula antillarum</i>)	Breeding, Migration
Black Skimmer (<i>Rynchops niger</i>)	Resident

Table 2. 2014-2015 Mississippi Audubon Coastal Bird Survey (ASCB) sites

Site Name	City, County	Description
Bayou Caddy	Lakeshore, Hancock County	Man-made shoreline
Buccaneer Beach	Waveland, Hancock County	Man-made shoreline
Ladner Pier	Waveland, Hancock County	Man-made shoreline
Washington Street Pier	Bay St Louis, Hancock County	Man-made shoreline
Menge Ave-Seal Ave	Pass Christian, Harrison County	Man-made shoreline
Jeff Davis Ave-Runnels Ave	Long Beach, Harrison County	Man-made shoreline
Moses Pier	Gulfport, Harrison County	Man-made shoreline
Debuys Rd-Cowan Rd	Gulfport, Harrison County	Man-made shoreline
Least Tern Area	Biloxi, Harrison County	Man-made shoreline
Front Beach	Ocean Springs, Jackson County	Man-made shoreline
Lake Mars	Ocean Springs, Jackson County	Natural shoreline
Graveline Beach	Ocean Springs, Jackson County	Natural shoreline
Pascagoula Beach	Pascagoula, Jackson County	Man-made shoreline
Singing River Island		Nearshore island
Deer Island (2 transects)		Nearshore island
West Ship Island		Barrier island
East Ship Island		Barrier island
Horn Island (2 transects)		Barrier island
Sand Island		Barrier island
Petit Bois Island		Barrier island

Table 3. List of species detected during 2014-2015 Mississippi Coastal Bird Surveys

Shorebirds	Wading Birds	Waterfowl	Landbirds	
American Avocet	American White Pelican	Black-bellied Whistling-Duck	American Crow	Marsh Wren
American Oystercatcher	Canada Goose	Blue-winged Teal	American Pipit	Mourning Dove
Baird's Sandpiper	Cattle Egret	Bufflehead	American Robin	Nelson's Sparrow
Black Skimmer	Clapper Rail	Common Goldeneye	Baltimore Oriole	Northern Cardinal
Black-bellied Plover	Double-crested Cormorant	Common Loon	Bank Swallow	Northern Flicker
Black-necked Stilt	Great Blue Heron	Gadwall	Barn Swallow	Northern Mockingbird
Dunlin	Great Egret	Greater Scaup	Belted Kingfisher	Northern Parula
Greater Yellowlegs	Green Heron	Hooded Merganser	Blue Grosbeak	Northern Rough-wing Swallow
Killdeer	Least Bittern	Horned Grebe	Blue Jay	Northern Rough-winged Swallow
Least Sandpiper	Little Blue Heron	Lesser Scaup	Blue-gray Gnatcatcher	Orange-crowned Warbler
Lesser Yellowlegs	Brown Pelican	Long-tailed Duck	Blue-headed Vireo	Orchard Oriole
Long-billed Curlew	Reddish Egret	Mallard	Boat-tailed Grackle	Painted Bunting
Long-billed Dowitcher	Roseate Spoonbill	Mottled Duck	Bobolink	Palm Warbler
Marbled Godwit	Snowy Egret	Northern Shoveler	Brown Thrasher	Pileated Woodpecker
Pectoral Sandpiper	Sora	Pied-billed Grebe	Brown-headed Cowbird	Pine Warbler
Piping Plover	Tricolored Heron	Red-breasted Merganser	Brown-headed Nuthatch	Prothonotary Warbler
Red Knot	Virginia Rail	Redhead	Carolina Chickadee	Purple Martin
Ruddy Turnstone	White Ibis	Ruddy Duck	Carolina Wren	Red-bellied Woodpecker
Sanderling	Yellow-crowned Night-Heron	Surf Scoter	Cedar Waxwing	Red-headed Woodpecker
Semipalmated Plover		Wood Duck	Chimney Swift	Red-winged Blackbird
Semipalmated Sandpiper	Pelagic		Chipping Sparrow	Rock Pigeon (Feral Pigeon)
Short-billed Dowitcher	Jaeger sp.		Cliff Swallow	Ruby-crowned Kinglet
Snowy Plover	Magnificent Frigatebird		Common Grackle	Ruby-throated Hummingbird
Western Sandpiper	Northern Gannet		Common Yellowthroat	Savannah Sparrow
Whimbrel			Downy Woodpecker	Scissor-tailed Flycatcher
White-rumped Sandpiper	Raptors		Eastern Bluebird	Seaside Sparrow
Willet	American Kestrel		Eastern Kingbird	Sedge Wren
Wilson's Plover	Bald Eagle		Eastern Meadowlark	Song Sparrow
Wilson's Snipe	Broad-winged Hawk		Eastern Phoebe	Summer Tanager
	Cooper's Hawk		Eastern Towhee	Swamp Sparrow
Gulls and Terns	Great Horned Owl		Empidonax sp.	Tennessee Warbler
Bonaparte's Gull	Merlin		Eurasian Collared-Dove	Tree Swallow
Black Tern	Mississippi Kite		European Starling	Tufted Titmouse
Caspian Tern	Northern Harrier		Fish Crow	Western Kingbird
Common Tern	Osprey		Gray Catbird	White-eyed Vireo
Forster's Tern	Peregrine Falcon		Great Crested Flycatcher	White-throated Sparrow
Franklin's Gull	Red-tailed Hawk		House Finch	White-winged Dove
Gull-billed Tern	Sharp-shinned Hawk		House Sparrow	Yellow Warbler
Herring Gull	Short-eared Owl		House Wren	Yellow-billed Cuckoo
Laughing Gull	Turkey Vulture		Indigo Bunting	Yellow-rumped Warbler
Least Tern			Loggerhead Shrike	
Ring-billed Gull				
Royal Tern				
Sandwich Tern				

Table 4. Abundance of Audubon's 10 coastal species of concern as detected during Mississippi 2014-2015 Coastal Bird Surveys and associated diversity data.

	County	Hancock	Hancock	Hancock	Hancock	Harrison	Harrison	Harrison	Harrison	Harrison	Jackson	Jackson	Jackson	Jackson	Nearshore	Nearshore	Barrier	Barrier	Barrier	Barrier	Barrier
Species*	Site	Bayou Caddy, Lakeshore	Buccaneer Beach, Waveland	Ladner Pier, Waveland	Washing-ton St. Pier, BayStLouis	Menge Ave-Seal Ave, Pass Christian	Jeff Davis Ave-Runnels Ave, LongBeach	Moses Pier, Gulfport	Debuys Rd-Cowan Rd, Gulfport	Least Tern Area, Biloxi	Front Beach, Ocean Springs	^Lake Mars, Ocean Springs	Graveline Beach, Ocean Springs	Pascagoula Beach, Pascagoula	^Deer Island	Singing River Island	East Ship Island	^Horn Island	Petit Bois Island	Sand Island	West Ship Island
American Oystercatcher	August						2						1			6					
	September		1				2	2			1		1	2	3	7					
	October						2														
	January				4	2					14	2	2		10	11	5			1	
	February		30										2		9	16		2			
	March				2								3		1	4	2			1	2
	April		2										4		4	6	4	4	2	4	4
	May	1											7		1	1					
Black Skimmer	August		6																		
	September	20	3				104	140		20			7			5					
	October	12	16			4	625	977	34	606					1	51					
	January				144	1	10	15		137											
	February	2			400			135													
	March			65	81	172	52	1296								86					
	April	1	35	15		800	237	507		239					3	1		1			
	May	2		17		423	11	2	70	135					4	3					
Brown Pelican	August	66	92									74									
	September	214	75			1	11	3	18	3	27	45	116			560					
	October	150	28			30	30	9	19	5	89	9	38	15	185	99					
	January	7	1		5	4	4	3		4	20	4	24	2	16	3	25	12	91	1	
	February	6	8		2	1		2				6	15	5	14	35	48	15	77	2	
	March	2	5		13	3	4	7	3	4	66	20	13	13	14	14	70	178	23	12	
	April	12	7		3	9	13	12	12	3	36	31	103	21	8	86	30	17	40	11	
	May	7	4		5	23	19	7	24	20	31	43	70	105	23	30					
Least Tern	August	24	5																		
	September															85					
	October																				
	January																				
	February																				
	March																				
	April	14	2	3	2	62	109	78	829	57	17	7	6	8	55	76	12	78	17	59	11
	May	12	6	6	10	88	29	75	684	426	32	12	7	3	62	124					
Piping Plover	August																				
	September	4						3								1					
	October	1				2		8						1	1						
	January				1	1							4		3		13	10		8	3
	February	2			1	4		1					4			3	15	16	1	3	1
	March				3	8									1		33	8		2	1
	April	1				2									3	1	13		7	3	7
	May														1						
Red Knot	August																				
	September																				
	October																				
	January																				
	February																				
	March																				
	April																4	29	1		
	May																				

Table 4. Abundance of Audubon's 10 coastal species of concern as detected during Mississippi 2014-2015 Coastal Bird Surveys and associated diversity data, cont.

	County	Hancock	Hancock	Hancock	Hancock	Harrison	Harrison	Harrison	Harrison	Harrison	Jackson	Jackson	Jackson	Jackson	Nearshore	Nearshore	Barrier	Barrier	Barrier	Barrier	Barrier
Species*	Site	Bayou Caddy, Lakeshore	Buccaneer Beach, Waveland	Ladner Pier, Waveland	Washington St. Pier, BayStLouis	Menge Ave-Seal Ave, Pass Christian	Jeff Davis Ave-Runnels Ave, LongBeach	Moses Pier, Gulfport	Debuys Rd-Cowan Rd, Gulfport	Least Tern Area, Biloxi	Front Beach, Ocean Springs	³Lake Mars, Ocean Springs	Graveline Beach, Ocean Springs	Pascagoula Beach, Pascagoula	⁴Deer Island	Singing River Island	East Ship Island	⁴Horn Island	Petit Bois Island	Sand Island	West Ship Island
Sanderling	August	74	14																		
	September	125	9			6	32	50	19	8	1					1					
	October	75	14			38	35	53	20	14	8		1	2	29	15					
	January	65	36	30	82	14	84		54	33	9	7	2		56	7	57	41	28	20	80
	February	17		20	17	11	32	4	17	55			1		31	11	46	74	46	19	59
	March	5		59	28	53	1	40			11				38	68	226	70	84	68	94
	April	29	9	19	21	79	77	95	26	17	7				37	90	88	122	153	70	104
	May	27	12	14	33	39	57	16	31	22	20				19	5					
Short-billed Dowitcher	August																				
	September	4	2					7					3								
	October	81					4	5	1	1			27		1						
	January	1	125	7									1		52	6	12	2			
	February	7	19										2		112	36					
	March	38	6										1		79		86				3
	April	15	40					2					15		74	5	112	71		4	26
	May	1	3										15		8	1					
Snowy Plover	August																				
	September					1															
	October					1	1														
	January					1									8		2	9		19	1
	February																5	11	10	4	4
	March																1	7	1	9	1
	April																	8	4	7	1
	May																				
Wilson's Plover	August																				
	September															1					
	October															2					
	January														1						
	February																1				
	March														8			5	1		2
	April														4	4	1	5	3	8	2
	May														6	3					

Table 4. Abundance of Audubon's 10 coastal species of concern as detected during Mississippi 2014-2015 Coastal Bird Surveys and associated diversity data, cont.

	County	Hancock	Hancock	Hancock	Hancock	Harrison	Harrison	Harrison	Harrison	Harrison	Jackson	Jackson	Jackson	Jackson	Nearshore	Nearshore	Barrier	Barrier	Barrier	Barrier	Barrier
Species*	Site	Bayou Caddy, Lakeshore	Buccaneer Beach, Waveland	Ladner Pier, Waveland	Washing-ton St. Pier, BayStLouis	Menge Ave-Seal Ave, Pass Christian	Jeff Davis Ave-Runnels Ave, LongBeach	Moses Pier, Gulfport	Debuys Rd-Cowan Rd, Gulfport	Least Tern Area, Biloxi	Front Beach, Ocean Springs	[‡] Lake Mars, Ocean Springs	Graveline Beach, Ocean Springs	Pascagoula Beach, Pascagoula	[^] Deer Island	Singing River Island	East Ship Island	[^] Horn Island	Petit Bois Island	Sand Island	West Ship Island
# Species of Concern Detected		7	6	4	6	7	6	7	5	5	4	4	7	5	9	8	9	10	8	8	8
# Species Detected per Pulse	Fall	58	61	N/A	N/A	33	37	29	28	30	30	48	98	47	62	76	N/A	N/A	N/A	N/A	N/A
	Winter	27	48	38	45	26	26	26	16	26	53	56	68	68	59	57	24	36	18	27	18
	Spring	60	71	30	41	39	40	45	39	37	41	54	86	52	85	100	35	51	39	35	34
# Species Shorebirds/ Gulls/Terns		32	27	19	22	24	22	26	21	20	18	18	36	23	34	31	25	29	24	24	24
# Species Waders		9	10	5	4	5	7	8	4	7	7	10	13	6	9	15	3	6	2	4	4
Total # Species		75	103	48	56	56	57	53	47	48	69	89	127	84	106	127	39	60	43	45	39

*Counts represent the maximum count of the 1-mile surveys conducted within the given month except where noted. [^]Represents the maximum count of the two transects surveyed within the given month. [‡]Represents counts per 0.6 mi.