



ALABAMA AUDUBON

Coastal Conservation Programs

2019 Report



Alabama Audubon
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The Alabama Coastal Bird Stewardship Program (ALCBSP) is a comprehensive conservation and research program protecting shorebirds and their habitats along the Alabama Gulf Coast. ALCBSP is funded by the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund with additional support from Alabama State Lands Division of the Department of Conservation and Natural Resources and is implemented by Alabama Audubon staff.

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Cover photo courtesy of Claudia Frosch. All photos were taken by Alabama Audubon and City of Orange Beach staff unless otherwise noted.

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Background

In North America, shorebirds have experienced a population loss of 37% between 1970 and 2017, with over 68% of species experiencing declining trends (Rosenberg et al. 2019). As a group, shorebirds face a variety of threats throughout the annual cycle, including habitat loss, increased predation pressure, and climate change. Knowledge of coastal bird reproductive success, habitat use, and survival are important in directing conservation and management strategies, and protection of habitat is increasingly important.

The Alabama coast consists of 60 miles of shoreline along the Gulf of Mexico, and another 600 miles along coastal bays and rivers. There are also several islands in the Mississippi Sound and Mobile Bay. These beach and island habitats support a diversity of bird species throughout the year; they are important for migratory birds and support numerous species during the breeding and nonbreeding seasons. Several coast-wide surveys and monitoring of specific species and/or locations along the Alabama coast have been conducted over the past four decades (Cooley 1987, Dindo et al. 1987, Robinson and Dindo 2008, Zdravkovic 2008). While these snapshots provide important information on the trends of coastal birds in Alabama, there has not been a consistent, coast-wide effort focused on examining the breeding success and management needs of beach-nesting birds.

The Alabama Coastal Bird Stewardship Program was established in 2017 and has two main components: (1) beach-nesting bird monitoring and stewardship, and (2) Audubon Coastal Bird Surveys. These two facets of our program allow us to collect data year-round. Our eleven priority species include Least Tern, Snowy Plover, Wilson's Plover, Piping Plover, Black Skimmer, American Oystercatcher, Short-billed Dowitcher, Red Knot, Sanderling, Reddish Egret, and Brown Pelican.



Beach-nesting Bird Stewardship



During 2018, 81 acres of nesting habitat were protected through symbolic fencing.

A total of 76 acres of beach and island habitat were protected through symbolic fencing in 2019.

Staff and volunteers conducted outreach and stewardship activities on the beach during holiday weekends and spring break in an effort to educate the public about nesting birds and minimize disturbance to colonies. We also attended outreach events throughout coastal Alabama.



Beach-nesting Bird Monitoring

2018

We began monitoring efforts in the breeding season of 2018. The first season largely focused on finding the nesting locations of priority species, protecting those sites, and collecting data on nest success. We monitored 23 Snowy Plover nests, which produced 7 fledglings (~0.41 fledglings/pair). A total of 18 Least Tern colony sites were found and monitored; we estimated 945 nests and a minimum of 100 fledglings (0.11 fledglings/pair maximum). Tern Island was the most productive site for Least Terns with 83 fledglings, despite extreme disturbance by recreationists. Two pairs of American Oystercatchers were monitored, and each pair fledged 3 young (3.00 fledglings/pair).



Audubon in Action

Birmingham Audubon Saves Terns After Beachgoers Destroy Hundreds of Eggs

Although the colony of some 600 Least Tern nests took a serious hit, the birds managed to fledge 83 chicks this year.

By Jillian Mock
August 07, 2018



In August 2018, people collected hundreds of Least Tern eggs on Tern Island, put them in a pile, then put up a volleyball net. Alabama Audubon staff were able to alert state authorities and save some of the eggs. There were ultimately 83 fledglings on Tern Island in 2018.

Beach-nesting Bird Monitoring

2019

In 2019, the Alabama Coastal Bird Stewardship Program consisted of one full-time coastal coordinator, one full-time biologist, and two part-time stewards with Alabama Audubon, and a subcontracted coastal stewardship coordinator with the City of Orange Beach. We completed a total of 1,034 solitary surveys and 147 colonial surveys for the 2019 season. Several volunteers also assisted with installing symbolic fencing and accessing nearshore islands.

In 2019, we were able to focus monitoring efforts on several priority sites (Table 1, Figures 1 and 2), and consequently were able to check nests at these sites a minimum of once weekly (for mainland sites) or twice monthly (for island sites). We collected data on adult behavior, number of eggs or chicks, signs of disturbance, and signs of predators within 15 meters of the nest. Upon nest or chick loss, we recorded likely causes of failure based on evidence near the nest, including predator tracks, eggshell fragments, washover/high tide marks, and wind-blown sand covering eggs. In several instances, the causes of failure had to be recorded as unknown due to lack of available evidence. In 2019, we deployed game cameras at several sites to document causes of failure and to obtain direct evidence of predation events (Table 1).

Table 1. Priority sites and species monitored during the 2019 breeding season.

Baldwin County	
Alabama Point, Orange Beach*	Least Tern
No Fly Zone, Orange Beach	Least Tern
Shallow Lot, Orange Beach	Least Tern
Bon Secour National Wildlife Refuge	Snowy Plover, Least Tern
Gulf State Park*	Snowy Plover
Beach Club, Fort Morgan*	Least Tern
Piggly Wiggly, Fairhope*	Least Tern
Mobile County	
Dauphin Island*	Snowy Plover, American Oystercatcher
Pelican Island	Snowy Plover, Least Tern
Tern Island	Least Tern, Black Skimmer, American Oystercatcher
Cat Island	Least Tern, American Oystercatcher
Coffee Island (Isle aux Herbes)	Least Tern, American Oystercatcher, Reddish Egret
Marsh Island	Black Skimmer

*Denotes sites where game cameras were deployed.

Beach-nesting Bird Monitoring



Figure 1. Beach-nesting bird monitoring sites in Baldwin County, Alabama.



Figure 2. Beach-nesting bird monitoring sites in Mobile County, Alabama.

Beach-nesting Bird Monitoring

Snowy Plover

Snowy Plovers are present year-round on the Alabama coast. They are small shorebirds that nest on unvegetated to slightly vegetated sand beaches. Plovers are solitary nesters and defend breeding territories. The species faces a suite of threats throughout the annual cycle (Page et al. 2009). Broadly, this includes habitat loss from human development and increased levels of human disturbance. Human disturbance can indirectly lead to nest loss, as adults will flush from eggs or young leaving them exposed to heat and predators. Direct mortality of nests and chicks has been caused by people, vehicles, pets, storms, and a host of predators including coyotes, foxes, American Crows, Common Ravens, and striped skunks (Page et al. 2009). Snowy Plovers are listed as 'highest conservation concern' in Alabama (ADCNR 2015).



In 2019, Snowy Plovers nested at three sites, with the majority nesting at Bon Secour National Wildlife Refuge (Table 2, Figures 3 and 4). Overall productivity was 0.33 fledglings/pair.

Table 2. Snowy Plover nest data at three sites in Alabama in 2019.

Site	# Pairs	# Successful nests	# Failed nests	# Chicks	# Fledged
Bon Secour	11	8	12	19	5
Gulf State Park	3	3	1	7	1
Dauphin Island	4	1	15	3	0



Figure 3. Locations of Snowy Plover nests in Baldwin County, AL, in 2019.

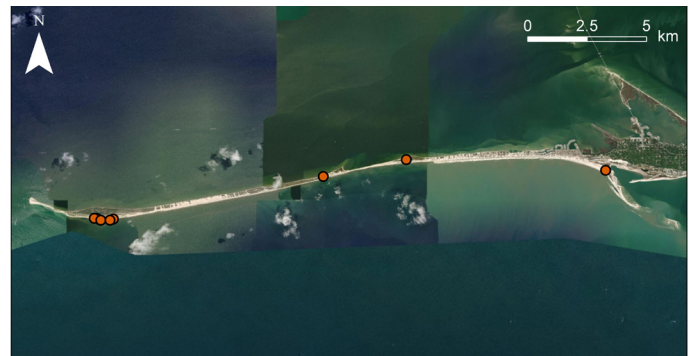


Figure 4. Locations of Snowy Plover nests in Mobile County, AL, in 2019.

Beach-nesting Bird Monitoring

Predation accounted for 65% of the known causes of nest failure (Table 3); both coyotes and foxes were captured on game cameras depredate plover nests (Figures 5 and 6).



Figure 5. Coyote depredate a Snowy Plover nest at Gulf State Park, AL, in June 2019.



Figure 6. Foxes depredate a Snowy Plover nest at the far west end of Dauphin Island, AL, in June 2019.

Table 3. Causes of Snowy Plover nest failure in 2019.

Cause of failure	# Nests
Predation: ghost crab	5
Predation: coyote	2
Predation: fox	2
Predation: unknown	2
Wind	2
Storm/Overwash	2
Abandoned	2
Unknown	6



Ghost crabs were the cause of failure for five Snowy Plover nests in 2019.

Beach-nesting Bird Monitoring

Snowy Plover nest survival analyses were conducted using RMark (Laake 2019). We tested four models and used the Akaike information criterion corrected for small samples sizes (AIC_c) to determine the best model (Table 4). We also calculated pseudo R^2 values (Nagelkerke 1991) to determine how well each model explained variation in nest survival. Constant daily survival rate (DSR) during the incubation period was 0.95 and the probability of a nest surviving the 30-day incubation period was 0.21. The top model in our analysis included the ‘site’ covariate and it explained 37% of the variation in nest survival (Table 5). Gulf State Park had the highest survival rate at 0.98 DSR and 0.68 for the incubation period. Bon Secour followed with 0.96 DSR and 0.34 for the incubation period and Dauphin Island had the lowest survival estimates at 0.84 DSR and 0.007 for the incubation period. These estimates were derived from one year of data and a small sample size; additional data collected during future seasons will allow for more accurate daily survival rate estimates.

Table 4. Covariates used in Snowy Plover nest survival analysis.

Model	Justification
Constant	Survival is constant.
Time	Survival decreases later in the season (Koczur et al. 2014).
Nest Age	Survival increases with nest age (Dinsmore et al. 2002).
Site	Survival varies by site.

Table 5. Summary of model results for Snowy Plover nest survival analysis.

Model	K	AIC_c	ΔAIC_c	w_i	Dev	Pseudo R^2
Site	3	130.78	0.00	0.99	124.73	0.37
Nest Age	2	139.92	9.13	0.01	135.89	0.13
Constant	1	142.64	11.85	0.00	140.63	0.00
Time	2	144.65	13.87	0.00	140.63	0.00

Beach-nesting Bird Monitoring

Many of the Snowy Plovers that nested at Baldwin County sites were banded, which allowed us to record locations for individual birds. We then used those locations to map their breeding territories. Mapping territories helps us understand how the plovers are using the habitat during the breeding season, and may provide insight into habitat management needs.

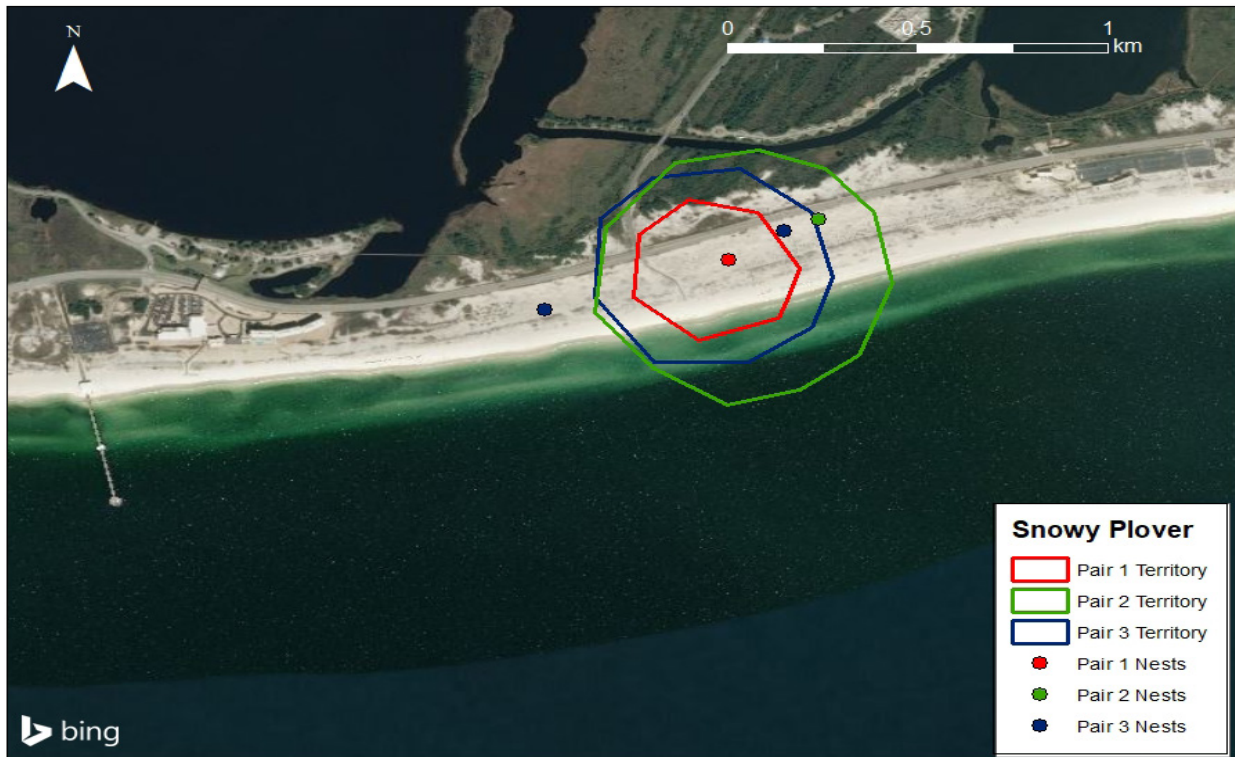


There were two known pairs with breeding territories on the Fort Morgan peninsula in 2019.

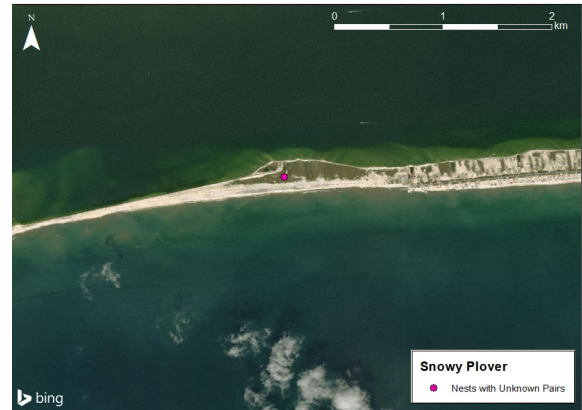


There were eight known pairs with breeding territories on the Perdue Unit of Bon Secour National Wildlife Refuge in 2019.

Beach-nesting Bird Monitoring



There were three known pairs with breeding territories at Gulf State Park in 2019.



There were several pairs of Snowy Plovers that nested along Dauphin Island in 2019; however, most were unbanded making it impossible to determine each pair's territory. We are hoping to continue banding efforts on Dauphin Island in the coming years.

Beach-nesting Bird Monitoring

Least Tern

Least Terns are the smallest tern species in North America. They are present in Alabama during the breeding season, and winter along the coasts of Mexico, Central America, and South America. Least Terns nest in colonies of tens to hundreds of pairs on mainland beaches, offshore islands, and gravel rooftops. Nests are shallow scrapes in the sand. Terns face similar threats as Snowy Plovers; nests and chicks can be lost due to flooding by high tides and storm events, and eggs can die if exposed to extreme temperatures (as when adults are disturbed and flushed from the nest). Predators of eggs and chicks include American Crow, Fish Crow, Common Raven, Boat-tailed Grackle, gulls, Great Horned Owl, red fox, coyote, raccoon, striped skunk, ghost crab, cats, and dogs, among others (Thompson et al. 1997). Least Terns are listed as ‘moderate conservation concern’ in Alabama.



Least Terns nested at 10 sites in 2019 (Table 4, Figures 7 and 8). There was a minimum of 660 breeding pairs; however, only 15 fledglings were produced leading to a maximum productivity estimate of 0.02 fledglings/pair.

Table 4. Estimates from Least Tern colonies during the 2019 breeding season.

Site	# Pairs	# Nests	# Failed nests	# Chicks	# Fledged
Bon Secour	1	1	1	1	0
Beach Club	26	39	17	7	5
Alabama Point	124	124	~118	7	6
No Fly Zone	11	11	3+	8	3
Shallow Lot	4	4	3	1	0
Piggly Wiggly	58	68	68	13	0
Pelican Island	57	58	58	0	0
Coffee Island	12	12	12	0	0
Cat Island	5	8	8	0	0
Tern Island	613	613	563	47	1
Total	911*	938	851	84	15

*Maximum number of pairs. There were likely pairs that re-nested after nest failure. The estimated minimum number of pairs at all sites monitored was 660, based on timing of failure and initiation of new colonies. The overall productivity estimate for LETE was based on a total of 660 pairs.

Beach-nesting Bird Monitoring



Figure 7. Least Tern nesting colony locations in Baldwin County, AL, in 2019.

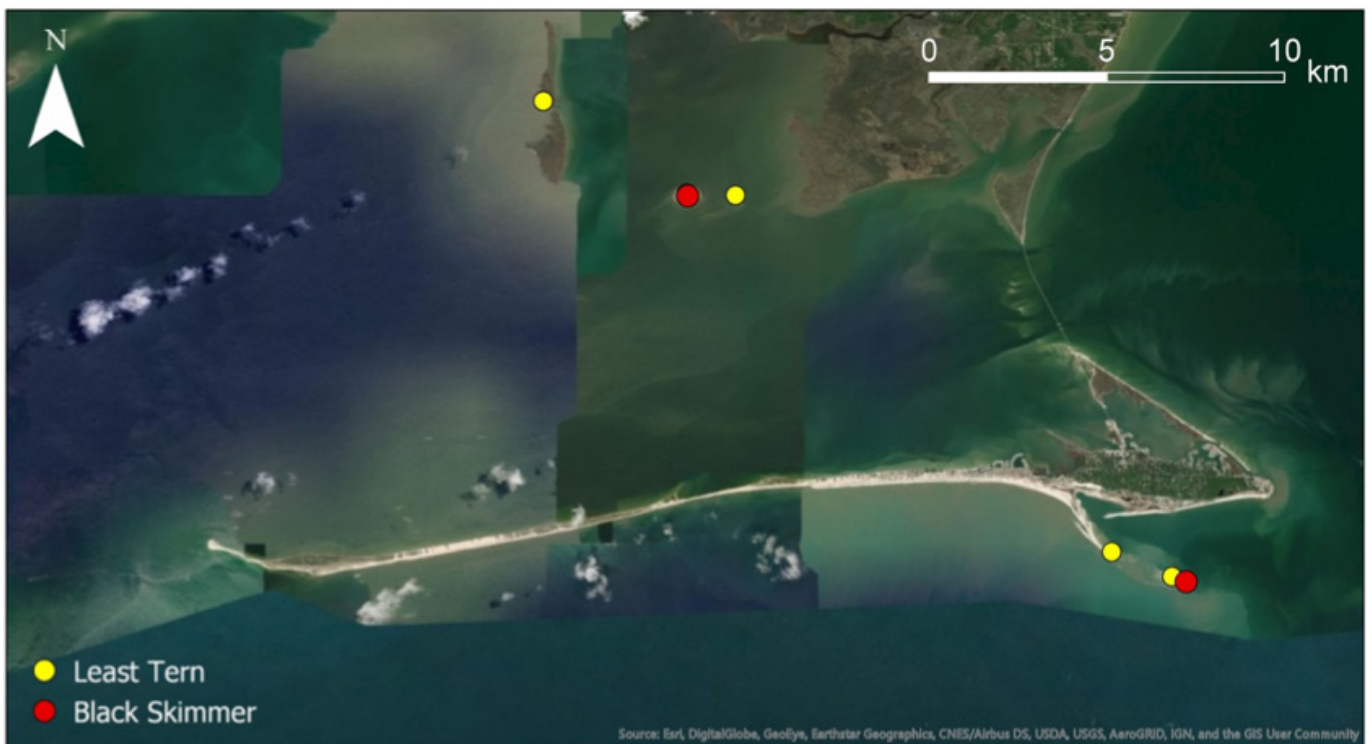


Figure 8. Least Tern and Black Skimmer nesting colony locations in Mobile County, AL, in 2019.

Beach-nesting Bird Monitoring

Least Tern colony failure at Alabama Point in Orange Beach was attributed to predation by coyotes (Figure 9). On islands, nests were lost due to overwash from storm-related high tides. We monitored one rooftop site (Piggly Wiggly; Table 4) that successfully hatched chicks but did not produce any fledglings. The game camera did not capture the cause of nest and chick failure, but we assumed it was avian predation.



Figure 9. Coyote at Alabama Point in Orange Beach, Alabama, in 2019.



Signs of disturbance and/or nest failure include predator tracks (left) and footprints (right) in the sand. The footprints were ~12" from a Snowy Plover nest, shown in the yellow circle.

Beach-nesting Bird Monitoring

Black Skimmer

Black Skimmers are unique birds with a distinctive bill and foraging strategy. They fly just above the water and use their lower bill to skim the surface for small fish. Black Skimmers are present year-round in Alabama. Like Least Terns, skimmers nest in colonies that range in size from tens to hundreds of pairs. In Alabama they tend to utilize islands for nesting, as they are generally free from disturbance and mammalian predators. Skimmers are highly sensitive to disturbance, which can lead to complete abandonment of a colony. Flooding, storms, and predation are also known causes of colony failure (Gochfeld and Burger 1994). Skimmers are listed as a species of 'moderate conservation concern' in Alabama. Black Skimmers historically nested along Alabama's barrier beaches; however, to date, the only known locations where Black Skimmers breed in Alabama is on nearshore islands. This may be a direct result of increased predator pressures, human disturbance, and habitat loss in the last decade.



Black Skimmer nesting was restricted to two islands, Tern and Marsh (Table 5). Although 63 fledglings were produced, overall productivity was low at 0.42 fledglings/pair. Fifty chicks were lost to overwash from storm-driven high tides on Tern Island.

American Oystercatcher

American Oystercatchers are charismatic shorebirds that can be found in Alabama year-round. They nest solitarily and defend territories during the breeding season. Oystercatchers nest on sand and shell beaches of barrier islands and nearshore islands. They make a shallow scrape for a nest that is usually near vegetation. Oystercatchers are sensitive to human disturbance and habitat loss. Storm events and high tides can lead to nest and chick loss. Predators of eggs and chicks include gulls, raccoons, foxes, coyotes, and cats, among others. The American Oystercatcher is listed as 'highest conservation concern' in Alabama (ADCNR 2015).



American Oystercatchers nested on three islands (Table 5) as well as one nest attempt at the far west end of Dauphin Island, which was unsuccessful. We assumed that the pair that nested on Dauphin Island re-nested on Tern Island, therefore overall productivity for oystercatchers was 1.0 fledglings/pair. Nest failure was likely a result of predation by foxes on Dauphin Island and overwash on Tern Island.

Beach-nesting Bird Monitoring

Reddish Egret

Reddish Egret breeding pairs have been historically low in Alabama. We documented one breeding pair in 2019 on Coffee Island. The pair successfully produced two fledglings.



Other Colonial Nesters

Caspian Terns, Gull-billed Terns, Royal Terns, and Sandwich Terns also nested on Marsh Island (Table 5). Royal Terns occurred in the greatest numbers on Marsh Island and had the highest productivity.



Table 5. Estimates from offshore islands during 2019 breeding season.

Site	Species	# Pairs	# Nests	# Chicks	# Fledglings	Productivity (F/pair)
Coffee Island	AMOY	2	2	4	3	1.50
Cat Island	AMOY	1	1	1	1	1.00
Tern Island	AMOY	1	1	0	0	0.00
Tern Island	BLSK	31	31	51	1	0.03
Marsh Island	BLSK	150	245	unk	63	0.42
Marsh Island	CATE	60	unk	78	23	0.38
Marsh Island	GBTE	45	25	19	19	0.42
Marsh Island	ROYT	887	unk	1,307	1,090	1.23
Marsh Island	SATE	276	unk	414	125	0.45

*Marsh Island counts conducted separately by Alabama Audubon staff and Dr. John Dindo of the Dauphin Island Sea Lab. AMOY: American Oystercatcher, BLSK: Black Skimmer, CATE: Caspian Tern, GBTE: Gull-billed Tern, ROYT: Royal Tern, SATE: Sandwich Tern

Heat-exposure Pilot Study

Prolonged exposure to extreme heat can cause mortality of eggs and chicks. Exposure can be caused by disturbance events; for example, if a person walks into a colony and flushes the adults from their nests, the eggs or chicks are left unprotected from heat and predators. We used chick shelters at several of our colony sites in order to provide shade for adults and young and have observed them being used. In 2019, we conducted a small pilot study focused on determining the difference in surface temperatures between full sun and shade at two Least Tern colonies, a rooftop site (Piggly Wiggly) and a mainland site (Beach Club).

In order to record temperature at these sites, we placed one Thermochron iButton (DS1921G, Embedded Data Systems) in full sun and one in shade at each of the two sites. The units were programmed to record the temperature every 30 minutes. Once the colonies were no longer active, the iButtons were collected and data were downloaded. There was a ~19°F difference in the average day time (08:00-19:00) temperature at the Piggly Wiggly rooftop site between full sun and shade and a more extreme difference in maximum temperature (Table 6, Figure 10). There was a 10°F difference at the Beach Club site (Table 6, Figure 11). The difference in the average day time temperatures was significant for both Piggly Wiggly ($t_{1085.6} = 27.27, p < 0.05$) and Beach Club ($t_{954.5} = -15.99, p < 0.05$).

Table 6. Average daytime temperatures and maximum temperatures (°F) at two Least Tern colony sites in full sun and in shade.

	Piggly Wiggly		Beach Club	
	Sun	Shade	Sun	Shade
Day time	107.0	88.4	101.1	91.8
Maximum	142.7	105.8	128.3	104.9



Chick shelters were placed at three colony sites, Alabama Point, Beach Club, and Piggly Wiggly. These structures were used by adults and chicks for shelter and shade. Adults also shade young birds to protect them from overheating.

Heat-exposure Pilot Study

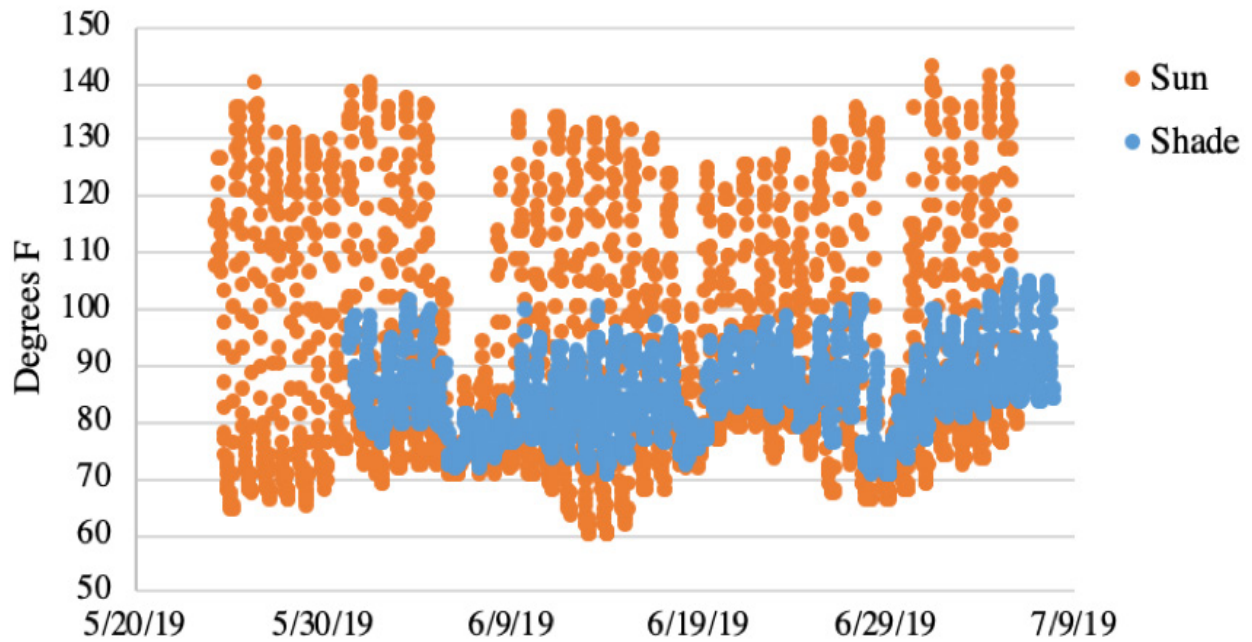


Figure 11. Temperatures on the Piggly Wiggly rooftop (Fairhope, AL) in full sun and shade from 24 May to 8 July 2019.

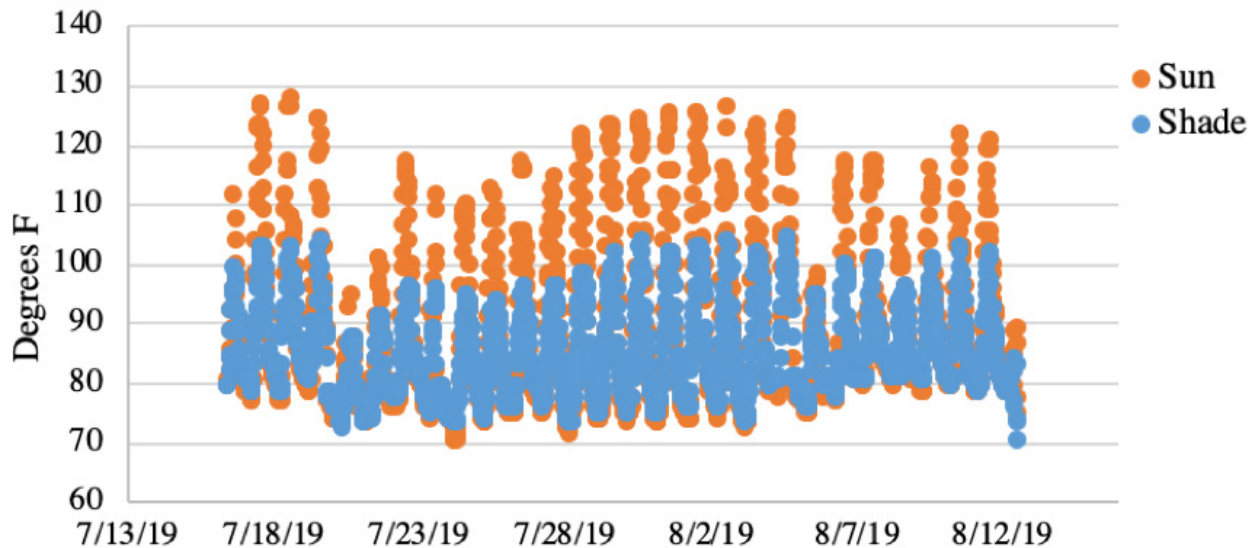
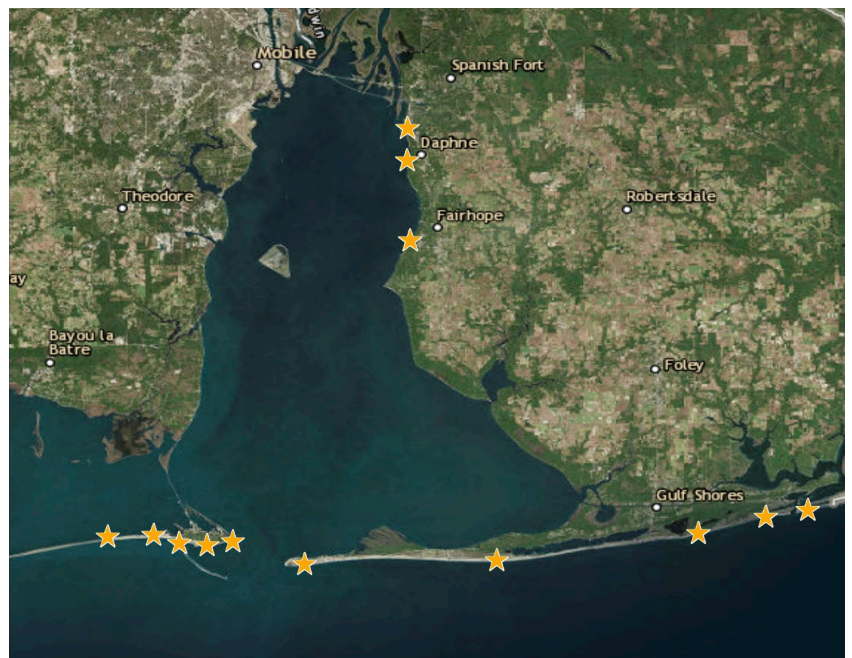


Figure 12. Temperatures at the Beach Club Least Tern colony site in full sun and shade from 16 July to 12 August 2019.

Audubon Coastal Bird Surveys

Audubon Coastal Bird Surveys are conducted across the northern Gulf of Mexico, providing regional information on coastal bird populations and habitat use. Staff and volunteers conduct these surveys each fall, winter, and spring. The fall pulse consists of six survey days during August-October, the winter pulse is three survey days during January-February, and the spring pulse is six survey days during March-May. Each survey is conducted within set 14-day intervals. Surveys were conducted along thirteen routes, and additional routes will be added beginning in the winter of 2020. Standardized protocols developed by National Audubon Society are followed for data collection. Every species and individual bird that is seen during a survey is recorded.

Audubon Coastal Bird Surveys were conducted along 13 routes during 2019 and 35 volunteers contributed ~360 hours to surveys.



Priority Species

With beach-nesting bird monitoring and Audubon Coastal Bird Surveys, Alabama Audubon is present on the coast year-round. This provides a unique opportunity to collect data on our priority species throughout the annual cycle. Staff and volunteers collected 210 records of priority birds during January–August of 2019 (Table 7, Figures 13-18). Nearly 40% of the records were from Pelican Island and each of the species was seen at that site aside from Wilson’s Plover (Figure 15).

Table 7. Data collected on priority species during January-August 2019.

Species	# Records	Max. individuals/record
American Oystercatcher	19	3
Piping Plover	41	8
Reddish Egret	46	5
Red Knot	5	6
Snowy Plover	91	15
Wilson’s Plover	8	2



Red Knot (left), Piping Plover (center, courtesy of Greg Harber), Wilson’s Plover (right, courtesy of Bill Summerour).

Priority Species

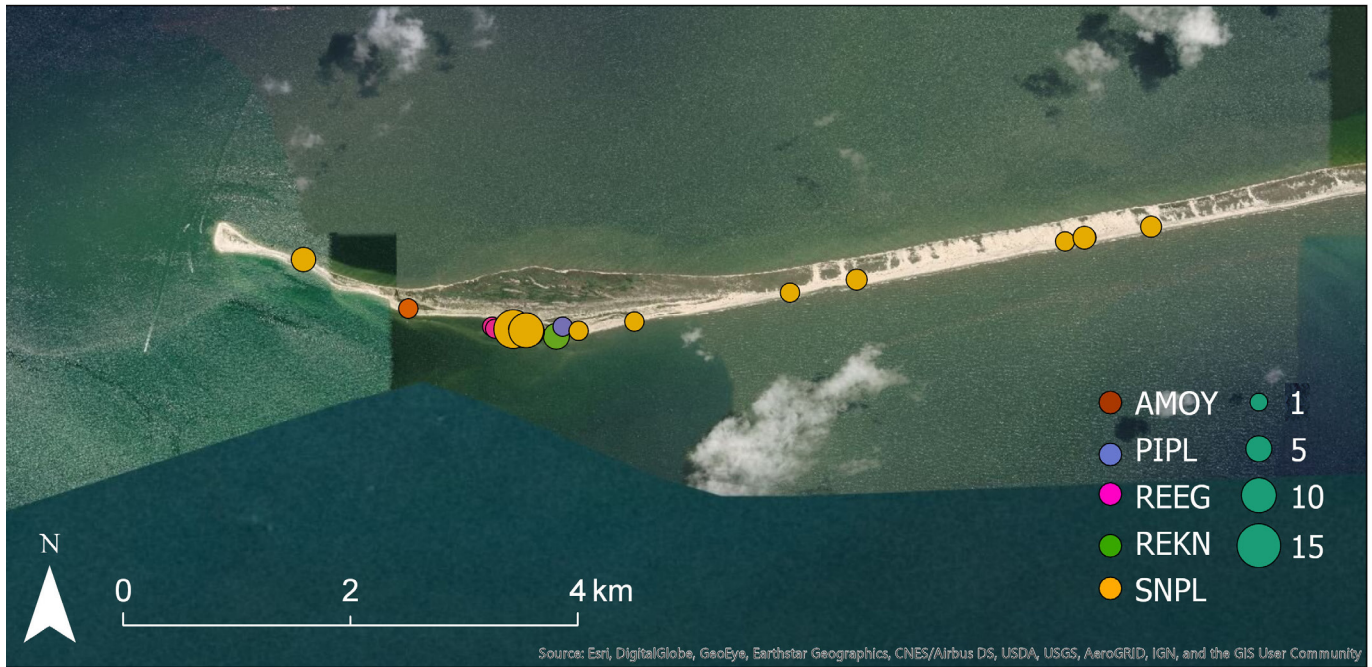


Figure 13. Priority bird locations on Dauphin Island, AL, during January–August 2019.



Figure 14. Priority bird locations on Dauphin Island, AL, during January–August 2019.

Priority Species



Figure 15. Priority bird locations on Dauphin Island, AL, during January–August 2019.



Figure 16. Priority bird locations at Bon Secour National Wildlife Refuge, AL, during January–August 2019.

Priority Species

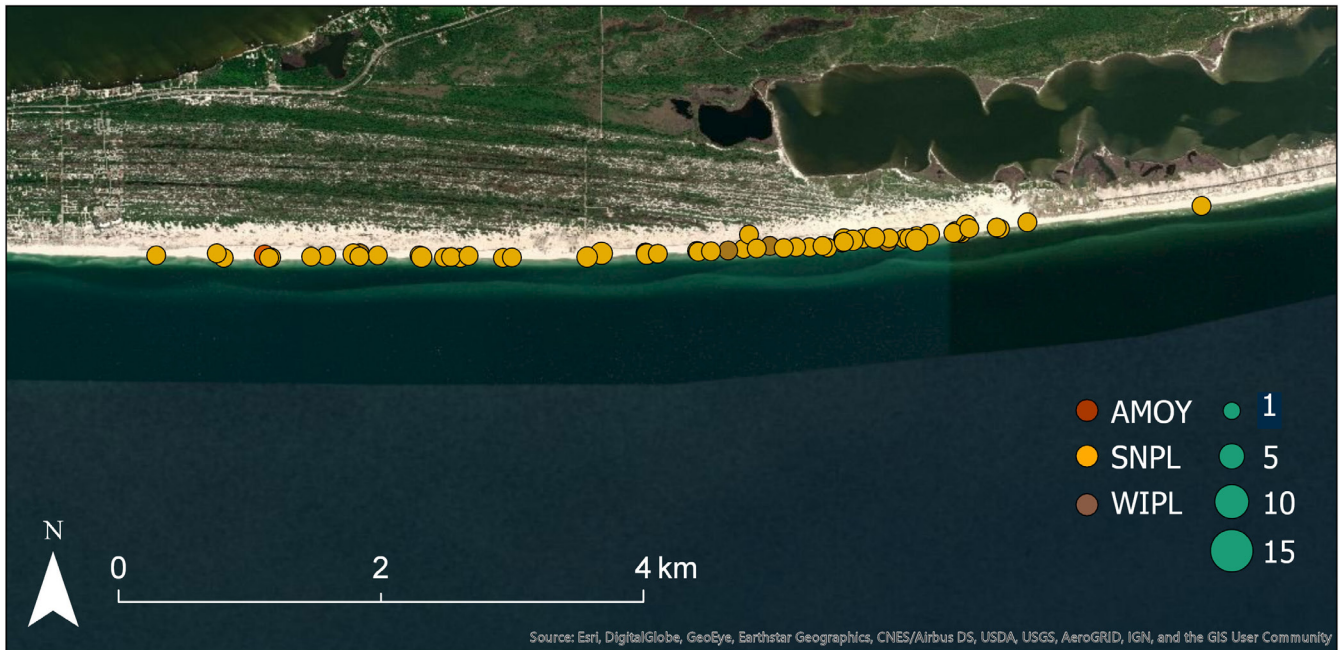


Figure 17. Priority bird locations along Bon Secour National Wildlife Refuge, AL, during January–August 2019.



Figure 18. Priority bird locations in Orange Beach, AL, during January–August 2019.

Banded Birds

Alabama Audubon staff began banding American Oystercatchers and Snowy Plovers in 2019 in order to learn more about these species' habitat use, movements, reproductive success, and survival. Four oystercatcher chicks were banded, one of which was resighted along the Florida panhandle, > 200 miles from its natal grounds. This is the first evidence of juvenile dispersal for Alabama oystercatchers. Five Snowy Plovers were banded at two sites on Dauphin Island. These efforts will yield important data on these species and in conjunction with monitoring data will help us to make informed management decisions.



American Oystercatcher 'JB' was banded on Coffee Island, AL, in May 2019 prior to fledgling (pictured above). It was resighted along the Florida panhandle in September 2019 (left, photo courtesy of Ezra Thompson).



A total of five Snowy Plovers were banded on Dauphin Island, AL, in 2019 by Alabama Audubon and Audubon Mississippi staff (bottom).



Banded Birds

Our year-round presence also allows us to record any banded birds that are seen along the Alabama coast. During January–August of 2019, 22 of the 41 Piping Plover records and 72 of the 91 Snowy Plover records included banded individuals. We recorded resight data for 116 individual banded birds (Table 8). We created 95% minimum convex polygons using adehabitatHR (Calenge 2019) in program R for 18 individual plovers that had > 24 resights. The average home range size was 282.8 ha and ranged from 7.7 to 1,900.2 ha. Individuals with a larger home range size were resighted on both Dauphin Island and the Fort Morgan/Bon Secour area of the coast.

Table 8. Number of banded bird resights recorded for Piping Plovers and Snowy Plovers during January–August 2019 in Alabama.

Species	# Resights	# Individuals
Piping Plover	27	17
Snowy Plover	1,034	99



Staff and members of the public collect resight data for banded Snowy Plovers (above) along the coast of Alabama.

Locations of two banded Snowy Plovers (left) show individual differences in habitat use and movements across the annual cycle.

Literature Cited

- Calenge, C. 2019. Home range estimation in R: the adehabitatHR package. <https://cran.r-project.org/web/packages/adehabitatHR/vignettes/adehabitatHR.pdf>
- Cooley, C.D. 1987. Status of colonial seabird resources in coastal Alabama in Symposium on the Natural Resources of the Mobile Bay Estuary, Lowery, T.A., ed., Alabama Sea Grant Extension Service, Mobile, AL pp. 56-66.
- Dindo, J. J., K. R. Marion and D. C. Holliman. 1987. Evaluation of colonial nesting habitats: Cat Island, Little Dauphin Island, and surrounding areas in Symposium on the Natural Resources of the Mobile Bay Estuary, Lowery, T.A., ed., Alabama Sea Grant Extension Service, Mobile, AL pp. 67-72.
- Dinsmore, S. J., G. C. White and F. L. Knopf. 2002. Advanced techniques for modeling avian nest survival. *Ecology* 83: 3476-3488.
- Gochfeld, M. and J. Burger. 1994. Black Skimmer (*Rynchops niger*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Koczur, L. M., A. E. Munters, S. A. Heath, B. M. Ballard, M. C. Green, S. J. Dinsmore and F. Hernandez. 2014. Reproductive success of the American oystercatcher (*Haematopus palliatus*) in Texas. *Waterbirds* 37: 371-380.
- Laake, J. 2019. Package 'RMark'. R Code for Mark Analysis. <https://cran.r-project.org/web/packages/RMark/RMark.pdf>
- Nagelkerke, N. J. D. 1991. A note on a general definition of the coefficient of determination. *Biometrika* 78: 691-692.
- Page, G. W., L. E. Stenzel, J. S. Warriner, J. C. Warriner and P. W. Paton. 2009. Snowy Plover (*Charadrius nivosus*), version 2.0 In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Robinson, O. J. and J. J. Dindo. 2008. Survey for colonial nesting birds on seven islands of coastal Alabama. *Alabama BirdLife* 54: 37-43.
- Rosenberg, K.V., A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr and P. P. Marra. 2019. Decline of the North American avifauna. *Science* 366: 120-124.
- Thompson, B. C., J. A. Jackson, J. Burger, L. A. Hill, E. M. Kirsch and J. L. Atwood. 1997. Least Tern (*Sternula antillarum*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.
- Zdravkovic, M. 2008. Beach-nesting bird breeding Census and Report for Coastal Alabama- 2007 Report, Audubon Coastal Bird Conservation Program, Science Dept. National Audubon Society, New York, NY

Appendix

Common and scientific names of species included in this document.

Birds

American Crow	<i>Corvus brachyrhynchos</i>
American Oystercatcher	<i>Haematopus palliatus</i>
Black Skimmer	<i>Rynchops niger</i>
Black-necked Stilt	<i>Himantopus mexicanus</i>
Boat-tailed Grackle	<i>Quiscalus major</i>
Brown Pelican	<i>Pelecanus occidentalis</i>
Caspian Tern	<i>Hydroprogne caspia</i>
Common Raven	<i>Corvus corax</i>
Fish Crow	<i>Corvus ossifragus</i>
Great Horned Owl	<i>Bubo virginianus</i>
Least Tern	<i>Sternula antillarum</i>
Piping Plover	<i>Charadrius melodus</i>
Reddish Egret	<i>Egretta rufescens</i>
Red Knot	<i>Calidris canutus</i>
Royal Tern	<i>Thalasseus maximus</i>
Sanderling	<i>Calidris alba</i>
Sandwich Tern	<i>Thalasseus sandvicensis</i>
Short-billed Dowitcher	<i>Limnodromus griseus</i>
Snowy Plover	<i>Charadrius nivosus</i>
Wilson's Plover	<i>Charadrius wilsonia</i>

Mammals

Coyote	<i>Canis latrans</i>
Red Fox	<i>Vulpes Vulpes</i>