
SOUTH CAROLINA COOPERATIVE FISH & WILDLIFE RESEARCH UNIT



ANNUAL REPORT

2019 & 2020

In 2019 & 2020, the South Carolina Cooperative Fish & Wildlife Research Unit continued to engage our cooperators to address natural resource questions and issues. Unit scientists advised and mentored graduate students in both M.S. and Ph.D. programs, taught graduate classes, and provided technical assistance to cooperators.

South Carolina Cooperative Fish & Wildlife Research Unit



South Carolina sunset; Pelican and egrets in Alabama; Prairie-chicken survey route in Kansas; Loblolly pines in South Carolina

260 Lehotsky Hall
Clemson University
Clemson, SC 29634

Phone: 864-656-0168
www.f.usgs.gov/coopunits/unit/SouthCarolina

Cooperators:

U. S. Geological Survey
Clemson University
South Carolina Department of Natural Resources
U. S. Fish and Wildlife Service
Wildlife Management Institute

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COOPERATORS AND PERSONNEL

COORDINATING COMMITTEE

United States Geological Survey

John Thompson, Acting Chief, Cooperative Research Units

Barry Grand, Regional Supervisor, Cooperative Research Units

South Carolina Department of Natural Resources

Robert Boyles, Director, South Carolina Department of Natural Resources

Emily Cope, Deputy Director for Wildlife and Freshwater Fisheries, South Carolina Department of Natural Resources

Billy Dukes, Chief of Wildlife, South Carolina Department of Natural Resources

Ross Self, Chief of Fisheries, South Carolina Department of Natural Resources

Clemson University

Keith Belli, Dean, College of Agriculture, Forestry and Life Sciences, Clemson University

Paula Agudelo, Associate Dean of Research, College of Agriculture, Forestry and Life Sciences, Clemson University

Tom Straka, Interim Chair, Forestry and Environmental Conservation, Clemson University

Todd Petty, Chair, Forestry and Environmental Conservation, Clemson University

Wildlife Management Institute

Steve Williams, President, Wildlife Management Institute

UNIT PERSONNEL

Patrick Jodice, Unit Leader, U.S. Geological Survey, and Professor, Department of Forestry and Environmental Conservation, Clemson University

Beth Ross, Assistant Unit Leader-Wildlife, U.S. Geological Survey, and Assistant Professor, Department of Forestry and Environmental Conservation, Clemson University

Brenna Byler, Administrative Assistant, South Carolina Cooperative Fish & Wildlife Research Unit and Department of Forestry and Environmental Conservation, Clemson University

Pamela Michael, Post-Doctoral Research Associate, South Carolina Cooperative Fish & Wildlife Research Unit and Department of Forestry and Environmental Conservation, Clemson University

Yvan Satgé, Research Specialist, South Carolina Cooperative Fish & Wildlife Research Unit and Department of Forestry and Environmental Conservation, Clemson University

Welcome



Robert Boyles

Robert Boyles is the director of the South Carolina Department of Natural Resources. He has worked for DNR for over 22 years and has been a member of senior DNR leadership for over 16 years. Robert has served as Deputy Director for Marine Resources since 2003.



Todd Petty

The SC Unit is pleased to introduce the new Chair for the Department of Forestry and Environmental Conservation, Dr. Todd Petty. Originally from Richmond, VA, Dr. Petty taught and conducted research at West Virginia University for 21 years before joining the Clemson University faculty.

COLLABORATORS

Clemson University

Robert Baldwin, Department of Forestry and Environmental Conservation
Kyle Barrett, Department of Forestry and Environmental Conservation
Troy Farmer, Department of Forestry and Environmental Conservation
Cathy Jachowski, Department of Forestry and Environmental Conservation
David Jachowski, Department of Forestry and Environmental Conservation
Richard Kaminski, James C. Kennedy Waterfowl and Wetlands Conservation Center
Brandon Peoples, Department of Forestry and Environmental Conservation
Robert Powell, Parks, Recreation and Tourism Management
Matt Brownlee, Parks, Recreation and Tourism Management
Thomas Rainwater, Department of Forestry and Environmental Conservation
John Rodgers, Department of Forestry and Environmental Conservation
Shari Rodriguez, Department of Forestry and Environmental Conservation

South Carolina Department of Natural Resources Cooperators

Jay Cantrell, Assistant Big Game Program Coordinator
Jamie Dozier, Tom Yawkey Wildlife Center
Christy Hand, Wildlife Biologist
Michael Hook, Small Game Program Coordinator
Molly Kneece, **Waterfowl Biologist**
Mary Catherine Marin, Wildlife Biologist
Mark McAlister, Wildlife Biologist, Tom Yawkey Wildlife Center
Charles Ruth, Big Game Program Coordinator
Felicia Sanders, Wildlife Biologist
Mark Scott, Fisheries Biologist
Michael Small, Assistant Small Game Program Coordinator
Amy Tegeler, Bird Conservation Coordinator
Janet Thibault, Wildlife Biologist

Federal Agency Cooperators

Laurel Barnhill, USFWS
Sarah Dawsey, USFWS Cape Romain Natural Wildlife Refuge
Dean Demarest, USFWS
Deborah Epperson, USGS WARC
Lance Garrison, NOAA/NMFS
Jeff Gleason, USFWS
Heath Hagy, USFWS
Kristin Hart, USGS

David Haukos, USGS Kansas Cooperative Fish and Wildlife Research Unit
Mike Hooper, USGS
Scott Johnston, USFWS
Mona Kalil, USGS
Meg Lamont, USGS
Susan Loeb, Southern Research Station, USFS
Jim Lyons, USGS
Clint Moore, USGS Georgia Cooperative Fish and Wildlife Research Unit
Dave Moran, BOEM
Rebekah Reid, USFWS
Anthony Roberts, USFWS
Emily Silverman, USFWS
John Stanton, USFWS
Melanie Steinkamp, USGS
Craig Watson, USFWS Ecological Services, Charleston, SC
Tim White, BOEM
Randy Wilson, USFWS
Bureau of Ocean Energy Management
USFWS Region 4, Cape Romain Natural Wildlife Refuge
USFWS Migratory Bird Program
USFWS Ecological Services
USFS Southern Forest Experiment Station
National Park Service, Congaree National Park
Smithsonian Migratory Bird Center

Private Sector Cooperators

Nemours Wildlife Foundation
Society for the Conservation and Study of Caribbean Birds
Terra Mar, LLC

Cooperating Scientists from other Colleges, Universities, and Institutes

Erik Blomberg, University of Maine
Lisa Ferguson, Wetlands Institute
Auriel Fournier, Illinois Natural History Survey
Peter Frederick, University of Florida
Christian Hagen, Oregon State University
Chris Haney, Terra Mar, LLC
Autumn-Lynn Harrison, Smithsonian Institute
William Mackin, Terra Mar, LLC
Hannah Madden, Ecological Professionals, St. Eustatius National Parks

Hannah Nevins & Brad Keitt, American Bird Conservancy

Ernst Rupp, Grupo Jaragua, the Dominican Republic

Mark Woodrey, Mississippi State University

Susan Zaluski, Jost van Dyke Preservation Society, British Virgin Islands

Elise Zipkin, Michigan State University

GRADUATE EDUCATION

CURRENT STUDENTS

Michael Adams, M.S. Wildlife & Fisheries Biology (Advisor: Ross)
Sheldon Davis, M.S. Wildlife & Fisheries Biology (Advisor: Loeb & Jodice)
Sarah Kimpel, M.S. Wildlife & Fisheries Biology (Advisor: Loeb & Jodice)
Janelle Ostroski, M.S. Wildlife & Fisheries Biology (Advisor: Ross)
Mikayla Thistle, M.S. Wildlife & Fisheries Biology (Advisor: Ross)
Bradley Wilkinson, Ph.D. Wildlife & Fisheries Biology (Advisor: Jodice)

RECENT GRADUATES

Abigail Lawson, Ph. D. Wildlife & Fisheries Biology (Advisor: Jodice)
Alexander Schindler, M.S. Wildlife & Fisheries Biology (Advisor: Ross)
Rochelle Streker, M.S. Wildlife & Fisheries Biology (Advisors: Jodice & Lamb)

CURRENT & RECENTLY COMPLETED RESEARCH

A Multi Species Approach to Managing the Effects of Weather and Land Cover on Upland Game Birds

Investigators: Beth Ross (SC CRU), and David Haukos (KS CRU)
Student: Alexander Schindler (M.S., Clemson University)
Sponsors: Pheasants Forever, USDA NRCS, and Clemson University
Dates: 2017-2019

Habitat Use and Breeding Ecology of Bachman's Sparrow in a Wiregrass-free Longleaf Pine Ecosystem in South Carolina

Investigators: Beth Ross (SC CRU)
Student: Mikayla Thistle (M.S., Clemson University)
Sponsors: SC DNR
Dates: 2019-2021

Variation of Chronology of Wild Turkey Gobbling in the Upstate of South Carolina

Investigators: Beth Ross (SC CRU)
Student: Janelle Ostroski (M.S., Clemson University)
Sponsors: SC DNR
Dates: 2019-2021

Effects of Forest Management on Early-Successional Avian Species in South Carolina

Investigators: Beth Ross (SC CRU)

Student: Michael Adams

Sponsors: SC DNR

Dates: 2020 – 2022

Monitoring of Rock Gnome Lichen populations to determine population stability, priorities for management, and potential for change in listing status

Investigators: Beth Ross (SC CRU)

Sponsors: USFWS/USGS

Dates: 2019-2021

Potential Prescribed Fire Effects on Bat Roost and Foraging Habitat Use on Big South Fork National River and Recreation Area

Investigators: Susan Loeb (USFS), Patrick Jodice (SC CRU)

Student: Sheldon Davis (M.S., Clemson University)

Sponsors: USFS

Dates: 2018-2021

Spatial & Disturbance Ecology of Eastern Brown Pelicans in the South Atlantic Bight

Investigators: Patrick Jodice (SC CRU)

Student: Bradley Wilkinson (Ph. D., Clemson University)

Sponsors: USGS and Bureau of Ocean Energy Management

Dates: 2017–2021

Spatial and Reproductive Ecology of Brown Pelicans in the Gulf of Mexico

Investigators: Patrick Jodice (SC CRU) and Juliet Lamb (University of Rhode Island)

Student: Rochelle Streker (M.S., Clemson University)

Sponsors: Bureau of Ocean Energy Management and USGS

Dates: 2012-2020

Gulf of Mexico Marine Assessment Program for Protected Species

Investigators: Patrick Jodice (SC CRU), Jeff Gleason (USFWS), Chris Haney (Terra Mar LLC), Pamela Michael (Clemson University), and Yvan Satgé (Clemson University)

Sponsors: US FWS and Bureau of Ocean Energy Management

Dates: 2017-2021

Ecology and Conservation of the Endangered Black-capped Petrel

Investigators: Patrick Jodice (SC CRU) and Yvan Satgé (SC CRU & Clemson University)

Sponsors: BirdsCaribbean, Neotropical Bird Club, SC CRU

Dates: 2018-2021

A Multi-Species Approach to Managing the Effects of Weather and Land Cover on Upland Game Birds

Incorporating the projected effects of climate and land use change into management actions is critical for ensuring the viability of future populations. As many species are affected by these changes, managing for multiple species rather than single species can maximize limited resources. Grasslands of the Great Plains provide an ideal opportunity to study the effects of changing weather and land cover on several species of management interest.

We conducted a study to quantify the effects of weather and land cover on four species of upland game birds in Kansas: Ring-necked Pheasant (*Phasianus colchicus*), Northern Bobwhite (*Colinus virginianus*), Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*), and Greater Prairie-Chicken (*Tympanuchus cupido*). We combined historic survey data with weather, land cover, and farm bill practice data in a hierarchical modeling framework. Variations of this model included threshold models, allowing us to estimate threshold points at which species respond to changes in land cover, as well as interaction models, allowing us to estimate the

interaction between weather and land cover on these populations on different spatial scales.

Results indicated both Lesser and Greater Prairie-Chicken, as well as Ring-necked Pheasant populations responded most to landscape variables, particularly grassland-to-cropland ratio and edge density. Northern Bobwhite populations did not exhibit a strong response to any weather or landscape variable. The populations of all four species also demonstrated significant threshold responses to grassland-to-cropland ratio and edge density (i.e., population initially had a positive, negative, or no response to the landscape variable, followed by a change in the response after a threshold value was reached), although the specific effect differed depending on individual species and spatial scale. We also used our model results as inputs into decision-support software to select potential areas for future conservation focus in Kansas. Through our approach, we better described how to manage multiple species to optimize conservation and management efforts.



Prairie-Chicken survey route in Phillips County, Kansas. (A. Schindler 2017).

Design and Testing of Monitoring Protocol for the Rock Gnome Lichen, *Cetradonia linearis*

The rock gnome lichen (*Cetradonia linearis*) is a federally listed endangered species found in the Southern Appalachians of North Carolina, Tennessee, Georgia, South Carolina and Virginia. It is found in two habitat types with the majority of populations on vertical rock outcrops in high altitudes spruce-fir forests with continuous water seepage, and several populations also in streams at mid- to high elevations. Threats to this species include trampling via heavy recreational use of its habitat, collection and vandalism, loss of habitat due to Fraser fir mortality caused by the invasive balsam wooly adelgid at higher altitudes and hemlock mortality caused by the hemlock wooly adelgid at lower altitudes, and potential changes in humidity and cloud cover caused by climate change.

The main objectives of this research are: 1) Establish and implement an easily-replicable photographic-based monitoring protocol to be implemented for regular 5-year review monitoring that has the precision to address the recovery criteria (a 10% change in cover at the population level); 2) Perform an uncertainty analysis on historic monitoring data to determine their precision and utility in inferring long-term trends, and 3) Measure canopy cover and cloud cover to increase understanding of suitable habitat requirements for the rock gnome lichen.

To address Objective 1, photographs of the lichen will be processed with Image-J software allowing for coverage estimates with a high level of precision. Objective 2 involves harmonizing historic data collected using 2 different monitoring protocols, a transect-based protocol and a rapid assessment protocol, and calculating the 2 methodologies differing degrees of uncertainty. The broad goal of

Objective 3 is to characterize the lichen's habitat requirements in greater detail, laying the foundation for assessing the potential threats of the 2 invasive wooly adelgids and possible raising cloud base at high elevations caused by warming sea temperatures from climate change.

Field work commences in April 2020 and will continue through August 2020, and will repeat for 2021 until all NC and TN populations have been assessed. Georgia, South Carolina and Virginia are each home to only 1 population, and will be assessed, time-permitting. Photographs of the lichen will be processed with Image-J software allowing for coverage estimates with a high level of precision.



Rock gnome lichen (S. Dolan, 2020)

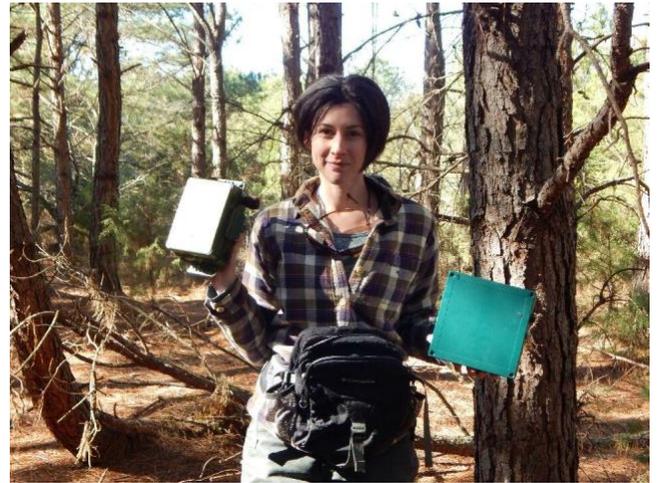
Variation of Chronology of Wild Turkey Gobbling in the Upstate of South Carolina

Wild turkey is a highly popular game species harvested primarily during the reproductive season. Due to the popularity of the species, there have been substantial efforts to establish sustainable harvest regulations while balancing hunter satisfaction. Hunter satisfaction is strongly correlated with hearing vocalizing males, or “gobbling”, thus wildlife agencies have used gobbling data to evaluate regional gobbling peaks and population responses to hunting activity and harvest.

Gobbling activity and associated habitat selection has been increasingly assessed through deployment of autonomous recording units (ARU), yet *post hoc* processing of audio data has been time-intensive particularly due to high false positive rates and streamlining this process would benefit future research. Our project goals are to assess upstate South Carolina gobbling chronology using monitoR as an alternative auto-recognition software and incorporate detection data from monitoR into occupancy models to inform management decisions.

Working with SC DNR, USFS, SC State Parks, Clemson University, local hunters and private landowners, we identified 38 sites of known turkey

activity representing various habitats in upstate SC where we will deploy ARUs annually from 2019-2021 and collect daily recordings from March 1 to May 30. In 2019, we accrued approximately 9000 hours of recordings and will be evaluating this data in the upcoming months.



Janelle Ostroski with ARU (Ostroski, 2020)

Habitat Use and Breeding Ecology of Bachman's Sparrow in a Wiregrass-free Longleaf Pine Ecosystem in South Carolina

Through much of its range, Bachman's Sparrow (*Peucaea aestivalis*) uses the wiregrass (*Aristida* sp.) dominant understory typical of longleaf pine (*Pinus palustris*) forest. The central South Carolina Coastal Plain, however, lies within the "wiregrass gap" where longleaf pine understories are absent of wiregrass and have greater shrub density. Habitat use of Bachman's Sparrow in this unique region has yet to be studied and declining Bachman's Sparrow populations necessitate a better understanding of habitat selection processes and population dynamics across regional habitat types. The objectives of this study are to (1) identify management treatments and landscape scale characteristics that Bachman's Sparrows select for home ranges, (2) identify vegetation characteristics that Bachman's Sparrows select for nest-sites, (3) quantify nest-success, post-fledging survival, and local recruitment, and (4) relate nest-site and home range selection to reproductive success within a wiregrass-free ecosystem

In 2020 and 2021, we will conduct point count surveys at Tom Yawkey Wildlife Center and Santee Coastal Reserve to estimate Bachman's Sparrow density across upland pine habitat and relate habitat management treatments (e.g., prescribed burning and stand thinning) and patch structure to home range

selection. We will locate nests and compare selected nest-site vegetation structure and species composition to available nest-sites. To determine if habitat selection in our study population is adaptive, we will monitor nests and fledglings, calculate daily survival rates, and relate nest-site and home range selection to daily survival.

As Bachman's Sparrow is adapted to frequently burned, ephemeral habitat, we expect that time since last burn will be the greatest predictor of home range selection. We expect that Bachman's Sparrow will select nest sites that mimic wiregrass understory structure despite differences in species composition. Finally, we predict that nest and post-fledging survival will be highest at nest-sites and home-ranges that have the highest probability of selection, providing evidence for adaptive selection. Our results will be used to inform region-specific management plans and restoration of degraded habitats, which also lack typical vegetation composition, to improve Bachman's Sparrow survival, recruitment, and nesting success.



Bachman's Sparrow (Tom Benson/Flickr)

Early successional habitat monitoring for ruffed grouse and golden-winged warblers.

Early-successional habitats are a critical habitat type for ruffed grouse and golden-winged warblers. In South Carolina, these habitats are declining and may be lacking. While included in the SCDNR's 2015 State Wildlife Action Plan, it remains unknown the extent of which ruffed grouse and golden-winged warblers use habitat in South Carolina. Additionally, golden-winged warblers are proposed to be listed under the Endangered Species Act, so knowing if they occur in the state of South Carolina will better prepare managers for a potential listing decision. Lastly, given that both species exist at the edge of their range in South Carolina, understanding how ruffed grouse and golden-winged warblers respond to habitat management practices locally may aid in management and conservation efforts.

Our first objective is to determine the distribution of ruffed grouse and golden-winged warblers in the Blue Ridge of South Carolina. We will additionally monitor prairie warblers, blue-winged warblers, and blue-winged warbler x golden-winged warbler hybrids as indicators of early succession habitat. We will conduct point count surveys to evaluate the presence/absence of these target species at many sites across public lands in the Blue Ridge of South Carolina.

The second objective is to conduct research to determine how management of early-successional habitats influences presence/absence of ruffed grouse and golden-winged warblers on public lands in the Blue Ridge of South Carolina. Sites will be chosen from a variety of different management applications, including burning, thinnings, and clear-cuts.

The third and last objective is to assess the use of Autonomous Recording Units (ARUs) to detect and monitor ruffed grouse and golden-winged warbler presence/absence. We will place ARUs at

sites with positive detections for either ruffed grouse or golden-winged warblers. We will also place ARUs at sites without previous detections to identify potential new sites that are occupied. Recordings will then be analyzed to determine if any target species were detected, after which additional point counts or ARU recordings would be conducted at positive sites.

We are currently working with project collaborators from the US Forest Service, South Carolina Department of Natural Resources, and South Carolina Department of Parks, Recreation & Tourism to determine potential study sites on managed lands. We are also in the process of hiring a technician to assist with field work. We are expecting the 2020 field season to begin in late March.



Early successional forest (M. Adams, 2020)

Potential prescribed fire effects on bat roost and foraging habitat use on Big South Fork National River and Recreation Area

Prescribed fire is a management tool commonly used in ecosystem restoration and maintenance in North America, though little is known about how fire characteristics affect bat foraging habitat use, roost use, and roost selection. While many studies suggest that prescribed fire improves bat foraging habitat, more information is needed regarding effects of time since last burn and fire severity on the summer ecology of bats. Thus our objective was to use acoustic detectors to determine how summer occupancy of bats present in Big South Fork National River and Recreation Area (BISO) is affected by time since last burn, fire severity, weather, and vegetation characteristics. Additionally, we examined potential summer roost tree availability for northern long-eared Bats (*Myotis septentrionalis*), Indiana bats (*M. sodalis*), little brown bats (*M. lucifugus*), and tri-colored bats (*Perimyotis subflavus*), as well as roost tree selection by radio-tagged male tri-colored bats captured during 2018 and 2019 mist net surveys. The results of this project will help revise the BISO Fire Management Plan to better support rare and endangered bats in forests managed with prescribed fire.

During May-August 2018 and 2019, we collected acoustic data using Anabat SD2 detectors in 56 prescribed fire sites for 2-6 nights each with varying

combinations of time since last burn (0-2, 3-4, and 5+ years), burn severity (low or medium), and forest type (Appalachian pine-oak, hemlock-hardwood cove, and mixed oak-hardwood forest) using a stratified random design. Nightly temperature was recorded at each detector site, and forest structure such as basal area, canopy closure, and potential roost availability were determined. A total of 1801 identifiable calls were recorded among these sites, and manually vetted for correct species identification. Preliminary results indicate that eastern red bats (*Lasiurus borealis*) and evening bats (*Nycticeius humeralis*) used higher severity, more recently burned sites that also had lower sapling density. Myotis bats generally used sites with higher sapling density and basal area, while tri-colored, big brown (*Eptesicus fuscus*), and silver-haired bats (*Lasionycteris noctivagans*) did not appear to prefer sites based on site fire or vegetative characteristics.

We also successfully tracked three tri-colored bats to roosts and characterized roost trees and surrounding habitat using methods similar to those at detector sites. We will also compare these roosts to randomly selected trees within a radius equal to the distance traveled from the capture location and known roosts to determine if bats select for roost, habitat, or burn severity.



Tri-colored bat captured in McCreary County, KY (S. Davis, 2018)

Spatial & Disturbance Ecology of Eastern Brown Pelicans in the South Atlantic Bight

As a nearshore marine predator and species of conservation concern, Brown Pelicans (*Pelecanus occidentalis*) in the southeastern United States constitute a valuable study population for investigating coastal ecological systems. Despite occupying a highly visible and elevated trophic position in estuarine and oceanic ecosystems, movement parameters describing habitat use patterns, foraging behaviors, and migratory corridors are undeveloped at multiple spatial and temporal scales. This study aims to resolve these information gaps by outfitting adult pelicans breeding in South Carolina with high-resolution GPS satellite transmitters, which will provide accurate locational data throughout the annual life-history cycle.

In addition to habitat use patterns, both natural and anthropogenic disturbances will also be investigated

to provide baseline risk assessments. These include the impacts of large-scale meteorological events such as hurricanes, potential interactions with offshore energy development, oil spill risk assessment modeling, and the magnitude of influence on pelican nestlings posed by the local shrimp trawling fleet.

To date, 60 adult pelicans have been equipped with satellite transmitters in South Carolina and Georgia. Upon the completion of various life-history stages, maps will be generated showcasing breeding ranges, migratory pathways, wintering locations, and site fidelity at colonial, subpopulation, and population structures. This information will greatly expand our knowledge of this species in the Atlantic, and complement prior research recently conducted on Brown Pelicans in the Gulf of Mexico.



Brown Pelican (B. Wilkinson, 2019)

Gulf of Mexico Marine Assessment Program for Protected Species

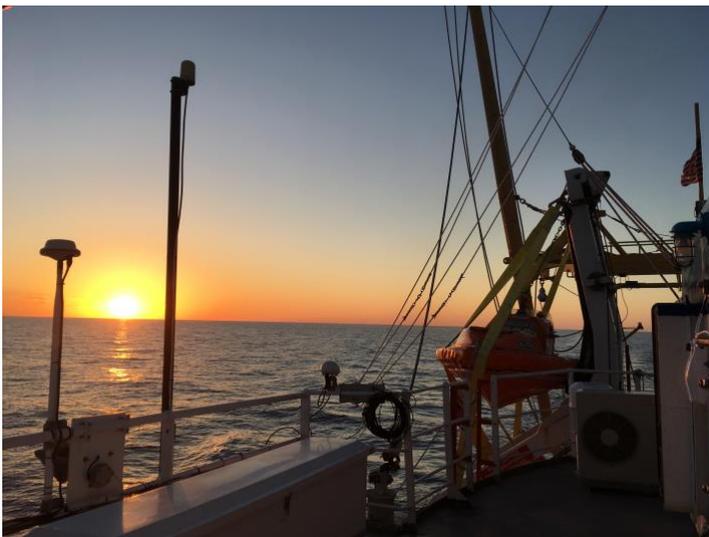
The Gulf of Mexico (GoM) supports seabirds from throughout the Atlantic basin during the annual cycle. Temporal use ranges from daily to resident, but data on species composition and abundance are limited in time and space, particularly in the offshore environment. The GoM also is one of the most industrialized seas globally, with substantial levels of oil and gas (O&G) activity occurring in the central and western regions within the U.S. EEZ. This combination of important habitats, little baseline data, and high but spatially variable levels of O&G activity constrains the capacity to mitigate, anticipate, and respond to potential conflicts.

In 2017, we implemented the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) to characterize the seabird community within the U.S. EEZ. From April 2017 – October 2019, we conducted 275 days and ~2,200 hrs of vessel-based surveys covering ~40,200 kms. We tallied 67 marine species, including North American temperate and high-latitude migrants, GoM-resident breeders, and breeding, migrating, and sub-adults originating from the Caribbean, eastern north Atlantic, and western south Atlantic. Simpson's diversity index (controlled for effort) was least in the

central (0.71; area of highest O&G activity), greatest in the western (0.82), and intermediate in the eastern (0.73; area of least O&G activity) GoM.

Black Terns, a North American inland breeding migrant, comprised ~1/3 of all individual birds observed, and were most numerous in the central region, particularly in the footprint of the Mississippi River plume. Audubon's Shearwater, a Caribbean and Bahamian breeder, was observed regularly throughout the GoM across the annual cycle. Sooty Tern, an abundant breeder in the southern GoM and Caribbean, was commonly observed in spring and fall, and most numerous in the east.

Ongoing analyses are characterizing seabird distribution in relation to oceanography and O&G activity, and subsequently will combine seabird data with survey data for marine mammals and sea turtles to provide the most extensive multi-taxa assessment of higher marine vertebrates in the GoM to date. These results will inform future O&G planning on the U.S. Outer Continental Shelf, further refine existing oil spill risk assessment models, and will be used to reduce or mitigate potential impacts from O&G activities on seabirds.



View from the deck during GoMMAPPS at-sea survey (P. Michael, 2019)

Ecology and Conservation of the Endangered Black-capped Petrel

The Black-capped Petrel (*Pterodroma hasitata*) has a fragmented and declining population, is considered Endangered throughout its range, and is under consideration for listing under the Endangered Species Act by the U.S. Fish and Wildlife Service. The only confirmed breeding sites have been located in the mountain ranges of Hispaniola, where habitat loss and degradation are continuing threats. Other nesting populations may still remain undiscovered but, to locate them, laborious in situ nest searches must be conducted over expansive geographical areas. To focus nest-search efforts more efficiently, we partnered with US-based American Bird Conservancy to track adult petrels from their U.S. non-breeding areas to unknown breeding grounds in the Caribbean. We also partnered with Caribbean NGOs Grupo Jaragua and Environmental Protection in the Caribbean to (I) estimate the characteristics of Black-capped Petrel nesting habitat and (II) model suitable nesting areas in the Caribbean region using openly available environmental datasets.

In Spring 2019, we captured 11 Black-capped Petrels along the western edge of the Gulf Stream east of Cape Hatteras, North Carolina. Unlike the two previous efforts to individually track petrels (2014 and 2018) which deployed tags at nest sites, this effort sought to capture birds at sea and subsequently track their movements. We equipped 10 petrels with solar-powered satellite trackers and followed them

for an average of 102 days (SD: 78.2). Most individuals ranged from 28.4 – 41.2 degrees latitude, with two recorded trips to Hispaniola. Thorough observations of these tracks strongly suggest that these individuals visited nesting areas at the onset of the nesting season. Compared to birds tracked from breeding sites in 2014 and 2018, the current use areas at sea appear similar to use areas during post-breeding periods, but dissimilar to use areas from 15 trips recorded during known breeding periods. Future studies include nest searches in suspected nesting areas, a revision of the published distribution and range for the species, an analysis of the marine habitat during the non-breeding season, and genomic sequencing of prey DNA.

Using significant environmental characteristics of Black-capped Petrel nesting breeding habitat (such as altitude, distance to coast, or vegetation), our nest habitat model highlighted possible nesting habitat in areas not previously considered suitable on Hispaniola. In contrast, areas in the central Dominican Republic that were thought to be suitable for petrels were not highlighted by the model. In the Caribbean, the model showed possible suitable nesting habitat in Cuba, Jamaica, Dominica, and Saint Vincent. Based on model results, we estimated the total area of suitable nesting habitat for Black-capped Petrels on Hispaniola and documented severe habitat loss due to hurricanes and forest fires, and encroachment from agriculture, in these areas.



Yvan Satgé holds a Black-capped Petrel captured at sea off Cape Hatteras, NC and outfitted with a satellite tracker. (D. Lebbin 2019)

PUBLICATIONS

JOURNAL ARTICLES and TECHNICAL REPORTS 2018-2020

* = graduate student author

- Blomberg, E.J., B.E. Ross, C.J. Cardinal, S.N. Ellis-Felege, D. Gibson, A.P. Monroe, and P.K. Schwlenberg. Conserving non-migratory birds in the United States: where has a century without the Migratory Bird Treaty Act left us? *Condor*. *In review*.
- Bodinof Jachowski, C.M., B.E. Ross, and W.A. Hopkins. 2020. Evaluating artificial shelter arrays as a minimally invasive monitoring tool for the hellbender, *Cryptobranchus alleganiensis*. *Endangered Species Research*. *In press*.
- Conners, M.G., ...B.P. Wilkinson..., J.A. Estes, & S.M. Maxwell. *In review*. Mismatches in scale between Marine Protected Areas and mobile marine megafauna. *Proceedings of the Natural Academy of Sciences*.
- Dertien, J., S. Self, R. Baldwin, B.E. Ross, and K. Barrett. 2020. The relationship between biodiversity and proportional wetland cover varies across regions of the conterminous United States. *PLoS ONE* 15:e0232052.
<https://doi.org/10.1371/journal.pone.0232052>.
- Fallon, J.A., E.P. Smith, N. Shoch, J.D. Paruk, E.A. Adams, D.C. Evers, P.G.R. Jodice, W.A. Hopkins. 2020. Ultraviolet-assisted oiling assessment improves detection of oiled birds experiencing clinical signs of hemolytic anemia exposed to the Deepwater Horizon oil spill. *Ecotoxicology*. <https://doi.org/10.1007/s10646-020-02255-8>
- Ferguson, L.M., Satgé, J. Tavano, and P.G.R. Jodice. 2018. Seabird colony registry and atlas for the Southeastern U.S. Final Report for U.S. Fish and Wildlife Service. South Carolina Cooperative Fish and Wildlife Research Unit, Clemson, SC.
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- Satgé, Y.G., E. Rupp, A. Brown, and P.G.R. Jodice. *In Press*. Habitat modelling locates nesting areas of the Endangered Black-capped Petrel *Pterodroma hasitata* on Hispaniola and identifies habitat loss. Bird Conservation International
- Satgé, Y.G., E. Rupp, P.G.R. Jodice. 2019. A preliminary report of ongoing research of the ecology of Black-capped Petrel in Sierra de Bahoruco, Dominican Republic – I. GPS tracking of breeding adults. Unpublished report, South Carolina Cooperative Research Unit.
- Schindler, A.R.*, D.A. Haukos, C.A. Hagen, and B.E. Ross. 2020. A decision-support tool to prioritize candidate landscapes for lesser prairie-chicken conservation. *Landscape Ecology* 35:1417-1434. <https://doi.org/10.1007/s10980-020-01024-6>.
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- Wilkinson, B.P.*, M.E. Johns, & P. Warzybok. 2019. Fluorescent ornamentation in the Rhinoceros Auklet *Cerorhinca monocerata*. *Ibis*, 161, 694-698.
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- Wood, J.M.*, A. Tegeler, and B.E. Ross. The effects of private forestland management on avian communities in the Southeastern United States. *Condor*. *In press*
- Zaluski, S., L.M. Soanes, J.A. Bright, A. George, P.G.R. Jodice, K. Meyer, N. Woodfield-Pascoe, J.A. Green. Potential threats facing a globally important population of the Magnificent Frigatebird. *Tropical Zoology* 32: 188-201.
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THESES AND DISSERTATIONS 2018-2019

- Rochelle Streker, Department of Forestry and Environmental Conservation, M.S., May 2019: Reproductive Ecology and Diet of Brown Pelicans in the Gulf of Mexico
- Abby Lawson, Department of Forestry and Environmental Conservation, Ph. D., May 2019: South Carolina Alligator Adaptive Management Strategies
- Alexander Schindler, Department of Forestry and Environmental Conservation, M.S., May 2019: Quantitative Approaches to Upland Game Bird Conservation in Kansas

DATA RELEASES

- Jodice, P.G.R., and B.P. Wilkinson*. 2020. At-sea movements of Masked Boobies from Pedro Cays, Jamaica. U.S. Geological Survey data release, <https://doi.org/10.5066/P9AK95EG>, <https://www.sciencebase.gov/catalog/item/5e74e01ce4b01d50926c6352>
- Lamb, J.S.*, Y.G. Satgé, P.G.R. Jodice. 2019. Brown Pelican Utilization Distribution, Breeding Season, Northern Gulf of Mexico, 2013-2015, <https://doi.org/10.5066/P9K0HK27>
- Lamb, J.S.*, Y.G. Satgé, P.G.R. Jodice. 2019. Physiological Ecology of Brown Pelican in the Gulf of Mexico, 2013-2016: U.S. Geological Survey, <https://doi.org/10.5066/P94GBJ4G>
- Lamb, J.S.*, Y.G. Satgé, R.A. Streker, and P.G.R. Jodice. 2020. Ecological Drivers of Brown Pelican Movement Patterns, Health, and Reproductive Success in the Gulf of Mexico. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM.
- Lawson, A.J.*, and Jodice, P.G.R. 2019, Mercury concentrations in American alligators in South Carolina, 2010-2017: U.S. Geological Survey data release, <https://doi.org/10.5066/P98XHBCY>
- Satgé, Y.G.^, E. Rupp, and P.G.R. Jodice. 2019. A preliminary report of ongoing research of the ecology of Black-capped Petrel (*Pterodroma hasitata*) in Sierra de Bahoruco, Dominican Republic – I: GPS tracking of breeding adults. Unpublished Report, South Carolina Cooperative Research Unit, Clemson University, Clemson, South Carolina, USA. DOI: 10.5066/P9UHASY4
- Wilkinson, B.P.*, Satgé^, Y.G., Lamb, J.S., and Jodice, P.G.R. 2019, GPS tracking of Brown Pelican in the South Atlantic Bight during cyclonic activity (2017-2018): U.S. Geological Survey data release, <https://doi.org/10.5066/P9D5IP0G>.

ACTIVITIES

TEACHING

- P. Jodice, Conservation Physiology (online), Fall 2019, Fall 2020.
- P. Jodice, Advanced Ecology (Co-teaching online), Spring 2020.
- P. Jodice, Unsolved Problems in Ecology, Fall 2020.
- P. Michael, Advanced Ecology (Co-teaching online), Spring 2020.
- B. Ross, Analysis of Fish and Wildlife Populations, Spring 2019, Fall 2020
- B. Ross, Spatial Ecology and Conservation, co-taught, Fall 2019

TRAINING

PRESENTATIONS AND SEMINARS

Invited presentations

- Jodice, P.G.R. 2019. Multi-scale movement and risk in seabirds. Duke Marine Lab, Duke University, Beaufort, North Carolina.
- Jodice, P.G.R. 2020. Using movement data from seabirds to assess risk in the marine environment. Clemson University, Clemson, South Carolina.
- Michael, P.E., J. Gleason, J.C. Haney, Y. Satgé, P.G.R. Jodice. 2020. Diversity and distribution of seabirds in pelagic waters of the northern Gulf of Mexico. Gulf of Mexico Oil Spill & Ecosystem Science Conference. February 3-6, 2020, Tampa, FL, USA.
- Michael, P.E., J. Gleason, J.C. Haney, Y. Satgé, P.G.R. Jodice. 2019. Black terns in the northern Gulf of Mexico: initial observations from the Gulf of Mexico Marine Assessment Program for Protected Species. Waterbird Society 43rd Annual Conference and General Meeting, Salisbury, MD, USA.
- Ross, B.E., C. Brady, S. Felege, and A. Mini. 2019. Effective networking strategies for hunters and non-hunters. North American Duck Symposium, Winnipeg, Manitoba, Canada.
- Ross, B.E., N. Mastro*, R. Kaminski, J. Dozier, M. McAlister, and J. Woods. 2019. Integrating counts from aerial and ground surveys to estimate densities of waterfowl. SEAFWA, Hilton Head, SC.
- Wilkinson, B.P.*, Y.G. Satgé, J.S. Lamb, & P.G.R. Jodice. 2019. Spatial ecology of brown pelicans in the South Atlantic Bight: Preliminary results from two years of tracking. SCDNR Shorebird Workshop, Charleston, SC.
- Wilkinson, B.P.* 2019. Importance of coastal refugia to brown pelicans during tropical cyclones. Clemson University Natural Resources Seminar Series, Clemson, SC.

Contributed papers / Presentations / Posters

- Haney, C., Y.G. Satgé, J. R. Gleason, P. G. R. Jodice, R. Wilson. 2019. When gaps aren't voids: what we [don't] know about marine birds in the Gulf of Mexico. Gulf of Mexico Oil Spill & Ecosystem Science Conference. New Orleans, Louisiana.
- Jodice, P. G. R., Gleason, J., Haney, J. C., Satgé, Y., Michael, P. E. 2019. Seabird Surveys in the Gulf of Mexico: Preliminary Results From Pelagic Cruises. 5th World Seabird Twitter Conference.
- Jodice, P.G.R., Lamb, J., And Y. Satgé. 2019. Health Assessments of Brown Pelicans From the Gulf of Mexico. 5th World Seabird Twitter Conference.
- Jodice, P. G. R., Gleason, J., Haney, J. C., Satgé, Y., Michael, P. E. 2019. Novel Insights On The Distribution And Abundance of Seabirds From Vessel-Based Surveys In The Northern Gulf of Mexico. Gulf of Mexico Oil Spill & Ecosystem Science Conference. New Orleans, Louisiana.
- Jodice, P. G. R., Gleason, J., Haney, J. C., Satgé, Y., Michael, P. E. 2019. The Gulf of Mexico Marine Assessment Program For Protected Species: Development And Implementation of Large-Scale, Long-Term Monitoring Strategies. Symposium: Implementation of The National Bird Conservation Priorities, The Wildlife Society Annual Conference, Reno, Nevada.
- Jodice, P.G.R., J. Gleason, J.C. Haney, Y. Satgé, P. Michael, C. Gaskin, B. Keitt. 2020. Revising the marine range of the endangered Black-capped Petrel. Pacific Seabird Group Annual Meeting, Portland, Oregon.
- Jodice, P. G. R., Y.G. Satgé, B. Keitt, C. Gaskin. 2019. First Successful Capture And Satellite Tagging of Black-Capped Petrels At Sea And Subsequent Movement Patterns. 43rd Annual Conference of The Waterbird Society 43rd Annual Conference And General Meeting, Salisbury, Maryland.
- Jodice, P. G. R., J.S. Lamb*, Y.G. Satgé. 2019. Exposure of Brown Pelicans To Polycyclic Aromatic Hydrocarbons In The Northern Gulf of Mexico. 43rd Annual Conference of The Waterbird Society, Salisbury, Maryland.
- Jodice, P. G. R., And J.S. Lamb. 2019. An Overview of Research And Conservation On Pelicans In The 21st Century: Data Gaps And Data Strengths. 43rd Annual Conference of The Waterbird Society, Salisbury, Maryland [Invited Symposia].
- Jodice, P.G.R., J.S. Lamb*, and Y.G. Satgé. 2019. Exposure of Brown Pelicans to polycyclic aromatic hydrocarbons in the northern Gulf of Mexico. Symposium: Birds and Offshore Energy, Waterbirds Society Annual Meeting, Salisbury, Maryland.
- Jodice, P.G.R., Y.G. Satgé, B. Keitt, and C. Gaskin. 2019. First successful capture and satellite tagging of Black-capped Petrels at sea and subsequent movement patterns. Waterbirds Society Annual Meeting, Salisbury, Maryland.
- Jodice, P. G. R., Gleason, J., Haney, J. C., Y.G. Satgé, and Michael, P. E. 2019. The Gulf of Mexico Marine Assessment Program for Protected Species: Development and implementation of large-scale, long-

term monitoring strategies. Symposium: Implementation of the National Bird Conservation Priorities, The Wildlife Society Annual Conference, Reno, Nevada.

Keitt, B., H. Nevins, A. Brown, E. Rupp, Y.G. Satgé, J. Wheeler. 2020. A review of land-based Black-capped petrel conservation efforts. Pacific Seabird Group Annual Meeting, Portland, Oregon.

Kemink, K., L. Webb, And B.E. Ross. 2019. Why We Need More Women In Stem Leadership Roles: Innovations To Overcome Obstacles And Identify Solutions. North American Duck Symposium, Winnipeg, Manitoba, Canada.

Lamb, J.S.*, Y.G. Satgé, C. Poli, C. Fiorello, and P.G.R. Jodice. 2019. Causes and consequences of individual variation in migratory patterns of Brown Pelicans: Insights from ten years of tracking data. Symposium: Pelicans of the World, Waterbirds Society Annual Meeting, Salisbury, Maryland.

Masto, N.M.*, R. Kaminski, B.E. Ross, M. Kneece, P. Gerard, And K. Barrett. 2019. Aerial Transect Surveys For Monitoring Fall-Winter Waterfowl Abundance And Distribution In South Carolina. North American Duck Symposium, Winnipeg, Manitoba, Canada.

Michael, P.E., J.S. Gleason, J.C. Haney, Y.G. Satgé, P.G.R. Jodice. 2020. Diversity and distribution of seabirds in pelagic waters of the northern Gulf of Mexico. Gulf of Mexico Oil Spill and Ecosystem Science Conference. Tampa, Florida.

Michael, P.E., J.S. Gleason, J.C. Haney, Y.G. Satgé, and P.G.R. Jodice. 2019. Black terns in the northern Gulf of Mexico: initial observations from the Gulf of Mexico Marine Assessment Program for Protected Species. Symposium: Birds and Offshore Energy, Waterbirds Society Annual Meeting, Salisbury, Maryland.

Michael, P.E., J. Gleason, J. C. Haney, Y.G. Satgé, P. G. R. Jodice. 2019. Novel insights on the distribution and abundance of seabirds from vessel-based surveys in the northern Gulf of Mexico. Gulf of Mexico Oil Spill & Ecosystem Science Conference. New Orleans, Louisiana.

Plumpton, H.M.*, S.G. Gilliland, And B.E. Ross. 2019. Geographic Differences In The Wintering Sites of The Atlantic Population of Black Scoters. North American Duck Symposium, Winnipeg, Manitoba, Canada.

Plumpton, H. M.*, E. D. Silverman, B. E. Ross. 2019. Black Scoter Habitat Use Along The Southeastern Coast of The United States. North American Duck Symposium. Winnipeg, Manitoba, Canada.

Ross, B.E., N. Masto*, R. Kaminski, J. Dozier, M. Mcalister, And J. Woods. 2019. Integrating Counts From Aerial And Ground Surveys To Estimate Densities of Waterfowl. North American Duck Symposium, Winnipeg, Manitoba, Canada.

Satgé, Y.G., R. Castro Alvarez, R. Gomès, W.A. Mackin, C. Pollock, E. Ventosa-Febles, L. Soanes, S. Zaluski, Karl Questel, B. Ibéné, S. Bedel, Z. Hillis-Starr, J.C. Fernández-Ordóñez, C. Lloyd, F.

- Mukhida, P.G.R. Jodice. 2019. Updates on pelican research and conservation in the Caribbean. Symposium: Pelicans of the World, Waterbirds Society Annual Meeting, Salisbury, Maryland.
- Satgé, Y.G., E. Rupp, A. Brown, and P.G.R. Jodice. 2019. Modelling the nesting habitat of the endangered Black-capped petrel to inform conservation actions in the Caribbean. Waterbirds Society Annual Meeting, Salisbury, Maryland.
- Satgé, Y.G., J.S. Lamb*, and P.G.R. Jodice. 2019. Using near real-time nighttime light imagery to locate existent seabird exposure to active oil and gas extraction. Symposium: Birds and Offshore Energy, Waterbirds Society Annual Meeting, Salisbury, Maryland.
- Satgé, Y.G., E. Rupp, A. Brown, and P.G.R. Jodice. 2019. Using predictive habitat modelling to locate unknown nesting areas of the endangered Black-capped petrel in the Greater Caribbean. BirdsCaribbean Biannual Meeting, Le Gosier, Guadeloupe.
- Satgé, Y.G., J.S. Lamb*, B.P. Wilkinson*, A-L. Harrison, and P.G.R. Jodice. 2019. Use of marine and freshwater systems of Cuba by migrating Brown pelicans. BirdsCaribbean Biannual Meeting, Le Gosier, Guadeloupe.
- Satgé, Y.G., E. Rupp, and P.G.R. Jodice. 2019. Using predictive habitat modelling to locate unknown nesting areas of the endangered Black-capped petrel in the Dominican Republic. Pacific Seabird Group Annual Meeting, Lihue, Hawai'i.
- Satgé, Y.G., E. Rupp, and P.G.R. Jodice. 2019. Individual tracking informs exposure of the endangered Black-capped petrel to marine threats during the breeding season. Pacific Seabird Group Annual Meeting, Lihue, Hawai'i.
- Schindler, A.* And B.E. Ross. 2019. The Use of Decision-Support Software To Select Candidate Areas For Lesser Prairie-Chicken Conservation. Us-IALE. Fort Collins, Colorado.
- Shurba, J.A.*, E.M. Miller, J. Merendino, B.A. Bauer, R.M. Kaminski, B.E. Ross, And E.P. Wiggers. Southeastern Regional Examination of Box-Nesting Wood Ducks: A 2019 Pilot Study At Lake Moultrie, South Carolina. Southeastern Association of Fish And Wildlife Agencies, Hilton Head, SC.
- Streker, R.*, J.S. Lamb, J. Dindo, And P.G.R. Jodice. 2019. Diet of Maturing Brown Pelican Chicks In Coastal Alabama. 43rd Annual Conference of The Waterbird Society, Salisbury, Maryland.
- Wilkinson, B.P.* & P.G.R. Jodice. 2019. Expansion Of Brown Pelican Diet Associated With Shrimp Trawling Effort In South Carolina. 43rd Annual Meeting Of The Waterbird Society, Salisbury, Maryland.
- Wilkinson, B.P.*, P. Michael, Y. G. Satge, & P.G.R. Jodice. 2019. Spatially Consistent Foraging Patterns In Masked Boobies (*Sula Dactylatra*) In Jamaica. Birdscaribbean 22nd International Conference, Le Gosier, Guadeloupe.

Wilkinson, B.P.*, Y.G. Satgé, J.S. Lamb, & P.G.R. Jodice. 2020. Low Use Of Cay Sal Bank To Transiting Brown Pelicans Despite Apparent Availability. Pacific Seabird Group Annual Meeting, Portland, Oregon.

Wilkinson, B.P.*, Y.G. Satgé, J.S. Lamb*, P.G.R. Jodice. 2020. Low use of Cay Sal Bank by transiting Brown pelicans despite apparent availability. Pacific Seabird Group Annual Meeting, Portland, Oregon, USA. Poster

Wilkinson, B.P.*, P.E. Michael, Y.G. Satgé, and P.G.R. Jodice. 2019. Spatially consistent foraging patterns in Masked boobies in Jamaica. BirdsCaribbean Biannual Meeting, Guadeloupe.

SERVICE

P. Jodice, Chair, World Seabird Union. 2015 – 2020.

P. Jodice, Steering Committee Member, Gulf of Mexico Avian Monitoring Network.

P. Jodice, Steering Committee Member, Atlantic Marine Bird Cooperative.

P. Jodice, Search Committee, Kennedy Director, Clemson University

P. Michael, Session Chair, Gulf of Mexico Oil Spill and Ecosystem Science Conference.

P. Michael, Session Co-Convener, 3rd World Seabird Conference.

B. Ross, Kennedy Center Advisory Council.

B. Ross, committee member, Department Chair Search, Dept. of Forestry and Environmental Conservation.

B. Ross, committee member, Kennedy Director, Clemson University

B. Ross, Secretary, The Wildlife Society, Biometrics Working Group.

B. Ross, Associate Editor, Wildlife Society Bulletin.

B. Ross, Associate Editor, The Condor.

Y. Satgé, Co-Chair, BirdsCaribbean Seabird Working Group. 2020 – 2025.

B. Wilkinson, Natural Resources Graduate Student Association, President, Clemson University. 2018-2019.

B. Wilkinson, Session Chair, General Ecology and Evolution, 43rd Annual Meeting of the Waterbird Society, Salisbury, Maryland. 2019.

AWARDS AND HONORS

P. Jodice, USGS Annual Performance Award, 2019.

B. Ross, USGS Annual Performance Award, 2019

Y. Satgé, American Bird Conservancy Globally Threatened Seabird Colony Restoration

PRESS / PUBLIC OUTREACH

Outreach: Flight of the pelican: Using satellite tracking technology to follow brown pelicans in the South Atlantic Bight. Harbor Island Homeowners Association, Harbor Island, SC. B.P. Wilkinson. February 2019.

Outreach: Glowing horns in a secretive seabird: Rhinoceros auklets found to have fluorescent bill structures during breeding season. Blog post, British Ornithologists' Union Blog. Bradley Wilkinson. June 2019.

Press: Movement patterns of brown pelicans in the South Atlantic Bight. Outdoor News Bulletin, Wildlife Management Institute. P. Jodice. 2019.

Press: Birds and marine life in SC have their own ways of coping with hurricanes. Charleston Post and Courier. C. Johnson. 2019.

Press: Island science: Special ecosystems lure researchers. Coastal Heritage Magazine, S.C. Sea Grant Consortium. J. Holleman. 2019.

Press: What do birds do in a hurricane? Hakai Magazine. J. Howard. 2020

Twitter:

SC CRU: @SCCoopUnit



Beth Ross: @betheros



Bradley Wilkinson: @Pelican_Paths





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