



CLEMSON
UNIVERSITY
JAMES C. KENNEDY
WATERFOWL &
WETLANDS
CONSERVATION
CENTER

2021

annual report

*LEAD IN EDUCATION AND SCIENCE
TOWARD CONSERVATION OF SOUTH
ATLANTIC AND OTHER WETLAND
ECOSYSTEMS*

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FROM THE DIRECTOR

I have been in the Director's seat for one week as I write this editorial, so I will keep it short while getting my feet wet. Prior to assuming this role on August 13, 2021, I was a Professor of Wildlife and Fisheries Resources and the Davis-Michael Professor of Forestry and Natural Resources at West Virginia University (WVU). I started at WVU in January 1999. I earned a B.S. in wildlife from the University of Wisconsin-Stevens Point (1991), a M.S. in range and wildlife management through the Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville (1994), and a Ph.D. in wildlife science from Texas Tech University (1997). Throughout this time, I conducted research on a diversity of wetland topics, taught waterfowl and wetland courses, and mentored graduate and undergraduate students.

I am humbled to be the Director of the James C. Kennedy Waterfowl and Wetland Conservation Center at Clemson University. One only has so many opportunities in their life to be part of something so special and the Center is indeed special. The location in an area of abundant and diverse wetlands and waterfowl, that are being impacted by climate change and development; an engaged community that is interested in wetland conservation and waterfowl hunting; and a Center with a solid financial base made this a unique and interesting position. The welcoming nature and support that I have received from the wetland and waterfowl community has been tremendous and greatly appreciated. I am thankful to Mr. Kennedy for his immense support of waterfowl and wetland conservation, and especially for funding this Center.

I am so grateful for Dr. Kaminski's input and guidance as I begin this journey. From introducing me to people throughout the community, to helping me navigate Clemson's bureaucracy, to compiling this annual report, his support has been incredible. I will forever be indebted to Rick for his kindness and advice. Rick has done a tremendous job of establishing a strong foundation for the Center, and I do not

foresee a fundamental shift in activities but further development and enhancement of the Center's mission to lead in science and outreach to sustain waterfowl and wetlands of South Atlantic coastal ecosystems and beyond. My vision is to make the Center world-renowned with a reputation for creating creative and utilitarian science and education programs and for developing diverse wetland and waterfowl conservation leaders. I envision the Center being a catalyst for developing partnerships to conserve wetlands, waterfowl, and other wetland-dependent wildlife in the Southeast.

I am excited to get started on this new adventure and to build active research, education, and outreach partnerships. I welcome your input, advice, and support to strengthen wetland and waterfowl conservation in the region and hopefully we will have the opportunity to work together.

All my best and take care,



James T. (Jim) Anderson, Ph.D.

Director, James C. Kennedy Waterfowl and Wetland Center

James C. Kennedy Endowed Professor of Waterfowl and Wetland Ecology

FROM THE FORMER DIRECTOR

The Corona Virus Disease 19 (COVID) has changed all of our lives and taken over 4 million people worldwide. We mourn the loss of family members, friends, and all humankind. May they rest in peace and their loved ones heal from the losses. Blessings to all partners on Planet Earth!

Indeed, amid the COVID pandemic, the Kennedy Center faced challenges and constraints that reduced our usual engagement and productivity in waterfowl and wetlands science, conservation, and outreach. For example, our 2020 annual report stated that my editorial (Fair Well but not Farewell) would be my final one as Director of the Kennedy Center, a position I've cherished from inception of the Center in 2015. However, South Carolina's Governor Henry McMaster froze all state funded positions, including mine; thus, I was fortunate to remain as Director and keep the Center and its students progressing. Another example of reduced engagement was our annual field trip over spring break 2020, which was cut short by COVID's closure of Clemson University, and no field trip was allowed in spring 2021.

Despite constraints, we were productive. We taught the Waterfowl Ecology and Management course online to over 50 students from across the USA in fall 2020. There has been great interest and enrollment in and revenue generation from the online waterfowl course since its inaugural offering in fall 2017. Including the current fall semester 2021 enrollment, over 250 students have taken the course, expanding their knowledge of waterfowl and wetlands ecology and management and hopefully their passion for these resources. Teaching the course face to face and alternating it between years with a wetlands ecology and management course during my Mississippi State University (MSU) years would have taken me about 30 years to reach over 250 students. Thank goodness for the internet, enabling us to offer the only online course in waterfowl ecology and management worldwide to our knowledge.

In addition to USA students taking the waterfowl course, we have established an agreement with Ducks Unlimited de Mexico (DUMAC). We are grateful to Eduardo Carrera, DUMAC

CEO, and Dr. Todd Petty, Clemson's Forestry and Environmental Conservation Department Chair, for instituting this relationship. English speaking DUMAC staff will enroll in the waterfowl and perhaps other courses and begin working toward earning Clemson's online master's degree in Wildlife and Fisheries Resources. We are hoping to employ a faculty member who is bilingual in English and Spanish. Meanwhile, we are fortunate to retain Lauren Hernandez-Rubio to co-teach the online waterfowl course, which she has done since fall 2017. Also, congratulations to Lauren, who now is Dr. Hernandez-Rubio after receiving her Ph.D. in May 2021. Lauren's dissertation research was unique; it included (1) a 3-year evaluation of enrolled students' perceptions of the online waterfowl course in comparison to other face-to-face and online courses they took previously, (2) academic and experiential credentials deemed necessary by wildlife professionals for a successful career in waterfowl science and management, and (3) graduate students' publication performance from their thesis or dissertation.

Besides completion of Lauren's dissertation research, M.S. candidates, Emily Miller and Jacob Shurba, have completed their field research on reproductive ecology of box-nesting wood ducks in South Carolina-North Carolina and Georgia-Florida, respectively. Emily and Jacob are part of a research team conducting this wood duck research across 8 states in the Southeast. Abstracts of Emily's and Jacob's research are presented in this annual report. Cindy Von Haugg, a new M.S. student who worked as a technician for 2 years on the wood duck project, will step into Emily's 'waders' and continue the research in South Carolina and North Carolina. We also are collaborating with MSU, Nemours Wildlife Foundation, Ducks Unlimited, Inc., South Carolina Department of Natural Resources, and the U.S. Fish and Wildlife Service to initiate a new study of waterfowl foraging habitat capacity in coastal and inland habitats of South Carolina and potentially North Carolina and Georgia. Stephen Clements, a 2016 Clemson wildlife-biology alumnus, will lead the study for his Ph.D. from MSU and be guided by Dr. Brian Davis, my former graduate student and Director of MSU's Kennedy Waterfowl and Wetlands Conservation Program. Lastly, being closeted by COVID for over a year enabled us



to write and publish a number of papers that languished for completion. You'll see these in the section on publications and presentations.

Although COVID constrained our outreach activities, we were able to visit a number of private landowners and provide waterfowl habitat management advice. We also visited with and assisted a number of children and seniors on waterfowl hunts. We're endeavoring to recruit youth and college level waterfowl hunters and retain them in this conservation-beneficial sport.

I'm privileged to be a member of the steering committee of the North American Waterfowl Professional Education Plan (NAWPEP). The NAWPEP is an integral subunit of the North American Waterfowl Management Plan (NAWMP): <https://nawmp.org/nawmp-update/north-american-waterfowl-professional-education-plan-2020-endorsed-and-released> The NAWMP was enacted in 1986 and is the most tenured and funded ecosystems management plan worldwide. Under the NAWMP umbrella, the goal of NAWPEP is to: Engage and assist universities, colleges, and all NAWMP partners with establishing, sustaining, and enhancing academic and experiential programs in waterfowl science and management, in order that sufficient numbers of professionals representing human diversity from across North America are supported, available, and employed to sustain professional capacity and excellence of future waterfowl science and management. Team NAWPEP has completed a strategic plan, which has been endorsed by NAWMP, surveyed waterfowl professors across the USA and Canada to determine the rate of graduating students who acquired waterfowl-related employment (i.e., <1 graduate/year from 1980-2020, suggesting possible low future availability of waterfowl specialists), developed an archive of professors in North America mentoring waterfowl students, built a list of scholarship/assistantship/internship opportunities for waterfowl and wetlands education or work experience, conducted a survey of employers to measure future demand for waterfowl specialists, assisted universities attempting to establish an endowed waterfowl program at their institution, and explored issues and barriers related to increasing human diversity and inclusion among waterfowl programs and employment. Further, the steering

committee has communicated NAWPEP's initiatives and progress to the Association of Fish and Wildlife Agencies, The Wildlife Society via the Wildlife Professional, the Flyway Councils, the National Association of University Fish and Wildlife Programs, NAWMP partner organizations, and professors who mentor waterfowl students.

I am delighted to report that Clemson University and Dr. Jim Anderson (formerly Wildlife Professor, West Virginia University) have come together. Dr. Anderson assumed his new role as Kennedy Center Director in August 2021. You can read the formal announcement at: <https://news.clemson.edu/anderson-named-new-director-of-clemsons-kennedy-center/>

In this annual report, Dr. Anderson penned his inaugural editorial, FROM THE DIRECTOR, describing his background and vision for Kennedy Center. I look forward to helping and collaborating with Dr. Anderson

I am most grateful for having served six years as Clemson's University's inaugural director of the James C. Kennedy Waterfowl and Wetlands Conservation Center. I'll be forever indebted to Mr. Kennedy for endowing two university waterfowl and wetlands programs that I've directed at MSU and Clemson University and endowing two others (University of Wisconsin-Stevens Point [with David Grohne] and Colorado State University). Reflecting on the dozen years that I served these niches at MSU and Clemson, I thank the dozens of graduate students with whom I've worked, taught, and mentored, the hundreds of students who enrolled in our courses, our research partners and sponsors especially our sister organization, the Nemours Wildlife Foundation, its executive director Dr. Ernie Wiggers, Beau Bauer, Nemours' wildlife biologist, and Nemours' board of directors, the advisory board and friends of the Kennedy Center, the MSU and Clemson University leadership, and all our colleagues and friends made over the decades and across the flyways.

I've made some errors along my 45 year path but also many correct decisions; several paramount ones were to 1) leave dental school in 1968 and discover a career in waterfowl and wetlands unknown to my parents and me at that time, 2) marry Loretta in 1972, 3) go to graduate school

at Michigan State University under Dr. Harold H. Prince, 4) study and work in Canada at Delta Waterfowl Foundation and Ducks Unlimited-Canada, 5) trek southward and spend 35 years at Mississippi State University, and 6) finish my career at Clemson's Kennedy Center.

Thank you to all who have facilitated my amazing life, especially thank you Loretta for her steadfast love over a half century and our family, Matt Kaminski (our son), Molly (his wife), and Madison (their daughter and our granddaughter), and Shannon Mayberry (our daughter), Neil (her husband), Tanner (their son and our grandson), and Penelope (their daughter and our granddaughter). Life is an one and done event. As said, mine has been magnificent because of family, friends, colleagues, and the waterfowl profession. I will never forget a quote by my dear friend, Dr. Guy Baldassarre (In memoriam, *The Auk* 130:194-195, 2013): "Family is first; there is no second."

With utmost gratitude for the roles I served and life experienced, please accept my best wishes to you and yours, and stay well!



Richard M. Kaminski

Richard M. Kaminski, Ph.D.

Waterfowl, Wetlands, & Fish Conservationist



RESEARCH ABSTRACT

ADVANCING WATERFOWL ECOLOGY AND MANAGEMENT: ASSESSMENTS OF AN ONLINE COURSE, PROFESSIONAL CREDENTIALS, AND GRADUATE STUDENT PUBLICATION PERFORMANCE

A Dissertation Presented to the Graduate School of Clemson University

In Partial Fulfillment of the Requirements for the Degree
Doctor of Philosophy Wildlife and Fisheries Biology

Lauren Amanda Hernandez-Rubio

University programs with waterfowl teaching, research, and outreach in the United States and Canada have decreased from approximately 55 to 33 programs (~40%). A reduction in these programs may lead to a loss in professional capacity of waterfowl and wetlands specialists working for science and conservation of these resources. Three research projects were conducted: (1) the creation and assessment of premiere worldwide online course in Waterfowl Ecology and Management through Clemson University, (2) identifying academic and experiential credentials perceived important for a successful career in the waterfowl profession by professionals and current students, and (3) determining waterfowl graduate students' performance in publishing from thesis or dissertation in peer-review literature

In the assessment of the online course, students indicated that pedagogical components of the waterfowl course maintained similar effectiveness in helping them learn material when compared to both in-person and other online courses they took. Significant differences observed between graduate and undergraduate responses suggested opportunities to modify current theoretical models in online learning.



A survey of waterfowl professionals and students who attended one or more of the North American Duck Symposium revealed that technical field and practical skills, such as animal capturing and handling and species identification, as well as traditional coursework in ecology and wildlife management, were important for a successful career in the waterfowl profession.

A separate survey of waterfowl professionals and students, who also attended the aforementioned survey(s), identified strategies most often used to motivate graduate students to publish and the most common barriers to publication. Professionals and students indicated that a combination of encouragement and assistance in editing manuscripts could improve student publication performance. Most common barriers to publication were lack of time during and outside work hours, as well as lack of job incentives to publish. The results from these three studies can aid university waterfowl programs and employers to advise and prepare students and professionals for successful careers in waterfowl and other wildlife disciplines.

RESEARCH ABSTRACT

NEST-BOX, MICROHABITAT, AND MICROBIAL INFLUENCES ON WOOD DUCK PRODUCTION AND RECRUITMENT IN GEORGIA AND FLORIDA

Jacob A. Shurba

M.S. Student, James C. Kennedy Waterfowl & Wetlands Conservation Center,
Clemson University and Nemours Wildlife Foundation

The wood duck (*Aix sponsa*) is a significantly harvested duck species in eastern North America that provisions important ecosystem services and economic values. The species nearly was extirpated by the early 20th century due to extensive market hunting and loss of forested habitats, wherein the species innately nests in tree cavities. With continuing degradation and loss of lowland forests and associated natural cavities, nest boxes have been used to supplement availability of suitable nesting space, help wood duck populations recover, and be sustained as legal game-duck in North America. However, recent analyses of a long-term data set of box-nesting wood ducks at the Savanna River Ecology Laboratory near Aiken, South Carolina suggested recruitment (i.e., annual return and nesting by yearling females produced in boxes) would not sustain this population without immigration of hens produced in boxes or natural cavities from other sites.

An important factor that influences wood duck recruitment is selection of nest boxes by hens. Little research has been done to determine how microhabitat and box characteristics influence wood duck box selection, reproduction, and recruitment. Additionally, as boxes are used multiple times by same or different hens in a year, the potential for build-up of bacteria, parasites, and other pathogens increases. Numerous different species of bacteria and fungus have the potential to invade eggshells, infect the



embryo, and possibly impact hatching success.

We are testing hypotheses related to dimensional features of nest boxes, associated microhabitat, and microbial communities and comparing our results to previous studies (e.g., Walls et al. 2012, *The Condor*; Croft et al. 2020, *Wildlife Society Bulletin*). Preliminary predictions include that recruitment rates to boxes in our Georgia and Florida study sites will be similar to previously reported results (~6%; Hepp et al. 2020; *Journal of Wildlife*

Management), and Florida nest boxes will have greater microbe counts and more diverse communities than Georgia, given a longer wood duck breeding and growing season in Florida. We also predicted that nest boxes in both states in which we placed odorous cedar wood shavings will have decreased microbial communities compared to boxes with unscented aspen shavings or no shavings.

In 2021, 123 (89%) of the 138 boxes in Florida were used by nesting ducks, with 213 nesting attempts (avg = 1.5/box) made by either wood ducks or black-bellied whistling ducks (*Dendrocygna autumnalis*). Of these attempts, 42.1% were successful with most failed nests due to abandonment for unknown reasons. We web-tagged 429 wood duck ducklings, all of which successfully exited the boxes. Additionally, we had 7 (1%) web-tagged yearling hens of 567 web-tagged ducklings return from 2020. We took sterile microbial samples of eggs from 50 boxes, 25



containing odorless aspen shavings and 25 containing cedar shavings. These samples will be analyzed for microbes in fall 2021 in comparison to swabs taken during the 2020 field season.

In 2021, 71 (59%) of 120 boxes in Georgia were used by nesting ducks, with 99 nesting attempts (avg = 1.2/box) by wood ducks or hooded mergansers (*Lophodytes cucullatus*). Of these nest attempts, 48.5% were successful, with failed nests occurring from abandonment for unknown reasons. We web-tagged 421 wood duck ducklings, all of which successfully exited boxes. We encountered 3 (0.8%) web-tagged yearling hens out of 351 web-tagged ducklings from the 2020. We took sterile microbial samples of eggs from 20 boxes, 10 containing aspen shavings and 10 containing cedar shavings. Preliminary microbial testing indicated that Florida does contain larger and more diverse nest-box microbial communities than Georgia, as predicted.

I will use simple correlation analysis to determine which habitat, box dimensional,

and microbial explanatory variables are independent of each other and then investigate if these independent variables explain variation in nest fates and recruitment (e.g., used box and successful nest, used but unsuccessful, depredated by snakes or other predators, used and female recruit attracted, etc.). Analysis of microbial data will involve a two-way analysis of variance to test the effects of shavings type (aspen, cedar, or none) and the location (FL or GA) on microbial densities within the nest-boxes. Additional emerging research needs from my thesis include further investigations into how specific microbe species found in nest boxes may impact wood duck (and other cavity-nesting waterfowl species) population dynamics.

I have completed my second field season for this project and will be analyzing my data and writing my thesis with the intention of graduating in May 2022. Following my graduation, I will pursue a Ph.D. studying wildlife disease ecology with the intention of receiving a faculty appointment to train the next generation of wildlife biologists.

MANAGEMENT STRATEGIES TO INCREASE PRODUCTION AND RECRUITMENT OF BOX-NESTING WOOD DUCKS IN SOUTH CAROLINA AND NORTH CAROLINA

Emily M. Miller, M.S. student,
James C. Kennedy Waterfowl & Wetlands Conservation Center
Clemson University and Nemours Wildlife Foundation

Wood ducks (*Aix sponsa*) have experienced one of the most significant population recoveries among North American waterfowl. Due to excessive harvest especially by market hunters and loss of forests, wood duck populations declined markedly through the early 20th century. With enactment of the Migratory Bird Treaty Act (MBTA) in 1918, the wood duck was afforded protection. Subsequently, their populations recovered, and the species now is one of the most harvested in eastern North America. In addition to protection provided by the MBTA, erection of nest boxes to supplement availability of natural cavities has greatly benefited this cavity-nesting species. However, few studies have examined nest-box and habitat characteristics that contribute to wood duck use of boxes, nest success, and recruitment. Following Hepp et al. (2020, *Journal of Wildlife Management*), I define recruitment as the rate (%) at which yearling females return to boxes in their natal area and are found nesting. Recruitment is a vital rate of population dynamics, which is estimated to: (1) discern if box-nesting populations can sustain themselves without immigration of females from populations other than the local box-nesting population and local or immigrant birds that lay eggs in boxes but don't incubate clutches (i.e., parasites) and (2) if box-nesting programs are cost-justified relative to recruitment rates. Additionally, if wood duck nest boxes and their locations are not maintained, boxes



deteriorate, and vegetation can surround the box decreasing their visibility and use by hens and increasing the probability of predator access to the box, thus reducing the possible contribution of boxes to wood duck production and recruitment.

For my thesis, I will examine multiple habitat and box variables in addition to predator deterrent strategies to determine their influence on selection and use of boxes, nest success, and recruitment of hen wood ducks using nest

boxes at Lake Moultrie, South Carolina ($n = 182$) and Mattamuskeet and Roanoke River National Wildlife Refuges and private lands in North Carolina ($n = 191$). Management techniques being evaluated include removing emergent and woody vegetation within a two-meter radius around and above nest boxes to deter rat snakes' (*Pantherophis alleghaniensis*) access to boxes and their depredation of eggs, deployment of new boxes away from those disturbed by passing boaters and anglers, sealing gaps between predator guards and posts, and deployment of commercial deterrents for woodpeckers (Picidae) and snakes. Woodpecker deterrents included a raptor decoy placed atop nest boxes with previous woodpecker egg punctures and that contained an incubating hen at the time of decoy deployment. Snake deterrents included commercially available granules placed in a cotton sock and attached to the bottom of nest boxes where snakes were found.



To determine return and recruitment rates, nesting hens were leg banded with standard USGS leg bands, and ducklings were web tagged with 1-mm self-piercing aluminum tags. Rat snakes found in boxes were tagged with a single glass passive integrated transponder (PIT) tag, each with a unique identification code to identify recaptured snakes. Use of PIT tags will enable us to estimate access to boxes and egg predation rates by individual snakes, sex ratios, dispersal and survival, and the population size of snakes able to access boxes.

Combined for South Carolina and North Carolina in 2021, 203 hens were banded and 3,027 ducklings were web-tagged. Ninety-seven percent ($n = 182$) and 84% ($n = 191$) of boxes were used in 2021 by wood ducks in South Carolina and North Carolina, respectively. A total of 78 rat snakes were captured and PIT tagged at Lake Moultrie in South Carolina, with 53% being recaptured ≥ 1 times. Of the 78 snakes, the majority were males (65.3%; $X^2 = 7.38$, $P = 0.006$). Mean length of male and female snakes was 150.2 cm (SE = 21.7, $n = 50$) and 136.9 cm (SE = 18.5, $n = 26$), respectively. Thus, snakes generally exceeded a meter in length to surmount predator shields and enter boxes. We counted 382 eggs in the stomachs of snakes caught in boxes. Many more eggs disappeared from boxes, possibly ingested by snakes or other predators not encountered by us.

For both states, there were 412 wood duck nest attempts and 613 recorded

nest fates. A nest fate of failure could be recorded before incubation was complete due to egg predation or nest abandonment. Of the recorded nest fates, 77% of nests were successful, 34% were depredated by either snakes or woodpeckers, 20% were abandoned, and 20% of nest fates were categorized as other. At Lake Moultrie in South Carolina, 289 and 568 female wood duck ducklings were tagged in 2019 and 2020 respectively, resulting in a 2020 return rate of yearling females of 4.15% ($n = 12$) and a 2021 return rate of 5.11% ($n = 29$). We will use these recruitment data to determine if the Lake Moultrie population is increasing, decreasing, or remaining stable.

Fourteen snake encounters were recorded for nest boxes with socks containing pellets compared to 19 encounters for boxes without pellets, but no significant difference was detected ($X^2 = 0.49$, $P = 0.48$). At Lake Moultrie and private lands in North Carolina, we randomly placed a raptor decoy on 12 nest boxes where woodpecker egg depredation was noted, and 13 random boxes, with woodpecker depredation, did not receive a raptor decoy. There were 11 successful nests and 1 failed nest and 4 successful and 9 failed nests in boxes with and without raptor decoys, respectively (Fisher's Exact Test, $P = 0.003$). I'll be developing and assessing statistical models to determine what variables and management strategies positively influence box use, nest success, and recruitment, and I plan to graduate in May 2022.

WETLAND ECOSYSTEM SERVICES

*Dr. Tom O'Halloran and Lucas Clay, Ph.D. student
Baruch Institute of Coastal Ecology and Forest Science*

Managed wetlands, also sometimes dubbed “duck ponds” in Lowcountry South Carolina, are extremely valuable for providing waterfowl habitat, and a new study facilitated by the Kennedy Center is examining other ecosystem services provided by these wetlands. Ecosystem services are benefits humans obtain from ecosystems’ natural functioning. Of the many types of ecosystem services, a few examples include habitat provisioning, water purification and reserving, and reducing greenhouse gasses from entering the atmosphere. The latter is the main subject of interest of this new study, because wetlands can be “sources or sinks” of some types of greenhouse gasses. We aim to determine how well managed duck ponds and non-impounded tidal marsh function as “sinks” in capturing these emissions.

In March 2020, Dr. Tom O’Halloran, Assistant Professor at the Baruch Institute, and his research team constructed an environmental sensor tower next to wetland impoundments managed for ducks at Annandale Plantation in the Santee River Basin south of Georgetown, South Carolina

(Fig. 1). The instruments continuously measure a suite of meteorological and water quality variables, as well as the exchange of carbon dioxide and methane between the wetland and the atmosphere. Weather conditions and plant photosynthesis vary seasonally, while water levels and salinity vary due to weather and management strategies. The instruments then detect changes in ecosystem photosynthesis, respiration, and methane production caused by seasonal environmental variability. With this information, greenhouse gas budgets will be quantified and compared with open tidal marsh and nearby coastal pine forests.

The first year of data are now available and are being analyzed for trends relating to how water levels, salinity, and impoundment management affect carbon dioxide and methane exchange. Figure 2 shows how seasonality during 2020 and 2021 has a significant effect on how much carbon dioxide is accumulated in the marsh. Values below zero indicated periods of carbon storage which will be quantified for the different systems under study.



Figure 1. Panoramic view of the eddy covariance flux tower and a managed waterfowl wetland at Annandale Plantation, Georgetown, SC.



The study is being funded through an Equipment Grant and Graduate Research Assistantship from the College of Agriculture, Forestry and Life Sciences at Clemson University. The Kennedy Center graduate student research assistantship will be partially funding Lucas Clay, a PhD student working under Dr. O'Halloran, to analyze the data from Annandale plantation

(Figure 3). Lucas will also compare the gas exchange of the impounded wetland to a nearby open tidal salt marsh at the Baruch Institute (Figure 4). Drs. O'Halloran and Kaminski and Lucas are grateful to Mr. Dan Ray, owner of Annandale Plantation and Mr. Bill Mace, Manager of Annandale Plantation, for hosting and facilitating the research.

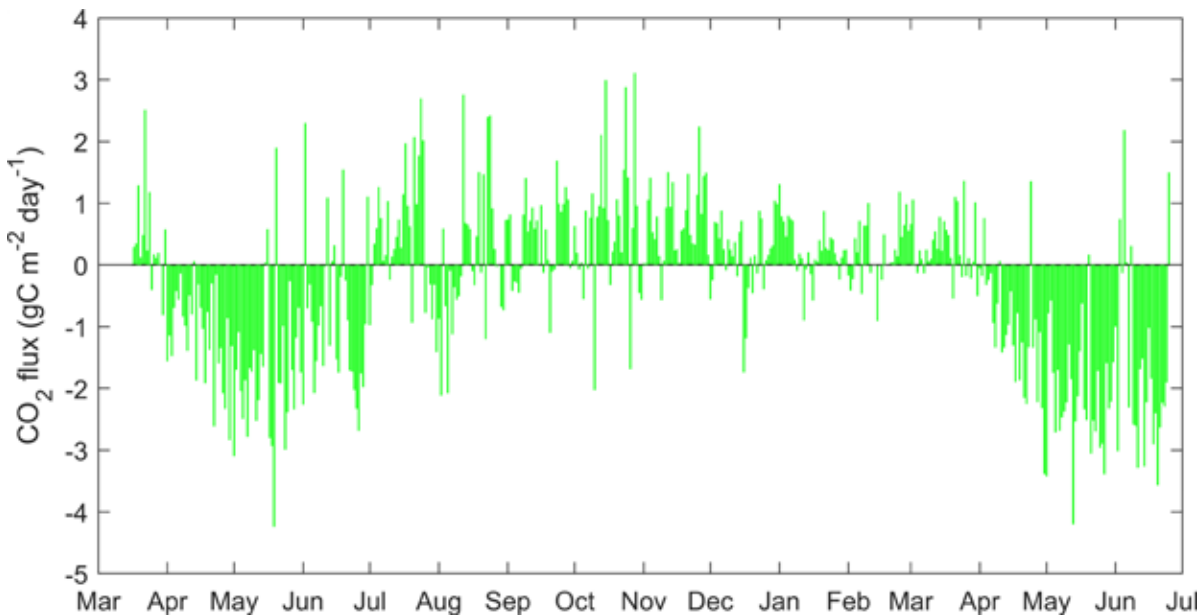


Figure 2. Total daily carbon dioxide fluxes from March 2020 – July 2021. Negative values are carbon storage and positive values are carbon emitted to the atmosphere. The wetland is a strong carbon sink during the growing season months, which accounts for over 50% of the year.



Figure 3. Lucas Clay, Clemson University PhD student, at Annandale Plantation



Figure 4. An eddy covariance flux tower in the North Inlet, open tidal salt marsh.

OUTREACH

The term *Outreach* means communicating research and other technical knowledge from various reputable sources to public and private stakeholders, similar to how Cooperative Extension Units are charged to do for land-grant universities and citizens of their state or nation. Land-grant universities also term outreach as Service and provide it to

the public along with *Teaching* and *Research*. Clemson University is a land-grant university; hence, an obvious role of the Kennedy Center is and will continue to be sharing technical information on ecology and management of waterfowl and wetlands. The following are outreach activities engaged in by the Kennedy Center during 2020-2021.

North American Waterfowl Professional Education Plan

Conservation of waterfowl, wetlands, and all natural resources neither occurs effectively nor efficiently without human engagement and contributions. Therefore, the North American Waterfowl Professional Education Plan (NAWPEP) and steering committee were established and approved as a sub-unit of the North American Waterfowl Management Plan (NAWMP). The goal of NAWPEP is to: *Engage and assist universities/colleges and NAWMP partners with establishing, sustaining, and enhancing academic and experiential programs in waterfowl and wetlands science and management, in order that sufficient numbers of professionals with this expertise and representative of North America's human society are available to sustain professional capacity and excellence of future waterfowl science and management across the continent.*

Dr. Kaminski and an esteemed cadre of waterfowl and wetlands colleagues from the United States, Canada, and Mexico compose NAWPEP's steering committee. Diane Eggeman, DU, Inc., coordinates the committee and is NAWPEP's liaison with NAWMP. The committee completed a strategic plan which was shared with and now has been endorsed by NAWMP partners: <https://nawmp.org/document/north-american-waterfowl-professional-education-plan-2020> Other accomplishments by NAWPEP were described in *From the Former Director*. Clearly, the need for NAWPEP is paramount to sustain human capacity to study waterfowl and wetlands and enable that science to guide conservation.

Assistance to South Carolina DNR

Dr. Kaminski and students continue to assist SC DNR with maintenance of and clearance of vegetation around wood duck nest boxes at Lake Moultrie. This effort is part of Emily Miller's (left) research on strategies to deter rat snakes from accessing nest boxes and eating wood duck eggs. Emily was assisted by Kennedy Center interns Stephanie Braswell and Jason Andrews.





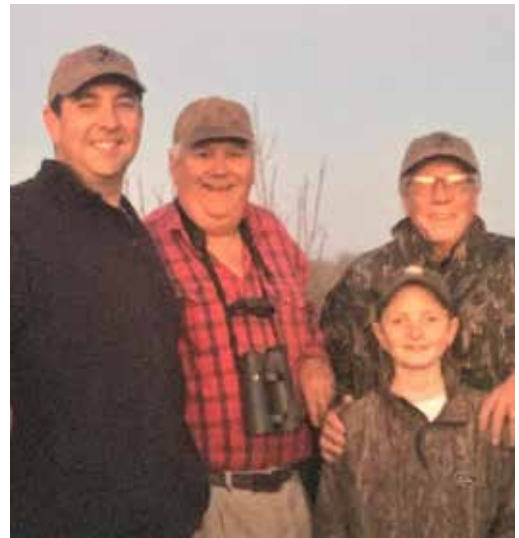
Recruiting and Retaining Waterfowl Hunters

The Kennedy Center partnered with Nemours Wildlife and Delta Waterfowl Foundations to host a duck hunt at Nemours Plantation in January for Clemson students enrolled in a course entitled *Wildlife Hunting and Conservation*, taught by Professor Rick Willey, Coach of Clemson University's shotgun and skeet shooting team. Dr. Kaminski also has lectured in Professor Willey's course on the history of waterfowl management in North America and waterfowl hunting strategies and cuisine recipes. Most students enrolled in the course had never hunted previously; thus, it was a great opportunity to 'baptize' these conservationists. As the tailgate picture reveals, the students had a successful day of fellowship and harvest. University students, especially those majoring in natural resources and hoping to work in the field of conservation, must understand support the legal harvest of fish and game. We are doing our part to connect Clemson students this form of conservation. Moreover, these students are adults and thus can hunt and fish without adult supervision, which greatly enhances their personal opportunities to engage in these sports.

We also assisted in youth hunting or other consumptive conservation activities to connect youngsters with waterfowling or fishing. Days in the blind or in the boat are working to transform these youngsters into life-long conservationists, assuming we adults provide opportunities for them before they become adults and can serve themselves accordingly.







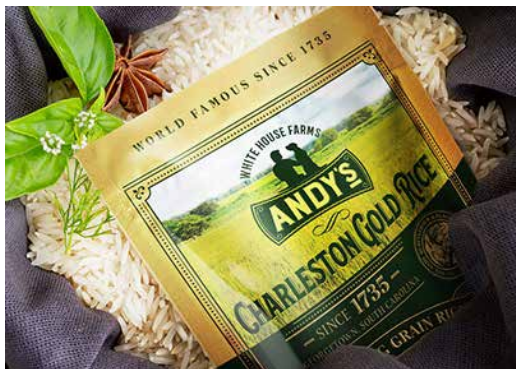
Dr. Kaminski was invited to make site visits to waterfowl properties of colleagues and friends and sometimes had opportunity of share a hunt with his hosts. These are cherished opportunities for we septuagenarians and octogenarians, who sometimes have opportunity to guide grandchildren to get them ‘decoyed’ and ‘hooked’ on natural resources.



We also conducted a few field trips with Horrey-Georgetown Community College (Georgetown, SC) natural resources students. The first was to collect samples of widgeongrass at Rochelle Plantation, with manager Michael Prevost, to determine if the energy value of the plant's foliage and seeds differed significantly. The gross energy of the seeds was about 1.5x greater than the foliage alone, but energy of this plant species generally is low compared to seeds and tubers of native grasses and sedges (aka moist-soil plants). Nonetheless, widgeongrass is an important forage for ducks and hosts abundant aquatic invertebrates. The second field trip was of marsh management by Bill Mace (fourth from right), manager of Annandale Plantation owned by Mr. Dan Ray, and an outdoor seminar by Dr. O'Halloran (under the tower) describing his eddy covariance flux tower used to measure carbon dioxide and other emissions from the marsh in an attempt to demonstrate ecosystem services generated by marsh management.

Amid the August heat and mosquito attack, Dr. Kaminski visited with Mr. Don Quattlebaum, a friend of the Kennedy Center, and owner of White House Farms near Georgetown, SC. There, Mr. Don is growing Charleston Gold rice—the same heirloom rice variety that was grown on the farm from the mid-1700s to early 1900s. The rice is named after and commemorates his late son, Andy. Get you some; it's delicious! <http://www.leesfarmersmarket.com/>

The rice is harvested generally in late August and that crop is marketed. After the August harvest, there remains adequate growing season to produce a second crop, termed a ratoon crop, meaning a new sprout from a parent plant. The ratoon crop is flooded and left as fall-winter food for hungry ducks.





Last but not least, Mississippi State University's (MSU) James C. Kennedy waterfowl and wetlands program is collaborating with Nemours Wildlife Foundation, Ducks Unlimited, Inc., Clemson's Kennedy Center, the U.S. Fish and Wildlife Service, South Carolina Department of Natural Resources, and private landowners in an unique South Atlantic regional study to determine contemporary foods of and foraging carrying capacity for wintering ducks on managed and non-managed wetlands in the South Atlantic Flyway.

Pictured at right (from left) are Stephen Clements (MSU Ph.D. student, leading the study), Beau Bauer (Nemours Wildlife Foundation), and Dr. Jim Anderson (Clemson's Kennedy Center, Director). The trio is holding widgeongrass collected by Michael Prevost, field trip host and manager of Rochelle Plantation (a 2021 study site) in Georgetown County, South Carolina. Widgeongrass is a favored submersed aquatic plant food used by foraging ducks.



STUDENT AWARDS

We are pleased to announce fellowships, assistantships, scholarships, and other scholarly awards received by Kennedy Center undergraduate and graduate students during 2020-2021. These students are the ‘heart, lungs, soul, and energy’ of the Kennedy Center and its many accomplishments. They will be future leaders in the roles of waterfowl and wetlands science and conservation.



Lauren Hernandez-Rubio, former Kennedy Center Ph.D. Fellow, is now Dr. Lauren Hernandez-Rubio after her doctorate was conferred by Clemson University in May 2021. Lauren’s dissertation is viewable at: <https://www.proquest.com/docview/2541700140?pq-origsite=gscholar&fromopenview=true>

Lauren now is a faculty lecturer, teaching an online course in waterfowl ecology and management through Clemson University’s Department of Forestry and Environmental Conservation with Dr. Kaminski and a biology with other courses through The Citadel University in Charleston, SC.



Lucas Clay is a Clemson Ph.D. student under Dr. Tom O’Halloran and received the Kennedy Center doctoral student fellowship during academic year 2021-2022. Lucas is researching how wetlands managed for waterfowl and other waterbirds and open tidal salt marsh similarly or differently generate ecosystem services, such as sequestering green-house gas emissions and improving water quality during annual seasonal cycles.



Emily Miller is a Kennedy Center M.S. Student Fellow and Nemours Wildlife Foundation graduate student. Emily has completed her second and final year of field work, conducting research on recruitment by box-nesting female wood ducks in South Carolina and North Carolina. Emily will be analyzing her data and writing her thesis with a plan to graduate in May 2022.



Cindy Von Haugg is a first year M.S. student, who will succeed Emily Miller on the wood duck research project. Cindy has worked on the wood duck project assisting Emily in North Carolina and South Carolina in 2020 and 2021, respectively; thus, she is well skilled to take over reigns of the project. Cindy's research will focus on assessing availability of natural cavities for nesting wood ducks and she will initiate a radiotelemetry study to determine potential use of natural cavities.



Jacob Shurba is a Kennedy Center, Nemours Wildlife Foundation, and South Carolina Department of Natural Resources Graduate Student. Jacob also is a member of Team Wood Duck conducting research on box-nesting wood ducks in Georgia and Florida. Jacob especially is interested in waterfowl diseases; therefore, he is conducting an experiment to test if odiferous and plain nest box bedding materials differentially affect microbe communities in nest boxes and on wood duck eggs. He too has completed his field work and is scheduled to graduate in May 2022.



Stephanie Braswell was a senior undergraduate student majoring in Wildlife and Fisheries Biology and minoring in Forestry and Animal Science; she graduated in May 2021 and was honored by receiving the Outstanding Senior Award in the Department of Forestry and Environmental Conservation. Stephanie worked as a research assistant at Nemours Wildlife Foundation during spring 2021. She always will be a Clemson Tiger but now is an Auburn University Tiger x War Eagle 'hybrid,' as she has begun her M.S. at Auburn under Dr. Robert Gitzen. She also was honored by receiving the Steven L. Potts Award from the Department of Forestry and Environmental Conservation for academic and other excellence in spring 2020.



Magdalyn Husser is an undergraduate student majoring in Wildlife and Fisheries. She was a 2020-2021 recipient of a Kennedy Center undergraduate scholarship for her contributions to Team Wood Duck and its students.



Jason Andrews has been a vital contributor to Team Wood Duck, assisting with nest-box monitoring at Clemson University Experimental Forest and clearing vegetation from around dozens of nest boxes at Lake Moultrie in an attempt to deter rat snakes from accessing nest boxes and depredating wood duck eggs. For Jason's contributions in the field, he was awarded the Department of Forestry and Environmental Conservation's Outstanding Field Training Award.



Emery Tumbleston is a senior Wildlife and Fisheries Biology major, who is receiving the Kennedy Center's undergraduate scholarship for academic year 2021-2022. Emery is a scholar, currently maintaining a perfect GPA of 4.0. Additionally, she is extensively engaged in Clemson's student chapter of The Wildlife Society, as its secretary and co-organizer of fund-raising activities. She also is active with her church and parent's blueberry farm, as well as assisting graduating students of the Kennedy Center.



Jordan McCall is a Clemson University senior, also with 4.0 GPA, majoring in Wildlife and Fisheries Biology and anticipating graduating in December 2021. Jordan was selected as a Clemson summer intern and worked as an assistant for the Kennedy Center and Nemours Wildlife Foundation during summer 2021. This fall, Jordan will receive an undergraduate scholarship toward her tuition from the Kennedy Center. She's hoping to pursue graduate school studying waterfowl and wetlands.



2021 ADVISORY COUNCIL MEMBERS

We sincerely thank the advisory council members of the James C. Kennedy Waterfowl and Wetlands Conservation Center. The members represent partners from academia, agencies, and the private sector. They advise, facilitate, and support teaching, research, and outreach activities of the Kennedy Center. The Center's new director, Dr. Jim Anderson, will announce plans for the next advisory council meeting.

- **John Andrae**, Interim Director, Baruch Institute of Coastal Ecology and Forest Science
- **Jason Ayers**, South Carolina Coastal Program Coordinator, U.S. Fish and Wildlife Service
- **Billy Dukes**, Chief of Wildlife, South Carolina Department of Natural Resources (SCDNR)
- **Jim Clark**, Plantation Manager
- **Jamie Dozier**, Project Leader, Tom Yawkey Wildlife Center, SCDNR
- **Travis H. Folk**, woodland and wildlife consultant, Folk Land Management, Inc.
- **Thomas Rainwater**, Wildlife Research Scientist, Yawkey Wildlife Foundation and Belle W. Baruch Institute of Coastal Ecology and Forest Science
- **Buford Mabry**, Delta Waterfowl Foundation
- **Bill Mace**, Manager, Annandale Plantation
- **Robert Perry**, Palmetto Natural Resources Management, LLC
- **Todd Petty**, Chairperson, Clemson Department of Forestry and Environmental Conservation
- **Michael Prevost**, wildlife biologist and land manager, White Oak Forestry and Rochelle Plantation
- **Emily Purcell**, Ducks Unlimited, Inc.
- **Craig Sasser**, U.S. Fish and Wildlife Service
- **Craig Watson**, South Atlantic Coordinator, U.S. Fish and Wildlife Service, Charleston Ecological Services Field Office
- **David Wielicki**, Executive Director, South Carolina Waterfowl Association
- **Ernie Wiggers**, CEO and Beau Bauer, Biologist, Nemours Wildlife Foundation
- **R. Kenneth Williams**, Owner, Williams Land Management Company
- **Greg Yarrow**, Professor, Clemson's Department of Forestry and Environmental Conservation

Publications (*n* = 23)

- Marty, J. R., J. B. Davis, R. M. Kaminski, M. G. Brasher, and S. A. Rush. 2020. Gulf coast riceland seed biomass estimates for waterfowl conservation. *Journal of Wildlife Management* 84:1315-1325.
- Monroe, K. C., J. B. Davis, A. P. Monroe, R. M. Kaminski, M. J. Gray, and D. L. Evans. 2021. Winter habitat selection by a declining American black duck population. *Wildlife Society Bulletin* 45:16-26.
- Meehan, T. D., R. M. Kaminski, et al. 2021. Half-century winter duck abundance and temperature trends in the Mississippi and Atlantic flyways. *Journal of Wildlife Management* 85:713-722.
- Bauer, B. A., R. M. Kaminski, D. Lanham, P. D. Gerard, and E. P. Wiggers. 2020. Hydrological management for submersed aquatic vegetation in South Carolina coastal impoundments. *Wildlife Society Bulletin* 44:579-584.
- Bauer, B. A., R. M. Kaminski, D. Lanham, P. D. Gerard, and E. P. Wiggers. 2021. Drawdown management influences aquatic invertebrate biomass in coastal South Carolina impoundments. *Wildlife Society Bulletin*, in revision.
- Lavretsky, P., E. Duenez, M. Kneece, and R. M. Kaminski. 2021. Conservation genetics of a translocated population of mottled ducks and allies in South Carolina. *Journal of Wildlife Management*, in press: DOI: 10.1002/jwmg.22124
- Masto, N. M., R. M. Kaminski, P. D. Gerard, B. E. Ross, and M. R. Kneece, and G. L. Wilkerson. 2021. Aerial strip-transect surveys: Indexing autumn-winter waterbird abundance and distribution in South Carolina. *Journal of Southeastern Fish and Wildlife Agencies* 8:89-100.
- Croft, G. D., R. M. Kaminski, E. P. Wiggers, P. D. Gerard, and G. K. Yarrow. 2020. Nest-box use by wood ducks and black-bellied whistling ducks in coastal South Carolina. *Wildlife Society Bulletin* 44:662-669.
- Davis, J. B., M. R. Boudreau, T. G. Peterson, R. M. Kaminski, and M. E. Colvin. 2022. Wintering waterfowl use of forested wetlands in Delta National Forest, Mississippi. *Journal Southeastern Fish and Wildlife Agencies*. in review
- Kaminski, R. M. 2021. Rescue a retired retriever. *Ducks Unlimited Magazine*, May/June 2021, Ducks Unlimited, Inc., Memphis, Tennessee.
- Hernandez-Rubio, L. A. 2021. Advancing waterfowl ecology and management: Assessments of an online course, professional credentials, and graduate student publication performance. Dissertation, Clemson University, Clemson, South Carolina.
- Bauer, B., D. Bakner, T. Gibson, T. Mezebish, E. Miller, J. Shurba, and N. Simmons. 2020. Regional examination of the contribution of nest boxes to wood duck recruitment in the southeast and mid-Atlantic United States: 2020 annual report. Available from Nemours Wildlife Foundation, Yemassee, South Carolina 29945, and Clemson University's James C. Kennedy Waterfowl & Wetlands Conservation Center, Georgetown, South Carolina, USA.



Bauer, B., and J. Malpass. 2020. Notes from the field: wood duck recruitment. <http://www.usgs.gov/center-news/notes-field-wood-duck-recruitment>.

Croft, G. D., R. M. Kaminski, E. P. Wiggers, P. D. Gerard, and G. K. Yarrow. 2022. Reproduction and management of box-nesting wood ducks and black-bellied whistling ducks in coastal South Carolina. *Journal of Southeastern Fish and Wildlife Agencies*, in review.

Masto, N. M., R. M. Kaminski, and H. H. Prince. 2021. Hemi-marsh concept prevails? Kaminski and Prince (1981) revisited. *Journal of Wildlife Management*, in review.

Davis, J. B., M. R. Boudreau, Kira C. Monroe, and Richard M. Kaminski. 2021. Resource partitioning or overlap by sympatric American black ducks and mallards wintering in Tennessee? *Journal of Fish and Wildlife Management*, in press.

Boudreau, M. R., J. D. Lancaster, J. B. Davis, R. M. Kaminski, et al. 2021. Do mallard winter home ranges in Mississippi contain sufficient duck energy days? *Journal of Wildlife Management*, in review.

Lancaster, J. D., J. B. Davis, R. M. Kaminski, M. R. Boudreau, G. M. Street, A. E. Minni, and K. D. Nelms. 2021. Mallard use of conservation program wetlands in Mississippi. *Wildlife Society Bulletin*, in preparation.

Shurba, J. A., R. A. Cole, M. S. Broadway, C. L. Roderick, J. D. Riddle, S. A. Dubay, and S. Hull. 2021. Gapeworm (*Syngamus* spp.) prevalence in Wisconsin greater prairie chickens (*Tympanuchus cupido pinnatus*). *Journal of Parasitology* 107: 600-605.

Hernandez-Rubio, L., R. M. Kaminski, and C. K. Williams. 2021. Professionals' and students' perceptions of waterfowl graduate student publication performance. *Wildfowl*, in preparation.

Straub, J. N., R. M. Kaminski, A. G. Leach, A. W. Ezell, T. Leininger, and J. Foth. 2021. Red-oak acorn abundance across the Mississippi Alluvial Valley. *Journal of Wildlife Management*, in preparation.

Foth, J. R., R. M. Kaminski, and F. J. Villela. 2021. Drought and hurricane influences on migrating shore- and other waterbirds in the Mississippi Alluvial Valley and Gulf Coast Conservation Region. *Waterbirds*, in preparation.

Croft, G. D., R. M. Kaminski, E. P. Wiggers, P. D. Gerard, and G. K. Yarrow. 2022. Reproduction and management of box-nesting wood ducks and black-bellied whistling ducks in coastal South Carolina. 2021 SEAFWA Conference, Roanoke, VA.



Oral and Poster Presentations (*n* = 8)

Poster and oral presentations during 2020 and 2021 were limited greatly because COVID cancelled or we did not participate in remotely convened meetings. Nonetheless, we contributed when we could via Zoom seminars and webinars.

Hernandez-Rubio, L. A. 2021. Advancing waterfowl ecology and management: Assessments of an online course, professional credentials, and graduate student publication performance. Dissertation defense seminar, Clemson University, Clemson, South Carolina, via Zoom.

Hernandez-Rubio, L. A. 2021. Assessment of credentials and experiences for a successful career in waterfowl science and conservation. Seminar given to the North American Waterfowl Professional Education Plan steering committee, 27 April 2021, via Zoom.

Kaminski, R. M. and NAWPEP steering committee. 2020. Who will mind the marsh? A strategic plan by the North American Waterfowl Professional Education Plan. Seminar given to the Association of Fish and Wildlife Agencies, October 2020.

Moritz, A., R. M. Kaminski, et al. 2021. Apparent metabolizable energy and performance of broilers and Japanese quail fed selected modern grain sorghum varieties. Poultry Science Association 2021 Annual Meeting. Online virtual conference, Omaha, Nebraska.

Shurba, J. A., E. M. Miller, R. M. Kaminski, B. A. Bauer, and E. Wiggers. 2021. Regional examination of the contribution of nest boxes to wood duck recruitment in the Southeastern United States. 2020 season summary given to the Atlantic Flyway Council, 2021, via Zoom.

Shurba, J. A., E. M. Miller, R. M. Kaminski, B. A. Bauer, E. P. Wiggers, P. Schmidt, G. R. Hepp, B. E. Ross, and K. J. Whitehead. Regional examination of the contribution of nest boxes to wood duck recruitment in the Southeastern United States. Project update given to the South Carolina chapter of the Wildlife Society, 2020, via Zoom.

Shurba, J. A., R. M. Kaminski, K. J. Whitehead, B. A. Bauer, R. K. Barrett, B. E. Ross, and G. Yarrow. Microbial communities in wood duck nest boxes in Georgia and Florida and an experiment to reduce bacterial infection of eggs. Southeastern Association of Fish and Wildlife Agencies conference, Roanoke, VA, 2021.

Miller, E., C. Von Haugg, R. M. Kaminski, J. Shurba, and B. Bauer, and J. Anderson. 2021. Effects of rat snakes on wood ducks nesting in boxes in South Carolina. Southeastern Association of Fish and Wildlife Agencies conference, Roanoke, VA, 2021.

