SE CASC Final Report

1. ADMINISTRATIVE:
Principal Investigator: Krishna Pacifici
Agency or institution: North Carolina State University
Project title: Assessing the Climate Vulnerability of Wild Turkeys Across the Southeastern U.S.
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2. PUBLIC SUMMARY:

Climate change is influencing temperature, precipitation, and the temporal availability of resources required for successful reproduction and survival. Implications for the economically and culturally important eastern wild turkey (*Meleagris gallopavo silvestris*) are largely unknown. Therefore, we assessed associations between observed weather and eastern wild turkey nest initiation timing and nest survival and then projected observed associations under multiple climate change scenarios to assess potential implications of future climate change. Nest initiation date was influenced by temperature and precipitation, but projected changes associated with climate change shift nest initiation date by <0.1 day by 2041-2060. Timing of spring green-up was not a predictor of nest initiation timing. This mismatch between spring green-up and wild turkey nest initiation could influence nest success or nest survival. However, our subsequent analyses found that climate change induced shifts in temperature and precipitation are likely to minimally influence nest success because observed relationships largely offset one another. Analyses into associations between weather and brood survival, the final piece of this puzzle, are ongoing. While we cannot yet speculate on the possibility of neutral or positive associations between projected future climate conditions and brood survival, analyses to-date find no negative associations. As eastern wild turkey populations continue to decline, it is reassuring to find little evidence that projected climate change over the next several decades will directly add to these declines. This information enables managers to shift focus and resources to understanding drivers of current declines, and their future implications for eastern wild turkey populations.

3. TECHNICAL SUMMARY:

Our objectives were to assess the relative importance of short-term weather events, longer-term weather shifts, and extreme weather events on wild turkey (*Meleagris gallopavo silvestris*) reproductive phenology and success and communicate findings and their implications to stakeholders. Temperature and precipitation have been identified as factors that potentially influence eastern wild turkey reproduction, but robust analyses testing the relationship between weather parameters and turkey nest success are lacking. Therefore, we assessed how weather influenced turkey daily nest survival using 8 years of data collected from 715 nests across the southeastern United States. We conducted exploratory analyses investigating if weather conditions during or prior to nesting best predicted nest success. We then assessed the possible implications of climate change through 2041–2060 for future eastern wild turkey daily nest survival and nest success for variables determined significant in analyses. During incubation,

positive anomalies of minimum daily temperature were associated with greater daily nest survival. Precipitation during nesting was not a good predictor of daily nest survival. Exploratory analyses unexpectedly indicated that weather conditions in January prior to incubation were more important to nest success than weather conditions during incubation. In January, negative anomalies of minimum temperature and greater average daily precipitation were associated with greater nest success. Projections of future nest success or daily nest survival based on these relationships with the predictive covariates, and informed by climate models, suggest that nest success may increase as January precipitation increases and that daily nest survival may increase as temperature during incubation increases. These positive associations could be offset by a negative association between nest success and the expected increases in January minimum average temperature. Additional research is needed to investigate causes of these relationships and assess the implications of climate change for eastern wild turkey poult survival.

Climate change may induce mismatches between wildlife reproductive phenology and temporal occurrence of resources necessary for reproductive success. Verifying and elucidating the causal mechanisms behind potential mismatches requires large-scale, longer-duration data. We used eastern wild turkey (*Meleagris gallopavo silvestris*) nesting data collected across the southeastern U.S. over eight years to investigate potential climatic drivers of variation in nest initiation dates. We investigated climactic relationships with two datasets, one inclusive of successful and unsuccessful nests (full dataset) and another of just successful nests (successfully hatched dataset), to determine whether successfully hatched nests responded differently to weather changes than all nests did. In the full dataset, each 10 cm increase in January precipitation was associated with nesting occurring 0.46–0.66 days earlier, and each 10 cm increase in precipitation during the 30 days preceding nesting was associated with nesting occurring 0.17–0.21 days later. In the successfully hatched dataset, a 10 cm increase in March precipitation was associated with nesting occurring 0.67–0.74 days earlier, and an increase of one unit of variation in February maximum temperature was associated with nesting occurring 0.02 days later. We combined the results of these modeled relationships with multiple climate scenarios to understand potential implications of future climate change on wild turkey nesting phenology; results indicated that mean nest initiation date is projected to change by <0.1 day by 2040–2060. Wild turkey nesting phenology did not track changes in spring green-up timing, which could result in phenological mismatch between the timing of nesting and the availability of resources critical for successful reproduction.

Throughout this project we engaged with relevant stakeholders (state agencies, National Wild Turkey Federation, and researchers) throughout the southeastern U.S. including active membership in the Southeastern Association of Fish and Wildlife Agencies' Wild Turkey Working Group (annual meetings with managers, researchers, and policy makers) and communication with states and the general public. Our results provided direct information for state agencies to incorporate into their State Wildlife Plans (SWPs) and planning for turkey harvest. Our results were presented in many different formats (public presentations, press releases, scientific papers, written and oral media interviews) and this would not have been possible without the funding from the SECASC. In addition, this funding made it possible to aggregate data from numerous small-scale studies throughout the SE and to leverage the collective information to project turkey reproductive phenology and success under future climate conditions. None of this would have been possible without the SECASC funds and without them, our inferences would have been limited to studies with limited spatial and temporal coverage.

4. PURPOSE AND OBJECTIVES:

Project objectives: a) Assess the climate-change vulnerability of a wide-spread and economically important game species, the wild turkey, across the southeastern U.S. where it is exhibiting long-term declines in abundance.

We successfully met this objective with our first two publications exploring the relationship between reproductive phenology and success and climate.

b) Work closely with natural resource managers and NGOs to provide usable recommendations for mitigation of any projected negative effects of climate change.

Throughout this project we worked closely with a number of natural resource managers from states and NGOs (NWTF). Information was shared through working groups, formal and informal meetings, public and conference presentations, media coverage (print, online, and televised coverage), and peer reviewed publications.

c) Provide a template for collaborative, large-scale conservation and management of game species.

This project provided a framework for aggregating multiple small scale studies over a large geographic range and using these results to work closely with resource managers. The network of partners we engaged (through connections from the Co-PIs) covered the majority of the Southeastern U.S. and a large portion of the eastern wild turkey's range. Our approach provides a template for how to assess the implications of climate change for the reproduction of broadly distributed wildlife species.

d) While not included in the project objectives, the proposal discusses investigating how hunter harvest influences wild turkey populations. However, data were insufficient to assess the implications of hunter harvest on wild turkey populations. Specifically, hunting seasons, bag limits, and other regulations were not modified during our study period in way that enabled us to investigate their implications. However, under separately funded projects, Co-PIs Mike Chamberlain and Bret Collier have begun working on these questions, following recent changes to hunting regulations in several of states included in this study. This gap in knowledge was elucidated through the funding for this project and will be a focus of future research.

5. ORGANIZATION AND APPROACH:

Nesting phenology: We selected the turkey datasets included in this study for their wide geographic scope and consistent methods. We paired these data with remotely sensed climate data. We obtained gridded daily high and low temperature and total rainfall data with a 4-km resolution, the finest scale available for the spatial and temporal extent of the project, from gridMET. We selected the C6 Eastern CONUS eMODIS RSP dataset as a surrogate for spring green-up for 2014–2020 because it was available throughout the study area, had daily temporal resolution, and had the finest spatial resolution available (250-m resolution). We used the Earth Resources Observation and Science Visible Infrared Imaging Radiometer Suite remotely sensed phenology dataset with 375-m resolution for 2021 because it replaced the C6 Eastern CONUS eMODIS RSP dataset, which was discontinued at the end of 2020. We used bilinear interpolation to rescale the 250-m resolution 2014–2020 data to 375-m resolution, which matched the resolution of the 2021 data. We used Cox proportional hazards models to assess associations between weather and spring green-up timing. We used this approach because they are commonly used, relatively well understood by the researchers in our target audience, and allowed us to account for potential bias induced by the spatially clustered nature of our data. We then projected statistically significant associations under multiple future climate change scenarios using weather projection data from the Multivariate Adaptive Constructed Analogs Coupled Model Inter-Comparison Project Phase Five model ensemble.

Nest success: We used the same turkey datasets as above for the same reasons as above, but now looked at weather associations with nest success. In addition to remotely sensed variables, we included visual obstruction at the nest site because this is an important predictor of nest success in some systems. We again extracted weather data from gridMET because it had the smallest spatial resolution (4-km) and spanned the duration of our study (2014-2021). For each individual nest location, we calculated average precipitation and average minimum temperature separately for January, February, March, 30 days prior to incubation initiation, and during incubation for each individual nest. We selected 30 days prior because breeding behaviors occur during this period. We calculated anomalies as the difference between the observed average minimum temperature and the average minimum temperature from 1981–2010 for each nest location in January, February, March, 30 days prior to incubation initiation, and during incubation for each individual nest (using the same ordinal dates for the 1981–2010 average and the nesting temporal period being investigated). We used anomalies from the mean rather than simply using the observed minimum average temperature to account for seasonal temperature change; for example, a low of 15°C in March would be uncharacteristically warm, but it would not be as anomalous in May. We did not include high temperatures in analyses because they were correlated with minimum temperatures (r range = 0.83–0.94), and because spring high temperatures are unlikely to reach thermal limits for a species that renests into the summer. We used a generalized linear mixed-effects model with an inverse-link function to assess associations between weather conditions and daily nest survival. This approach allowed for the inclusion of random effects, enabling us to include study area as a random intercept to account for possible spatial autocorrelation caused by non-random sampling. We tested all possible combinations of the three fixed effect variables, plus pairwise interactions between these variables (13 models total) and ranked the models using Akaike's Information Criterion accounting for small sample size. We conducted full model averaging of all competing models ($\Delta AICc < 4$) and considered variables with 95% confidence intervals that did not overlap zero to be significant predictors of daily nest survival. We projected significant associations under multiple future climate change scenarios using data extracted from the Multivariate Adaptive Constructed Analogs Coupled Model Inter-Comparison Project Phase Six model ensemble.

We performed exploratory analyses investigating whether temperature anomalies and precipitation best predicted nest success during or prior to incubation. We started by determining if weather conditions in January, February, March, 30 days prior to incubation initiation, or during incubation were more important to nest success (binary measure of whether or not a nest hatched). We built 5 models, 1 for each of the aforementioned time periods that included weather variables (minimum average temperature anomaly and average daily precipitation) plus incubation initiation date, visual obstruction, and year. We again used generalized linear mixed-effects models because they enabled us to account for possible spatial autocorrelation caused by non-random sampling. We ranked models using Akaike's Information Criterion accounting for small sample size. We conducted full model averaging of all competing models (ΔAICc < 4) and considered variables with 95% confidence intervals that did not overlap zero to be significant predictors of wild turkey nest success. We then applied the previously described approach for projecting climate change effects on daily nest survival to project the effects on eastern wild turkey nest success.

6. PROJECT RESULTS:

Qualitative results: Our primary challenges pertained to aggregating, cleaning, and verifying data collected over a large time scale and from many different projects (different PIs, field technicians, graduate students). Conducting QAQC and cleaning turkey data was a time consuming task, but was made easier and more efficient by the high degree of involvement of our collaborators and their current grad students. Additionally, the climate data were sometimes difficult to work with given the large spatial and temporal extent of our study and it required the postdoc to learn new skills necessary to work with data stored in large files and in hard-to-access formats. However, we benefited significantly from the guidance and expertise of our USGS collaborator Adam Terando, whose advice made the learning curve less challenging and increased our efficiency.

Nesting phenology:

The full dataset included 717 nests and the successfully hatched dataset included 186 nests. The timing of nesting and spring green-up varied among years in the dataset. In the full dataset, the first nest occurred on ordinal day 71, the last nest occurred on ordinal day 186, and the mean date was ordinal day 110. Analysis of the full dataset revealed two statistically significant relationships that were present in both semi-global models. Greater total January rainfall was associated with earlier nesting (full dataset Model 1: $\hat{\beta} = 0.007$, 95% CI = 0.004 to 0.009; Model 2: $\hat{\beta} = 0.007$, 95% CI = 0.003 to 0.011). Each 10 cm increase in January rainfall was associated with nesting occurring 0.67 to 0.69 days earlier (full dataset Model 1 and 2, respectively). Greater total precipitation in the 30 days prior to nest initiation was associated with later nesting (full dataset Model 1: $\hat{\beta} = -0.002$, 95% CI = −0.003 to −0.0005; Model 2: $\hat{\beta} = -0.002$, 95% CI = −0.004 to −0.001). Each 10 cm increase in precipitation was associated with nesting occurring 0.17 to 0.24 days later (full dataset Model 1 and 2, respectively). No other variable, including spring green-up, was a significant predictor of turkey nest initiation date in the full dataset.

Average observed January precipitation was 13.16 cm. Average projected January precipitation for 2041–2060 for RCP 4.5 was 11.86 cm and for RCP 8.5 was 12.27 cm (minimum single-year average: 10.67 cm; maximum single-year average: 14.73 cm). Based on the full dataset models and projected future changes in January precipitation for 2041–2060, nest initiation could shift later by 0.09 days (independent estimate for both semi-global models) under

RCP 4.5 or later by 0.06 days (independent estimate for both semi-global models) under RCP 8.5.

Average observed total precipitation in the 30 days prior to nest initiation was 12.46 cm. Average projected total precipitation in the 30 days prior to nest initiation for 2041–2060 for RCP 4.5 was 11.02 cm (minimum single-year average: 8.78 cm; maximum single-year average: 13.47 cm) and for RCP 8.5 was 10.91 cm (minimum single-year average: 9.28 cm; maximum single-year average: 13.61 cm). Based on the full dataset models and projected future changes in total precipitation in the 30 days prior to nest initiation for 2041–2060, nest initiation could shift earlier by 0.02 to 0.03 days (range of semi-global models) under RCP 4.5 or earlier by 0.03 to 0.04 days (range of semi-global models) under RCP 8.5. Cumulatively, the two predictors of nest initiation date using the full dataset indicate nest initiation could occur 0.06 to 0.07 days later (range of semi-global models) under RCP 4.5 or 0.02 to 0.03 days later (range of semi-global models) under RCP 8.5 during 2041–2060.

Average observed March precipitation was 11.17 cm. Average projected March precipitation for 2041–2060 for RCP 4.5 was 12.05 cm (minimum single-year average: 8.57 cm; maximum single-year average: 14.55 cm) and for RCP 8.5 was 12.36 cm (minimum single-year average: 10.42 cm; maximum single-year average: 15.09 cm). Based on the successfully hatched dataset models and projected future changes in March precipitation for 2041–2060, initiation of successful nests could shift 0.05 to 0.06 days earlier (range of semi-global models) under RCP 4.5 or 0.07 to 0.08 days earlier (range of semi-global models) under RCP 8.5.

Average observed variance of daily maximum temperature in February was 27.59. Average projected variance of daily maximum temperature in February for 2041–2060 for RCP 4.5 was 28.45 (minimum single-year average: 25.38; maximum single-year average: 32.28) and for RCP 8.5 was 27.91 (minimum single-year average: 24.87; maximum single-year average: 34.82). Based on the successfully hatched models and projected future changes in variance of daily maximum temperature in February for 2041–2060, initiation of successful nests could shift 0.02 days later (independent estimate for both semi-global models) under RCP 4.5 or 0.06 to 0.07 days later (range of semi-global models) under RCP 8.5. Cumulatively, the two predictors of nest initiation date using the successfully hatched dataset indicate nest initiation could occur 0.03 to 0.04 days earlier (range of semi-global models) under RCP 4.5 or 0.00 to 0.02 days earlier (range of semi-global models) under RCP 8.5 during 2041–2060.

Nest success:

We monitored 715 first nests initiated by 682 individual female turkeys during the 2014-2021 breeding seasons. Of 17 turkeys monitored multiple years, we monitored 16 individuals for two years and one individual for three years. Overall hatch rate was 26% (186 nests) and failure rate was 74% (529 nests). Annual hatch rate ranged from 14.9% in 2017 to 37.3% in 2015 (Table 1). Study area hatch rate ranged from 0% (out of four nests) in ANF to 42.6% (out of 61 nests) in FLP. Incubation of the earliest nest started 12 March, the latest initial nest being incubated failed on 14 July, and mean incubation initiation date was 19 April (non-leap year).

Analyses pertaining to the primary objective (i.e., understanding associations between weather conditions during incubation and daily nest survival) produced six competing models. Model averaging of competing models revealed one significant predictor of daily nest survival. As observed daily minimum temperature anomalies went from negative to positive relative to the historical average, daily nest survival increased ($\hat{\beta} = 0.07$, CI = 0.05 to 0.09) with daily nest survival increasing from 94.50% (CI = 93.29% to 95.50%) to 97.15% (CI = 96.41% to 97.74%) as temperature anomaly increased from 5°C below average to 5°C above average. The four other variables included in competing models were not significant predictors of daily nest survival. Based on results of the top model, using the projected temperature increases through 2041-2060, relative to nest survival at the observed mean temperature eastern wild turkey daily nest survival would be expected to increase by 0.40% (66% CI = 0.33% to 0.54%) from 96.03% to 96.42% under SSP1-2.5, 0.51% (66% CI = 0.42% to 0.62%) from 96.03% to 96.52% under SSP2-4.5, and 0.66% (66% CI = 0.53% to 0.78%) from 96.03% to 96.66% under SSP5-8.5. When looking at expected nest survival cumulatively for the incubation period, relative to nest survival at the observed mean temperature eastern wild turkey nest survival could increase by up to 11.28% (66% CI = 9.16% to 15.23%) under SSP1-2.5, 14.28% (66% CI = 11.76% to 17.42%) under SSP2-4.5, and 18.54% (66% CI = 14.81% to 21.73%) under SSP5-8.5.

Analyses pertaining to the secondary objective (i.e., performing exploratory analyses to investigate whether temperature anomalies and precipitation best predicted nest success during or prior to incubation) indicated that weather conditions in January preceding nesting were the best predictor of nest success. There were no other competing models, so model averaging was not necessary. Greater average daily precipitation in January was associated with greater nest success ($\hat{\beta}$ = 0.43, CI =0.11 to 0.75) with a 1 mm increase in average daily rainfall above the mean observed in this study (4.24 mm/day) associated with a 19.14% increase in nest success from 30.18% to 35.96%. Warmer minimum January temperatures were associated with decreased nest success ($\hat{\beta}$ = -0.50, CI = -0.82 to -0.19) with a 1°C increase in temperature anomalies associated with a 13.48% relative decrease in nest success (absolute values of 35.02% nest success for mean conditions that declined to 30.30% for every 1ºC increase in temperature). As the nesting season progressed, nest success declined ($\hat{\beta}$ = -0.02, CI = -0.04 to -0.01) with every additional day that a nest was initiated after mean nest initiation date associated with a 0.50% decrease in nest success. Visual obstruction by nest-site vegetation was not a significant predictor of nest success (Table 6).

Over 2041-2060, annual precipitation is projected to increase in eastern North America by 3.86% (66% CI = 2.04% to 6.78%) under SSP1-2.5, 5.22% (66% CI = 2.41% to 7.39%) under SSP2-4.5, and 5.65% (66% CI = 2.81% to 8.70%) under SSP5-8.5. Based on results of the top model because model averaging was not necessary, assuming similar changes in future January precipitation relative to the annual mean, such increases would also increase eastern wild turkey nest success by 2.77% (66% CI = 1.32% to 5.11%) from 30.18% to 31.02% under SSP1-2.5, 3.86% (66% CI = 1.62% to 5.60%) from 30.18% to 31.34% under SSP2-4.5, and 4.20% (66% CI = 1.93% to 6.67%) from 30.18% to 31.45% under SSP5-8.5. Over the same mid-century period, annual temperatures in eastern North America are projected to increase by 1.55°C (66% CI = 1.25°C to 2.13°C) under SSP1-2.5, 1.99°C (66% CI = 1.62°C to 2.46°C) under SSP2-4.5, and 2.63°C (66% CI = 2.07°C to 3.13°C) under SSP5-8.5. Based on results of the top model since model averaging was not necessary, assuming future January temperature increases that are similar to the projected annual temperature change, eastern wild turkey nest success would decrease by 20.85% (66% CI = 16.80% to 27.47%) from 35.02% to 27.72% under SSP1-2.5, 25.67% (66% CI = 21.47% to 28.61%) from 35.02% to 26.03% under SSP2-4.5, and 34.01% (66% CI = 35.55% to 38.32%) from 35.02% to 23.11% under SSP5-8.5.

7. ANALYSIS AND FINDINGS:

Previous studies have investigated the influence of weather on eastern wild turkey nest survival using data from small geographic areas, from a relatively small number of individuals, or from only a few years. Results of these studies were often inconsistent and therefore implications have been difficult to generalize across space and time. Additionally, there is a lack of knowledge regarding how climate-induced shifts in spring green-up timing could influence turkey nesting phenology and success. Yet, with climate change being one of the most consequential threats facing wildlife populations, understanding how weather and climate influence wild turkey nest survival is integral to successfully managing their populations. The decline of wild turkey populations in many portions of the eastern U.S. further highlights the need to understand this relationship. Therefore, to maximize inference drawn from our analyses, we used robust long-term turkey reproduction data spanning the southeastern U.S. We paired these data with fine scale remotely sensed spring green-up data (375-m spatial resolution, daily temporal resolution, data source: C6 Eastern CONUS eMODIS RSP) and precipitation and temperature data (4-km spatial resolution, daily temporal resolution, data source: gridMET). We then ran a series of analyses using approaches that best leveraged these data to provide inference into current associations between observed weather and wild turkey reproduction, and projected these relationships into the future under multiple climate change scenarios. Cumulatively, we performed the most thorough and broadly generalizable investigation of associations between weather and eastern wild turkey nest survival yet conducted.

Models indicated that incubation initiation date will change by <0.1 day with projected climate change associated weather changes. Likewise, nest survival may change only minimally because observed relationships largely offset one another. These findings are notable because they suggest climate change may not be a major threat to eastern wild turkey populations. However, numerous factors influence wild turkey recruitment and none of them should be considered separate of the others, which necessitates additional research.

8. CONCLUSIONS AND RECOMMENDATIONS:

Broadly, we found the timing of wild turkey reproduction to be unresponsive to climate change at biologically meaningful scales. We also found climate change to have limited implications for wild turkey reproductive success when observed relationships were aggregated.

Challenges arose in relation to data management (aggregation and quality control of data obtained from ~20 graduate student projects conducted over the preceding decade) and data manipulation (extraction and aggregation of data from climate datasets whose size required specialized programs and computing resources).

We believe our approach was solid and robust although we did not plan for the lack of information regarding harvest policies from individual states. This was a challenge that we did not find a solution to during this project, but our Co-PIs are currently exploring. We were very happy with our findings and more importantly our ability to circulate results to the research and management communities. Again a testament to the network that our Co-PIs have created and strive to maintain. If something had to be changed it would be to increase communication with collaborators throughout the project. Communication is always difficult for highly collaborative projects, but especially so during the COVID era.

Next steps include a) replicating our study in northerly portions of the wild turkey's range where snow persists (or historically persisted) into the spring, b) assessing how climate change could influence wild turkey nest and poult predator populations and reproductive phenology, and c) assessing how climate change could influence wild turkey survival via other pathways than recruitment (e.g. disease transmission, severity, and resultant mortality or reproductive consequences). Finally, our project serves as a blueprint for assessing potential consequences of climate change for wildlife. In particular, we demonstrate how the aggregation of data from numerous small-scale projects of well-studied species can be leveraged to provide robust inference regarding implications of weather and potential implications of climate change.

9. MANAGEMENT APPLICATIONS AND PRODUCTS:

We expect that our findings will be used by state agencies, NGOs, and researchers throughout the Southeast working with wild turkeys. Our results provided ample support and evidence in regards to how turkeys may respond to climate change in the future and provides sufficient data to allow managers to focus on more immediate factors driving changes in turkey distribution and abundance. We were able to test a large number of competing hypotheses in the turkey literature directly relevant to management by states and other organizations.

We were fortunate to work with a large number of collaborators, outside of the Co-PIs and associated Post-Doc (Dr. Wesley Boone) and graduate students we communicated with state agencies and land managers across the five states in which the study was conducted (Texas, Louisiana, Georgia, South Carolina, and North Carolina). We also participated in the Wild Turkey Working Group, which enabled us to receive insight and feedback from wild turkey stakeholders throughout their native and introduced range. This provided a platform to engage with many different members across the Southeast including: **Adam Butler**, Wild Turkey Program Coordinator, MS Dept of Wildlife, Fisheries, and Parks; **Jay Cantrell**, Assistant Big Game Program Coordinator, SC Dept of Natural Resources; **Cody Cedotal**, Wild Turkey Program Manager, LA Dept of Wildlife and Fisheries; **Zak Danks**, Ruffed Grouse and Wild Turkey Program Coordinator, KY Dept of Fish and Wildlife Resources; **Mike Dye**, Statewide Turkey and Grouse Program Coordinator, VA Dept of Game and Inland Fisheries; **Steven Mitchell**, Upland Game Bird Coordinator, AL Dept of Game and Inland Fisheries; **David Moscicki**, Turkey Program Coordinator, AR Game and Fish Commission; **Nicholas Oakley**, Wild Turkey Biologist, MO Dept of Conservation; **Michael Peters**, Wild Turkey and Migratory Game Bird Project Leader, WV Division of Natural Resources; **Hannah Plumpton**, Upland Game Bird Biologist, NC Wildlife Resources Commission; **Roger Shields**, Wild Turkey Program Coordinator, TN Wildlife Resources Agency; **Eric Suttles**, Southeast Region Wildlife Supervisor, OK Dept of Wildlife Conservation; **Emily Rushton**, Wildlife Biologist, GA Dept of Natural Resources; **Jason Hardin**, Wild Turkey Program Coordinator, TX Parks and Wildlife Dept; **Steve Barnett**, District Wildlife Supervisor/Wild Turkey Project Leader, AL Dept of Conservation and Natural Resources; **Elizabeth Johnson**, Small Game/Turkey Biologist, KY Dept of Fish and Wildlife Resources; **Charles Ruth**, Big Game Coordinator, SC Dept of Natural Resources; and **Billy Dukes**, Chief of Wildlife, SC Dept of Natural Resources. Finally, we communicated with the National Wild Turkey Federation, the preeminent NGO advocating for conservation and sustainable use of wild turkeys, primarily through **Mark Hatfield**, National

Director of Science and Planning for NWTF. It would be impossible to include the names of every stakeholder that we interacted with, but here are a few of the most notable contributors: **Chris Kreh**, Assistant Chief and Program Coordinator for the NC Wildlife Resources Commission's Game and Furbearer Program, aided project inception and provided feedback throughout the process. **Hannah Plumpton**, Upland Game Bird Biologist, NC Wildlife Resources Commission, provided feedback throughout the process.

Quote from stakeholder/partner:

"Robust research and analyses that seek to inform stewardship practices by agencies are vital for game species managers to recommend management actions and regulation changes. Thus, state wildlife biologists and resource managers are reliant on peer reviewed literature sources to remain informed with the most up to date data. More importantly, it is imperative for researchers to remain at the forefront of emerging issues including long-term impacts of climate change. Many upland game species populations continue to decline for many reasons. Whereas climate change has resulted in a mismatch between resource availability and arrival of offspring in numerous species across the globe. As climate change continues it becomes more important to understand the impact it may have on species reproductive phenology and population dynamics. This [SECASC funded] research has provided a direct understanding of how [and whether] eastern wild turkey's breeding phenology is impacted by climatic factors (e.g., precipitation, temperature etc.). The findings here demonstrate the year to year fluctuations in reproductive vital rates and allows us [Arkansas Game and Fish Commission] to prioritize proximate factors influencing reproductive success of wild turkeys. These results give us the knowledge to focus our resources on understanding short-term variation in vital rates while preparing for the long-term consequences of climate change on reproductive phenology and success."

David Moscicki, Ph.D.
Turkey Program Coordinator
Arkansas Game and Fish Commission
David.Moscicki@agfc.ar.gov

10. OUTREACH AND COMMUNICATION:

Boone, W., C. Moorman, D. Moscicki, B. Collier, M. Chamberlain, A. Terando, J. Kilgo, & K. Pacifici. *In Prep*. Brooding over climate change: weather, brood survival, and potential implications of projected climate change.

Boone, W., C. Moorman, D. Moscicki, B. Collier, M. Chamberlain, A. Terando, & K. Pacifici. 2024. Robust assessment of associations between weather and eastern wild turkey nest success. Journal of Wildlife Management. e22524.

Boone, W., C. Moorman, A. Terando, D. Moscicki, B. Collier, M. Chamberlain, & K. Pacifici. 2023. Minimal shift of eastern wild turkey nesting phenology associated with projected climate change. Climate Change Ecology. 6:100075.

Boone, W., C. Moorman, D. Moscicki, B. Collier, M. Chamberlain, A. Terando, J. Kilgo, & K. Pacifici. 2024. Assessing potential impacts of climate change on eastern wild turkey nesting phenology and nest success. The Wildlife Society's Annual National Conference. Poster Presentation.

Moorman, C., W. Boone, D. Moscicki, B. Collier. M. Chamberlain, A. Terando, & K. Pacifici. 2023. Will climate change influence eastern wild turkey nesting? North Carolina Chapter of The Wildlife Society's Annual Conference.

Boone, W., C. Moorman, D. Moscicki, B. Collier, M. Chamberlain, A. Terando, & K. Pacifici. 2022. Using weather data to assess implications of climate change for eastern wild turkey nest survival. The Wildlife Society's Annual National Conference. Oral Presentation.

Boone, W. 2022. Brooding over climate change: implications for eastern wild turkey reproduction. Southeast Climate Adaptation Science Center July Webinar. Oral Presentation.

Boone, W., C. Moorman, D. Moscicki, B. Collier, M. Chamberlain, A. Terando, & K. Pacifici. 2022. Eastern wild turkey nesting chronology tracks precipitation and temperature, not spring green-up. 12th National Wild Turkey Symposium. Poster Presentation.

North Carolina State University and SE CASC issued press releases for each manuscript, resulting in the following media coverage. This list is not all-inclusive, but it includes the most notable press coverage:

Duensing, R. 2024. NC State studying how weather, climate change impact wild turkey nesting. CBS17 Raleigh Weather (TV and Online News Media).

Grandoni, D. 2023. Wild turkeys are disappearing – but no one is sure why. The Washington Post (Online News Media).

Frey, D. 2023. Wild turkeys may face a tougher future in a warmer world. The Wildlife Society (Online News Media).

Frey, D. 2023. As the climate changes, wild turkeys aren't keeping up. The Wildlife Society (Online News Media).

McGrath, G. 2023. Climate change could threaten NC's wild turkey population. Here's how. StarNews Online (Online News Media).

Deem, J. 2023. Fowl future? NC wild turkeys face potential climate threat, study says. Winston-Salem Journal (Newspaper).