

## CAnVAS: Climate Analysis and Visualization to Support Species Status Assessments

PI: Kathie Dello, PhD

Title: Director and State Climatologist of North Carolina

Institution: NC State University with subaward to Auburn University

Award Number: G19AC00364

Date of report: February 25, 2024

Period of Performance: October 1, 2019 - September 30, 2023

Actual total cost: \$307,168

**PUBLIC SUMMARY:** Among the challenges facing native plant and animal species across the Southeast, climate change is pushing many beyond the environmental conditions to which they are adapted. To help inform US Fish & Wildlife Service scientists assessing such changes and threats, the North Carolina State Climate Office has developed a new web-based visualization tool, CAnVAS, to show projections of weather and climate parameters with known connections to endangered species. The CAnVAS tool is tailor-made for biologists investigating climate impacts on environmentally sensitive species. The CAnVAS team tested the tool using eye-tracking and interviews to ensure that the tool would be useful and usable by US Fish and Wildlife Service scientists.

### **TECHNICAL SUMMARY:**

**Task 1 (initial) - Initial Needs Assessment with Key Stakeholders:** The needs assessment will identify climate information required to support species status assessments (SSAs). It has two components:

1. Through the Technical Advisory Committee (TAC), obtain input from USFWS scientists about what they need to support decisions: what types of climate information are most valuable, at what space and time scales, and in what forms or formats.
2. Develop an index of climate vulnerability for each species within a set of at-risk wildlife species and associated habitat species that are identified as priorities through discussions with the TAC. Through literature review, analysis of occurrence data (Mims et al., 2018; Sievert et al., 2016) and expert elicitation, we will assimilate information relevant to assessing the sensitivities of these wildlife and habitat species to climate variability and change.

**Task 1 (actual)** The research team met with the TAC for the first and only time in February 2020. Due to the ongoing pandemic and uncertainty in both the research team and in DOI staff, and loss of key team members the team chose the following approach:

- 1) Engage DOI/USFWS/USGS scientists individually in matters related to CAnVAS, rather than as an entire TAC. Erin Rivenbark played a key convening and connecting role between the research team and DOI scientists. Key personnel Drs. Jennifer

Costanza and Alexa McKerrow left NC State and the project team. Darrian Bertrand left the NCSCO, and she was the lead developer of the climate data.

- 2) Undergo a literature review of current SSAs to determine if they incorporated climate change data. This project was led by Auburn University graduate student Haven Cashwell. 48 SSAs were reviewed and coded.

### **Task 2 (initial) - Development of a Prototype CAnVAS Framework and Training**

**Materials:** Future climate projections are produced by organizations around the world. They typically include output from multiple Global Climate Models and Earth System Models. Various approaches, including statistical and dynamic downscaling (Sunyer et al., 2012), are applied to produce usable guidance at a regional or local level. These models and the techniques used to downscale their output are complex and vary widely in their underlying assumptions and uses of input data. Most stakeholders are unfamiliar with these modeling systems and, therefore, may find these datasets intimidating, opaque, and potentially even untrustworthy (Eden et al., 2016). This project seeks to improve the transparency of these future data as well as historical and current datasets to facilitate the effective use of climate information by USFWS personnel in developing SSAs. SCONC will design a prototype CAnVAS framework that provides salient climate information in formats found to be preferred by the target audience of USFWS scientists. The variables will address climate-based risks and species sensitivities. Species relevant weather and climate variables displayed can include climatic means (e.g., monthly and seasonal averages and extremes of temperatures and precipitation), derived parameters (e.g., precipitation minus evapotranspiration), and thresholds (e.g., counts of the average number of days per year where critical values for temperature or precipitation are exceeded).

The needs assessment (Task 1) will also inform the overall format of the CAnVAS interface. Possible design elements include capabilities to select specific time slices and scenarios consistent with the needs of a particular SSA, displays of information on one or more maps, and download- or print-ready output options. Features to enhance the user experience could include the ability to extract spatial averages and extremes within a polygon the user draws on a map to define a region of interest, such as the current range of a species.

**Task 2 (actual):** Task 2 was largely completed as scoped, and is accessible at <https://products.climate.ncsu.edu/canvas/>.

In conversation with stakeholders, we pivoted away from specific design elements for SSAs, making the tool more broadly accessible. There was unclear direction as to the usefulness of the tool for one or more specific SSAs, and the DOI scientists that we spoke to saw value in broader climate change projections that they could access for SSAs and other efforts. The

We did not develop training materials for the CAnVAS interface, though the website was tested significantly, and on-screen help and tooltips are available throughout the tool.

**Task 3 (initial) - CAnVAS Framework Assessment & Refinement:** The CAnVAS must address user needs, in that USFWS scientists must be able to obtain the climate information they need in support of SSA development efficiently and accurately. The framework will be assessed through multiple methods, including feedback sessions and conventional surveys, along with eye-tracking evaluations of users while they engage with the CAnVAS. Eye-tracking measures what aspects of a visual display engage the attention of users, showing whether or not users are attentive to the elements that are salient for answering their questions. The eye-tracking experimental design will include measurements that examine how a user navigates the system. It will also assess the user's efficiency, effectiveness, and satisfaction with the resource through multiple choice questions that the user completes in the course of performing specific information gathering tasks. Additionally, a short post-survey will be provided to each research subject, requesting feedback about how they would use the information in completing SSAs and what additional information they would have liked. Information about each subject (e.g., demographic, job title, years of experience, climate content knowledge, experience with climate data, experience with SSAs) will be collected. Based on this evaluative information about the visualization prototype, modifications will be recommended to improve its efficacy and usability. These refinements will then be implemented and re-evaluated using an iterative approach that engages the intended stakeholder group to ensure it meets their needs. As such, an additional eye-tracking and post-survey collection will be made with USFWS scientists after refinements are made to the CAnVAS.

Subjects for eye-tracking studies will be recruited from meetings where USFWS scientists will already be in attendance, such as the Southeastern Association of Fish and Wildlife Agencies (SEAFWA) annual meeting. In conjunction with eye tracking studies, focus group sessions will be held to better understand how the prototypes would be used in the SSA process.

**Task 3 (actual):** This task was modified due to the ongoing COVID-19 pandemic, the slow return to office by DOI employees, and the limited in person engagements and opportunities for eye tracking and engagement in 2020-2022. Haven Cashwell first tested the tool on Auburn University undergraduates and made refinements due to their feedback and eye tracking evaluations. Ms. Cashwell then traveled to USFWS offices to eye track on an individual basis with scientists who signed up for in-person interviews. Eye-tracking was mostly conducted within private locations at USFWS offices.

### **PURPOSE AND OBJECTIVES:**

The project experienced significant delays and change in scope due to the COVID-19 pandemic. The initial proposal had a much more robust eye tracking mechanism with USFWS scientists, and more targeted species work with experts. The team lost key personnel throughout the four-year project. Dr. Jennifer Constanza departed the research team for a new position in July 2020, leaving the team without a plant species expert. Dr. Darrian Bertrand, the NCSCO staff climate lead, left the CAnVAS team in late 2020. Dr. Alexa

McKerrow retired from NC State University in 2021. Darrian Bertrand was replaced by Dr. Tim Glotfelty in 2022.

## **ORGANIZATION AND APPROACH:**

### SSA Coding

- 48 SSAs were obtained from the USFWS Southeast region website
- A coding scheme and ranking rubric were created

### Eye-tracking

- Usability of CAnVAS was tested through eye-tracking and interviews
- Eye-tracking was mostly conducted within private locations at USFWS offices and not in large meetings
- For the eye-tracking portion of the research, participants answered nine multiple choice questions
- Areas of Interest (AOIs) were drawn on the website interface

### Interviews

- Interviews were conducted immediately following the eye-tracking portion of the study and audio recorded transcriptions were thematically coded using the Dedoose qualitative coding software

## **PROJECT RESULTS**

A fully-functioning, tested, and co-developed Decision Support Tool (DSS) was developed by the CAnVAS team and is hosted at <https://products.climate.ncsu.edu/canvas/>

## **ANALYSIS AND FINDINGS**

### SSA Analysis

- Pages including a heading with the words “climate change” explicitly mentioned ranged from a minimum of 0% to a maximum of 15% of the total number of pages in the reports
- Average percentage of pages of 2.91% including climate information under an explicit heading of climate change
- Averages of rankings were generated across the three evaluated categories. Accuracy (M = 2.79), relevancy (M = 2.63), and quality/depth (M = 2.39)

### Eye Tracking Results

- Participants did not attend to the spatial representation of the data for a statistically significant amount of time

- Climate snapshot may have been difficult for users to find, since it was only displayed after clicking on a time series in the box-and-whisker plot data
- eye-tracking visualizations indicated that participants did not fixate on the climate snapshot (bottom) portion of the website since there are no concentrations of red within heatmaps and a very small sample of circles (which represents fixations or high attention) within gaze plot

## **Interviews**

- All 15 participants would use or would have their staff use the CAnVAS website to visualize information about climatic changes
- Recommended adding instructions to the website to provide steps on how to plot the spatial data at the bottom of the CAnVAS interface
- Recommendation to make the font larger on the website when the pop-up information appears while hovering over the box and whisker temporal data
- Recommendation to include more climate variables to choose from when plotting data

## **CONCLUSIONS AND RECOMMENDATIONS**

**Despite enormous challenges and delays as a result of the COVID-19 pandemic and key personnel departures the CAnVAS team was able to successfully deliver a tested, useful, and usable tool to the SECASC team. The NCSCO team was in regular contact with SECASC staff and leadership about the project and any associated issues and pivots that the team had to make either due to the pandemic or loss of staff.**

Additionally, the research team was incredibly productive and published a peer-reviewed paper on the project and presented it at multiple venues and conferences. Often, tool development occurs in a vacuum, and rarely with an accompanying peer-reviewed paper.

The project could have been completed in the initial 2-year time frame if we had dropped the eye tracking. Eye-tracking was a resource-intensive and lengthy endeavor, but made for a better and more useful and usable final product. The trade-off is that the product now has a shorter shelf life with CMIP5 data. The team recommends that SECASC explore an update in the current framework using CMIP6 data. NCSCO staff learned that tools may need to be broadened to serve many needs, as DOI scientists may be using climate projections beyond SSAs.

## **MANAGEMENT APPLICATION AND PRODUCTS**

Though CAnVAS was developed specifically for SSAs and the USFWS, we believe that it will be used widely by state and local resource managers, interested public, and other visitors to the NCSCO website.

### **KEY NON-PROJECT PERSONNEL AND CONTACTS:**

Erin Rivenbark, US Fish and Wildlife Service, our liaison to USFWS  
<https://www.fws.gov/staff-profile/erin-rivenbark>

## **OUTREACH AND COMMUNICATION**

### **Presentations:**

Cashwell, H.J., McNeal, K.S. (2023) *Enhancing Climate Resiliency and Climate Communication in Southeastern United States through Co-production*. Poster presentation at the American Meteorological Society Student Conference, Denver, CO.

Davis, C.\*, Glotfelty, T., Dello, K., Cashwell, H. J., McNeal, K. S., Boyles, R. (2023) *A Vivid CAnVAS: Developing a Tool Informing Climate Change Impacts to Endangered Species*. Oral presentation at the American Meteorological Society Annual Meeting, Denver, CO.

Cashwell, H.J., McNeal, K.S. (2022) *Enhancing Climate Resiliency and Climate Communication in Southeastern United States through Co-production*. Poster presentation at the Climate Adaptation Science Center Early Career Workshop, Albuquerque, NM.

Cashwell, H.J., McNeal, K.S. (2022) *Enhancing Climate Resiliency and Climate Communication in Southeastern United States through Co-production*. Poster presentation at the Southeast Climate Adaptation Science Center Regional Meeting, Gulf Shores, AL.

Cashwell, H.J., McNeal, K.S., Dello, K., Boyles, R., Davis, C. (2022) *User Engagement Testing with a Pilot Decision Support Tool Aimed to Support Species Managers*. Oral presentation at the American Meteorological Society Annual Meeting, Houston, TX.

Cashwell, H.J., McNeal, K.S., Dello, K., Boyles, R. (2021) *User Engagement with a Web-based Decision Support Tool to Support USFWS Scientists' Development of Species Status Assessments*. Oral presentation at the Geological Society of America Southeast Regional Meeting, Virtual Meeting.

Cashwell, H.J., McNeal, K.S., Dello, K., Boyles, R. (2021) *An Evaluation of Species Status Assessments: Discovering Climate Information Themes, Understanding USFWS Scientists' Climate Information Needs, and User Engagement with a Web-based Decision Support Tool*. Poster presentation at the American Meteorological Society Annual Meeting, Virtual Meeting.

Cashwell, H.J., McNeal, K.S., Dello, K., Boyles, R. (2020) *An Evaluation of Species Status Assessments: Discovering Climate Information Themes, Understanding USFWS Scientists' Climate Information Needs, and User Engagement with a Web-based Decision Support Tool*. Poster Presentation at the American Geophysical Union Annual Meeting, Virtual Meeting.

Cashwell, H.J., McNeal, K.S. (2023) *Enhancing Climate Resiliency and Climate Communication in Southeastern United States through Co-production*. Poster presentation at the American Meteorological Society Student Conference, Denver, CO.

### **Papers:**

Cashwell, H. J., McNeal, K. S., Dello, K., Boyles, R., & Davis, C. (2023). User Engagement Testing with a Pilot Decision Support Tool Aimed to Support Species Managers. *Weather, Climate, and Society*, 15(2), 327-338.

Cashwell, H. J., McNeal, K. S., Dello, K., Davis, C., and Glotfelty T (2024). Addressing Usability of a Decision Support System. *Weather, Climate, and Society* (submitted, in revision)

### **Final Webinar:**

SECASC webinar (107 attendees, 300+ registered): <https://youtu.be/Eq3C4vNVDvA>

### **Decision Support Tool:**

<https://products.climate.ncsu.edu/canvas/> (Will be supported for 2 years by the NC State Climate Office from the webinar/tool launch on February 15, 2024. In late 2025, we will connect with SECASC about tool transition).