

SCIENTIFIC IMPACT PAPER

A network of refugia: Whooping Crane drought response informs international habitat conservation goals

Andrew J. Caven^{1,2}  | Aaron T. Pearce³ ¹International Crane Foundation, Baraboo, Wisconsin, USA²Platte River Whooping Crane Maintenance Trust, Wood River, Nebraska, USA³U.S. Geological Survey, Northern Prairies Wildlife Research Center, Jamestown, North Dakota, USA**Correspondence**

Andrew J. Caven, International Crane Foundation, E11376 Shady Lane Road, Baraboo, WI 53913, USA.

Email: acaven@savingcranes.org; acaven@cranetrust.org**Funding information**

U.S. Geological Survey; International Crane Foundation

KEYWORDS: climate refugia, drought, endangered species, Great Plains, *Grus americana*, recovery plan, wetland conservation, Whooping Crane

Whooping Cranes (*Grus americana*) are an iconic endangered species, and great efforts have been made during the last 80 years to support progress toward recovery from the brink of extinction. The remnant population, identified as the Aransas-Wood Buffalo Population (AWBP), numbered approximately 540 individuals in 2023, from a low of just 15 individuals during the winter of 1941. During migration, the AWBP traverses 4000 km of the Great Plains of the United States and Canada. Whooping Cranes depend on wetlands throughout their lifecycle and generally prefer shallow wetland habitats with few visual obstructions and minimal human development. Such locations help protect cranes from terrestrial predators during nocturnal roosting. Individuals in the AWBP typically make about 12 stopovers during migration, with one-third of those being extended stays that support their energetic needs (Pearse et al., 2020). Whooping Cranes typically migrate in bouts averaging 300 km, with most <500 km. Consequently, the species requires a network of resilient wetland habitats throughout its migratory corridor. Experts consider habitat loss and degradation in the migratory corridor one of the top threats in the coming decades (Caven et al., 2023). The species' migratory corridor has experienced persistent

wetland loss and degradation related to agricultural, industrial, and suburban development; the over-appropriation of ground and surface water resources; and invasions of exotic and woody species (Caven et al., 2023). Drought is a natural environmental force that has helped structure the Great Plains ecosystem. However, extended drought can exacerbate the effects of wetland habitat loss on migratory waterbirds by temporarily restricting the availability of surface water at several scales. Moreover, climate change predictions indicate increased duration and intensity of droughts across this ecoregion.

Pearse et al. (2024) examined how migrating AWBP cranes altered their relative use of wetland habitats with data from 146 birds, including >8000 unique nocturnal stopover sites used from 2010 to 2022. Whooping Cranes modified migration bouts and habitat use patterns across drought intensity levels. Cranes generally used natural palustrine wetlands during normal hydrological conditions but shifted toward rivers, impounded systems, and larger wetlands during increased drought intensities. Nonetheless, drought response varied regionally, highlighting the species' behavioral plasticity. The results clearly indicate that wetland complexes with a variety of

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2025 The Author(s). *Conservation Science and Practice* published by Wiley Periodicals LLC on behalf of Society for Conservation Biology.

hydroperiods, from temporary to permanent, would be more likely to provide appropriate habitat across multiple hydrological conditions and, if conserved appropriately, could maintain or enhance the species' resilience to climate change during migration.

The U.S. Fish and Wildlife Service (USFWS) worked with species experts from several institutions in the United States and Canada throughout 2023 and 2024 to draft a fourth update to the Whooping Crane Recovery Plan (K. McAbee, Whooping Crane Coordinator, U.S. Fish and Wildlife Service, personal communication). Contemplating existing research, including Pearse et al. (2024), the working group drafted delisting criteria and recovery actions to ensure the integrity of the AWBP's migratory corridor into the foreseeable future, considering climate change and other threats. Specifically, the working group advised preserving and managing nearly 50,600 ha of wetland and associated upland buffer habitat in four new habitat complexes of >12,650 hectares where habitat conservation is ostensibly insufficient within the migration corridor. The draft Recovery Plan also required surface and groundwater conservation strategies with clear targets to be approved by the USFWS that support roosting and foraging habitat as well as maintain the ecological function of preserved areas. Therefore, recovery plan criteria and associated actions aimed to limit the number of gaps >500 km between conserved wetland stopover complexes. Pearse et al. (2024) underscored the need for habitat and water conservation provisions in the Recovery Plan to support migratory climate refugia. This analysis will also be considered when prioritizing wetland stopover complexes for future investment.

Pearse et al. (2024) and the draft Recovery Plan reflect steps in the "climate change refugia conservation cycle" as defined by Morelli et al. (2016) and each identify appropriate wetland stopover habitat in the Whooping Crane migration corridor within the Central Flyway of North America as a valued resource (step 1). Pearse et al. (2024) assessed a valued resource's climate vulnerabilities (step 2) and the draft Recovery Plan revised and refined conservation goals and objectives (step 3) by including a network of protected and functional stopover complexes that effectively serve as drought refugia as a new delisting criterion. Moreover, these efforts set the stage for ongoing work to map key stopover complexes and to evaluate their respective habitat values (step 4; Figure 1). The Whooping Crane requires a network of drought- and climate-resilient wetland refugia, the availability of which is strongly impacted by water resource management that is mediated by a myriad of local, regional, state, and federal policies and procedures governing water management and wetland development. Despite these complexities, a roadmap for climate refugia

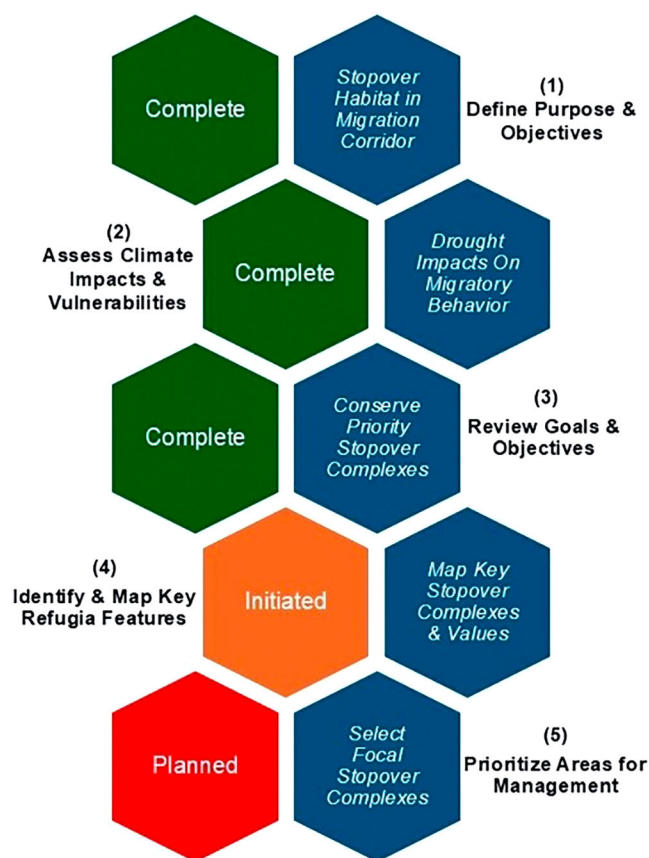


FIGURE 1 Steps 1–5 of the "Climate Change Refugia Conservation Cycle" per Morelli et al. (2016) including progress toward defining and conserving climate-change resilient Whooping Crane (*Grus americana*) migratory stopover habitat.

identification, monitoring, conservation, and management is being realized that considers multiple spatial scales and migratory connectivity (Morelli et al., 2025). Future efforts to preserve a network of climate resilient wetlands to facilitate Whooping Crane migration will continue to follow steps outlined by Morelli et al. (2016), including the future identification and implementation of priority management actions to enhance refugia.

AUTHOR CONTRIBUTIONS

Andrew J. Caven and Aaron T. Pearse were both responsible for the paper's conceptualization and composition. Andrew J. Caven developed the figure and managed revisions.

ACKNOWLEDGMENTS

We would like to thank D. M. Baasch, M. T. Bidwell, J. A. Conkin, and D. A. Brandt for their contributions to the 2024 manuscript on which this work builds. We would like to thank K. McAbee, J. Austin, and the rest of the contributors to the 2025 Draft Whooping Crane Recovery Plan on which this paper is also based.

Additionally, we want to thank three anonymous reviews as well as Dr. C. Murcia (Editor-in-Chief), Dr. T. L. Morelli (Sr. Assoc. Editor), and Dr. K. I. McLean (USGS) for their helpful feedback. Funding for this manuscript came from the International Crane Foundation and the U.S. Geological Survey. Finally, we would like to thank M. L. Forsberg for allowing us to use one of his beautiful photographs as the graphical abstract for this paper.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

This paper does not include primary data or analyses.

ORCID

Andrew J. Caven  <https://orcid.org/0000-0002-5482-8191>

Aaron T. Pearse  <https://orcid.org/0000-0002-6137-1556>

REFERENCES

Caven, A. J., Thompson, H. L., Baasch, D. M., Hartup, B. K., Hegg, A. M., Schmidt, S. M., Louque, I., Allen, C. R., Crouch, C. G., Davis, C. A., Jorgensen, J. G., Austin, J. E., Ostrom, B. L., Beilfuss, R. D., Archibald, G. W., & Lacy, A. E. (2023). *Biological case against downlisting the Whooping Crane and for improving implementation under the Endangered Species Act* (p. 114). University of Nebraska, School of Natural Resources, Faculty Publications.

Morelli, T. L., Daly, C., Dobrowski, S. Z., Dulen, D. M., Ebersole, J. L., Jackson, S. T., Lundquist, J. D., Millar, C. I., Maher, S. P., Monahan, W. B., & Nydick, K. R. (2016). Managing climate change refugia for climate adaptation. *PLoS One*, 11(8), e0159909.

Morelli, T. L., Mozelewski, T., Cavalieri, C. N., Caven, A. J., Dreiss, L. M., Hovel, R. A., Hua, M., Jennings, M. K., Kehm, G., Keppel, G., Langdon, S. F., Lawler, J. J., John, A., Lyon, L. M., Meigs, G. W., Mora-Gonzalez, M., Stolar, J., Thorne, J. H., Tourville, J. C., ... Stralberg, D. (2025). Climate-change refugia in practice: Emerging insights from research and adaptive management. *Conservation Science and Practice* [this issue].

Pearse, A. T., Caven, A. J., Baasch, D. M., Bidwell, M. T., Conkin, J. A., & Brandt, D. A. (2024). Flexible migration and habitat use strategies of an endangered waterbird during hydrological drought. *Conservation Science and Practice*, 6(5), e13120.

Pearse, A. T., Metzger, K. L., Brandt, D. A., Bidwell, M. T., Harner, M. J., Baasch, D. M., & Harrell, W. (2020). Heterogeneity in migration strategies of Whooping Cranes. *The Condor*, 122(1), duz056.

How to cite this article: Caven, A. J., & Pearse, A. T. (2025). A network of refugia: Whooping Crane drought response informs international habitat conservation goals. *Conservation Science and Practice*, e70106. <https://doi.org/10.1111/csp2.70106>