



**USGS LAND MANAGEMENT RESEARCH PROGRAM**  
**SAGEBUSH & FIRE SCIENCE WEBINAR SERIES**  
*SESSION #1 - January 30, 2025*

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**GREATER SAGE-GROUSE HIERARCHICAL POPULATION MONITORING FRAMEWORK: RANGE-WIDE APPLICATION OF AN EARLY WARNING SYSTEM FOR POPULATIONS AT-RISK**

- *Pete Coates (USGS-WERC), Cam Aldridge (USGS-FORT), Brain Prochazka (USGS-WERC), Cali Weise (USGS-WERC), Mike O'Donnell (USGS-FORT), Adrian Monroe (USGS-FORT), Meg McLachlan (BLM), Lief Wiechman (USGS-LMRP)*

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**EVALUATING THE EFFECTIVENESS OF CONSERVATION ACTIONS DIRECTED FOR GREATER SAGE-GROUSE USING HIERARCHICAL MODELS AND THE CONSERVATION EFFORTS DATABASE**

- *Pete Coates (USGS-WERC), Brain Prochazka (USGS-WERC), Cam Aldridge (USGS-FORT), Lief Wiechman (USGS-LMRP), Kevin Doherty (USFS), John Tull (USFWS)*

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**GREATER SAGE-GROUSE RANGE-WIDE SEASONAL HABITAT MAPS: IDENTIFYING REGIONAL THRESHOLDS and RELATIONSHIP BETWEEN TRENDS AND SEASONAL HABITAT USE**

- *Greg Wann (USGS-FORT), Cam Aldridge (USGS-FORT), Pete Coates (USGS-WERC), Brain Prochazka (USGS-WERC), Mike O'Donnell (USGS-FORT), Meg McLachlan (BLM)*

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**CHARACTERIZING THE ENVIRONMENTAL DRIVERS OF RANGE-WIDE GENE FLOW FOR GREATER SAGE-GROUSE**

- *Shawna Zimmerman (USGS-FORT), Sara Oyler-McCance (USGS-FORT), Greg Wann (USGS-FORT), Cam Aldridge (USGS-FORT)*

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**CHARACTERIZING GREATER SAGE-GROUSE CLIMATE DRIVEN MALADAPTATION**

- *Shawna Zimmerman (USGS-FORT), Sara Oyler-McCance (USGS-FORT), Cam Aldridge (USGS-FORT)*

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**QUANTIFYING CARBON STORAGE AND GREENHOUSE GAS EMISSIONS IN SAGEBRUSH RANGELANDS TO INFORM MANAGEMENT FOR CARBON RESILIENCE**

- *Maddy Case (USGS-FRESC), Seren Bagcilar (USGS-FRESC)*

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## GREATER SAGE-GROUSE HIERARCHICAL POPULATION MONITORING FRAMEWORK: RANGE-WIDE APPLICATION OF AN EARLY WARNING SYSTEM FOR POPULATIONS AT-RISK

*Pete Coates (USGS-WERC), Cameron Aldridge (USGS-FORT), Brian Prochazka (USGS-WERC), Cali Weise (USGS-WERC), Mike O'Donnell (USGS-FORT), Dave Edmunds (USGS-FORT), Adrian Monroe (USGS-FORT), Lief Wiechman (USGS-LMRP), Meg McLachlan (BLM)*

**ABSTRACT:** Greater sage-grouse (*Centrocercus urophasianus*) are at the center of state and national land use policies largely because of their unique life-history traits as an ecological indicator for health of sagebrush ecosystems. This updated population trend analysis provides state and federal land and wildlife managers with best-available science to help guide current management and conservation plans aimed at benefitting sage-grouse populations. This analysis relied on previously published population trend modeling methodology from Coates and others (2021) and includes the addition of three analytical updates: (1) identification of population nadirs (lowest points within cycles) at the lek (breeding ground) and neighborhood cluster (group of leks) spatial scales, (2) truncation of prior distributions on rate of change in apparent abundance values to more realistic boundaries for leks with missing data, and (3) addition of 2 years of population lek count data (2022 and 2023) to the current dataset (1953–2023). Bayesian state-space models estimated 2.8 percent average annual decline in sage-grouse populations across their geographical range, which varied among subpopulations at the largest scale of analysis, termed climate clusters (2.1–3.4). Cumulative declines were 41.1, 64.5, and 78.4 percent range-wide across short (19 years), medium (35 years), and long (55 years) temporal periods, respectively. Population growth during 2022 and 2023 continue to point to 2021 as the most recent range-wide nadir.

- TOPICS: Wildlife, Greater Sage-Grouse, Web App, Decision Support Tools
- ADAPTIVE MANAGEMENT APPLICATION: Biological Planning, Monitoring, Triggers, Causal Factor Analysis
- PROJECT WEBSITE: [Greater Sage-Grouse Population Monitoring Framework | U.S. Geological Survey](#)

### PROPOSED DELIVERABLES:

- The TAWS web-tool (v.1) that generates spatiotemporal trends and watches and warnings from the Targeted Annual Warning System with lek data inputs on an annual basis to launch application, subsequent maintenance and development needs based on partner feedback which may lead to updated versions of the web-tool
- Reassessment of population trends (as data allow) and TAWS through 2024 using updated lek database
- Continued development of approaches to assess the effects of different environmental covariates and mechanistic drivers of population change across the range to on sage-grouse (growth rates) and possible links to signals identified from the TAWS.
- Webpages that centralize background information, deliverables, and updates
- Information sheets on each component of the framework that explain the science need and relevant methods
- Recorded training videos for the public to address project motivation, important methods, and management applications for each component of the framework

- Hybrid training modules for state and BLM biologists that guide them through the use of the framework and cover specific case studies for management application.

#### COMPLETED DELIVERABLES/PRODUCTS:

- Monroe, A.P., J.A. Heinrichs, A.L. Whipple, M.S. O'Donnell, D.R. Edmunds, and C.L. Aldridge. 2022. Spatial scale selection for informing species conservation in a changing landscape. *Ecosphere* 13:e4320. <https://doi.org/10.1002/ecs2.4320>.
  - o Monroe, A.P., J.A. Heinrichs, A.L. Whipple, M.S. O'Donnell, D.R. Edmunds, and C.L. Aldridge. 2022. Spatial scale selection for greater sage-grouse population trends, version 1.0.0. U.S. Geological Survey Software Release. <https://doi.org/10.5066/P9WC5BEP>.
  - o Monroe, A.P., J.A. Heinrichs, A.L. Whipple, M.S. O'Donnell, D.R. Edmunds, and C.L. Aldridge. 2022. Sagebrush (*Artemisia* spp.) scale of effect for greater sage-grouse (*Centrocercus urophasianus*) population trends in southwest Wyoming, USA 2003–2019. U.S. Geological Survey Data Release. <https://doi.org/10.5066/P9KDOB2>.
- O'Donnell, M.S., D.R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, and L.A. Wiechman, 2022, Defining biologically relevant and hierarchically nested population-management units to inform wildlife management. *Ecology and Evolution* 12:22, <https://doi.org/10.1002/ece3.9565>.
  - o O'Donnell, M.S., D.R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, and L.A. Wiechman, 2022, Hierarchically nested and biologically relevant range-wide monitoring frameworks for greater sage-grouse, western United States. U.S. Geological Survey Data Release, <https://doi.org/10.5066/P9D1KOLX>.
  - o O'Donnell, M.S., D. R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, and L.A. Wiechman, 2022, *popcluster*: hierarchical population monitoring frameworks (version 2.0.0): U.S. Geological Survey software release, <https://doi.org/10.5066/P9X68ADU>.
- O'Donnell, M.S., D.R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, and L.A. Wiechman. 2022. Defining fine-scaled population structure amongst continuously distributed populations: a case study for greater sage-grouse. *Methods in Ecology and Evolution* <https://doi.org/10.1111/2041-210X.13949>.
  - o O'Donnell, M.S., Edmunds, D.R., Aldridge, C.L., Heinrichs, J.A., Monroe, A.P., Coates, P.S., Prochazka, B.G., Hanser, S.E. and Wiechman, L.A., 2022, Greater sage-grouse population structure and connectivity data to inform the development of hierarchical population units: U.S. Geological Survey data release, <https://doi.org/10.5066/P991D45Q>.
  - o O'Donnell, M.S., D.R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, and L.A. Wiechman, 2021, *lcp\_centrality*: Defining least-cost paths and graph theory centrality measures. U.S. Geological Survey software release, version 1.0, <https://doi.org/10.5066/P9QQ39WG>.
- O'Donnell, M.S., D.R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, L.A. Wiechman, T.J. Christiansen, A.A. Cook, S.P. Espinosa, L.J. Foster, K.A. Griffin, J.L. Kolar, K.S. Miller, A.M. Moser, T.E. Remington, T.J. Runia, L.A. Schreiber, M.A. Schroeder, S.J. Stiver, N.I. Whitford, and C.S. Wightman, 2021, Synthesizing and analyzing long-term monitoring data: A greater sage-grouse case study: *Ecological Informatics*, v. 63, p. 1-16, <https://doi.org/10.1016/j.ecoinf.2021.101327>.
  - o O'Donnell, M.S., D.R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, L.A. Wiechman, T.J. Christiansen, A.A. Cook, S.P. Espinosa, L.J. Foster, K.A. Griffin, J.L. Kolar, K.S. Miller, A.M. Moser, T.E. Remington, T.J. Runia, L.A.

- Schreiber, M.A. Schroeder, S.J. Stiver, N.I. Whitford, and C.S. Wightman, 2021, *grsg\_lekdb*: Compiling and standardizing greater sage-grouse lek databases. U.S. Geological Survey software release, version 1.0, <https://doi.org/10.5066/P9TDSJWS>.
- O'Donnell, M.S., D.R. Edmunds, C.L. Aldridge, J.A. Heinrichs, A.P. Monroe, P.S. Coates, B.G. Prochazka, S.E. Hanser, L.A. Wiechman, M. Cline, A.A. Cook, S.P. Espinosa, K.A. Griffin, H. Harris, M. Kemner, J. L. Kolar, K. S. Miller, T. E. Remington, T.J. Runia, L.A. Schreiber, M. Schroeder, S.J. Stiver, S.T. Vold, N.I. Whitford, and C. Wightman, 2022, *grsg\_lekdb*: Compiling and standardizing greater sage-grouse lek databases, Version 1.1.0: U.S. Geological Survey software release, <https://doi.org/10.5066/P90N2O2N>.
  - O'Donnell, M. S., D. R. Edmunds, C. L. Aldridge, J. A. Heinrichs, P. S. Coates, B. G. Prochazka, and S. E. Hanser. 2019. Designing multi-scale hierarchical monitoring frameworks for wildlife to support management: a sage-grouse case study. *Ecosphere* 10(9):e02872. 10.1002/ecs2.2872
    - O'Donnell, M. S., D. R. Edmunds, C. L. Aldridge, J. A. Heinrichs, P. S. Coates, B. G. Prochazka, and S. E. Hanser. 2019. Hierarchically nested and biologically relevant monitoring frameworks for Greater sage-grouse, 2019, Nevada and Wyoming, Interim: U.S. Geological Survey data release, <https://doi.org/10.5066/P9J0B7JR>.
    - O'Donnell, M. S., D. R. Edmunds, C. L. Aldridge, J. A. Heinrichs, P. S. Coates, B. G. Prochazka, and S. E. Hanser, 2019, *popcluster*: Developing Hierarchical Population Monitoring Frameworks for mobile species with high site fidelity: U.S. Geological Survey software release, version 1.0, <https://doi.org/10.5066/P928QJZP>.
  - Coates, P.S., B.G. Prochazka, M.A. Ricca, G.T. Wann, C.L. Aldridge, S.E. Hanser, K.E. Doherty, M.S. O'Donnell, D.R. Edmunds, and S.P. Espinosa, 2017, Hierarchical population monitoring of Greater Sage-Grouse (*Centrocercus urophasianus*) in Nevada and California—Identifying populations for management at the appropriate spatial scale. U.S. Geological Survey Open File Report 2017-1089, <https://doi.org/10.3133/ofr20171089>.
  - Coates, P.S., B.G. Prochazka, M.S. O'Donnell, C. L. Aldridge, D.R. Edmunds, A.P. Monroe, M.A. Ricca, G.T. Wann, S.E. Hanser, L.A. Wiechman, M.P. Chenaille, 2021, Range-wide greater sage-grouse hierarchical monitoring framework—Implications for defining population boundaries, trend estimation, and a targeted annual warning system. U.S. Geological Survey Open File Report 2020-1154, <https://doi.org/10.3133/ofr20201154>.
  - Coates, P.S., B.G. Prochazka, C.L. Aldridge, M.S. O'Donnell, D.R. Edmunds, A.P. Monroe, S.E. Hanser, L.A. Wiechman, M.P. and Chenaille, 2022, Range-wide population trend analysis for greater sage-grouse (*Centrocercus urophasianus*)—Updated 1960–2021. U.S. Geological Survey Data Report 1165. <https://doi.org/10.3133/dr1165>.
  - Coates, P.S., B.G. Prochazka, C.L. Aldridge, M.S. O'Donnell, D.R. Edmunds, A.P. Monroe, S.E. Hanser, L.A. Wiechman, and M.P. Chenaille, 2022, Trends and a targeted annual warning system for greater sage-grouse in the western United States (1960–2021): U.S. Geological Survey Data Release, <https://doi.org/10.5066/P9OQWQWIV>.
  - Weise, C.L., P.S. Coates, B.G. Prochazka, M.S. O'Donnell, C.L. Aldridge, D.R. Edmunds, M.A. Ricca, G.T. Wann, A.P. Monroe, S.E. Hanser, L.A. Wiechman, M.P. Chenaille, 2022, Greater Sage-grouse Trends and TAWS: U.S. Geological Survey provisional software release.
  - Coates, P.S., Prochazka, B.G., Aldridge, C.L., O'Donnell, M.S., Edmunds, D.R., Monroe, A.P., Hanser, S.E., Wiechman, L.A., and Chenaille, M.P., 2022, Trends and a targeted annual warning system for greater sage-grouse in the western United States (ver. 3.0, February 2024): U.S. Geological Survey data release, <https://doi.org/10.5066/P9OQWQWIV>.

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## EVALUATING THE EFFECTIVENESS OF CONSERVATION ACTIONS DIRECTED FOR GREATER SAGE-GROUSE USING HIERARCHICAL MODELS AND THE CONSERVATION EFFORTS DATABASE

*Pete Coates (USGS-WERC), Brian Prochazka (USGS-WERC), Sarah Webster (USGS-WERC), Cali Weise (USGS-WERC), Cameron Aldridge (USGS-FORT), Michael O'Donnell (USGS-FORT), Lief Wiechman (USGS-LMRP), Kevin Doherty (USFS), John Tull (USFWS)*

**ABSTRACT:** Developing a monitoring framework that integrates efficacy assessments of cooperative conservation and restoration actions in relation to population viability is critical for successful long-term recovery of ecosystems and species. However, often it is difficult to quantify conservation action efficacy because of the complex, dynamic nature of ecosystem processes and practical limitations associated with assessing target species' population dynamics. Here, we present an analytical framework that allows for quantification of conservation action efficacy using greater sage-grouse (*Centrocercus urophasianus*; hereafter, sage-grouse) across their range. This framework utilizes web-based repositories of conservation efforts carried out in sagebrush ecosystems and readily fits within contemporary sagebrush conservation design strategies. We employed a state-space model within a Bayesian framework to estimate abundance (N) as inputs for a progressive change before-after-control-impact paired series (BACIPS) design. Count data from 2286 leks (monitored between 2009–2023) coupled with 85 unique actions provided clear evidence that conservation actions increased population abundance, on average, by 0.65% annually across the study area, resulting in a 13.4% cumulative increase since 2020. Population gains varied by the type of conservation action and according to the number of lag years following its implementation.

- TOPICS: Restoration, Decision Support Tools
- ADAPTIVE MANAGEMENT APPLICATION: Conservation Design, Monitoring, Evaluation
- PROJECT WEBSITE: *Expected winter 2025*

### PROPOSED DELIVERABLES:

- Presentation to partners on model methods and preliminary results for Bi-State DPS (January 2023)
- Peer-reviewed journal manuscript describing effectiveness of conservation efforts on sage-grouse populations across Bi-State DPS (February 2024)
- Presentation to partners on model methods and final findings of conservation effectiveness for Bi-State DPS analysis (January 2024)
- Draft data and model code for ScienceBase release associated with effectiveness of conservation actions in the Bi-State DPS (March 2024)
- Preliminary model results of range-wide conservation efforts effectiveness on sage-grouse populations (August 2024)
- Peer-reviewed journal manuscript describing effectiveness of conservation efforts on sage-grouse populations across their entire range (in prep)
- Final presentations and workshops to partners on model methods and results (November-December 2024)

### COMPLETED DELIVERABLES/PRODUCTS:

- Coates, P. S. Sage-grouse population trends, effectiveness of conservation actions, and threat assessment in the bi-state distinct population segment. Presentation to the Technical Advisory Committee for 10-y Bi-State Sage-Grouse Action Plan. Lee Vining, NV. 8/24/2023.

- Coates, P. S., B. G. Prochazka, M. C. Milligan, M. P. Chenaille, S. R. Mathews, B. E. Brussee, and S. T. O'Neil. 2023. Population and habitat analysis of greater sage-grouse: implication for Bi-State Action Plan. Executive Oversight Committee. Walker, CA. 9/6/2023.
- Coates, P. S., B. G. Prochazka, C. G. Lundblad, K. E. Doherty, S.T. O'Neil, B.E. Brussee, J.C. Tull, and S. Abele. 2024. Evaluating the Sagebrush Conservation Design Through the Performance of a Sagebrush Indicator Species. Presentation to the Society for Rangeland Management 2024 annual conference in Sparks, Nevada
- Coates, P. S., B.G. Prochazka, S.C. Webster, C.L. Weise, C.L. Aldridge, M.S. O'Donnell, L. Wiechman, K.E. Doherty, and J.C. Tull. In Review. Assessing performance of cooperative conservation actions on population growth of greater sage-grouse (*Centrocercus urophasianus*). [Peer reviewed manuscript in review at Rangeland Ecology and Management]
- Coates, P. S., M.C., Milligan, B.G. Prochazka, B.E. Brussee, S.T. O'Neil, C.G. Lundblad, S.C. Webster, C.L. Weise, S.R. Mathews, C.L. Aldridge, M.S. O'Donnell, S.P. Espinosa, A.C. Sturgill, K.E. Doherty, J.C. Tull, K. Miller, L.A. Wiechman, S. Abele, J. Boone, and M.L. Casazza. *In Press*. Population and Habitat Analyses for Greater Sage-Grouse (*Centrocercus urophasianus*) in the Bi-State Distinct Population Segment: 2022 Update. USGS Open File Report in production
- Coates, P. S., B. G. Prochazka, K. E. Doherty, C. G. Lundblad, S. C. Webster, S. T O'Neil, J. C. Tull, C. L. Weise, C. L. Aldridge, M. S. O'Donnell, and L. Wiechman. 2024. Evaluating the conservation design strategy and targeted conservation efforts using a sagebrush indicator species, the greater sage-grouse. 34th Biennial WAFWA Sage & Columbian Sharp-tailed Grouse Workshop. Wenatchee, WA. 08/08/2024.
- Coates, P. S., B. G. Prochazka, S. C. Webster, C. L. Weise, C. L. Aldridge, M. S. O'Donnell, K. E. Doherty, and J. C. Tull. 2024. Effectiveness of sagebrush conservation actions on greater sage-grouse population performance: Did the birds get the memo?. American Ornithological Society 2024 Annual Conference. Estes Park, CO. 10/03/2024.

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## GREATER SAGE-GROUSE RANGE-WIDE SEASONAL HABITAT MAPS: IDENTIFYING REGIONAL THRESHOLDS and RELATIONSHIP BETWEEN TRENDS AND SEASONAL HABITAT USE

*Greg Wann (USGS-FORT), Cameron Aldridge (USGS-FORT), Meg McLachlan (BLM)*

**ABSTRACT:** Wildlife populations spanning large distributions depend on habitat conditions that vary both geographically and seasonally. Habitat quality is often a strong driver of population health, which is reflected in population growth rates. In support of the Bureau of Land Management (BLM) and their implementation of the Habitat Assessment Framework (HAF) for greater sage-grouse (*Centrocercus urophasianus*), we created a set of continuous range-wide seasonal habitat maps for three general seasons (spring, summer-fall, and winter) and three life-history seasons (nesting, early brood, and late brood). These maps represent the probability of a raster pixel being selected, conditional on the environmental conditions surrounding that pixel. To make these maps more accessible for discrete seasonal decisions (i.e., classifying the pixel to different habitat categories), we are in the process of deriving an additional set of maps using thresholding criteria developed to vary by different regions within the greater sage-grouse range. Additionally, we are using the continuous habitat maps to evaluate changes in annual population growth as a function of different seasonal habitats to identify which seasonal habitat conditions most limit (or promote) population growth. This analysis will help key in on seasonal habitat prioritizations to aid population recovery across the greater sage-grouse U.S.

distribution. These two extensions of the seasonal habitat modeling project will therefore facilitate technical transfer of the datasets to on-the-ground habitat assessments.

- TOPICS: Wildlife, greater sage-grouse, seasonal habitats
- ADAPTIVE MANAGEMENT APPLICATION: Biological Planning, Conservation Design, Monitoring
- PROJECT WEBSITE: <https://www.usgs.gov/centers/fort-collins-science-center/science/creating-range-wide-predictive-maps-greater-sage-grouse>

#### PROPOSED DELIVERABLES:

- Wann, G.T., A.L. Whipple, C.L. Aldridge, et al. Seasonal habitat associations of Greater and Gunnison Sage-Grouse: A review of modeled relationships and study designs from tracking studies. *Journal of Wildlife Management*. *In press*.
- Wann, G.T., A.L. Whipple, M.L. O'Donnell. Combining wildlife tracking datasets collected from ground-based and satellite-based telemetry transmission devices: A greater sage-grouse example. *Ecological Informatics*. *In review*.
- Wann, G.T., C.L. Aldridge, M.M. McLachlan et al. Range-wide seasonal habitat models for Greater Sage-Grouse. Expected publication describing the methodologies behind seasonal habitat models. (FY25-Q4)
- Wann, G.T., C.L. Aldridge, M.M. McLachlan et al. Range-wide seasonal habitat model datasets for Greater Sage-Grouse. Expected data release with raster datasets of seasonal habitat maps. (FY25-Q2)
- Compiled Range-wide oil and gas well-site database for application in seasonal models. (FY25-Q4)

#### COMPLETED DELIVERABLES/PRODUCTS:

- Wann, G.T., and A.L. Whipple. Building range-wide seasonal habitat models for greater sage-grouse (Phase 1). Internal Progress Report, April 2022. 47 pp.
- Wann, G.T., N.D. Van Schmidt, J.E. Shyvers, B.C. Tarbox, M.M. McLachlan, M.S. O'Donnell, A.J. Titolo, P.S. Coates, D.R. Edmunds, J.A. Heinrichs, A.P. Monroe, and C.L. Aldridge. 2022. A regionally varying habitat model to inform management for greater sage-grouse persistence across their range. *Global Ecology and Conservation* e02346  
<https://doi.org/10.1016/j.gecco.2022.e02349>
  - o Wann, G.T., N.D. Van Schmidt, J.E. Shyvers, B.C., Tarbox, M.M. McLachlan, M.S. O'Donnell, A.J. Titolo, P.S. Coates, D.R. Edmunds, J.A. Heinrichs, A.P. Monroe, and C.L. Aldridge. 2022. U.S. range-wide spatial prediction layers of lek persistence probabilities for greater sage-grouse: U.S. Geological Survey data release.  
<https://doi.org/10.5066/P95YAUPH>

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## CHARACTERIZING THE ENVIRONMENTAL DRIVERS OF RANGE-WIDE GENE FLOW FOR GREATER SAGE-GROUSE

*Shawna Zimmerman (USGS-FORT), Sara Oyler-McCance (USGS-FORT), Ashley Whipple (USGS-FORT), Greg Wann (USGS-FORT), Cam Aldridge (USGS-FORT)*

**ABSTRACT:** Understanding how species are affected by landscape composition is crucial to effective management, particularly when that environment is altered through climate and land use change. Much of this understanding is currently based on directly observable traits (e.g., survival, use, occupancy, etc.),

and the relationship between landscape composition and gene flow is not as well studied. The variable effects of landscape features on multiple life history traits can result in shifts or limitations to gene flow that may lead to reduced health and fitness for the species in the long-term. We will use existing range-wide genetic and environmental data and recently developed statistical tools to better understand the relationship between landscape composition and gene flow for the greater sage-grouse. From these relationships, we will also create a range-wide predicted gene flow surface describing areas likely to have relatively high or low gene flow and thus areas that might be targeted for different conservation and management strategies. The proposed work would provide managers with an understanding of the main drivers of gene flow and spatial predictions identifying areas of relatively high and low gene flow.

- TOPICS: wildlife, sage-grouse, restoration
- ADAPTIVE MANAGEMENT APPLICATION: Biological Planning, Evaluation, Conservation Design
- PROJECT WEBSITE: <https://www.usgs.gov/centers/fort-collins-science-center/science/characterizing-environmental-drivers-range-wide-gene>

#### **PROPOSED DELIVERABLES:**

- USGS Sage & Fire Science Webinars
- Conference presentation
- Peer reviewed manuscript
- USGS Data Release: Spatial data for predicted gene flow surface

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### **CHARACTERIZING GREATER SAGE-GROUSE CLIMATE DRIVEN MALADAPTATION**

*Shawna Zimmerman (USGS-FORT), Sara Oyler-McCance (USGS-FORT), Cam Aldridge (USGS-FORT)*

**ABSTRACT:** Climate change will expose many species to new and extreme environmental conditions that could be particularly challenging for those already of conservation concern. Habitat specialists, like the greater sage-grouse, have evolved to use resources within a relatively narrow ecological niche and may have traits (and genes that underly those traits) that are locally adapted, which may not be beneficial (or, maladaptive) if their local environments undergo rapid change. Effective conservation and management of the greater sage-grouse requires an understanding of how and where climate is likely to affect long-term persistence. We propose to expand our on-going investigation of greater sage-grouse adaptive divergence to include the development of spatial predictions of adaptive similarity (i.e., adaptive index) and predicted maladaptation (i.e., genomic offset) under multiple climate change scenarios.

- TOPICS: wildlife, sage-grouse, restoration, climate
- ADAPTIVE MANAGEMENT APPLICATION: Biological Planning, Evaluation, Conservation Design
- PROJECT WEBSITE: <https://www.usgs.gov/centers/fort-collins-science-center/science/characterizing-greater-sage-grouse-climate-driven>

#### **PROPOSED DELIVERABLES:**

- USGS Sage & Fire Science Webinars
- Conference presentation
- Peer reviewed manuscript

- USGS Data Release: Predicted adaptive similarity and risk of climate maladaptation (i.e., genomic offset).

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## QUANTIFYING CARBON STORAGE AND GREENHOUSE GAS EMISSIONS IN SAGEBRUSH RANGELANDS TO INFORM MANAGEMENT FOR CARBON RESILIENCE

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**ABSTRACT:** Management partners have identified a major need to understand the short and long-term consequences of altered wildfire patterns, vegetation change, climate change, and management actions for the carbon cycle. We know substantial belowground carbon is stored in sagebrush rangelands, but it has been historically difficult to characterize how it varies across the landscape and in response to disturbance, landcover change, and restoration, making it difficult to tie management decisions to the fate of carbon. By synthesizing and mapping the heterogeneity of carbon storage across the Great Basin, we aim to fill a major gap in linking the Sagebrush Conservation Design to carbon dynamics, and create a resource that land managers can use as a supporting reference for planning management actions with carbon storage and climate adaptation in mind. We will utilize above and belowground carbon data from sites across the SageSTEP experiment before and after vegetation treatments ([sagestep.org](http://sagestep.org)), in addition to synthesizing compatible datasets collected by the USDA ARS, NDOW, and other partners, to improve our understanding of what drives heterogeneity in total ecosystem carbon storage and carbon resilience across the Great Basin. In this talk, we will present preliminary results from an analysis of 10-year change in soil organic carbon in response to fuel treatments in sagebrush and pinyon-juniper ecosystems in the SageSTEP network.

- TOPICS: Fire, Invasives, Climate, Restoration
- ADAPTIVE MANAGEMENT APPLICATION: Monitoring, Evaluation, Conservation Design
- PROJECT WEBSITE: [Quantifying Carbon Storage and Greenhouse Gas Emissions in Sagebrush Rangelands | U.S. Geological Survey \(usgs.gov\)](https://www.usgs.gov/land-management/conservation-design/quantifying-carbon-storage-and-greenhouse-gas-emissions-in-sagebrush-rangelands)

### PROPOSED DELIVERABLES:

- 1-2 peer-reviewed manuscripts describing methodology, results, and implications.
- A practical guide for land managers that outlines options for preserving resilient carbon storage under different management scenarios and in alignment with other priorities (fuels management, habitat conservation, native species restoration).
- Webinars for BLM partners to disseminate findings.
- Conference presentations at SRM and ESA.
- Final datasets including SOC database and spatially explicit map products made publicly available through USGS ScienceBase.