United States
Department of
Agriculture

NATURAL RESOURCES CONSERVATION SERVICE

WORKING LANDS FOR WILDLIFE

A DECADE OF SCIENCE SUPPORT IN THE SAGEBRUSH BIOME

2011–2021

A Decade of Science Support in the Sagebrush Biome

Natural Resources Conservation Service. 2021. A decade of science support in the sagebrush biome. United States Department of Agriculture. Washington, D.C. 32 pp.
https://doi.org/10.32747/2021.7488985

Photo: Jeremy Roberts/Conservation Media

Cover photo: Jeremy Roberts/Conservation Media

Photo: Jeremy Roberts/Conservation Media

Table of Contents

Introduction

Photo: Jeremy Roberts/Conservation Media

Seventy percent of the western United States is rangeland where rural communities maintain large intact grass and shrublands through domestic livestock grazing. More than 350 plant and animal species call this land home, notably sage grouse, sagebrush songbirds, and migratory big game populations. These important rangelands are under threat from land–use conversion, woodland expansion, invasive annual grasses, and dewatering of wet meadows and riparian sites.

Starting in 2010, the USDA's Natural Resources Conservation Service (NRCS)—through its Working Lands for Wildlife (WLFW) Sage Grouse Initiative (SGI)—accelerated efforts to help combat these threats to the sagebrush biome through WLFW's vision of wildlife conservation through sustainable ranching. To date, the NRCS has invested $536.2 million into SGI with 2,366 participating landowners in the sagebrush biome, resulting in the conservation of 8.58 million acres of working lands. A decade later and WLFW's new five–year Framework for Conservation Action (https://wlfw.rangelands.app) is the agency's continuing contribution to voluntary conservation of sagebrush country with the people who live and work in this biome.

COPRODUCTION OF SCIENCE: LINKING PEOPLE TO CONSERVATION

Coproduction is the joint creation of new knowledge based on interactions between scientists and affected stakeholders. Coproduction in rangeland conservation makes science more actionable by engaging stakeholders to share in both design and implementation, striving to achieve better outcomes for ranching and wildlife.[1] Along with the rise of coproduction is a renewed interest in working lands as stewards of some of the most productive lands in the West. A focus on working lands also helps actively manage persistent threats for conservation–reliant species like sage grouse.

WLFW scientists engage with practitioners to proactively target conservation and assess resulting outcomes, focusing efforts on threats that can be addressed through voluntary

> **"Outcomes provide the backbone for effective communications with producers."** —Julia Debes, WLFW Director of Agricultural Communications

Science investment is an integral part of WLFW because outcomes don't measure themselves.

conservation on private working lands. The uptake of science is rapid because findings are directly relevant to conservation actions.

QUANTIFYING OUTCOMES IN CONSERVATION

WLFW recognized early that limited resources necessitate a strategic, landscape approach to succeed. Outcomes are defined as the impact of conservation actions. Outputs, on the other hand, are defined as the amount of something produced. In conservation, outputs typically are tallied as acres enrolled, dollars allocated, or miles restored. Outputs are an integral, yet interim, step in quantifying outcomes, allowing conservationists to track progress towards implementation goals.

Tracking outputs electronically is vital as it enables scientists to evaluate the effectiveness of resulting outcomes. For example, practitioners that maintain GIS shapefiles showing locations and timing of pinyon–juniper cuts enables scientists to assess the restorative outcomes of these actions on deep–rooted forage plants or nest survival of radio–tagged grouse.

Outcomes answer the "so what?" question in strategic conservation. WLFW invests in science support and provides the capacity to proactively target investments and quantify outcomes. Knowing outcomes provides the mechanism for sustained investment because stakeholders can communicate their return on investment.

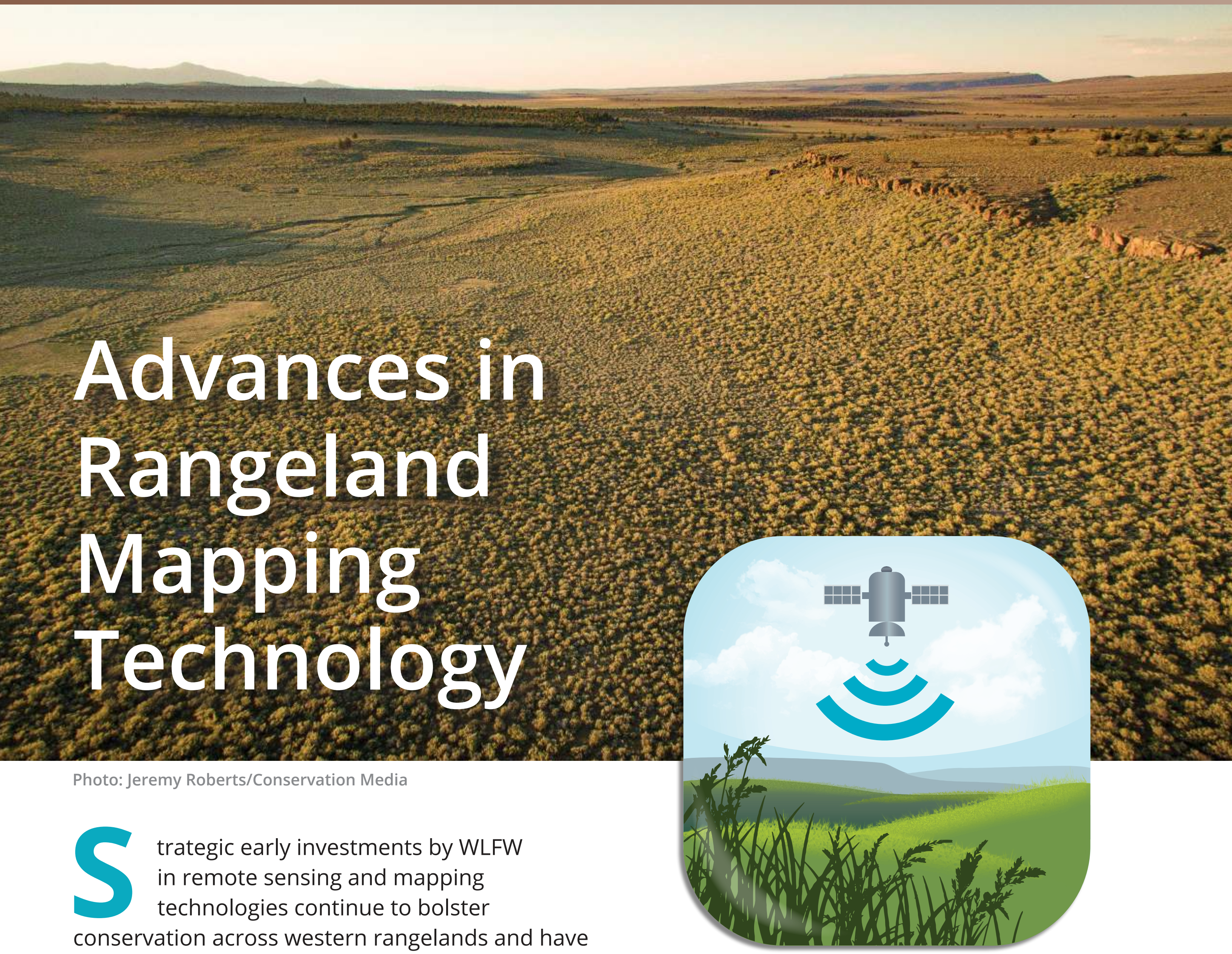
PURPOSE

This report summarizes—in one place—more than a decade of WLFW science support that NRCS staff and partners can incorporate into their future work. Rather than list citations, this report summarizes science's current understanding of identified threats and how best to address them through voluntary conservation actions.

At the time of this report, WLFW scientists have authored 61 peer–reviewed publications that help target conservation and quantify outcomes for threats that can be reduced with voluntary actions. These papers have been cited 1,264 times thus far by other researchers in the scientific literature and another 43 times in the Federal Register to articulate the outcomes of voluntary conservation (SGI Outcomes in Conservation Report 2015) in Endangered Species Act determinations.

This accumulation of findings quantifies outcomes and sparks new ways of thinking about how to address threats facing rangelands and wildlife. The report also details WLFW's advanced spatial technologies that help practitioners best identify where conservation work will yield the greatest outcomes. WLFW thanks the NRCS' Conservation Effects Assessment Project–Wildlife Component as an early adopter and continued partner in the coproduction of science on western rangelands.[2] Please explore this report and learn what we have learned over more than a decade of putting science into action.

1. Naugle, D.E., B.W. Allred, M.O. Jones, D. Twidwell, and J.D. Maestas. 2020. Coproducing science to inform working lands: The next frontier in nature conservation. BioScience 70:90–96.
2. Naugle, D.E., J.D. Maestas, B.W. Allred, C.A. Hagen, M.O. Jones, M.J. Falkowski, B. Randall, and C.A. Rewa. 2019. CEAP quantifies conservation outcomes for wildlife and people on western grazing lands. Rangelands 41:211–217.

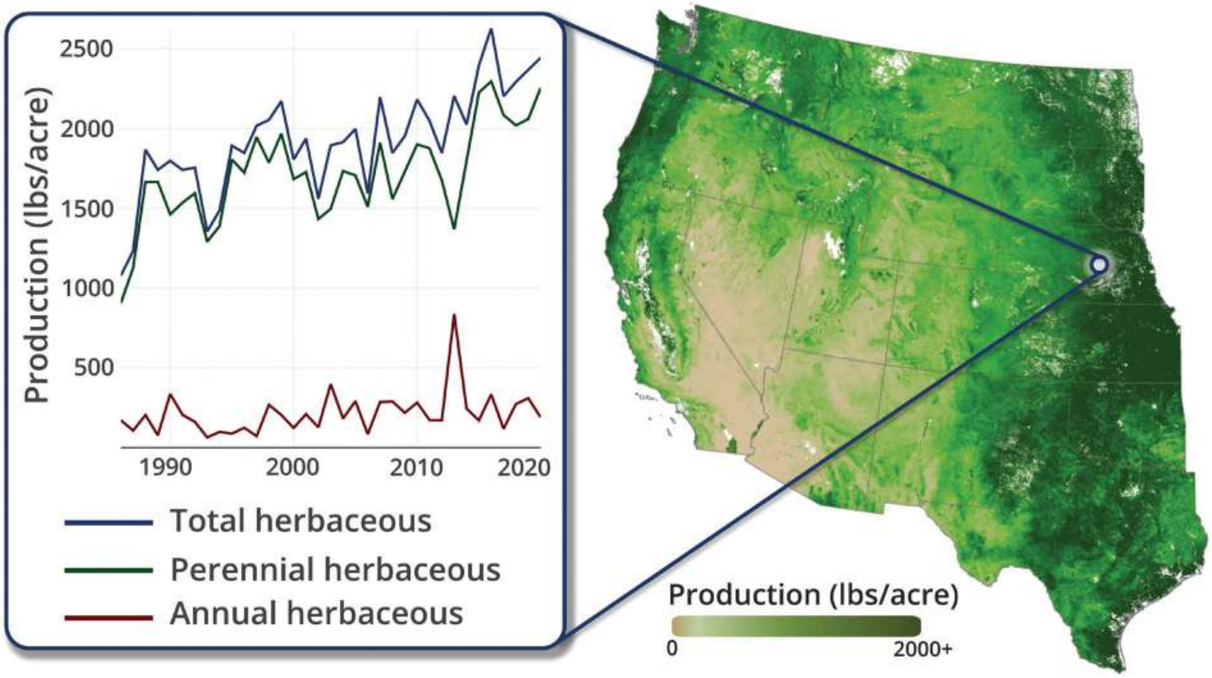


Advances in Rangeland Mapping Technology

Photo: Jeremy Roberts/Conservation Media

Strategic early investments by WLFW in remote sensing and mapping technologies continue to bolster conservation across western rangelands and have spurred the creation of cutting–edge geospatial data and tools that make conservation efforts more efficient and effective. Innovations in early online mapping tools spurred the creation of the Rangeland Analysis Platform (RAP)—a free online application that provides an unprecedented ability to monitor rangelands across space and time and serves as a primary mechanism to deliver rangeland conservation at landscape scales.

In Brief: Early WLFW investments in mapping technologies via the Rangeland Analysis Platform (RAP) provide spatial context for conservation actions and usher in a new era in rangeland monitoring and evaluation.



RAP–based estimates of herbaceous production put change–detection tools at the fingertips of land managers and other decision–makers.

WLFW developed annual, 30–meter, percent cover maps for U.S. rangeland vegetation from 1984 to the present.[1] Plant types mapped are those used for rangeland monitoring and evaluation including annual forbs and grasses, perennial forbs and grasses, shrubs, trees, and bare ground. These land cover data were improved using fresh field plot data and the latest machine learning techniques.[2]

In parallel, cutting–edge vegetation productivity maps that quantified plant carbon uptake were being produced at ever finer spatial and temporal resolutions;[3,4] providing a detailed view of vegetation productivity with cascading implications for conservation and management.[5] WLFW then combined the land cover data with productivity computations to create first–ever rangeland herbaceous production data that has been split into separate estimates for perennials and annuals.[6,7] Together, these cutting–edge data provide views of cover, carbon, and production at temporal and spatial resolutions never seen before.

Using these data, WLFW and partners developed the Rangeland Analysis Platform (RAP). This web application allows anyone to view and analyze land cover and vegetation production through time—from ranch to watershed scales.[8] The RAP and its data serve as a primary component in WLFW's strategic spatial approach to address rangeland threats across the West, embedded in the Sagebrush Biome Framework for Conservation Action.

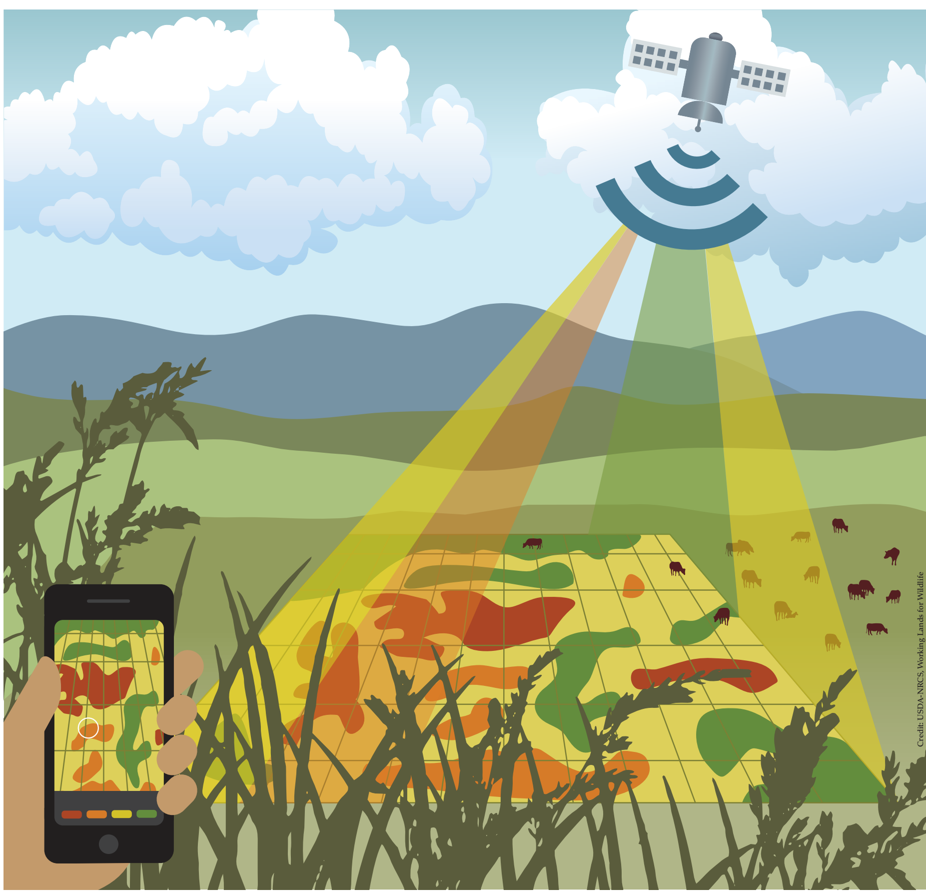
RAP data are also a critical component in Idaho's Cheatgrass Challenge, where NRCS leaders and partners launched a statewide effort to fight invasive annual grasses. This effort highlights the role of the RAP in WLFW's spatial–based conservation strategy—Defend the Core, Grow the Core, Mitigate Impact—which focuses proactive conservation efforts where they are most likely to be successful and cost–effective. The Cheatgrass Challenge is using RAP to identify core intact areas, defending and growing those cores through conservation actions and partnerships, and mitigating impacts in areas where annual grasses have a strong foothold.

The RAP has also provided critical data to identify the severity and extent of woodland expansion into sagebrush rangelands. This threat has detrimental effects on rangeland resiliency, hydrology, productivity, and wildlife. The RAP is being used to prioritize areas for conservation action and assess outcomes of past and future conservation efforts. Recent studies demonstrate the use of RAP data to assess outcomes of targeted conifer removal which increased sage grouse habitat,[9] resulting in a +12% increase in population growth rate.[10] Invasive annual grasses and expanding woodlands are pervasive across the West, and RAP data helps detect early warning signals before these threats result in irreversible shifts in vegetation assemblages.[11]

Rangeland monitoring is quickly evolving—with the RAP at the forefront—as WLFW is pioneering new approaches to rangeland conservation. WLFW has added the capacity to help train more ranchers and practitioners to apply this technology while continuing to innovate through new data and web applications to assist in managing and monitoring America's rangelands.

WLFW–SUPPORTED SCIENCE PUBLICATIONS:

1. Jones, M.O., B.W. Allred, D.E. Naugle, J.D. Maestas, P. Donnelly, L.J. Metz, J. Karl, R. Smith, B. Bestelmeyer, C. Boyd, J.D. Kerby, and J.D. McIver. 2018. Innovation in rangeland monitoring: Annual, 30 m, plant functional type percent cover maps for U.S. rangelands, 1984–2017. Ecosphere 9:e02430.



RAP provides spatial context to conservation strategies and makes it easy to quantify outcomes of management actions.

2. Allred, B.W., B.T. Bestelmeyer, C.S. Boyd, C. Brown, K.W. Davies, M.C. Duniway, L.M. Ellsworth, T.A. Erickson, S.D. Fuhlendorf, S.D., T.V. Griffiths, V. Jansen, M.O. Jones, J. Karl, A. Knight, J.D. Maestas, J.J. Maynard, S.E. McCord, D.E. Naugle, H.D. Starns, D. Twidwell, and D.R. Uden. 2021. Improving Landsat predictions of rangeland fractional cover with multitask learning and uncertainty. Methods in Ecology and Evolution 12:841–849.

3. Robinson, N.P., B.W. Allred, M.O. Jones, A. Moreno, J.S. Kimball, D.E. Naugle, T.A. Erickson, and A.D. Richardson. 2017. A dynamic Landsat derived normalized difference vegetation index (NDVI) product for the conterminous United States. Remote Sensing 9:863.

4. Robinson, N.P., B.W. Allred, W.K. Smith, M.O. Jones, A. Moreno, T.A. Erickson, D.E. Naugle, and S.W. Running. 2018. Terrestrial primary production for the conterminous United States derived from Landsat 30 m and MODIS 250 m. Remote Sensing in Ecology and Conservation 4:264–280.

5. Robinson, N.P., B.W. Allred, D.E. Naugle, and M.O. Jones. 2019. Patterns of rangeland productivity and land ownership: Implications for conservation and management. Ecological Applications 29:e01862.

6. Robinson, N.P., M.O. Jones, A. Moreno, T.A. Erickson, D.E. Naugle, and B.W. Allred. 2019. Rangeland productivity partitioned to sub–pixel plant functional types. Remote Sensing 11:1427.

7. Jones, M.O., N.P. Robinson, D.E. Naugle, J.D. Maestas, M.C. Reeves, R.W. Lankston, and B.W. Allred. 2021. Annual and 16–day rangeland production estimates for the western United States. Rangeland Ecology and Management 77:112–117.

8. Jones, M.O., D.E. Naugle, D. Twidwell, D.R. Uden, J.D. Maestas and B.W. Allred. 2020. Beyond inventories: Emergence of a new era in rangeland monitoring. Rangeland Ecology and Management 73:577–583.

9. Olsen, A.C., J.P. Severson, B.W. Allred, M.O. Jones, J.D. Maestas, D.E. Naugle, K.H. Yates and C.A. Hagen. 2021. Reversing tree encroachment increases usable space for sage–grouse during the breeding season. Wildlife Society Bulletin: In Press.

10. Olsen, A.C., J.P. Severson, J.D. Maestas, D.E. Naugle, J. Smith, J.D. Tack, K.H. Yates, and C.A. Hagen. 2021. Reversing tree expansion in sagebrush steppe yields population level benefit for imperiled grouse. Ecosphere 12:e03551.

11. Roberts, C.P., D. Twidwell, J.L. Burnett, V.M. Donovan, C.L. Wonkka, C.L. Bielski, A.S. Garmestani, D.G. Angeler, T. Eason, B.W. Allred, M.O. Jones, D.E. Naugle, S.M. Sundstrom, and C.R. Allen. 2018. Early warnings for state transitions. Rangeland Ecology and Management 71:659–670.

ADDITIONAL READINGS:

Uden, D.R., D. Twidwell, C.R. Allen, M.O. Jones, D.E. Naugle, J.D. Maestas, and B.W. Allred. 2019. Spatial imaging and screening and regime shifts. Frontiers Ecology and Evolution 7:e407.

Protecting Rangelands from Land–Use Conversion

Photo: Jeremy Roberts/Conservation Media

Working Lands for Wildlife (WLFW) uses Farm Bill resources like conservation easements to proactively remove the risk of cultivation and new housing developments to maintain the open space, habitat, water quality, and soil health required for ranching and wildlife. While the impacts from constructing homes or other buildings are more localized, habitat destruction is severe and virtually impossible to reverse. Both forms of development can sever big game migration routes and reduce habitat below levels needed to support sage grouse movements.

Conservation easements are one tool provided by the USDA's Natural Resources Conservation Service (NRCS) and partners to help reduce these threats with producers who voluntarily agree to keep working lands undeveloped. Pace and extent of easement acquisition accelerated in the sagebrush biome since WLFW became an NRCS national priority. From 2010–2013, for example, easements increased more than 1,800 percent, providing certainty for current and future generations that sagebrush grazing lands will remain as large and intact watersheds. Since 2013, SGI has published five outcome–

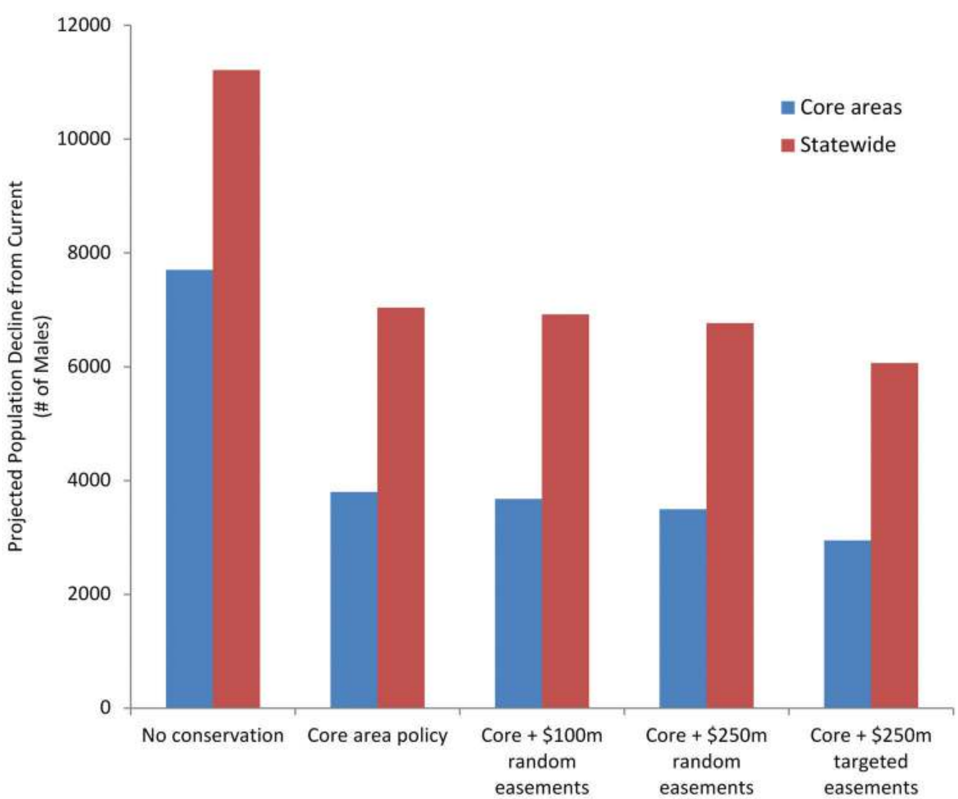
In Brief: WLFW is keeping grazing lands connected with conservation easements before crops and houses creep in, and using science to inform the landscape context of these actions.

based evaluations to help target conservation easements and evaluate their effectiveness in maintaining intact rangelands.

In Wyoming, NRCS and partners place easements to remove the threat of housing developments inside sage grouse strongholds. Easements complement the Wyoming governor's approach to managing oil and gas development. SGI's assessment back in 2013 predicted that $250 million in targeted easements can cut sage grouse losses by roughly half statewide and nearly two–thirds within core areas.[1] To date, NRCS and matching partners in Wyoming have invested $131 million towards meeting the conservation easement goal and keeping 192,565 acres of intact habitat on working lands. Easements taken for sage grouse also have conserved 75% of priority habitats for two populations of migratory mule deer.[2]

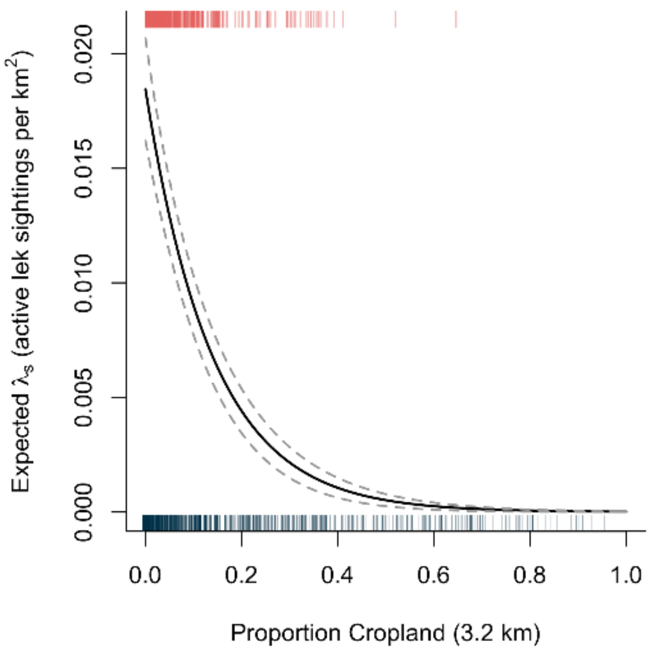
In eastern Montana, the western Dakotas, and northeast Wyoming, 70 percent of sagebrush habitats are privately owned and under the primary threat of cultivation. An NRCS–sponsored assessment published in 2016 found that 96 percent of active leks are surrounded by less than 15 percent cropland and that additional cultivation would decrease the regional populations by five to seven percent.[3] The reach of impact is striking—a single square mile of new cropland negatively impacts sage grouse in a landscape 12 times that size. Findings also indicate that optimal placement of a $100 million easement investment would prevent most losses, and that clumped easements rather than scattered ones yield higher returns on biological investment.[3]

Fast–forward to 2021, and Montana now leads the nation in using easements to perpetually conserve working rangelands. Over the past



Science–based targeting predicts that targeted easements in Wyoming can cut sage grouse losses by roughly half statewide and nearly two–thirds within core areas (1).

Land–Use Conversion

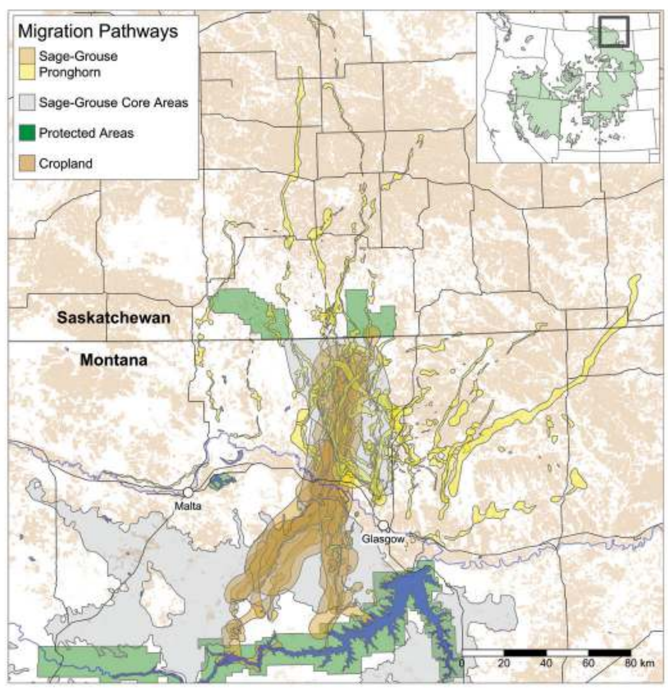


Science showing the rapid decline in sage grouse lek density associated with new cultivation of sagebrush rangelands (3).

decade, NRCS and partners here have invested $78 million to conserve a quarter–million acres of intact sagebrush grazing lands. To deliver these tools at scale, NRCS and its partners built their easement culture from the ground up, including early dialogue with communities, additional investment in people to complete the complex transactions, and the ingenuity to combine diverse funding sources.

Montana's effort is conserving—in perpetuity—the largest sage grouse and pronghorn migrations in the West.[4] Easements were strategically placed within the longest known sage grouse migratory pathway—the birds here travel more than 100 miles each way annually. And these grouse are international travelers, crossing the border where they comprise Canada's last sage grouse population in Saskatchewan.[5]

The NRCS is adding to the mix a novel approach for retaining grassland that is exiting the Conservation Reserve Program (CRP) by replacing landowners' lost annual CRP payments with revenues from livestock grazing. WLFW science showed a doubling of grassland retention when these efforts are targeted to poor–performing croplands.[6] The likelihood of retaining these grasslands is high because of their proximity to existing rangelands that support a grazing culture. Producers revert to cropping their most productive CRP fields once payments end but are open to keeping in grass their less productive fields (Barnes et al. 2020). Landowners interested in keeping their expired CRP fields in grassland can get the help they need from NRCS to design sustainable grazing systems, such as the installation of water for domestic livestock.



Migratory pathways for sage grouse and pronghorn in the northern Great Plains, Montana, USA, and Saskatchewan, Canada (4).

WLFW–SUPPORTED SCIENCE PUBLICATIONS:

1. Copeland, H.E., A. Pocewicz, D.E. Naugle, T. Griffiths, D. Keinath, J.S. Evans, and J. Platt. 2013. Measuring the effectiveness of conservation: a novel framework to quantify

Photo: Jeremy Roberts/Conservation Media

the benefits of sage–grouse conservation policy and easements in Wyoming. PLoS One 8:e67261.

2. Copeland, H.E., H. Sawyer, K.L. Monteith, D.E. Naugle, A. Pocewicz, N. Graf, and M.J. Kauffman. 2014. Conserving mule deer through the umbrella of sage–grouse. Ecosphere 5:art117.

3. Smith J.T., J.S. Evans, B.H. Martin, S. Baruch–Mordo, J.M. Kiesecker and D.E. Naugle. 2016. Reducing cultivation risk for at–risk species: Predicting outcomes of conservation easements for sage–grouse. Biological Conservation 201:10–19.

4. Tack, J.D., A.F. Jakes, P.F. Jones, J.T. Smith, R.E. Newton, B.H. Martin, M. Hebblewhite, and D.E. Naugle. 2019. Beyond protected areas: Private lands and public policy anchor intact pathways for multi–species wildlife migration. Biological Conservation 234:18–27.

5. Newton, R.E., J.D. Tack, J.C. Carlson, M.R. Matchett, P.J. Fargey, and D.E. Naugle. 2017. Longest sage–grouse migratory behavior sustained by intact pathways. Journal of Wildlife Management 81:962–972.

6. Sullins, D.S., M. Bogaerts, B.H.F. Verheijen, D.E. Naugle, T. Griffiths, and C.A. Hagen. 2021. Increasing durability of voluntary conservation through strategic implementation of the Conservation Reserve Program. Biological Conservation 259:109177.

ADDITIONAL READINGS:

Barnes, J.C., M. Sketch, A.R. Gramza, M.G. Sorice, R. Iovanna, A.A. Dayer. 2020. Land use decisions after the Conservation Reserve Program: Re–enrollment, reversion, and persistence in the southern Great Plains. Conservation Science and Practice 2:e254.

Lipsey, M.K., K.E. Doherty, D.E. Naugle, S. Fields, J.S. Evans, S.K. Davis, and N. Koper. 2015. One step ahead of the plow: Using cropland conversion risk to guide Sprague's Pipit conservation in the northern Great Plains. Biological Conservation 191:739–749.

Sawyer, H., F. Lindzey, and D. McWhirter. 2005. Mule deer and pronghorn migration in western Wyoming. Wildlife Society Bulletin 33:1266–1273.

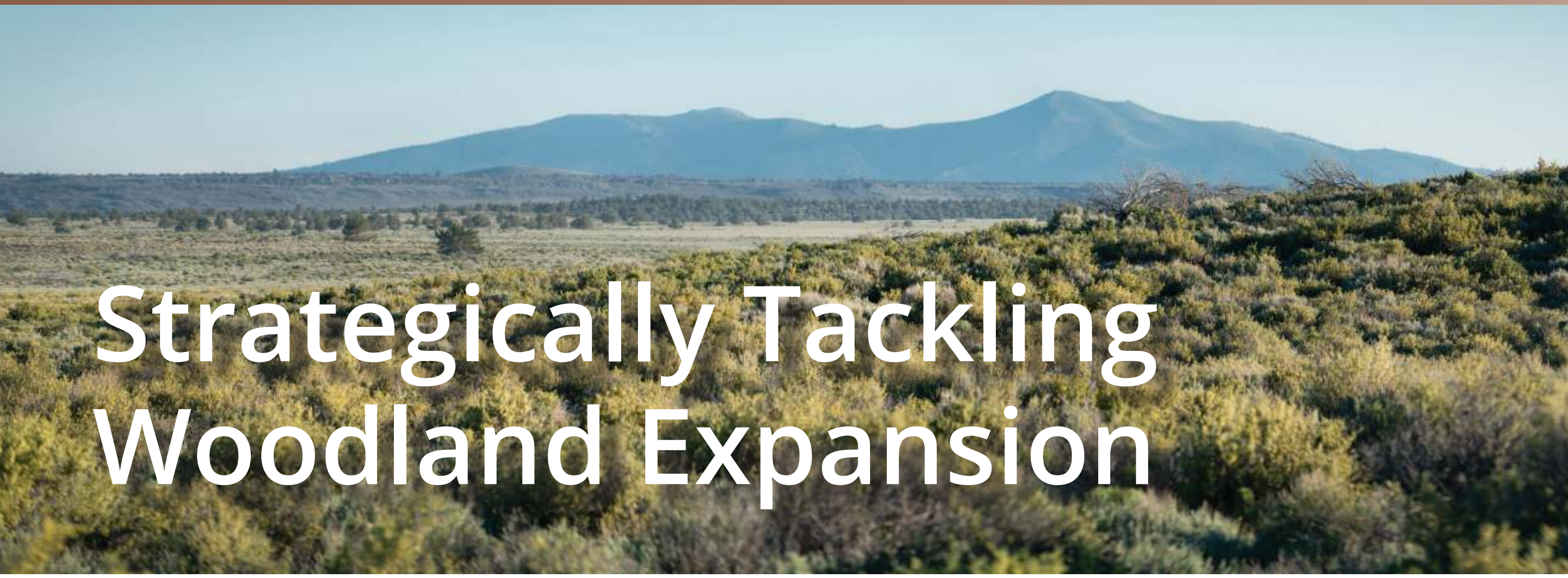


Photo: Jeremy Roberts/Conservation Media

Strategically Tackling Woodland Expansion

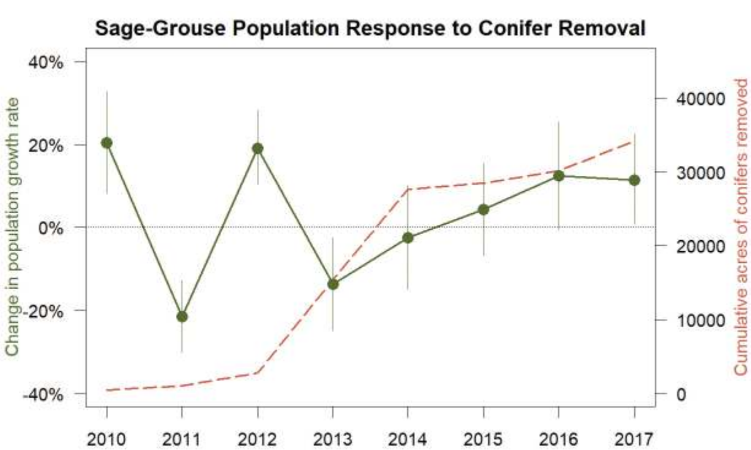
Woodland expansion into grasslands and shrublands is a global problem as trees displace wildlife and reduce the productivity of grazing lands (Nackley et al. 2017). Scattered trees across the sagebrush biome may look harmless to a casual observer, but science shows woodland expansion erodes rangeland resilience when left unchecked. In the Intermountain West, conifer trees—including juniper, pine, and fir—have increased up to 600 percent since the 1800s, with 90 percent of expansion occurring at the expense of sagebrush rangelands (Miller et al. 2011). Woodland expansion results in sagebrush wildlife habitat loss and fragmentation, reduced forage production, decreased resilience to fire, and less resistance to cheatgrass invasion.[1]

The extent and severity of woodland expansion as a primary threat to sage grouse was poorly understood a decade ago. WLFW–sponsored science showed sage grouse are particularly sensitive to trees, abandoning otherwise suitable breeding habitat with just a few trees per acre (i.e., 4 percent canopy cover) thereby elevating awareness of this threat to grouse.[2] To help practitioners better target tree removal, WLFW coproduced the first high–resolution mapping of tall woody plant cover across sagebrush habitats[3] and made this tool freely available via the SGI interactive web application for partners to identify areas of early tree invasion and visualize potential areas in need of treatment. Today, this tool has been replaced by newer tree mapping technology available through the Rangeland Analysis Platform (see Sagebrush Conservation Tab; http://rangelands.app). Under WLFW's proactive "'Protect the Core, Grow the Core" strategy, participants focus on conserving core areas of key sage grouse habitat with little or no tree cover and then expanding into areas where woody species are present but not dominant.

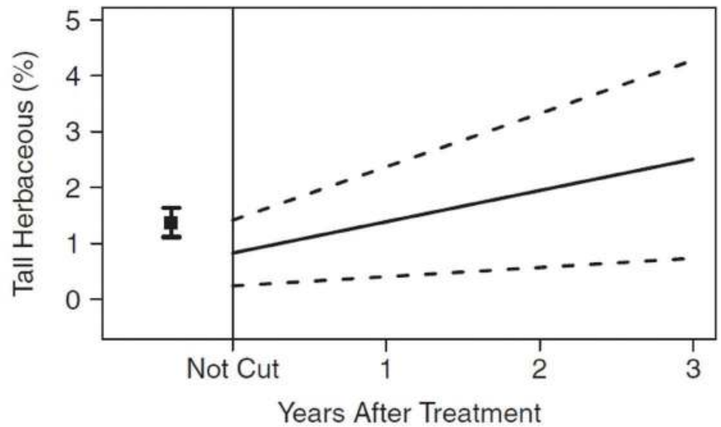
In Brief: Targeted removal of expanding conifers improves ecosystem resilience and benefits sage grouse and other sagebrush–dependent wildlife.

Woodland expansion also reduces available forage for wildlife and livestock across U.S. rangelands. West–wide, livestock producers lose more than $300 million annually in revenue as a result of lost production from woodland expansion.[4] In the western Dakotas, Montana, and Wyoming, woodland expansion and cropland conversion threaten biome connectivity and biodiversity. As these lands are critical habitat for grassland birds and home to some of the last remaining big game migrations in the contiguous U.S., halting woodland expansion and conserving intact shrublands is crucial. To support outreach and project targeting WLFW scientists developed a web application (https://rangelands.app/yield–gap). This free online app helps producers estimate the productivity and forage gains that accompany the restoration of grazing lands through woodland management.

WLFW scientists also quantified wildlife outcomes in a decade–long evaluation of juniper removal in Oregon. Findings show that restored rangelands are rapidly recolonized by sage grouse[5] with higher survival rates inside than outside of treatments,[6] resulting in a +12% increase in population growth rate.[7]



Sage grouse population growth rates increased +12% as conifer trees were removed from the landscape (7). No such response occurred in the nearby control landscape where conifers were left unmanaged.



Restoring sagebrush communities with conifer management increased understory vegetation critical for sage grouse nesting habitat three years post–treatment (8). Square symbol on the left represents the average cover found at radio–marked bird nest sites.

Nesting hens were quick to use restored habitats made available by conifer removal. Within three years of initiating treatments, a third of marked females were nesting near or within restored habitats; no such response was apparent in the nearby control landscape where conifers were not removed. The relative probability of nesting in newly restored sites increased by 22 percent annually, and females were 43 percent more likely to nest near treatments. Herbaceous vegetation responded favorably when nutrient–robbing trees were removed from sagebrush rangelands.[8]

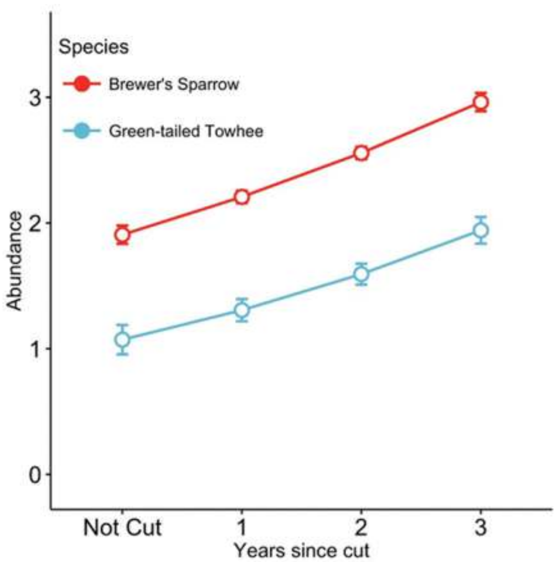
From 2011 to 2017, the amount of newly available open space used by marked grouse increased six–fold (from five to 31 percent) with no change in probability of use in the untreated control landscape.[9]

These outcomes demonstrate that targeted conifer removal works and is one of the few management actions available to increase sage grouse population growth rates. Next–generation modeling continues to explore how to enhance targeting of restoration cuts to improve seasonal habitats for sage grouse, facilitate their movement between seasonal habitats, and maintain connectivity among sage grouse strongholds.[10]

Woodland Expansion

Targeted removal should be scaled up further as conifer expansion continues in unmanaged landscapes in the sagebrush biome.[11,12]

Additional outcomes from southern Oregon show that abundances of Brewer's sparrow, green–tailed towhee, and vesper sparrow more than doubled following mechanical conifer removal.[13] Annual increases each year post tree removal suggest that Brewer's sparrow use may increase even more with time. Findings illustrate that conifer removal conducted for sage grouse that retained shrub cover can result in immediate benefits for other sagebrush songbirds of high conservation concern.



Songbird abundance increased after sagebrush communities were restored through conifer management (13).

WLFW–SUPPORTED SCIENCE PUBLICATIONS:

1. Maestas, J.D., D.E. Naugle, J.C. Chambers, J.D. Tack, C.S. Boyd, J.M. Tague. 2021. Conifer expansion. In T.E. Remington, P.A. Deibert, S.E. Hanser, D.M. Davis, L.A. Robb, and J.L. Welty (editors). Sagebrush conservation strategy—Challenges to sagebrush conservation. U.S. Geological Survey Open–File Report 2020–1125, 327 pages. https://doi.org/10.3133/ofr20201125.

2. Baruch–Mordo, S., J.S. Evans, J.P. Severson, D.E. Naugle, J.D. Maestas, J.M. Kiesecker, M.J. Falkowski, C.A. Hagen, and K.P. Reese. 2013. Saving sage–grouse from the trees: A proactive solution to reducing a key threat to a candidate species. Biological Conservation 167:233–241.

3. Falkowski M.J., J.S. Evans, D.E. Naugle, C.A. Hagen, S.A. Carleton, J.D. Maestas, A.H. Khalyani, A.J. Poznanovic, and A.J. Lawrence. 2017. Mapping tree canopy cover in support of proactive prairie grouse conservation in western North America. Rangeland Ecology and Management 70:15–24.

4. Morford, S.L., B.W. Allred, D. Twidwell, M.O. Jones, J.D. Maestas, and D.E. Naugle. 2021. Biome–scale woody encroachment threatens conservation potential and sustainability of U.S. rangelands. bioRxiv https://doi.org/10.1101/2021.04.02.438282

5. Severson J.P., C.A. Hagen, J.D. Maestas, D.E. Naugle, J.T. Forbes and K.P. Reese. 2017. Short–term response of sage–grouse nesting to conifer removal in the northern Great Basin. Rangeland Ecology and Management 70:50–58.

6. Severson J.P., C.A. Hagen, J.D. Maestas, D.E. Naugle, J.T. Forbes and K.P. Reese. 2017. Better living through conifer removal: A demographic analysis of sage–grouse vital rates. PloS One 12:e0174347.

7. Olsen, A.C. Olsen, J.P. Severson, J.D. Maestas, D.E. Naugle, J. Smith, J.D. Tack, K.H. Yates, and C.A. Hagen. 2021. Reversing tree expansion in sagebrush steppe yields population level benefit for imperiled grouse. Ecosphere 12:e03551.

8. Severson J.P., C.A. Hagen, J.D. Maestas, D.E. Naugle, J.T. Forbes and K.P. Reese. 2017. Restoring sage–grouse nesting habitat through removal of early successional conifer. Restoration Ecology 25:1026–1034.

9. Olsen, A.C., J.P. Severson, B.W. Allred, M.O. Jones, J.D. Maestas, D.E. Naugle, K.H. Yates and C.A. Hagen. 2021. Reversing tree encroachment increases usable space for sage–grouse during the breeding season. Wildlife Society Bulletin: In Press.

10. Reinhardt J.R., D.E. Naugle, J.D. Maestas, B. Allred, J. Evans, and M. Falkowski. 2017. Next–generation restoration for sage–grouse: A framework for visualizing local conifer cuts within a landscape context. Ecosphere 8:e01888.

11. Reinhardt, J.R., S. Filippelli, M. Falkowski, B. Allred, J.D. Maestas, J.C. Carlson, and D.E. Naugle. 2020. Quantifying pinyon juniper reduction within North America's sagebrush ecosystem. Rangeland Ecology and Management 73:420–432.

12. Filippelli, S.K., M.J. Falkowski, A.T. Hudak, P.A. Fekety, J.C. Vogeler, A H. Khalyani, B.M. Rau, and E.K. Strand. 2020. Monitoring pinyon–juniper cover and aboveground biomass across the Great Basin. Environmental Research Letters 15:1–15.

13. Holmes A.L., J.D. Maestas and D.E. Naugle. 2017. Bird responses to removal of western juniper in sagebrush–steppe. Rangeland Ecology and Management 70:87–94.

RELATED READINGS:

Doherty, K.E., J.D. Hennig, J.B. Dinkins, K.A. Griffin, A.A. Cook, J.D. Maestas, D.E. Naugle, and J.L. Beck. 2018. Understanding biological effectiveness before scaling up range–wide restoration investments for Gunnison sage–grouse. Ecosphere 9:e02144.

Donnelly J.P., J.D. Tack, K.E. Doherty, D.E. Naugle, B.W. Allred and V.J. Dreitz. 2017. Extending conifer removal and landscape protection strategies from sage–grouse to songbirds, a range–wide assessment. Rangeland Ecology and Management 70:95–105.

Nackley, L.L., A.G. West, A.L. Skowno, and W.J. Bond. 2017. The nebulous ecology of native invasions. Trends in Ecology and Evolution 32:814–824.

Maestas, J.D., C.A. Hagen, J.T. Smith, J.D. Tack, B.W. Allred, T. Griffiths, C.J. Bishop, K.M. Stewart, and D.E. Naugle. 2019. Mule deer juniper use is an unreliable indicator of habitat quality: Comments on Coe et al. (2018). Journal of Wildlife Management 83:755–762.

Miller, R.F., S.T. Knick, D.A. Pyke, C.W. Meinke, S.E. Hanser, M.J. Wisdom, A.L. Hild. 2011. Characteristics of sagebrush habitats and limitations to long–term conservation. Pages 145–185 In S.T. Knick and J.W. Connelly, Editors. Greater sage–grouse: Ecology and conservation of a landscape species and its habitats. Studies in Avian Biology Volume 38. Berkeley, California, University of California Press.

Miller R.F., D.E. Naugle, J.D. Maestas, C.A. Hagen and G. Hall. 2017. Targeted woodland removal to recover at–risk grouse and their sagebrush–steppe and prairie ecosystems. Rangeland Ecology and Management 70:1–8.

Severson J.P., C.A. Hagen, J.D. Maestas, D.E. Naugle, J.T. Forbes and K.P. Reese. 2017. Effects of conifer expansion on greater sage–grouse nesting habitat selection. Journal of Wildlife Management 81:86–95.

Livestock Grazing

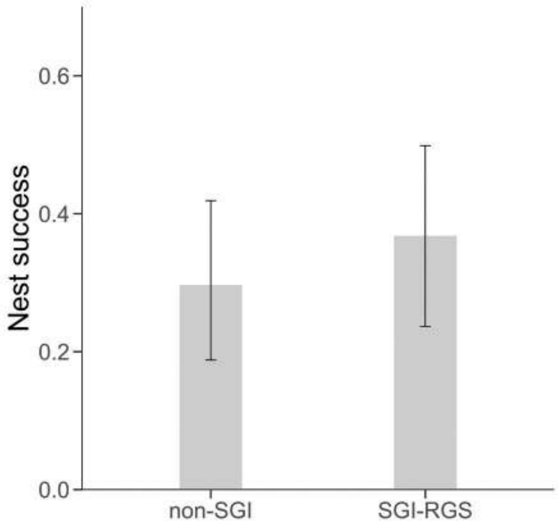
Grazing by Domestic Livestock

Photo: Jeremy Roberts/Conservation Media

Working Lands for Wildlife's (WLFW) shared vision of wildlife conservation through sustainable ranching includes producers as part of the solution for implementing conservation to reduce persistent, non–regulatory threats. This vision rallies and sustains partnerships from the very start and sustains landowner enrollment. Landowners are not forced to enroll. Instead, the WLFW shared vision is congruent with ranchers' values and leverages the Farm Bill's 80–year history of voluntary conservation to put that vision into practice.

WLFW use of coproduced science does not always yield anticipated outcomes, but forces conservationists to think differently about perceived threats. Such was the case when pastures rested from domestic grazing did not benefit sage grouse populations as originally

In Brief: WLFW science has raised the collective understanding of the importance of ranching to wildlife conservation across western public–private land ownerships.

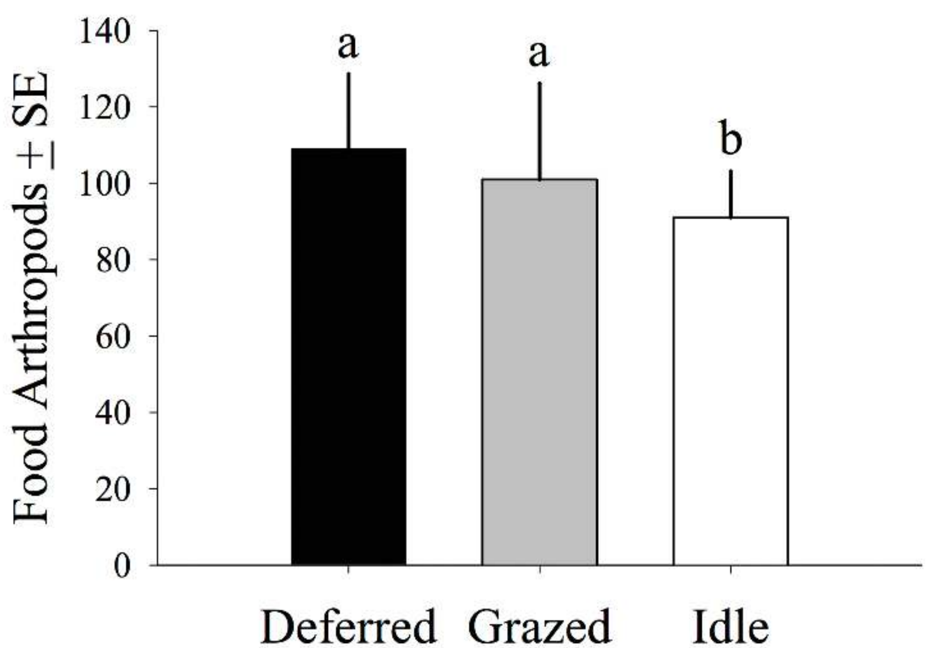


Nesting success was similar among different grazing management systems (non–SGI), and rotational grazing, which kept livestock off of designated areas to allow vegetation to recover (SGI–RGS bar) had no effect on nest survival (1).

hypothesized.[1,2] Outcome assessments found no evidence that rest from grazing (≥12 months) increased daily nest survival rates. Rotational grazing systems and rest had negligible effects on herbaceous vegetation height and cover relative to other grazing strategies.[1] Nest survival was comparable to range–wide averages, suggesting concealing cover for nests is unlikely to be limiting population growth regardless of grazing strategy. In response, the USDA's Natural Resources Conservation Service (NRCS) adjusted the delivery of conservation practices to de–emphasize financial incentives for extended rest within rotational grazing systems.

Additional science revealed maximization of hiding cover may be overemphasized in grazing management guidelines and policies.[1] Findings suggested females instead select nest sites based on relatively static features such as sagebrush cover and distance from roads, whereas nest failure was driven primarily by extended periods of heavy precipitation. As a result, the management of sage grouse nesting habitat should focus on conserving areas of adequate shrub cover and preventing fragmentation of intact grazing lands.

Entomological study in the same landscapes showed arthropods consumed by sage grouse were twice as prevalent in grazed shrublands than in nearby pastures that had been idled without



Activity–density of grouse–food arthropods in grazed, rested and idled pastures in central Montana. Bars represent average weekly catch and standard errors. Grazed rangelands produced more sage grouse food compared to idled pastures where predatory spiders were most abundant (3).

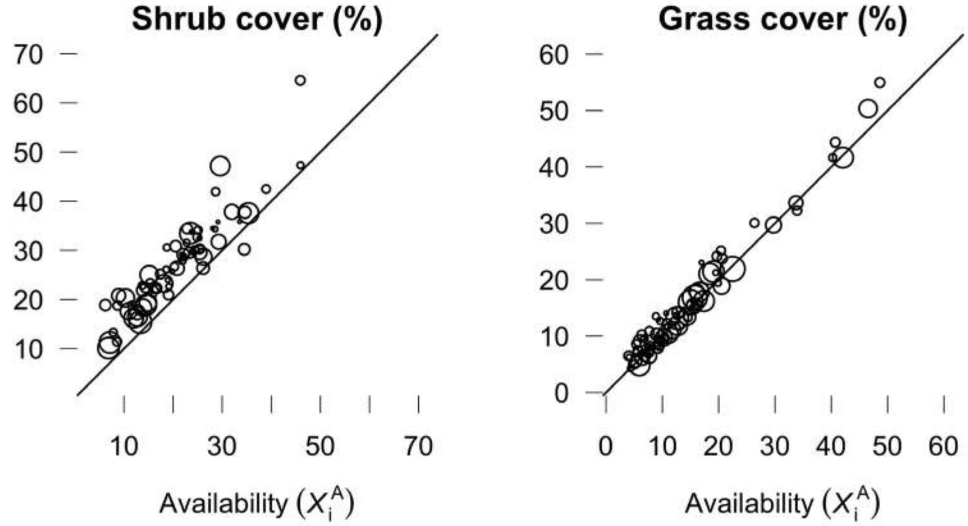
Livestock Grazing

Photo: Jeremy Roberts/Conservation Media

domestic grazing for more than a decade.[3] Lands managed with grazing supported a more diverse assemblage of ground–dwelling arthropods, which may be particularly beneficial as food resources for birds. Outcomes suggested that periodic disturbance may enhance arthropod diversity and that sage grouse may benefit from livestock grazing with periodic rest or deferment.

Findings spawned additional inquiry challenging the long–held belief that grazing restrictions inevitably benefit sage grouse populations. A follow–up study revealed commonly used methodologies are inherently biased, misrepresenting the relationships between habitat structure and sage grouse nest success.[4] A range–wide meta–analysis reveals weak effects of grass height on nest–site selection with no relationship to nest success, suggesting nesting habitat–fitness relationships have been inappropriately extrapolated in developing range–wide habitat management objectives.[5]

Management of public lands, and who should have access to them, remains contentious in the West. Most private ranching enterprises rely upon seasonal grazing access to public lands, and ongoing wildlife conflicts result in continual calls to restrict grazing on public lands. In a final line of questioning, WLFW found restricting grazing on public lands can increase habitat loss on private lands and reduce community support for conservation.[6] A preferred approach for maintaining habitat is a policy that facilitates management on public lands while also supporting sustainable, economically viable ranching operations on private lands.



Sage grouse selected slightly denser shrub cover at nest sites but used herbaceous grass cover based on its availability. Deviation above the diagonal line represents selection by nesting sage grouse. Circles represent individual studies (5).

WLFW–SUPPORTED SCIENCE PUBLICATIONS:

1. Smith, J.T., J.D. Tack, L.I. Berkeley, M. Szczypinski, and D.E. Naugle. 2018. Effects of rotational grazing management on nesting greater sage–grouse. Journal of Wildlife Management 82:103–112.

2. Smith, J.T., J.D. Tack, L.I. Berkeley, M. Szczypinski, and D.E. Naugle. Effects of livestock grazing on nesting sage grouse in central Montana. 2018. Journal of Wildlife Management 82:1503–1515.

3. Goosey, H.B., J.T. Smith, K.M. O'Neill and D.E. Naugle. 2019. Ground–dwelling arthropod community response to livestock grazing: Implications for avian conservation. Environmental Entomology 48:856–866.

4. Smith, J.T., J.D. Tack, K.E. Doherty, B.W. Allred, J.D. Maestas, L.I. Berkeley, S.J. Dettenmaier, T.A. Messmer, and D.E. Naugle. 2018. Phenology largely explains taller grass at successful nests in greater sage–grouse. Ecology and Evolution 8:356–364.

5. Smith, J.T., B.W. Allred, C.S. Boyd, J.C. Carlson, K.W. Davies, C.A Hagen, D.E. Naugle, A.C. Olsen, and J.D. Tack. 2020. Are sage–grouse fine–scale specialists or shrub–steppe generalists? Journal of Wildlife Management 84:759–774.

6. Runge, C.A., A.J. Plantinga, A.E. Larsen, D.E. Naugle, K.J. Helmstedt, S. Plasky. J.P. Donnelly, J.T. Smith, T.J. Lark, J.J. Lawler, S.M. Martinuzzi, and J. Fargoine. 2019. Unintended habitat loss on private land from grazing restrictions on public rangelands. Journal of Applied Ecology 56:52–62.

RELATED READINGS:

Runge, C.A., J.C. Withey, D.E. Naugle, J.E. Fargione, K.J. Helmstedt, A.E. Larsen, S. Martinuzzi, and J.D. Tack. 2019. Single species conservation as an umbrella for management of landscape threats. PLoS One 14:e0209619.

Dahlgren, D.K., R.T. Larsen, R. Danvir, G. Wilson, E.T. Thacker, T.A. Black, D.E. Naugle, J.W. Connelly, and T.A. Messmer. 2015. Greater sage–grouse and range management: Insights from a 25–year case study in Utah and Wyoming. Rangeland Ecology and Management 68:375–382.

Stevens, B.S., D.E. Naugle, B. Dennis, J.W. Connelly, T. Griffiths, and K.P. Reese. 2013. Mapping sage grouse collision risk: Spatially explicit models for targeting conservation implementation. Wildlife Society Bulletin 37:409–415.

Stevens, B.S., K.P. Reese, and J.W. Connelly. 2011. Survival and detectability bias of avian fence collision surveys in sagebrush steppe. Journal of Wildlife Management 75:437–449.

Photo: Jeremy Roberts/Conservation Media

Restoring Riparian and Wet Meadow Resilience

Photo: Jeremy Roberts/Conservation Media

On the range, water is life. Riparian, wet meadow, and other mesic areas —places where land meets water—are rare but disproportionately important to wildlife and working lands. These areas are reservoirs of late–season productivity that provide reliable water and food for livestock and wildlife during the dry summer and fall.

Past degradation and dewatering have reduced the size and function of these mesic areas. Protecting and restoring these sites is essential to improving overall rangeland resilience to drought, fire, watershed scale, and flooding. From a wildlife standpoint, targeting conservation actions close to sage grouse breeding and nesting habitats helps ensure a reliable source of insects and forbs to feed growing chicks as uplands dry out in the summer sun.

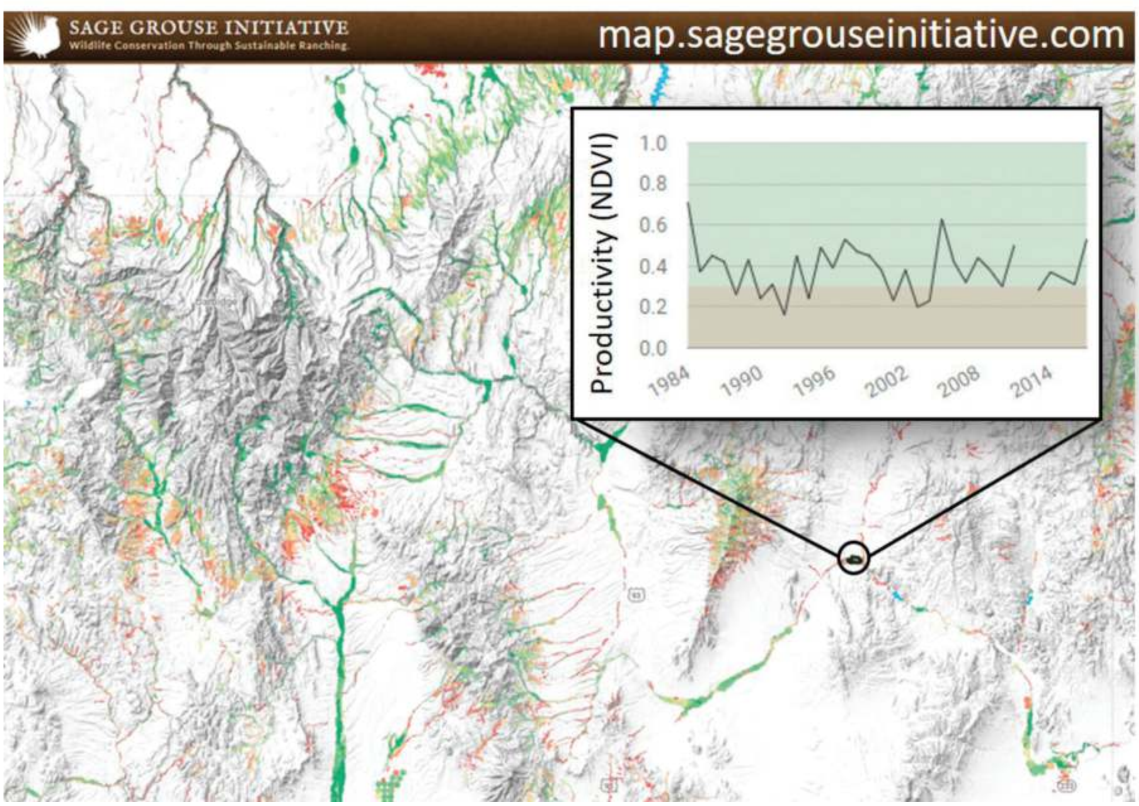
Anchored in Working Lands for Wildlife (WLFW) science, the USDA's Natural Resources Conservation Service (NRCS) has created a cooperative venue for ranchers to restore and

In Brief: Restoration of riparian areas and wet meadows realize quantifiable gains in productivity and drought resiliency.

enhance water resources. Working lands science shows private grazing lands are central to water conservation in the sagebrush biome. Although wet summer habitats cover less than 2 percent of the landscape, 50–90 percent are located on privately managed ranchlands.[1,2] Availability of nesting habitat was previously thought to be the primary determinant of grouse distributions. WLFW science shows that sage grouse also place their breeding grounds near water where hens go to raise their chicks—with 85 percent of leks within six miles of these wet habitats.[1] Drought sensitivity also structured grouse populations wherein landscapes with the greatest uncertainty in mesic abundance and distribution supported the fewest grouse.[2]

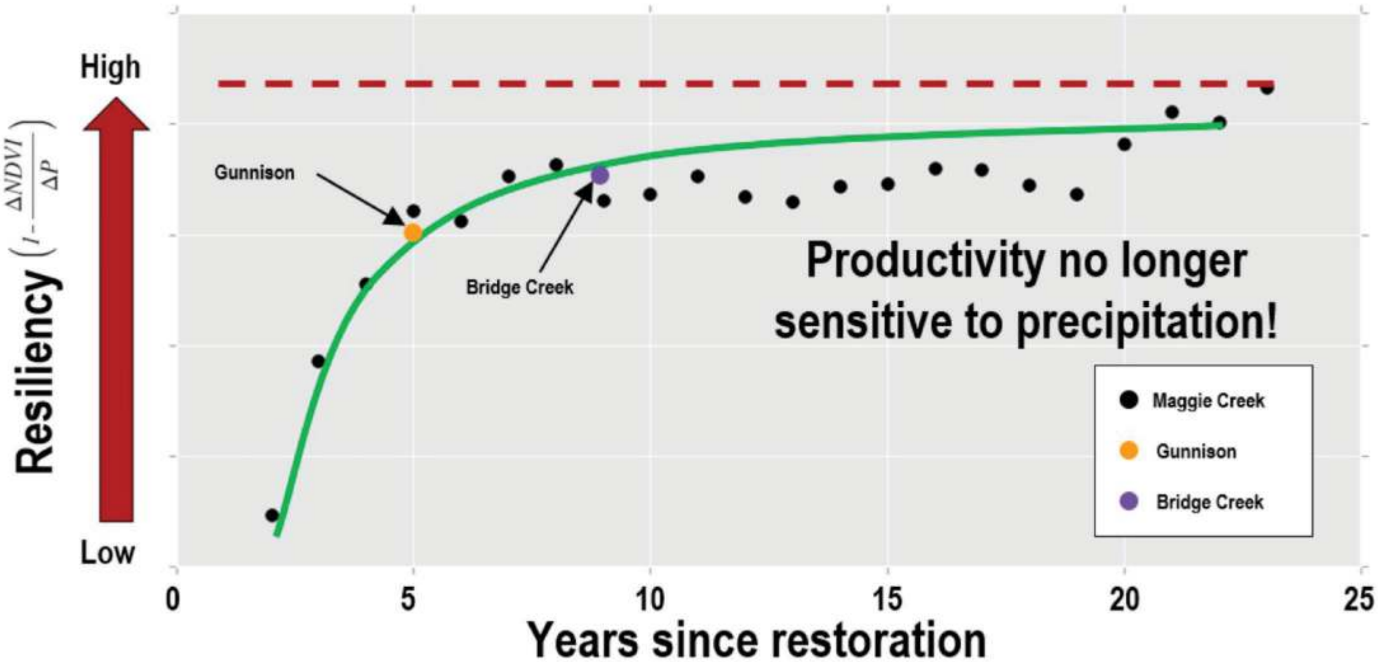
To better target management opportunities, WLFW scientists mapped these wet resources over time across the West and provided these data through a free and publicly available web application (https://map.sagegrouseinitiative.com/). Follow–up science extends the importance of privately stewarded wet meadows to other species, including continental waterbird migrations.[3,4]

In addition to these insights, WLFW science documented the efficacy of various mesic restoration techniques. In a retrospective study of three watershed–scale restoration projects across the West, scientists found that Zeedyk structures, beaver dam analogues, and grazing management increased riparian and wet meadow vegetation productivity by 25 percent and kept plants greener longer throughout the growing season.[5] Restoration efforts also exhibited reduced sensitivity to precipitation over time, resulting in greater resiliency against the stresses of drought and climate variability. Findings exemplify the dual benefits of restoration to ranching and wildlife.



Mesic productivity maps enable managers to visualize the changing productivity of wet their resources during drought and deluge.

Riparian and Wet Meadow Degradation

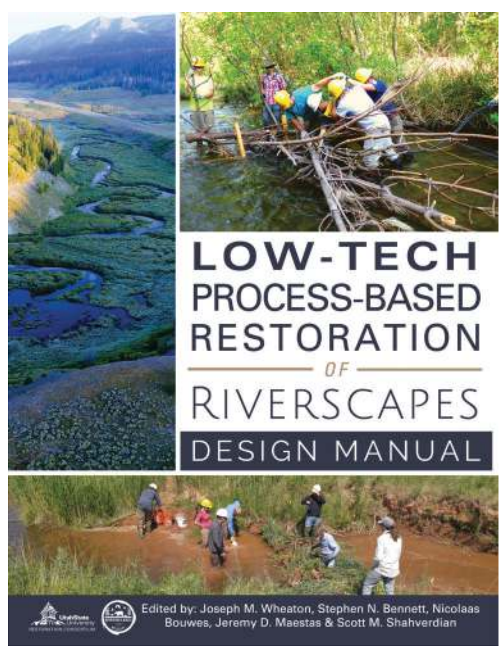


Gunnison, CO
Zeedyk Structures (short-term: 2-5 years)

Bridge Creek, OR
Beaver Dam Analogues (medium-term: 9 years)

Maggie Creek, NV
Grazing Management (long-term: 20+ years)

WLFW is putting this science into practice through technology transfer and training led by the NRCS' West National Technology Support Center in partnership with Utah State University's Restoration Consortium, private consultants, and other agencies. Together, these groups have hosted dozens of field and virtual workshops (http://lowtechpbr.restoration.usu.edu/) and webinars reaching nearly 2,000 practitioners. WLFW also sponsored the publication of technical restoration design manuals and pocket guides detailing how to implement this low–tech restoration work. These efforts have enabled more landowners and partners to participate in scaling up mesic restoration to improve the resiliency of water resources in the region for the benefit of people, wildlife, and livestock.



WLFW–SUPPORTED SCIENCE PUBLICATIONS:

1. Donnelly J.P., D.E. Naugle, C.A. Hagen, and J.D. Maestas. 2016. Public lands and private waters: Scarce mesic resources structure land tenure and sage–grouse distributions. Ecosphere 7:e01208.

2. Donnelly, J.P., B.W. Allred, D. Perret, N.L. Silverman, J.D. Tack, V.J. Dreitz, J.D. Maestas, and D.E. Naugle. 2018. Seasonal drought in North America's sagebrush biome structures dynamic mesic resources for sage–grouse. Ecology and Evolution 8:12492–12505.

3. Donnelly, J.P., S.L. King, N.L. Silverman, D.P. Collins, E.M. Carrera–Gonzalez, A. Lafón–Terrazas, and J. N. Moore. 2020. Climate and human water use diminish wetland networks supporting continental waterbird migration. Global Change Biology 26:2042–2059.

4. Donnelly, J.P., D.E. Naugle, D.P. Collins, B.D. Dugger, B.W. Allred, J.D. Tack, and V.J. Dreitz. 2019. Synchronizing conservation to seasonal wetland hydrology and waterbird migration in semi–arid landscapes. Ecosphere 10:e02758.

5. Silverman, N.L., B.W. Allred, J.P. Donnelly, T.B. Chapman, J.D. Maestas, J.M. Wheaton, J. White, and D.E. Naugle. 2019. Low–tech riparian and wet meadow restoration increases vegetation productivity and resilience across semiarid rangelands. Restoration Ecology 27:269–278.

RELATED READINGS:

Bouwes, N., N. Weber, C.E. Jordan, W.C. Saunders, I.A. Tattam, C. Volk, J.M. Wheaton, M.M. Pollock. 2016. Ecosystem experiment reveals benefits of natural and simulated beaver dams to a threatened population of steelhead (Oncorhynchus mykiss): Scientific Reports 6:28581.

Fairfax E., and A. Whittle. 2020. Smokey the beaver: Beaver–dammed riparian corridors stay green during wildfire throughout the western USA. Ecological Applications 30:e02225.

Fesenmyer, K.A., D.C. Dauwalter, C. Evans, and T. Allai. 2018. Livestock management, beaver, and climate influences on riparian vegetation in a semi–arid landscape. PLoS ONE 13:e0208928.

Maestas J.D., S. Conner, B. Zeedyk, N.M. Sapello, B. Neely, R. Rondeau, N. Seward, T. Chapman, L. With, R. Murph. 2018. Hand–built structures for restoring degraded meadows in sagebrush rangelands: Examples and lessons learned from the Upper Gunnison River Basin, Colorado. Range Technical Note Number 40. USDA–Natural Resources Conservation Service, Denver, Colorado.

Swanson S., S. Wyman, and C. Evans. 2015. Practical grazing management to maintain or restore riparian functions and values. Journal of Range Applications 2:1–28.

Wheaton, J.M., S.N. Bennett, N. Bouwes, (editors). 2019. Low–tech process–based restoration of riverscapes: design manual Version 1.0. Utah State University Restoration Consortium. Logan, Utah.

Wheaton, J.M., A. Wheaton, J. Maestas, S. Bennett, N. Bouwes, S. Shahveridan, R. Camp, C. Jordan, W. Macfarlane, E. Portugal, and N. Weber. 2019. Low–tech process–based restoration of riverscapes: Pocket field guide. Utah State University Restoration Consortium. Logan, Utah.

Defending Core Rangelands Against Invading Annual Grasses

Photo: Jeremy Roberts/Conservation Media

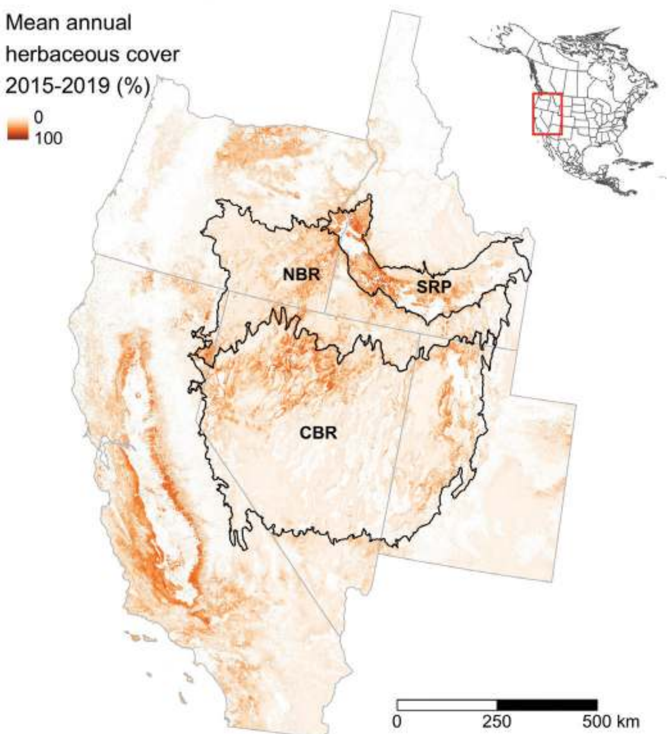
Invasive annual grasses represent one of the largest threats to the health and resilience of western rangelands.[1] Invading annual grasses increase wildfire risk and shorten return intervals, exacerbate drought, reduce forage for wildlife and livestock, and have long–term negative implications for carbon and climate.

Past efforts to control invasive annual grasses were often done reactively, at small scales, in areas of intense infestation, and void of regional context, ultimately hindering long–term success. Working Lands for Wildlife (WLFW) has developed spatial tools to help conservation planners better mitigate risks using soil data.[2] WLFW science has also quantified the elevational ascent and spread of annual grassland transitions, showing movement upslope at 200 to 330 feet per decade.[3] This ascent and spread contribute to an alarming six–fold increase in annual grassland area from 1986–2019 in the U.S. Great Basin.

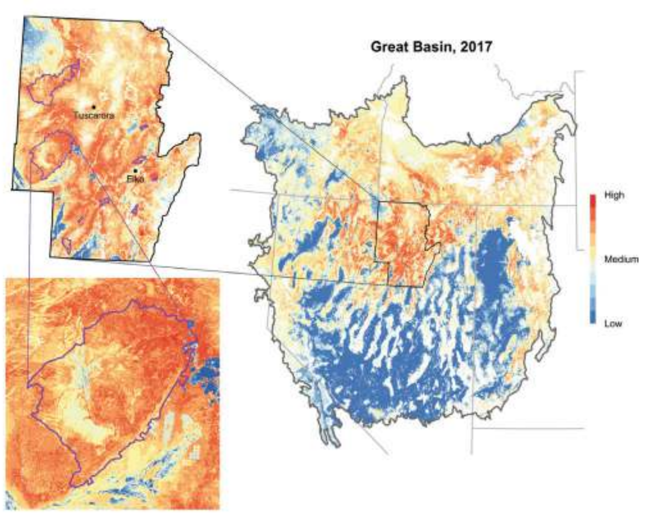
In Brief: WLFW science has spurred biome–wide application of geospatial data to proactively address the conversion of native rangelands to annual grasslands.

Fire probability maps built on data from the [Rangeland Analysis Platform](#) (RAP) demonstrate fine fuels like annual grasses are a primary predictor of large fires. Fire activity in the Great Basin is largely predictable based on accumulating fuel conditions and drought.[4] Over the last three decades, about 80 percent of burned area has occurred on a quarter of the Basin and the annual burned area is increasing in some areas. This science supports a call to action where accelerated intervention is critically needed to conserve rangelands in the face of an ever–growing distribution of annual grasses fueling megafires.[5] WLFW, with public and private partners, has introduced an innovative approach to tackle this problem and address the conversion of sagebrush rangelands to annual grasslands.

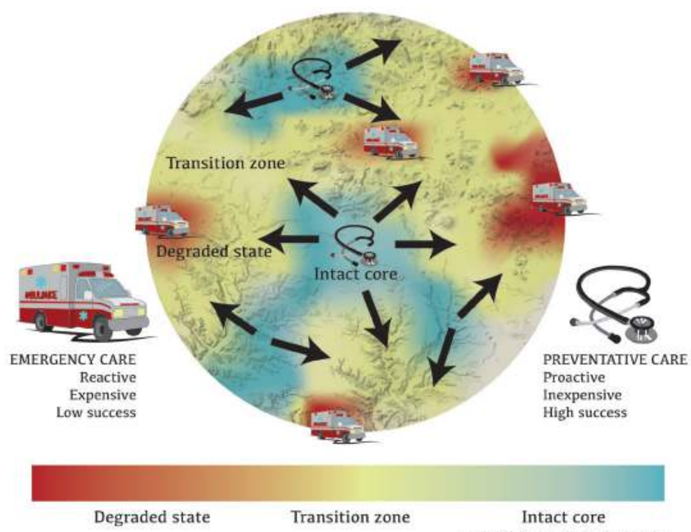
Invasive species control is more effective and cost–efficient when done early, before infestations become widespread, and when management is informed by the surrounding landscape. This science spurred WLFW's new spatial targeting strategy for tackling this threat; a proactive management approach—Defend the Core, Grow the Core, Mitigate Impacts—that is embedded in [WLFW's Sagebrush Biome Framework for Conservation Action](#).



The Rangeland Analysis Platform has mapped invasive annual grasses across western grazing lands (1,3).



Fire probability in 2017 for the Great Basin. These largely RAP–based seasonal fire probability maps help managers prepare for where and when ignitions are likely to result in large and damaging wildfires. Insets depict in purple the perimeters of wildfires >1,000 acres that burned in 2017 (4).



Invasive species control is more effective and cost–efficient when done early and at biologically large scales. Mapping of invasive grasses in the Rangeland Analysis Platform spurred a new spatial targeting strategy of 'Defend the Core, Grow the Core'.

Exotic Annual Grass Invasion

Core areas with minimal annual grass invasion serve as anchors for conservation where efforts are most likely to be successful and cost–effective. Defending and growing those cores through conservation actions and partnerships is prioritized and invasion impacts are mitigated in areas where annual grasses have a strong foothold. This spatial strategy relies on comprehensive geographic data of annual grass cover and interannual variability, and WLFW's early investment in remote sensing and mapping technologies is paying dividends.

No state has been hit harder by cheatgrass than Idaho, which is why USDA's Natural Resources Conservation Service (NRCS) in Idaho worked closely with ranchers and partners to launch the Cheatgrass Challenge, a proactive strategy for tackling exotic annual grasses. Using RAP data and considering assessments of sagebrush ecosystem resilience and resistance,[2] the strategy identified relatively uninvaded areas in Idaho and guided conservation efforts. Following Idaho's lead, the Western Governors' Association–appointed Western Invasive Species Council convened a cheatgrass committee. The committee stretched across agencies, created an integrated annual herbaceous cover map,[6] and developed a new toolkit for invasive annual grass management across the West that incorporated WLFW's spatial targeting strategy and RAP data.

Photo: Jeremy Roberts/Conservation Media

Capitalizing on a network of partners, new geospatial data from RAP, and insights from cutting–edge science NRCS and WLFW have spurred uptake and application of this new innovative strategy to address the deterioration of sagebrush rangelands.

WLFW–SUPPORTED SCIENCE PUBLICATIONS:

1. Jones, M.O., D.E. Naugle, D. Twidwell, D.R. Uden, J.D. Maestas, and B.W. Allred. 2020. Beyond inventories: Emergence of a new era in rangeland monitoring. Rangeland Ecology and Management 73:577–583.

2. Maestas, J.D., Campbell, S.B., Chambers, J.C., Pellant, M., Miller, R.F., 2016. Tapping soil survey information for rapid assessment of sagebrush ecosystem resilience and resistance. Rangelands 38:120–128.

3. Smith, J.T., B.W. Allred, C.S. Boyd, K.W. Davies, M.O. Jones, J.D. Maestas, S.L. Morford, and D.E. Naugle. 2021. The elevational ascent and spread of exotic annual grasslands in the Great Basin, USA. bioRxiv https://doi.org/10.1101/2021.01.05.425458

4. Smith, J.T., B.W. Allred, C.S. Boyd, K.W. Davies, M.O. Jones, A.R. Kleinhesselink, and D.E. Naugle. 2021. Where there's smoke, there's fuel: Predicting Great Basin rangeland wildfire. bioRxiv https://doi.org/10.1101/2021.06.25.449963

5. Murphy, T., D.E. Naugle, R. Eardley, J.D. Maestas, T. Griffiths, M. Pellant, and S.J. Stiver. 2013. Trial by fire: Improving our ability to reduce wildfire impacts to sage–grouse and sagebrush ecosystems through accelerated partner collaboration. Rangelands 35:2–10.

6. Maestas, J., M. Jones, N.J. Pastick, M.B. Rigge, B.K. Wylie, L. Garner, M. Crist, C. Homer, S. Boyte, and B. Whitacre. 2020. Annual herbaceous cover across rangelands of the sagebrush biome: U.S. Geological Survey data release https://doi.org/10.5066/P9VL3LD5

RECOMMENDED READINGS:

Chambers, J.C., J.L. Beck,; J.B. Bradford, J. Bybee, S. Campbel,; J. Carlson, T.J. Christiansen, K.J. Clause, G. Collins, M.R. Crist, J.B. Dinkins, K.E. Doherty, F. Edwards, S. Espinosa, K.A. Griffin, P. Griffin, J.R. Haas, S.E. Hanser, D.W. Havlina, K.F. Henke, J.D. Hennig, L.A. Joyce, F.M. Kilkenny, S.M. Kulpa, L.L. Kurth, J.D. Maestas, M. Manning, K.E. Mayer, B.A. Mealor, C. McCarthy, M. Pellant, M.A. Perea, K.L. Prentice, D.A. Pyke, L.A. Wiechman, and A. Wuenschel. 2017. Science framework for conservation and restoration of the sagebrush biome: Linking the Department of the Interior's integrated rangeland fire management strategy to long–term strategic conservation actions. Part 1. Science basis and applications. General Technical Report RMRS–GTR–360. Fort Collins, Colorado. U.S. Department of Agriculture, United States Forest Service, Rocky Mountain Research Station. 213 pages. https://www.fs.usda.gov/treesearch/pubs/53983

Chambers, J.C., J.D. Maestas, D.A. Pyke, C.S. Boyd, M. Pellant, and A. Wuenschel. 2017. Using resilience and resistance concepts to manage persistent threats to sagebrush ecosystems and Greater sage–grouse. Rangeland Ecology and Management 70:149–164.

Rangeland Connectivity

Photo: Jeremy Roberts/Conservation Media

Connectivity is a core principle for maintaining healthy wildlife populations and for keeping rangelands intact for rural grazing communities. If rangelands are increasingly fragmented, wildlife populations become more isolated. For species like sage grouse, isolation can sever the dispersal of breeding birds necessary to maintain genetic diversity. Using feather DNA, Working Lands for Wildlife (WLFW) scientists and partners are identifying spatially the ties that bind the sagebrush biome. The USDA's Natural Resources Conservation Service (NRCS) is using this information to incorporate conservation actions that facilitate sagebrush connectivity on which wildlife depend.

In the largest genetic evaluation conducted for any species, scientists extracted unique DNA signatures from feathers collected at sage grouse breeding sites (i.e., leks) to identify individual birds and then recapture them in subsequent feather collections. Surveyors conducting annual bird counts at leks collected tens of thousands of fallen grouse feathers from ~1,200 leks across the West. Genotyping feather DNA identified 5,950 individual grouse. Scientists used these data to characterize the sage grouse connectivity as a network of 458 genetic hubs that facilitate gene flow throughout the West.[1] Hubs are centrally located across Wyoming and in eastern Idaho, with genetic exchange most evident in Montana and northern Wyoming, and Utah and eastern Nevada. Scientists then used feather DNA to build resistance maps classifying the landscape into "habitat" and "nonhabitat".[2] Mountains and valleys that facilitate and naturally restrict movement shape genetic connectivity. Other major contributors include sagebrush availability (less than 10–30 percent), tree canopy cover (more than 10 percent), and cultivation (more than 25 percent) within parts of the range with each reducing movement beyond their respective thresholds.

In additional work across Montana, Wyoming, and Idaho, 2.5 percent of unique individuals occurred twice in feather samples, and in 41 recaptures, birds had dispersed to different leks.[3] These are important indicators of connectivity that should be maintained because dispersal is a rare event (less than 1 percent), and evidence of dispersal reduces the risk of genetic isolation and inbreeding. Seven grouse journeyed more than 30 miles away, and one recapture dispersed 120 miles. Across Montana, North Dakota, and South Dakota, these short–range dispersals translate to long–range connectivity.[4] Genetic bird groupings largely mirrored their known population strongholds.

Early investment in genetic analyses is an emerging opportunity for WLFW to further incorporate connectivity into conservation delivery. Connectivity maps are just now being used to identify where conservation actions might best facilitate movement within and between population strongholds. Early examples include woodland management within and outside priority areas of conservation (PACs) to facilitate movement between seasonal habitats and among populations. Easements too have been placed inside and outside of PACs to alleviate large–scale cultivation risk. Connectivity may inform cheatgrass–reduction strategies before it invades intact core areas.

Feather DNA studies will soon help inform management of ways to keep population strongholds connected throughout the biome.

WLFW–SUPPORTED SCIENCE PUBLICATIONS:

1. Cross, T.B., M.K. Schwartz, D.E. Naugle, B.C. Fedy, J.R. Row, and S.J. Oyler–McCance. 2018. The genetic network of greater sage–grouse: Range–wide identification of keystone hubs of connectivity. Ecology and Evolution 8:5394–5412.

2. Row, J.R., K.E. Doherty, T.B. Cross, M.K. Schwartz, S. Oyler–McCance, D.E. Naugle, S.T. Knick, and B.C. Fedy. 2018. Quantifying functional connectivity: The role of breeding habitat, abundance, and landscape features on range–wide gene flow in sage–grouse. Evolutionary Applications 11:1305–1321.

3. Cross, T.B., D.E. Naugle, J.C. Carlson, and M.K. Schwartz. 2017. Genetic recapture identifies long–distance breeding dispersal in greater sage–grouse (*Centrocercus urophasianus)*. Condor 119:155–166.

4. Cross, T.B., D.E. Naugle, J.C. Carlson and M.K. Schwartz. 2016. Hierarchical population structure in greater sage–grouse provides insight into management boundary delineation. Conservation Genetics 17:1417–1433.

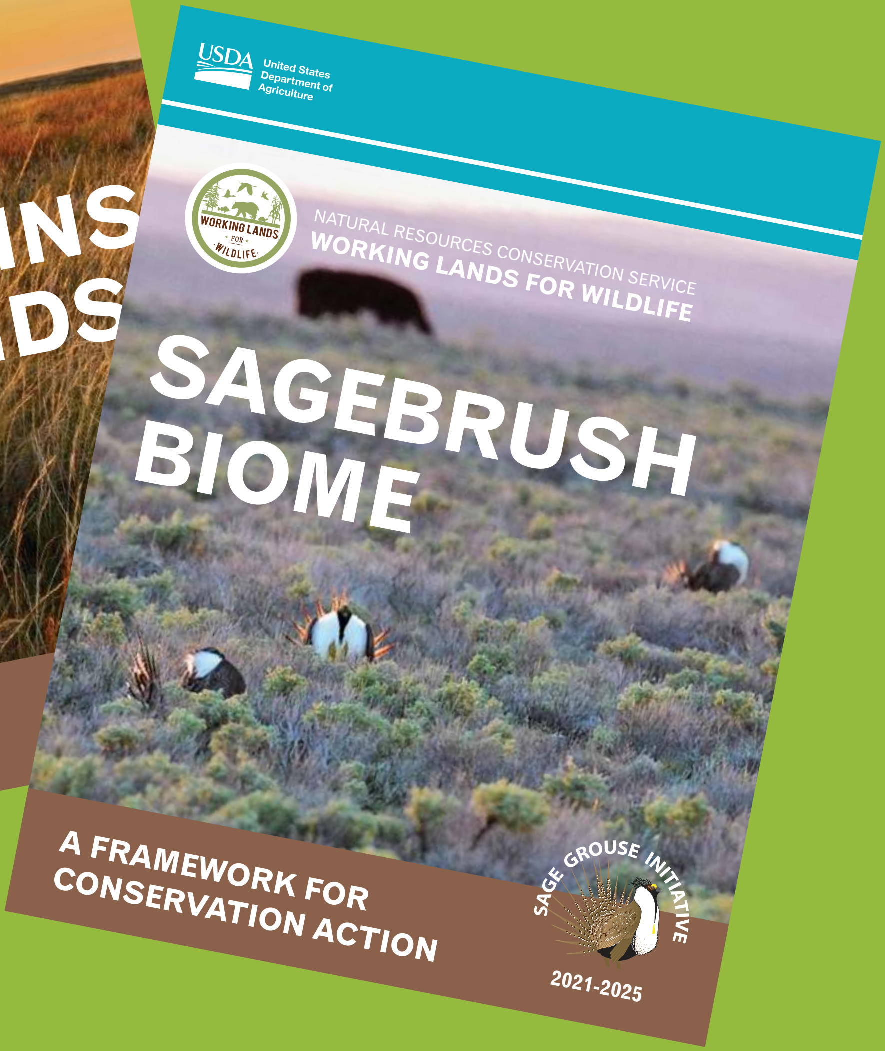
Conclusion

Photo: Jeremy Roberts/Conservation Media

Over the last decade, Working Lands for Wildlife (WLFW) has advanced the science on working rangelands and put that knowledge to work in the sagebrush biome. Coproduced science and locally–led work have informed more effective treatments, pinpointed areas of focus, and, most importantly, achieved beneficial outcomes for wildlife, ranchers, and the rural communities dependent on this iconic landscape.

Now, this legacy of conserving working rangelands continues in WLFW's new Framework for Conservation Action in the Sagebrush Biome.

This new framework continues to target the most severe and large–scale threats causing biome–level impacts. This new approach focuses on the entire ecosystem, but the success of focal species—like sage grouse—helps measure the outcomes and success of private land conservation because these species require healthy, functioning ecosystems. As states implement the framework locally, the WLFW team will be there to support them with annual tracking of progress, reporting of milestones, assistance in spatial targeting, and ongoing science–based assessments of conservation outcomes.



Learn more about this work and how to get involved at https://wlfw.rangelands.app

Acknowledgements

We thank NRCS leadership, staff and partners for locally–led implementation of conservation actions that benefit ranching and wildlife. The NRCS Conservation Effects Assessment Project was an early adopter that continues to fund outcome–based assessments that inform the efficacy and benefits of Working Lands for Wildlife. Numerous scientific colleagues and universities have been integral over the years to the success of the science support presented here. Lastly, we thank the western landowners and producers for voluntarily implementing conservation on their private working rangelands.

Photo: Jeremy Roberts/Conservation Media


Photo: Jeremy Roberts/Conservation Media


Photo: Jeremy Roberts/Conservation Media


Photo: Ken Miracle


Photo: Ken Miracle


Photo: Jeremy Roberts/Conservation Media