Sagebrush Conservation Strategy, Part II: Strategies for Sagebrush Conservation

Prepared by the Western Association of Fish and Wildlife Agencies in cooperation with the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey.

Acknowledgements

We thank the USFWS, Region 6, and the BLM for their support for this project. Both volumes of the Sagebrush Conservation Strategy benefited greatly from the Federal, State, Tribal, and NGO contributors to Parts I and II of the *Sagebrush Conservation Strategies* series. These efforts were additional to the day jobs of the dozens of professionals who enthusiastically contributed intellect and insights to help ensure lasting benefits to the sagebrush resource.

Preface

The Western Association of Fish and Wildlife Agencies coordinated, with USFWS and BLM financial and technical support, and USGS technical support, the development of a 2-part Sagebrush Conservation Series because of collective concern over the status of the sagebrush biome and the wildlife species that depend on it. Part I, "Sagebrush Conservation Strategy—Challenges to Sagebrush Conservation" was published in March of 2020 and is available at the following link: Sagebrush Conservation Strategy—Challenges to Sagebrush Conservation (usgs.gov). It is an overview and assessment of the challenges facing land managers and landowners in conserving sagebrush ecosystems. It summarized the importance of the biome to people and wildlife, described the nature and extent of the numerous threats to the biome, and reviewed other sagebrush conservation challenges such as restoration of sagebrush plant communities, communication, and monitoring and adaptive management.
Part II, "Sagebrush Conservation Strategy—Strategies for Sagebrush Conservation", this volume, describes a strategic approach to sagebrush conservation and strategies to address individual threats to sagebrush. This strategic approach uses the Sagebrush Conservation Design (SCD; Doherty, et.al., 2022) and its ecological integrity metric to inform a "Defend the Core, Grow the Core" prioritization framework and is divided into the following three sections

Section I - Describes components of an overall framework for sagebrush conservation. With individual chapters that provide a manager's guide to inform landscapes conservation prioritization, approaches to increasing capacity across scales, monitoring and adaptive management constructs, and alternative approaches to develop partnerships and coordinate conservation actions at various scales.

Section II - Contains chapters that describe strategies and actions to address individual threats or to restore degraded sagebrush communities. Each includes a brief introductory narrative establishing the rationale and contextual basis for the strategic themes.

Section III - Highlights 15 case studies that were selected for possible best management practices and provides focused examples of successful collaborative conservation programs from across the West.

Suggested Citation:

Remington, T.E., Doherty, K.E., Deibert, P.A., and Prentice, K.L., 2024. Sagebrush Conservation Strategy, Part II: Strategies for Sagebrush Conservation. Western Association of Fish and Wildlife Agencies, Boise, Idaho. 168pp.

Contributors

Hannah E. Anderson, Wildlife Diversity Division Manager, Washington Department of Fish and Wildlife, Olympia, WA

Marisa Anderson, Ecologist, U.S. Department of Agriculture, Forest Service, Ogden, UT

Patrick J. Anderson, Ecologist, USGS-Wyoming Landscape Conservation Initiative Coordination, U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO

Cara V. Applestein, Ecologist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

Trevor T. Balzer, Habitat Coordinator, Colorado Parks and Wildlife, Grand Junction, CO

Geoffrey Bedrosian, Wildlife Biologist, U.S. Fish and Wildlife Service, Denver, CO

Patrick Bixler, Assistant Professor**,** LBJ School of Public Affairs, University of Texas, Austin, TX

Myra Black, Rangeland Program Manager, U.S. Department of Agriculture, Forest Service, Washington, DC

John B. Bradford, Research Ecologist, U.S. Geological Survey, Southwest Biological Science Center, Flagstaff, AZ

Brett Brownscombe, Special Projects Director, Wild Salmon Center, Portland, Oregon, formerly, Senior Project Manager, Oregon Consensus, National Policy Consensus Center, Portland State University, Portland, OR

Matthew Cahill, Sagebrush Sea Program Director, The Nature Conservancy, Bend, OR

Charlie D. Clements, Rangeland Management Specialist, Great Basin Rangelands Research Unit, U.S. Department of Agriculture, Agricultural Research Service, Reno, NV

Peter S. Coates, Wildlife Biologist, U.S. Geological Survey, Western Ecological Research Center, Dixon, CA

Duane Coombs, Managing Partner, Cabal Cattle Company, LLC, Battle Mountain, NV

Michelle Cox, Invasive Species Coordinator, Region 1, U.S. Department of Agriculture, Forest Service, Missoula, MT

Megan K. Creutzburg, Research Associate, Institute for Natural Resources, Oregon State University, Portland, OR

Michele R. Crist, Landscape Ecologist, U.S. Department of the Interior, Bureau of Land Management, National Interagency Fire Center, Boise, ID

Jacqueline B. Cupples, Wildlife Biologist, U.S. Fish and Wildlife Service, La Grande, OR

Bill Davidson, Ecologist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

Dawn M. Davis, formerly Sagebrush Ecosystem Coordinator, U.S. Fish and Wildlife Service, Bend, Oregon, currently, Greater Sage-Grouse Conservation Coordinator, Cheyenne, WY

Lee Davis, Wildlife Staff Specialist, Nevada Department of Wildlife, Reno, Nevada; currently The Nature Conservancy, Reno, NV

Nicole DeCrappeo, Director, U.S. Geological Survey, Northwest Climate Adaptation Science Center, Corvallis, OR

Patricia A. Deibert, National Sage-grouse Conservation Coordinator, U.S. Department of the Interior, Bureau of Land Management, Cheyenne, WY

Jonathan B. Dinkins, Assistant Professor, Department of Animal and Rangeland Science, Oregon State University, Corvallis, OR

Rita D. Dixon, State Wildlife Action Plan Coordinator, Idaho Department of Fish and Game, Boise, ID

Kevin Doherty, Senior Scientist, U.S. Fish and Wildlife Service, Denver, CO

Ali Duvall, Director of Strategic Partnership, Intermountain West Joint Venture, Missoula, Montana, currently, Eco Alliance for Change, LLC, Missoula, MT

Cristina Eisenberg, Courtesy Faculty, Oregon State University, MT

Rebecca Epanchin-Niell, Fellow, Resources for the Future, Washington, D.C.

Shawn P. Espinosa, Upland Game Staff Specialist, Nevada Department of Wildlife, Reno, NV

Maureen Essen, Social Science Analyst, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Missoula, MT

Sean P. Finn, Science Coordinator, U.S. Fish and Wildlife Service, Boise, ID

Slade Franklin, Wyoming Weed and Pest Coordinator, Wyoming Department of Agriculture, Cheyenne, WY

Mark T. Freese, Habitat Division Administrator, Nevada Department of Wildlife, Reno, NV

Lindy Garner, Sagebrush Ecosystem Team Invasive Species Coordinator, U.S. Fish and Wildlife Service, Mountain-Prairie Region, Denver, CO

Matthew J. Germino, Supervisory Research Ecologist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

Dana K. Goodson, Senior Program Manager, John S. McCain III National Center for Environmental Conflict Resolution, Morris K. Udall and Stewart L. Udall Foundation, Washington, D.C.

Steven E. Hanser, Sagebrush Ecosystem Specialist, U.S. Geological Survey, Ecosystems Mission Area, Reston, VA

Stuart P. Hardegree, Plant Physiologist, Northwest Research Center, U.S. Department of Agriculture, Agricultural Research Service, Boise, ID

Tomer Hasson, Western States Senior Policy Advisor, The Nature Conservancy, Portland, OR

Susan Hayman, Senior Associate, Certified Professional Facilitator, Ross Strategic, Seattle, WA

Matthew J. Holloran, Ecologist, U.S. Geological Survey, Fort Collins Science Center, Fort Collins, Colorado, currently, Biologist, U.S. Department of the Interior, Bureau of Land Management, Cheyenne, WY

Jon Holst, Energy and Wildlife Senior Advisor, Theodore Roosevelt Conservation Partnership, Durango, CO

Michael R. Ielmini, National Invasive Species Program Coordinator, U.S. Department of Agriculture, Forest Service, Washington, D.C.

Stephen T. Jackson, Director, U.S. Geological Survey, Southwest Climate Adaptation Center, Tucson, AZ

Vincent S. Jansen, Spatial Analyst, Washington Department of Wildlife, Olympia, WA

Michelle I. Jeffries, Ecologist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

Shawn Johnson, Managing Director, Center for Natural Resources & Environmental Policy, University of Montana, Missoula, MT

Brad F. Jost, Wildlife Biologist, U.S. Department of the Interior, Bureau of Land Management, Headquarters, Boise, ID

Emily J. Kachergis, Terrestrial Assessment, Inventory, and Monitoring Lead, U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO

Matthew C. Kales, Sagebrush Ecosystem Coordinator, U.S. Fish and Wildlife Service, Denver, CO

Mona Khalil, Leader, Energy and Wildlife Research Program, Ecosystems Mission Area, U.S. Geological Survey, Reston, VA

Melanie Knapp, Project Manager, Training Program Manager, John S. McCain III National Center for Environmental Conflict Resolution, Morris K. Udall and Stewart L. Udall Foundation, Tucson, AZ

Alexander V. Kumar, Biologist, U.S. Department of the Interior, U.S. Fish and Wildlife Service, Fort Collins, CO

Brynne Lazarus, Botanist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

Caitlin E. Littlefield, Lead Scientist, Conservation Science Partners, Truckee, CA

Daniel Manier, Ecologist, U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO

Mary E. Manning, Regional Vegetation Ecologist, U.S. Department of Agriculture, Forest Service, Missoula, MT

Kenneth E. Mayer, Wildlife Ecologist, Western Association of Fish and Wildlife Agencies, Reno, NV

Megan M. Mclachlan, Wildlife Biologist, U.S. Department of the Interior, Bureau of Land Management, National Operations Center, Denver, CO

Heather H. McPherron, Wyoming Sagebrush Ecosystem Conservation Coordinator, U.S. Fish and Wildlife Service, Cheyenne, WY

James R. Meldrum, Research Economist, U.S. Geological Survey, Fort Collins Science Center, Fort Collins, CO

Terry A. Messmer, Director (retired), Jack H. Berryman Institute, Utah State University, Logan, UT

Brian W. Miller, Research Ecologist, U.S. Geological Survey, North Central Climate Science Center, Boulder, CO

Adrian P. Monroe, Research Scientist, Natural Resource Ecology Laboratory and Department of Ecosystem Science and Sustainability, Colorado State University, CO

Tina Mozelewski, Lead Scientist, Conservation Science Partners, Truckee, CA

Monique Mullenaux, Program Associate, Training Program Coordinator, John S. McCain III National Center for Environmental Conflict Resolution, Morris K. Udall and Stewart L. Udall Foundation, Tucson, AZ

Aleta M. Nafus, Terrestrial AIM Lead, Ecologist, U.S. Department of the Interior, Bureau of Land Management, Denver, CO

Patti J. Novak-Echenique, Rangeland Management Specialist, U.S. Department of the Interior, Bureau of Land Management, Reno, NV

Andrew C. Olsen, Science to Implementation Coordinator, Intermountain West Joint Venture, Missoula, MT

David C. Pavlacky, Biometrician, Bird Conservancy of the Rockies, Fort Collins, CO

David S. Pilliod, Supervisory Research Ecologist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

Holly R. Prendeville, Coordinator, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, OR

Karen L. Prentice, Scientific Integrity Officer and Landscapes Initiative Coordinator, Bureau of Land Management, Lakewood, CO

Brian G. Prochazka, Wildlife Biologist, U.S. Geological Survey, Western Ecological Research Center, Dixon, CA

Thomas E. Remington, Sagebrush Science Initiative Coordinator, Western Association of Fish and Wildlife Agencies, Fort Collins, CO

Katherine M. Renwick, Natural Resources Science Specialist, U.S. Department of Agriculture, Forest Service, Missoula, MT

Thomas J. Rodhouse, Ecologist, U.S. Department of the Interior, National Park Service, Upper Columbia Basin Network, Inventory and Monitoring Program, Bend, OR

Brian A. Rutledge, Director, The Sagebrush Ecosystem Initiative (retired), The National Audubon Society, Livermore, CO

Charles P. Sandford, Wildlife Biologist, Conservation Partnerships, U.S. Fish and Wildlife Service, Twin Falls, ID

Sarah C. Sawyer, National Wildlife Ecologist, U.S. Forest Service, Washington, D.C.

Leslie Schreiber, formerly Sage-grouse/sagebrush Biologist, Wyoming Game and Fish Department, Cody, WY

Chris Sheridan, Restoration Program Coordinator, U.S. Department of the Interior, Bureau of Land Management, Spokane District, Eugene, OR

Douglas J. Shinneman, Supervisory Research Fire Ecologist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

William D. Sparklin, Spatial Ecologist, U.S. Fish and Wildlife Service, Great Falls, MT

San J. Stiver, Sagebrush Coordinator, Western Association of Fish and Wildlife Agencies, Prescott, AZ

Daniel D. Summers, Habitat Restoration Coordinator, Utah Division of Wildlife Resources, Ephraim, UT

Leona K. Svancara, Spatial Ecologist, Idaho Department of Fish and Game, Boise, ID

David L. Tart, Regional Vegetation Ecologist (retired), U.S. Department of Agriculture, Forest Service, Ogden, UT

Daniel R. Tekiela, Assistant Professor and Extension Specialist, Department of Plant Sciences, University of Wyoming, Laramie, WY

David M. Theobald, Owner, Conservation Planning Technologies, Fort Collins, CO

Tyler Thompson, Watershed Program Director, Utah Department of Natural Resources, Salt Lake City, UT

John C. Tull, Nevada Science Coordinator, Science Applications Program, Pacific Southwest Region, U.S. Fish & Wildlife Service, Reno, NV

Alexandra K. Urza, Research Ecologist, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Maintaining Resilient Dryland Ecosystems Science Program, Reno, NV

Justin L. Welty, Ecologist, U.S. Geological Survey, Forest and Rangeland Ecosystem Science Center, Boise, ID

Jana Heisler-White, formerly Senior Scientist**,** Trihydro Corporation, Lander, WY

Lief A. Wiechman, Sagebrush Ecosystem Specialist, U.S. Geological Survey, Ecosystems Mission Areas, Fort Collins, CO

Catherine S. Wightman, Coordinator, Northern Great Plains Joint Venture, Clancy, MT

Amanda Withroder, Biologist, Habitat Protection Program, Wyoming Game and Fish Department, Cheyenne, WY

Zack Wurtzebach, Corridors and Crossings Program Director, Center for Large Landscape Conservation, Bozeman, MT

Katherine A. Zeller, Research Biologist, USDA Forest Service, Rocky Mountain Research Station, Aldo Leopold Wilderness Research Institute, Missoula, MT

Executive Summary

The sagebrush biome has been heavily impacted by numerous stressors, most significantly invasive annual grasses, fire, conifer expansion, and human modification. The sagebrush ecological integrity metric developed for the Sagebrush Conservation Design (SCD) allowed for a quantification of the status and trends in the amount and relative quality of sagebrush rangelands and confirmed significant concerns regarding the status of the Biome. Only 13.6% of mapped rangelands were classified as "core", having ecologically appropriate levels of sagebrush, perennial grass, and forb cover in the absence of invasive annual grass or conifer cover or human disturbance (Fig. 2, from Doherty, et.al., 2022). Over half of rangelands were classified as having very low levels of sagebrush and perennial grass cover and/or high levels of invasive annual grass, conifer, or human disturbance. Since 2001, an alarming trend has emerged with over 20 million acres of sagebrush having transitioned to a degraded status and are no longer classified as sagebrush core. To combat this loss of intact sagebrush communities, an estimated 1.3 million acres of additional annual future conservation efforts are needed to prevent loss and degradation or restore impacted sagebrush communities. The extensive scale of conservation actions needed will require additional funding and capacity, prioritizing conservation investment in places we can succeed, and accountability among collaborators to ensure investments are effective and lasting.

The SCD was developed as a biome-wide framework that can tie together strategies to address individual threats and greatly increase the effectiveness of prescribed conservation efforts. This approach supports a **"defend the core, grow the core"** paradigm by identifying core areas of intact sagebrush that retain high ecological integrity and growth opportunity areas that have potential for restoration to core status. The sagebrush ecological integrity metric and supporting threat layers can facilitate conversations among stakeholders that can lead to development of a shared vision for sagebrush persistence in the future. Sagebrush Core and Growth Opportunity Areas identified by the SCD assists planners in identifying priority areas for conservation emphasis, while associated threat layers suggest treatments or other actions to defend or grow Core Areas.

Fiscal and human capacity for sagebrush conservation has increased significantly, with over 1.5 million acres of protection activities and 10.7 million acres of restoration treatments between 2010 and 2019. Given continued declines in core sagebrush areas and ecological integrity, it is apparent that stabilizing current losses of sagebrush will require a substantial increase in funding and on-the-ground capacity to treat invasive annual grass and conifer expansion; prevent, detect, and rapidly suppress fires; and restore burned and otherwise degraded areas. Support for increased fiscal and human capacity will likely require substantial communication efforts to increase understanding and appreciation for the economic, social, and ecological benefits of the sagebrush ecosystem.

Sagebrush conservation is an incredibly complex undertaking given the scale of the biome, diverse landownerships, and numerous ecological and anthropogenic threats to it. Interactions among these threats and the fact that authorities and responsibilities for addressing these threats are scattered across federal, state, county, and tribal governments and private landowners. Addressing complex rangeland problems will require the formation of partnerships and networks of partnerships (comprised of those with authority, responsibility, and knowledge over land or threats) and an adaptive management process that "learns by doing". Potential collaborative conservation partnerships are explored, and three potential models to accomplish this are presented including considerations for local, state, regional and/or partner led efforts.

Strategies to address the primary threats to sagebrush ecological integrity and defend core sagebrush areas and grow sagebrush core areas are presented. The bulk of losses in ecological integrity are attributable to expansion of invasive annual grasses and conifers and the fires they facilitate. These ecosystem transitions are not amendable to regulatory control. Management actions will be required, at scale, to effectively address these ecological transitions from sagebrush shrubland to annual grassland or woodlot states. Defending Core Areas from invasion and controlling invasive grasses within Growth Opportunity Areas while infestations are small and not well-established will be critical to future success. Prevention, early detection, and rapid suppression of fire in fire-prone and susceptible sagebrush will reduce suppression and post-fire restoration costs. Many strategies address the need for a paradigm shift regarding sagebrush fire -- away from escalating suppression resources as fire size increases and towards prevention, early detection, and rapid suppression of fires. Conifer expansion is also a significant threat with 1.2 million acres of Core Sagebrush Areas and 9.5 million acres of Growth Opportunity Areas with moderate to high levels of conifer cover. Addressing conifer expansion may be a reasonable focal point because Phase I treatments are relatively simple and effective. They are expanding into sagebrush and grasslands, but management of this encroachment is complicated by imperiled woodland-associated species, like pinyon jay. For this reason, a strategy is presented for convening a task force of plant ecologists and wildlife experts to evaluate the status and trends in habitat quality within pinyon-juniper woodlands and make recommendations to land managers.

Restoration of Growth Opportunity, or in some cases, Other Rangeland Areas impacted by fire, invasive annual grasses, other invasive plants, wild horses, prolonged drought, human modifications, or other causes is both an enormous challenge and opportunity. Restoration tools and techniques are improving, but overcoming historically low success rates in these arid landscapes will require improving our “skill” in addressing the impacts of climate/weather, livestock grazing, invasions, and technological shortcomings on restoration success. Strategies and actions are proposed to do this, as are recommendations to increase native seed sources, restoration capacity, and policy changes to enhance flexibility in restoration efforts.

Human modifications to sagebrush landscapes are not causing loss of ecological integrity at biome scales to the degree that invasive annual grasses, fire, and conifer expansion are, but industrial scale activities such as mining and renewable and fossil-fuel based energy development and supporting infrastructure have large impacts at local scales that are additive to losses of ecological integrity from other causes. Given that only 13% of sagebrush is currently classified as having core ecological integrity status and this amount is declining for reasons we have little control over, it is important to prevent loss through anthropogenic causes we do have control over. Being pro-active provides opportunities for local communities and industries to conserve wildlife, sagebrush habitats, and associated ecosystem service while minimizing the potential for future regulatory restrictions.

Collectively, the approaches and strategies in this volume can be used as a resource to focus strategic planning and information sharing for sagebrush conservation. It is ambitious in its desire to provide a collaborative, all-hands, all-lands approach to meet common objectives for the biome and bring forward a suite of management actions to address threats on common priority landscapes. The case studies described in the appendices are living examples of how collaborative conservation can be achieved, be it at the scale of the biome, state, or locally led conservation. They provide substantive examples of successes and challenges that serve as applied examples of how success can be found through the strategies contemplated throughout the document. As a community of land and wildlife managers, we hope these ideas serve to organize at local, state, and biome-wide scales and develop disciplined strategies that elevate our efforts beyond the experiences insight of what has already been done.

Table of Contents

Acknowledgements 2
Preface 2
Suggested Citation: 2
Contributors 3
Executive Summary 6
Table of Contents 8
Section I. Strategic Approaches for Implementing Sagebrush Conservation Design and Governance 9
Chapter A. A Guide to Using the Sagebrush Conservation Design as a Framework to Defend and Grow Core Sagebrush Landscapes 10
Chapter B. Increasing Capacity for Sagebrush Conservation 35
Chapter C. Adaptive Management and Monitoring 51
Chapter D. Sagebrush Partnerships 58
Section II. Strategies to Address Threats or Restore Sagebrush Communities 76
Introduction to Threat/Conservation Topic Narratives and Tables 77
Chapter E. Overarching Strategies 77
Chapter F. Strategies for Restoration of Sagebrush Plant Communities 82
Chapter G. Strategies for Addressing Invasive Plants 86
Chapter H. Strategies for Managing Altered Fire Regimes 90
Chapter I. Strategies for Addressing Conifer Expansion 97
Chapter J. Strategies for Addressing Mining and Energy Development in the Sagebrush Ecosystem: Increasing the Effectiveness and Efficiency of Implementing the Mitigation Hierarchy 100
Chapter K. Strategies to Improve Management of Grazing 108
Chapter L. Strategies to Address Land Use Conflicts 113
Chapter M. Strategies to Adapt to a Changing Climate 115
Section III. Case Studies of Successful Collaborative Conservation 122
Case Study 1- Southeast Conservation Adaptation Strategy 122
Case Study 2 - Utah's Watershed Restoration Initiative 124
Case Study 3 - Oregon Watershed Enhancement Board (OWEB) 127
Case Study 4 - Oregon SageCon Partnership 128
Case Study 5 - Voluntary Conservation Through Candidate Conservation Agreements with Assurances in Oregon 130
Case Study 6 - Wyoming Sage-grouse Implementation Team 133
Case Study 7 - Douglas Core Area Restoration Team (DCART) 137
Case Study 8 - Wyoming Landscape Conservation Initiative (WLCI) 139
Case Study 9 - The Idaho Cheatgrass Challenge 142
Case Study 10 - Cooperative Weed Management Areas 147
Case Study 11 - Colorado Firefighting Air Corps 151
Case Study 12 - Oregon (and Idaho) Rangeland Fire Protection Associations 155
Case Study 13 - The Harney County Wildfire Collaborative 159
Case Study 14 - Ranchers Stewardship Alliance 160
Case Study 15 - The Wet Meadow Restoration and Resiliency Building Project 163

Section I. Strategic Approaches for Implementing Sagebrush Conservation Design and Governance

Chapter A. A Guide to Using the Sagebrush Conservation Design as a Framework to Defend and Grow Core Sagebrush Landscapes

By Thomas E. Remington,[1] Megan K. Creutzburg,[2] Lee Davis,[3] Kevin Doherty,[4] Lindy Garner,[4] Vincent S. Jansen,[5] Brad F. Jost,[6] Andrew Olsen,[7] Charles P. Sandford,[4] Sarah C. Sawyer,[8] Daniel D. Summers,[9] Lief A. Wiechman,[10]

[1] Western Association of Fish and Wildlife Agencies
[2] Oregon State University
[3] Nevada Department of Wildlife
[4] U.S. Fish and Wildlife Service, U.S. Department of the Interior
[5] Washington Department of Fish and Wildlife
[6] Bureau of Land Management, U.S. Department of the Interior
[7] Intermountain West Joint Venture
[8] U.S. Forest Service, U.S. Department of Agriculture
[9] Utah Division of Wildlife Resources
[10] U.S. Geological Survey, U.S. Department of the Interior

Introduction

The Sagebrush Conservation Design (SCD) framework (Doherty, et.al., 2022) used remote sensing products to develop spatially explicit maps of current and past trends in sagebrush rangeland condition and landscape threats (maps accessible at: Sagebrush Resources | Grassland & Sagebrush Conservation Portal (arcgis.com)). The SCD defines core sagebrush areas (CSAs), growth opportunity areas (GOAs) and other rangeland areas (ORAs) (see Fig. A1) that can inform a "Defend and Grow the Core" strategic approach to sagebrush conservation that has been successfully employed to address cheatgrass invasions in Idaho and Wyoming.

This chapter is intended to provide federal, state, local, and Tribal managers and others a guide for using the SCD in strategic conservation planning and implementation. It identifies factors managers and others should consider when using the SCD in combination with local knowledge and other datasets at multiple scales. Information on how the SCD categorizes sagebrush ecological integrity and on the Defend and Grow the Core strategic approach is presented below, but **readers will benefit from reading the paper that described the SCD framework**. Those utilizing the SCD and the steps in this guide will be equipped to:

- Understand and align with, or adapt, the SCD for their management area.
- Prioritize areas for management actions to reduce threats of invasive annual grasses, conifer encroachment, and/or human modification.
- Apply the tool for decision-making processes related to partitioning of budgets and leveraging funding in common priority areas for conservation.
- Use case studies as examples of how to use local and state information and datasets
- Grow core sagebrush.

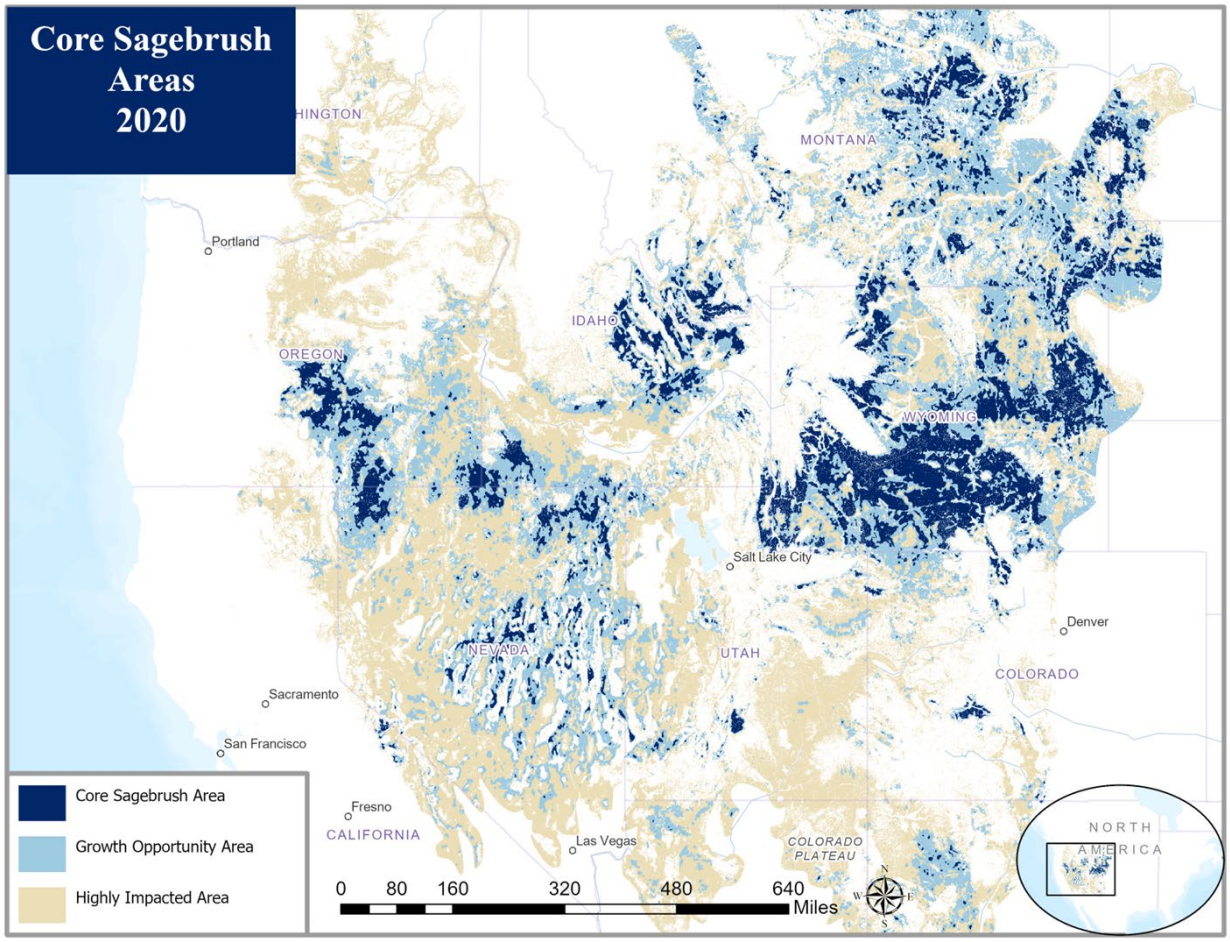


Figure A1. Core, Growth, and Other Rangeland Areas in the sagebrush biome in 2020 from the Sagebrush Conservation Design.

The Critical Need for Accelerated Strategic Conservation

It is imperative that we strategically increase the pace and effectiveness of sagebrush conservation.

Since 2001, over 20 million acres of sagebrush have been lost to invasive annual grasses, conifer encroachment, human modification, and other threats. Even with increased conservation efforts for greater sage-grouse, these losses continue at an average rate of 1.3 million acres per year. To retain human benefits and maintain populations of sagebrush dependent and associated species such as sage-grouse, pygmy rabbits, and mule deer, those with the ability and/or responsibility to impact sagebrush conservation efforts in their respective areas must strategically identify where conservation and restoration are both needed and likely to be most effective, and then increase the pace, scale, and effectiveness of sagebrush conservation management actions.

Sagebrush Conservation Design

The SCD categorized areas based on Sagebrush Ecological Integrity (SEI), defined by the relative amounts of sagebrush and perennial grass cover (positive attributes) versus cover of invasive annual grasses, conifer, or amount of human disturbance (threats). Landscapes were aggregated into three categories based on SEI: **core sagebrush areas** (CSAs) that retain high ecological integrity and function with limited to no threats, **growth opportunity areas** (GOAs) where sagebrush and native grass cover still persist and threats are low to moderate, and **other rangeland areas** (ORAs) that have little or no sagebrush and perennial grass and/or high levels of invasive annual grass, conifer or human disturbance. It should be noted that other rangeland areas are a mix of sagebrush areas degraded by invasive annual grasses or conifer, recently burned areas, sagebrush communities on steep, saline, or otherwise poor sites, and non-sagebrush native plant communities such as greasewood in alkaline areas or aspen galleries. The SEI metric and supporting threat layers facilitate conversations among stakeholders about high value sagebrush habitats and the location, extent, and type of threats in their region. These conversations can lead to development of a shared vision and business plans for sagebrush persistence in the future, and inform goals, objectives, and adaptive management in support of that vision. Figure A2 suggests steps and desired outcomes for strategic sagebrush conservation planning. The SCD can help create the vision and define the priority areas used as a basis for the strategic implementation plan.

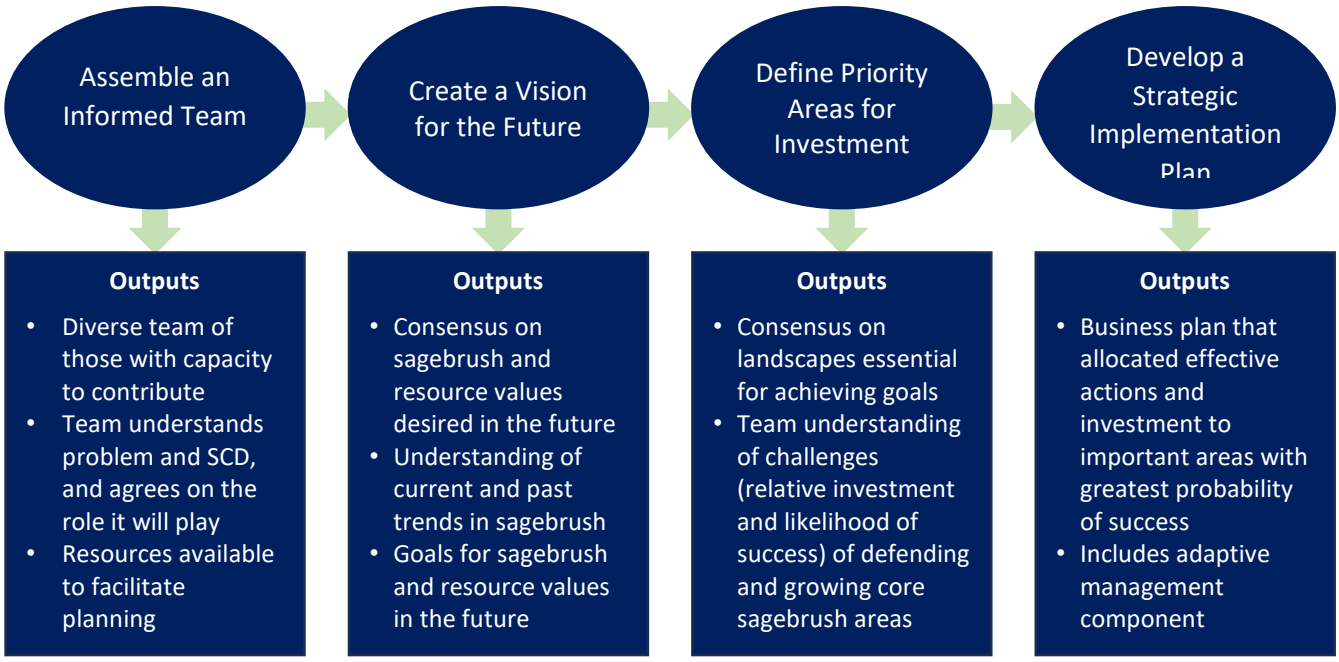


Figure A2. Use of the Sagebrush Conservation Design to support strategic sagebrush conservation planning.

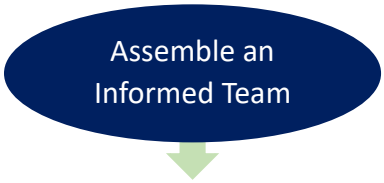
The sections that follow elaborate on how to integrate the SCD and adapt to any framework limitations in local planning efforts. The guide also presents **case studies** of existing governor-led, and stakeholder driven processes that are underway in several states, including Oregon's SageCon, Washington's Shrubsteppe Restoration & Resiliency Initiative (WSRRI), Nevada's Sagebrush Habitat Plan and Strategic Action Plan, and the Idaho Cheatgrass Challenge. These case studies illustrate different components of the ways in which the SCD has been used to inform sagebrush planning, and how other layers describing resource values and ecological condition/potential can augment the SCD to inform state and local planning efforts.

Decision Spaces and the SCD

The spatial extent that a person works largely defines how they view biome wide efforts such as the SCD. *Open Decision Spaces* refers to large extents, such as the sagebrush biome or a State, that are large enough that prioritization of areas and efforts is needed. Practitioners within *Open Decision Spaces* are more likely to use the Sagebrush Conservation Design to plan strategic allocation of effort and funds, discuss overall strategies for the biome, and decide which locations are the "best" investments. *Defined Decision Spaces* refers to a smaller spatial extent such as a county, BLM field district, or other smaller areas with defined boundaries such as a U.S. Fish & Wildlife Service National Wildlife Refuge or our U.S. National Park system. Managers and landowners within *Defined Decision Spaces* are deeply passionate about their area and think more about how they can move the needle within their work area than how their management areas align with national or biome level priorities. Strategic conservation is possible within a *Defined Decision Space*, however the lift in sagebrush ecological integrity from conservation efforts may be lower when not considering all possible areas to work within the biome. Further, within Defined Decision Spaces additional local information/datasets will almost certainly be used to refine project selection and/or implementation.

Ultimately, strategic prioritization generally occurs in *Open Decision Spaces* and conservation is delivered within local management partnerships working within *Defined Decision Spaces*. Therefore, understanding of both Open and Defined decision spaces and communication between stakeholders operating at different scales is important to developing a reasonable business plan to fight threats to the sagebrush biome. This chapter is not intended to describe individual project planning which revolves around tactical decisions at the local level.

Step 1: Assemble an Informed Team



Outputs

- Diverse team of those with capacity to contribute
  - Recruit participants
- Team understands problem and SCD, and agrees on the role it will play
  - Present, validate, and modify SCD as suggested by local data
- Resources available to facilitate planning
  - Assemble resource value and ecological data

Sagebrush landscapes provide numerous services and benefits, many of which (for example, grazing, hunting, renewable resources, energy development, mining) are important economic pillars for western communities. Conserving sagebrush landscapes will invariably necessitate both allocation of resources and tradeoffs. Strategic conservation requires informed participation by those potentially impacted by sagebrush conservation actions, as well as those that can help facilitate implementation of such actions.

Given the diverse nature of threats to the sagebrush biome this should include those with authority and responsibility over invasive weeds, fire, and land use. These roles will vary at Federal, State, and local scales. Individuals with expertise in GIS applications and access to spatially explicit data layers describing resource values important to stakeholders are critical to involve early on.

Bringing together diverse constituencies associated with sagebrush ecosystem management is as challenging as it is necessary and brings with it numerous organizational and process challenges. Chapter B of this volume describes alternative ways in which partnerships could be structured and governed, and Appendices B1-B8, B13, and B17

describe case study examples of various partnerships at multiple scales that have formed for the purposes of conservation, most of which relate to sagebrush or sage-grouse.

Part 1 of the Sagebrush Conservation Strategy (2021), and particularly for Federal agencies, the 2-part Science Framework for the Conservation and Restoration of the Sagebrush Biome (https://doi.org/10.2737/RMRS-GTR-360; https://www.fs.usda.gov/treesearch/pubs/57911) can serve as useful primers to create a planning team's shared understanding of the importance of the sagebrush biome to people and wildlife, and the nature and extent of the myriad threats to it. The SCD ecological integrity metric is intuitive—the way in which it is calculated is complex. It is imperative that the Team receive a presentation early on about the SCD, why it was developed, and how it calculates SEI so that the team both buys into the utility of the SCD and can use the information at the appropriate scale to answer questions or evaluate risk and opportunity.

An important aspect of assembling an informed team is getting validation and buy-in of the SCD and modifying it or the presentation of ecological integrity as needed. For instance, presenting SEI values as deciles bins (top 10% of SEI values, next highest 10%, etc.) may be more informative where core areas are limited than aggregating into CSAs, GOAs, and ORAs. The SCD, using remote-sensed products, performs well at the biome-scale—however, there will always be local exceptions creating the need to integrate locally-developed data. For example, the SCD masked out croplands and did not include those areas when depicting CSAs or GOAs. In most of the range this was appropriate, though problematic in places like Washington where cropland planted to grass with some sagebrush under the Conservation Reserve Program (CRP) provides an essential element of their efforts to increase CSAs. Other discrepancies have been identified at local scales, and evaluating for and resolving these is an important early step for building confidence in the SCD as a planning tool and developing optimal downscaled maps of CSAs, GOAs, and ORAs.

Resolving questions and concerns about the SCD is important to undertake before the team tries to apply it to their area of interest. Questions for the team to consider about the maps include: Do they accurately depict sagebrush vegetation and SEI for that area? How do CSAs and GSAs capture other priorities such as important habitats for sagebrush obligates and associates such as sage-grouse, mule deer winter range, pronghorn, etc.? In the case of Washington State (see the Case Study Below) the stakeholder team with a dedicated spatial analyst used the concepts of the SCD, but tuned their model by incorporating CRP into the model and modified definitions of core. Not all local groups will have a dedicated analyst, however the Washington case study is a great example of how the intent of the SCD can be preserved but the model can be tuned to local situations to better meet the goals of a large and diverse stakeholder group which will allow more buy-in to the process.

Step 2: Create a Vision for the Future (Where and to What Extent?)

Next, the team develops a vision for their area of interest relative to how they consider their sagebrush rangelands fitting within that broader vision, and/or what role their area can serve to foster sagebrush conservation and meet their resource value needs. Developing a shared vision for the specific project area with partners and stakeholders is paramount for goal setting and operationalizing management to meet those goals in a cost-effective manner. Consider, also, future projections/climate change and opportunities for cross-jurisdictional collaboration in the face of change and uncertainty.

Consider the following questions during vision development: What do you want to see when you look out at your area/region of interest? What ecosystem services do you want to retain or improve and how does sagebrush support that? How does your area fit into larger regional and/or biome-wide sagebrush conservation? How do local needs/uses for recreation, and local economic opportunities fit in? Are there valid existing rights for oil and gas development or mining that must be considered?

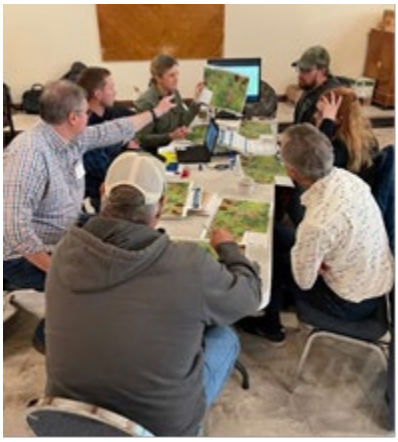
Once the team agrees to an aspirational vision, translating these into goals for the amount and relative quality of resource values desired in the future is helpful. The type of goal for sagebrush conservation is much less important than the discussions around the goal setting process. Even goals that in hindsight prove beyond available resources or ability to achieve initially can motivate conservation and lead to more tractable goals in the future.

The strategic approach utilized in this document for prioritizing landscapes for conservation emphasis and goal setting utilizes a “Defend the core, grow the core, mitigate impacts” decision making framework. This framework was first advanced by the Cheatgrass Challenge to address invasive annual grasses in Idaho and Wyoming (see Case Study 8), and was also adopted into the Western Governors Association Invasive Annual Grass Management Toolkit (FINAL_Cheatgrass_Toolkit_July_2020.pdf (westgov.org)).
The sagebrush conservation design expanded upon the original invasive annual grass construct by defining the “core” as those areas that retain high ecological integrity; robust sagebrush overstories with understories dominated by perennial grasses (and forbs) and without threshold levels of invasive annual plants, conifer expansion, or anthropogenic disturbance. These high ecological integrity areas provide disproportionate levels of ecosystem services including forage production, watershed maintenance, and wildlife habitat. Cores and growth areas or the underlying ecological integrity metric consequently can serve as proxies for ecosystem services for goal setting purposes.

Assessing trends (rate and location of loss or gain of core and growth areas) over the last two decades is critically important to setting up realistic goals and business plans to achieve those goals when stepping down the SCD to smaller areas such as a State, National Park, Wildlife Refuge, or a BLM Field office.

Given 1.3 million acres of CSAs and GOAs are lost each year within the sagebrush biome, we do not have the resources to restore all of these areas to historic baseline conditions.

Therefore, it is important to evaluate the attainability of goals given: 1) the trajectory of threats, 2) the conservation volume needed to ameliorate annual acreage losses (Defend the Core), 3) The conservation volume needed to Grow the Core to agreed upon size, 4) a general concept of effectiveness of treatments, and 5) a realistic assessment of the financial resourced needed to Defend and Grow the Core given the answers to 1-4 above. For example, a group may establish a no-net-loss of core goal for an area, but an evaluation may reveal it has lost 20,000 acres per year over the last two decades and the stakeholder group has the capacity (financial and people) to defend and restore only 12,000 acres per year. This evaluation can identify bottlenecks in capacity or inform hard choices on more realistic goals at least in the short term, and focus planning on what is needed to obtain desired resource values.



Step 3: Define Priority Areas for Investment

Define Priority Areas for

Outputs

- Consensus on landscapes essential for achieving goals
  - Use SCD, species, and other resource value maps to identify
- Team understanding of challenges (relative investment and likelihood of success) of defending and growing core sagebrush areas
  - Use SCD to evaluate past trends, cause of declines, and current threat state
  - Leverage local knowledge

The ecological integrity metric and associated core, growth, and other rangeland area designations are starting points that inform discussions and planning processes to define priority areas for investment, not end points. The SCD can be used to complement existing prioritization schemes developed for greater sage-grouse, such as Wyoming's Sage-grouse Core areas, and Bureau of Land Management- (BLM) and U.S.D.A. Forest Service (USFS) Priority Habitat Management Areas (PHMAs) for sage-grouse, etc., by providing geographic context on relative SEI and threats to those areas.

Regional or state-level application of the SCD starts by understanding how the localized area fits into larger contexts, as well as understanding sagebrush status and trends. Understanding where changes in SEI have occurred, what has caused the changes, and the conservation volume needed to Defend and Grow the core will help stakeholders to prioritize areas and ultimately work (Fig. A3).

Stakeholders will need to bring in data on other resource priorities within the area. While the current level of sagebrush ecological integrity and past trends are hugely informative, they don't provide information on critical seasonal habitats for wildlife, migration corridors, valid existing mineral rights, forage production, future climate vulnerabilities, etc. These and other layers that spatially identify valued resources must be brought into planning efforts. Ultimately, planning teams must reach a consensus on what the priority areas for sagebrush conservation investment are considering goals, inevitable tradeoffs, and importantly where threat reduction or restoration can be successful. When doing so it is important to recognize that areas within CSA, GOA, and ORA designations are not all equal. They may, and likely do, differ in their contribution to

resource value, connectivity, land use and fire history, soils, threat levels, and potential response to treatments. Consequently, additional resource value layers and local information used together will better inform management decisions.

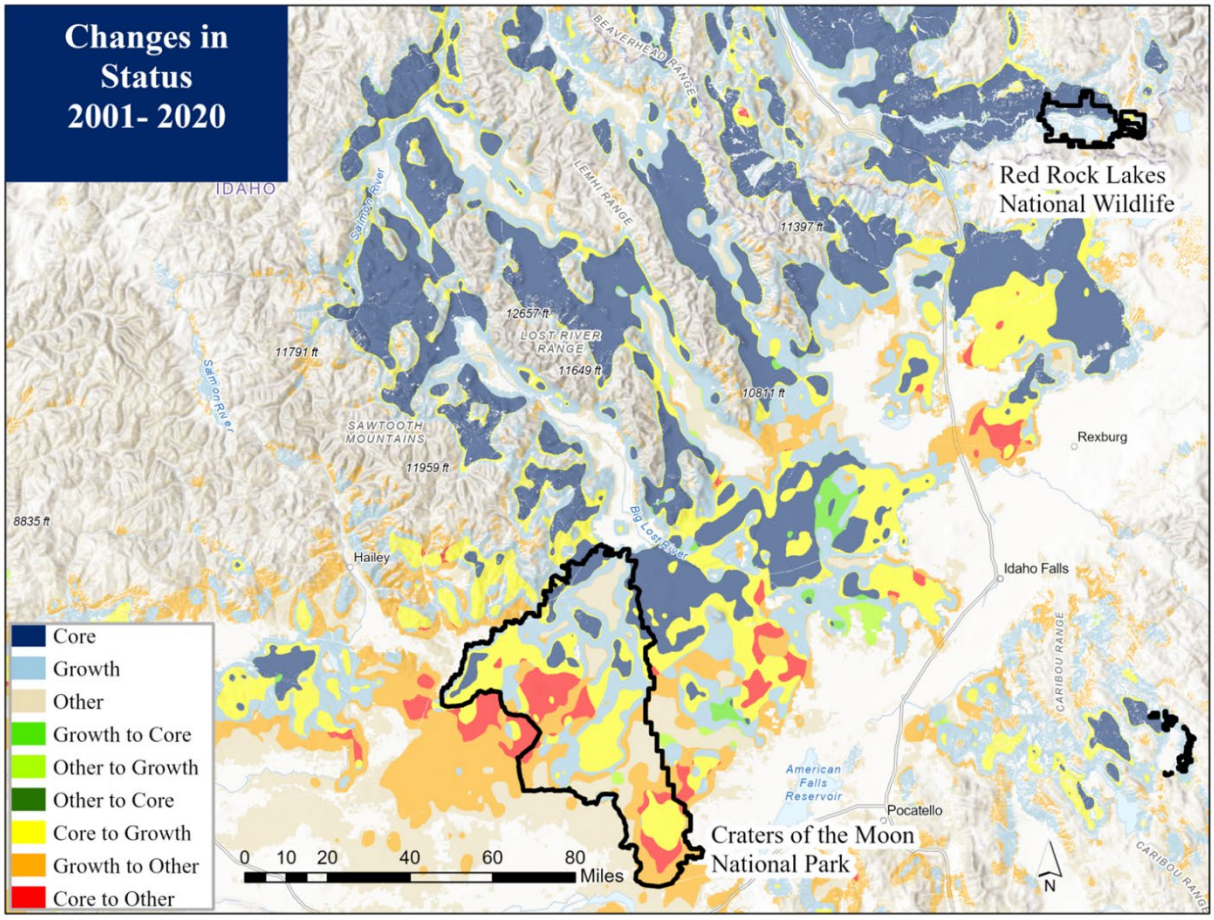
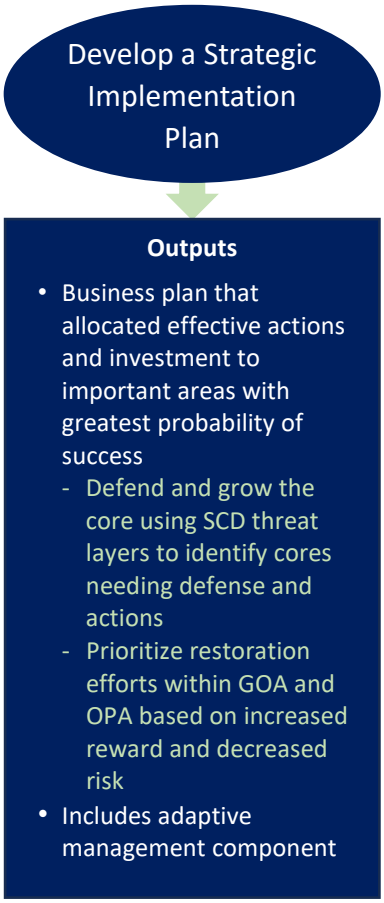


Fig. A3. Evaluating and mapping changes in core, growth, and other rangeland areas over time within areas of interest and regionally can provide context important to defining priority areas as well as indicating which areas are recovering (Growth to Core, Other to Core or Growth) and which are losing ecological integrity (Core to growth or Other, Growth to Other).

Step 4: Develop a Strategic Implementation Plan to Defend and Grow the Core

Even within areas identified as strategically important for sagebrush conservation investment, determining which areas to focus on and which threats to address first can be daunting given the number of threats, their scope and scale, and the complex integration of these threats. Defend and Grow the Core provides a useful decision-making framework to help with that prioritization process, particularly when informed by the SCD, it's underlying threat layers and other ecological context. Figure A4 summarizes key aspects of defending and growing CSAs in multiple threat landscapes and managing impacts of threats outside core and growth areas. Sections that follow expand upon these key aspects.



CSAs serve as anchor points for conservation and restoration actions. Local management in these areas will be less costly and more successful at maintaining healthy rangelands in the long run because of the favorable landscape context. Defending CSAs that still retain high ecological integrity and functionality from loss or degradation should be the highest priority across scales. Core sagebrush areas with high ecological integrity represent only 13% of the biome but are critically important to sage-grouse and other sagebrush obligates.

Defend the Core

Both past fire history (Wildland Fire Trends Tool (usgs.gov)) and probability of future fire should be evaluated. If fire risk is significant or if the core is within a region where fire return intervals have been short (<= 50 years?), then actions to prevent fire, or detect and suppress fires rapidly are paramount. When considered across the biome, fire is a large cause of loss of sagebrush cores, often fueled by expansion of invasive annual grasses or more locally conifer expansion. In excess of 1.2 million acres of sagebrush burn annually on average across the biome. New fires degrade functionality and integrity of core areas for at least decades, while recurrent fires set back recovery/restoration efforts in growth areas and facilitate essentially unrecoverable type conversion from sagebrush to annual grass states, particularly in the Great Basin. Many burned areas will require large investments in restoration efforts over a period of many years with uncertain outcomes. That, and the tremendous acreages potentially involved, suggests defense against fire should be first and foremost where fire return intervals are short, when and where fire probability is high or where irreputable damage may occur in dry sites.

Not all core areas need active defense. Determining where to focus treatments will require analyzing trends through time in ecological integrity and trends in, or potential for, threats such as invasive annual grass and/or conifer expansion within core areas and areas adjacent to core areas. The SCD Web Application described in Section 5 below can provide a map of where change has occurred, trends in CSA, GOA, and ORAs within a user defined area, and which threats are increasing through time. These trends should be considered with other important metrics such as relative resistance to invasive annual grasses and conifer encroachment and resilience to disturbances such as fire of these core areas. Relative levels and trends in invasive annual grasses and conifer should be assessed against invasion levels where control efforts become less successful, or more expensive, or both.

Defend the Core	Grow the Core	Manage Impacts
• Treat core sagebrush areas as anchor points and work outward. • Implement actions that maintain or improve SEI in sagebrush communities with an already high SEI--the most intact habitat. • Assess current and past trends in threats, vulnerability, and resource values to determine which cores need defense and what restoration treatment is needed. • Prevent, monitor for new detections and reduce threats within and adjacent to cores early and before threats are well established. • Evaluate which cores are at risk for wildland fire and identify actions to prevent, detect and suppress these quickly. • Minimize human disturbance.	• Prioritize threat-reduction management and restoration actions adjacent to or connecting core areas. • Foster native perennial plant communities for success and durability of management and restoration actions. • Evaluate and prioritize areas where success is likely, for example, GOAs or ORAs with no-to-low threats and high resistance and resilience. • Implement actions to prevent, detect and suppress fires before investing heavily in fire-prone areas. • Evaluate trends in sagebrush ecological integrity and assess threats to see if and what restoration treatment is needed. • Consider unintended consequences and tradeoffs.	• Contain extensive annual grass infestations and reduce fuel loads to minimize fire intensity and spread to core or growth areas or impacting human infrastructure. • Where the type and/or level of human disturbance is the cause of lost ecological integrity, maintain native plant communities to the extent practical and decommission when disturbance is completed. • Design fuel breaks to minimize fragmentation of cores and prevent new invasions in CSA or GOAs. • For sites where successful restoration is highly unlikely, consider directing to other vegetative states that can prevent or mitigate the invasive annual grass/fire cycle.

Figure A4. Key aspects of Defending and Growing Core Sagebrush Areas in multiple-threat landscapes

Core sagebrush areas have no-to-low levels of invasive annual grasses (or conifer) at the scale of the depicted CSA, but may have local infestations within them that should be controlled to protect the rest of the CSA. In areas which are free of these threats, monitoring and an aggressive early detection, rapid response (EDRR) to new infestations is needed. Potential approaches to monitoring within sagebrush communities are described in Chapter B.

Other Defend the Core considerations include:

- Defense efforts should prioritize prevention, and early detection of invasive annual grasses, conifer encroachment, and fire ignitions. Rapid initial response and suppression of sagebrush fires when they are small, rather than control efforts directed at large fires should be the goal.
- Treatment of invasive annual grasses, fuels reduction and fuel breaks to minimize spread should be prioritized adjacent to core sagebrush areas to prevent spread of fine fuels and fire into cores.
- Conifer cover is low within CSAs but monitoring and early detection and rapid removal of seedlings within CSAs can prevent conifer seed banks from building up. Conifer removal in early stages of invasion is also more cost effective. Conifer removal efforts may be considered in GOAs or ORAs adjacent to core areas, within common dispersal distances for conifer seeds to reduce expansion of conifers into CSAs and to mitigate risk of fire spreading into cores. Impact

of conifer removal on conifer dependent species such as pinyon jays and on potential release of invasive annual grasses should be evaluated in these areas.

- Anthropogenic disturbance is not the most impactful threat to sagebrush grasslands at biome-wide scales, but it can be locally significant and is the threat managers and landowners typically have the most control over. The SCD, supported by species distribution and other data layers, can inform locations where anthropogenic disturbances are likely to have less impact to sagebrush vegetation and important wildlife resources.

Specific strategies to address threats or change agents useful to defend and grow CSAs and reduce impacts within ORAs are presented by threat or change agent in Chapters D-L of this volume.

Grow the Core

The SCD highlights GOAs and ORAs with no-to-low level of threats and these are good first approximations for restoration investments, particularly if they are adjacent to, or can connect cores. GOAs and ORAs with no-to-low levels of threats have less than optimal sagebrush and/or perennial grass cover. Relative deficiencies, and the degree to which these areas may be recovering on their own can be assessed by looking at trends in ecological integrity and component sagebrush and perennial grass cover over time.

GOAs have higher ecological integrity than ORAs, either because they have fewer or a lower prevalence of threats, or higher sagebrush or perennial grass cover, or both. Consequently, they may be better candidates for active management and restoration in the near term. Because ORAs contain areas that have effectively permanently transitioned into annual grassland states or conifer woodlands, areas that have lost sagebrush and perennial grass to recent fire, and alkaline, or steep and rocky sites with limited potential to improve sagebrush or perennial grass cover, it is important to distinguish between them. The SCD can't make that determination, but it can assist by showing past trends in sagebrush ecological integrity (what that site was once capable of supporting), the threat context around the area, and past fire perimeters.

Chapter R of Part 1 of the Sagebrush Conservation Strategy, Restoration (Sagebrush Conservation Strategy—Challenges to Sagebrush Conservation (usgs.gov)) provides important context and information on restoration in sagebrush communities. Chapter E, this volume, Strategies for Restoration of Sagebrush Plant Communities, provides numerous specific strategies for restoration of sagebrush communities. Resistance of sagebrush stands to invasion by invasive annual grasses and resilience to disturbance (R&R) is another important ecological context to inform prioritizing treatments which is available at biome-wide scales (Frontiers | New indicators of ecological resilience and invasion resistance to support prioritization and management in the sagebrush biome, United States (frontiersin.org)). State and Transition models, or ecostate maps (Oregon Explorer Topics | oregonexplorer | Oregon State University) provide threat information and likely response to treatment at more local scales.

Other Grow the Core considerations include:

- It is important to note Utilize local info and datasets to inform growth opportunity priority areas. that while the SCD can help decision-makers identify and prioritize landscapes to defend and grow core sagebrush areas at large scales, other local information and data provide more refined ecological context to inform conservation efforts at project scales, such as species layers, connectivity data, resistance and resilience of sites (ecological condition), state and transition models, and local or traditional knowledge about plant communities in the area. Proposed

projects should be evaluated on the extent to which they potentially will defend and/or grow core areas, not just on their initial SCD status.

- Defend restoration efforts from the multiplicity of threats to sagebrush for as long as ecologically necessary (as opposed to rigid program/policy constraints). For instance, defer grazing until perennial grasses have grown to the point they can tolerate it, continue to control cheatgrass until perennial grasses are established, etc.
- Understand Potential Unintended Consequences, including:
    - Conifer reduction treatments may release invasive annual grasses, and disturbances associated with site preparation for seeding or planting may create opportunities for invasive annual grass spread or increased cover.
    - Treatments where invasive annual grasses are present should be monitored and control efforts implemented when needed.
    - Invasive annual grass management may result in weed succession for noxious weedy forbs that will require monitoring and consistent invasive species management with restoration seeding to achieve restoration success.
    - Fuel breaks may fragment core or growth opportunity areas and facilitate annual grass invasion requiring annual maintenance to prevent spread and dispersal.
    - Use emerging science and local knowledge to avoid impacts to pinyon jays when planning conifer removals.
- Siting anthropogenic disturbances in areas where management efforts are focused on growing core sagebrush areas would obviously be counterproductive in addition to creating an opportunity for invasive annual grass introduction or spread.

Manage Other Rangeland Areas to Reduce Impacts

Heavily invaded regions dominated by moderate-to-high amounts of invasive annual grasses will require much larger conservation inputs to restore and probability of success is much lower. In most cases, management in these areas should focus on mitigating impacts adjacent to CSAs or GOAs or to human infrastructure.

Strategies to reduce impacts are presented for those areas that have essentially transitioned to an annual grassland state, or have been so heavily impacted by conifer expansion, perennial invasive plants, or anthropogenic disturbance that restoration to a functional sagebrush system is highly unlikely in the foreseeable future or would come at an unacceptable opportunity cost. Strategies are designed to mitigate the most severe impacts of invasive annual grasses and conifer expansion (and resultant high intensity fires) on adjacent CSAs and GOAs and life and property rather than attempt to restore functional sagebrush ecosystems.

Other Manage Impact considerations include:

- Where invasive annual grasses dominate, primary actions relate to containment of invasive annual grasses to decrease the effects and spread of the fire/invasive annual grass cycle including asset protection, spread containment, fine fuels reduction, fuel breaks, fire suppression, and rehabilitation and maintenance of perennial grasses.
- Where anthropogenic disturbance is the driving force for inclusion in ORAs and where that disturbance is finite even over long timescales, such as coal mining or oil and gas development, reclamation of those sites through decommissioning of structures and restoration should be pursued in the appropriate time frame.

There may well be exceptional reasons to target conservation efforts at ORAs such as managing for species of conservation concern or endangered species.

These categories are intended to aid in prioritizing and focusing conservation effort by state and federal agencies at the scale of the entire biome and should not be viewed as absolute. There may well be exceptional reasons to target conservation efforts at ORAs such as managing for species of conservation concern or endangered species. Further, some ORAs do not have high levels of threats and are just not sagebrush habitats. For example, greasewood is a component of naturally occurring plant communities on alkali soils within rangeland areas mapped by the SCD.

Implementation Considerations

Conservation implementation is a complicated and complex undertaking affected by many aspects that conservation designs and ecologically based decision-making frameworks don't necessarily recognize. Land ownership and authorities and responsibilities over threats and land management are diverse. Funding sources and/or statutory spending limitations often have constraints on where and how they can be used. Further, the needs and priorities of funding partners vary. Capacity to accomplish needed conservation may be limited. It may not be possible to always start work at the highest-ranking areas immediately because of the constraints listed above. Starting work in lower priority areas can still contribute to range-wide goals if conservation projects are based on plausible business plans for those areas (see objectives).

If lack of capacity, funding or other constraints are preventing work on high priority defend and grow projects then the highest priority likely becomes to increase capacity, funding, or reduce other constraints.

It may be tempting to focus efforts on treatments that are relatively easier to implement that provide immediate gratification such as conifer removal. Efforts should build off these successes and transition to more difficult but potentially more consequential treatments such as invasive annual grass and fire prevention and control. If lack of capacity, funding or other constraints are preventing work on high priority defend and grow projects then the highest priority likely becomes to increase capacity, funding, or reduce other constraints. Constraints related to dedicated funding sources for specific program or geographic areas can be overcome with diverse partnerships where funds without constraints can fill in the gaps. Such partnerships require some level of structure to ensure projects are meeting group goals, and an ability to award pooled resources through a flexible contracting system such as that employed by the Utah Watershed Restoration Initiative.

Tracking Sagebrush Conservation Progress

Monitoring and adaptive management as a component of strategic conservation planning and implementation for the sagebrush biome is covered in Chapter C. This Section addresses specific use of the SCD Reporting Tool as a resource for tracking changes in SEI resulting from effective sagebrush conservation efforts or in their absence.

The Reporting Tool allows the user to assess spatially explicit trends in sagebrush ecological integrity as well as to visualize trends in individual threat levels (invasive annual grass, conifer encroachment, or human modification) and changes in the amount of CSA, GSA, and ORA in an area of interest over time.

It enables users to explore these trends at management-relevant scales, supporting strategic conservation targeting to defend and grow core areas. Users of the tool can draw unique polygon(s) of interest and receive a summary of information on the acreage changes in CSIs, GOAs, and ORAs, the trends over the last two decades, and which threats are likely causing the changes displayed. The tool will also produce more detailed reports within pre-populated areas such as States, Sagebrush Reporting Units (SRUs; developed for the Conservation Efforts Database), or BLM field offices from 2001 to present. Other pre-populated reporting metrics are being considered such as Sage-grouse Priority Habitat Management Areas (PHMA), by State and/or other federal administrative boundaries and state wildlife management areas.

By highlighting trends in ecological integrity, changes in core area acreage, and the percent coverage of individual threats in an area of interest, the SCD Web App helps users focus on defending core areas and determining, and tracking changes in, the primary challenges and threats to core areas. For pre-populated SRUs and other area units within the tool, users can download pdfs that present summarized data in more detail, including the acreage of an area of interest in individual threat classes, in a visually pleasing, graphically designed template that optimizes readability. Figures A5 and A6 illustrate output summary statistics for an SRU and a user defined polygon, respectively. The SCD Web Application is in final stages of development, but will be through the Conservation Efforts Database (Conservation Efforts Database).

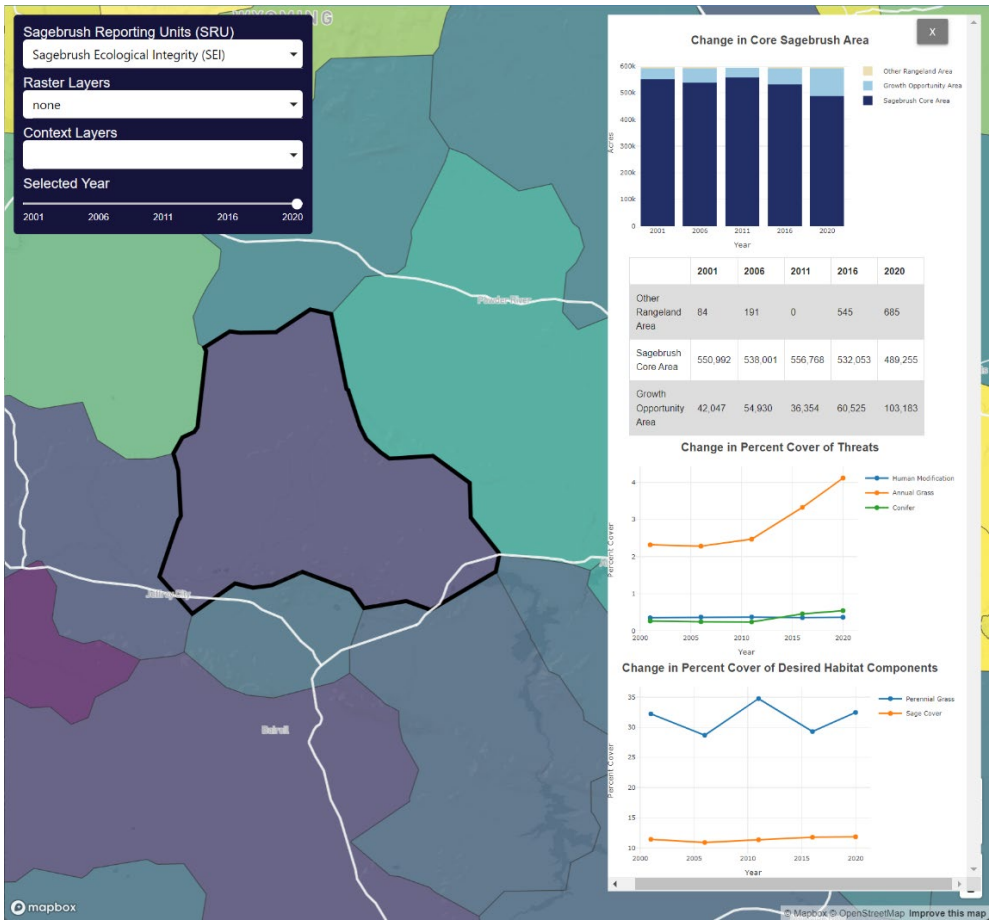
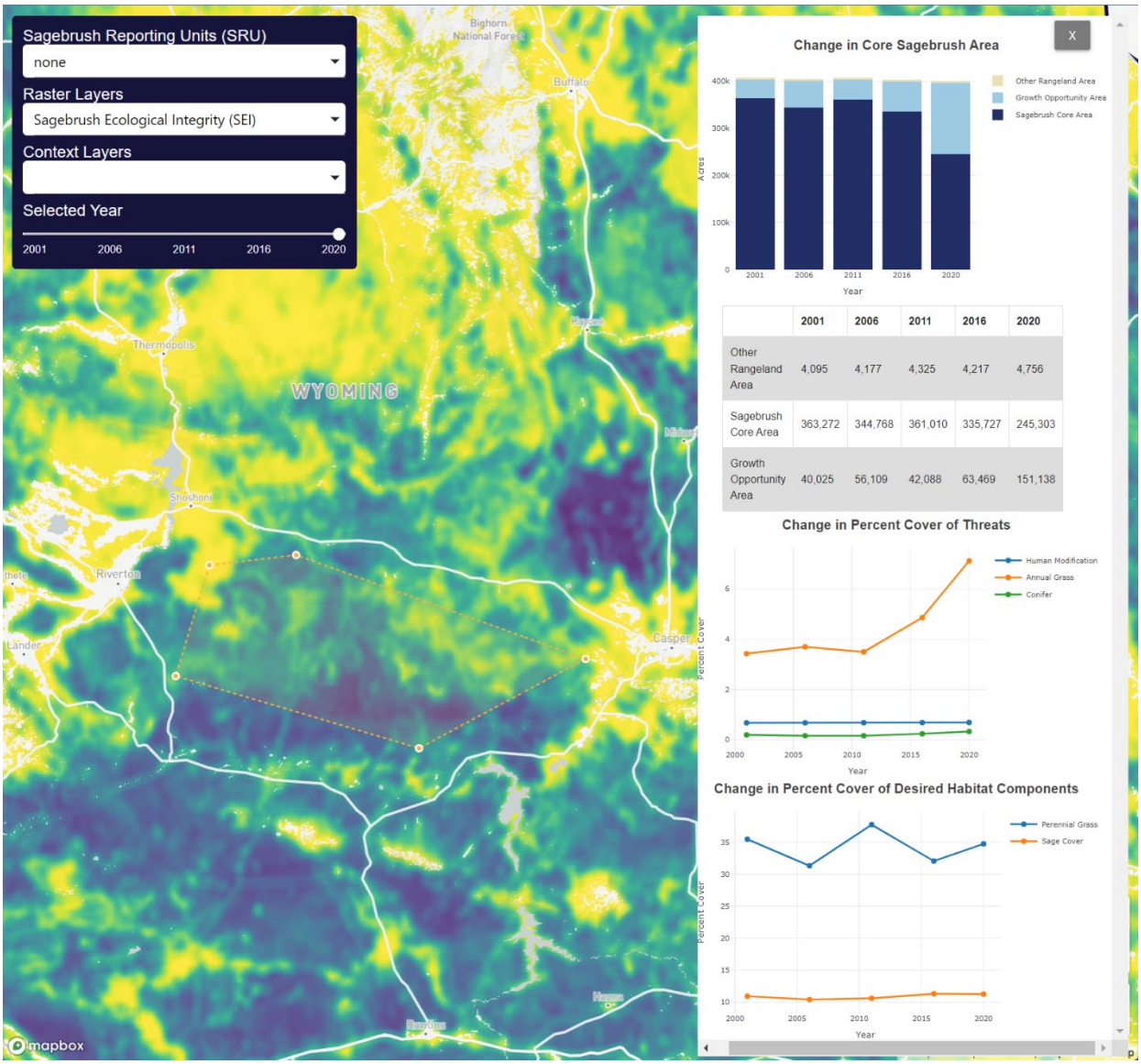


Fig. A5. Output of SCD Web Application for a SRU showing trends in ecological integrity, percent of area with no, one, two, or three threats, and percentage of core, growth opportunity, and other rangeland areas.



	2001	2006	2011	2016	2020
Other Rangeland Area	4,095	4,177	4,325	4,217	4,756
Sagebrush Core Area	363,272	344,768	361,010	335,727	245,303
Growth Opportunity Area	40,025	56,109	42,088	63,469	151,138

Fig. A6. Output of SCD Web Application for a user-defined polygon showing trends in ecological integrity, percent of area with no, one, two, or three threats, and percentage of core, growth opportunity, and other rangeland areas.

State and Local Case Studies

The following four case studies demonstrate approaches used by Nevada, Oregon, Washington, and a conservation partnership in Idaho to use the SCD and other data sets to define or refine their own priority conservation areas, and to prioritize conservation actions within larger planning processes.

Case Study: Idaho Cheatgrass Challenge

This Case Study Illustrates Step 1: Assemble an Informed Team.

- The importance of framing SCD as simple, predictable, scalable and not prescriptive
- State-level partnerships and state-wide data are critical for implementing SCD.

Background: The Idaho Cheatgrass Challenge Steering Committee (IDCC) formed in 2019, when Leadership of Idaho NRCS, FWS, BLM, Idaho Department of Fish and Game, and the Idaho Governor's Office of Species Conservation (among others) agreed that the existing model of Invasive Annual Grass (IAG) management was not strategic. The model up until 2019 was generally a shotgun approach – all agencies targeted IAG invasions, but at different scales, and with little coordination, resulting in a patchwork of projects at risk for reinvasion. The concept of "Core Areas" where IAGs were not present or only a minor component requiring low-cost implementation with high success intervention was proposed by NRCS to facilitate coordinated, cross-boundary investment. This "Core Area" concept was widely accepted by the IDCC, thanks to relatable logic, straightforward terminology, and easily understood and repeatable mapping. The IDCC has seen the concept of "Defending the Core" and investing in low risk, high reward projects applied to other threats, including mesic restoration, conifer encroachment, and even the broader sagebrush biome.

Application of the Sagebrush Conservation Design and lessons learned:
The Sagebrush Conservation Design (SCD) is an example of how "Core Areas" are a fluid concept and can be scaled to entire ecosystems like sagebrush steppe, or specific threats like IAGs. When the IDCC "Core Area" map is overlayed with the SCD map, there is significant alignment; so much so that it has empowered DOI agencies in Idaho to use the IDCC Core Areas map to identify priority projects, and then verify importance and secure funding with SCD validation. Other groups within Idaho have performed the same exercise of identifying singular threats (conifer encroachment) and validating with the SCD. This has allowed the IDCC and other groups to ask when there is not model alignment, what other underlying issues may be in an area that also need to be addressed. This approach of utilizing multiple decision support tools has helped Idaho partners engage in holistic rangeland restoration through common language, and directed, predictable funding.

Of course, the IDCC did not arrive at consensus of "Core Areas" or the inclusion of the SCD data without hurdles. Idaho has gone through many iterations of "the latest and greatest science", and many partners are overwhelmed when a new product is delivered. Adoption of these concepts hinged on the fact that they were simple, predictable, scalable, and not prescriptive. These attributes allowed all of the partners involved in the IDCC to deliver simple, consistent messaging to practitioners, showing state-wide adoption and support. As mentioned, the IDCC "Core Areas", and the SCD have been delivered with clear intent that they are not prescriptive, and they are intentionally simple. As such, these products are part of a larger decision-support toolbox and offer insight into IAG treatment priorities (IDCC), and

sagebrush conservation priorities (SCD). Idaho partners often utilize other information to prioritize treatments, including but not limited to; big game habitat or connectivity areas, proximity to other landscape scale improvement projects, proximity to high value sensitive species (greater sage-grouse) habitat, time/scale of recent disturbance (for instance, wildfire rehabilitation), and local office or biologist priorities. When these considerations are taken together, we can be confident that our resources are directed to the most impactful projects in a strategic way.

Many of the successes of the IDCC can be traced directly to practitioner buy-in. The IDCC is co-led by management level state and federal agency employees, who are often not the ones ultimately implementing projects. Therefore, it was important early on that the Team's messaging was delivered by trusted partners. With respect to western culture, state level partners are often the most trusted, as they are viewed as most tied to resources. Without state adoption of the concepts and leadership with delivery, it is likely that IDCC "Core Areas" and the SCD would have experienced slower and reduced adoption rates. Additionally, State partners bring a substantial amount of information to the table; as mentioned above, the IDCC utilizes other screening data such as big game habitat and sensitive species breeding areas – this data is generated, managed and distributed by State agencies, and therefore would be unavailable in an all-federal approach.

Case Study: Threat-Based Strategic Conservation: A hands-on workshop to defend and grow the core at local scales in Oregon

This Case Study Illustrates Step 2: Create a Vision for the Future.

Collaborative workshops created the vision and emphasized that maps and technology are not an end point but are tools to help achieve goals and understand the "why".

Background. Partners from Oregon State University Extension, the Institute for Natural Resources, and the USDA Agricultural Research Service have developed a model for a hands-on, interactive workshop to facilitate landscape-scale, proactive planning to implement the 'Defend and Grow the Core' framework in complex local landscapes with multiple threats and values in Oregon. This responds to the need to help local stakeholders work through a process to apply these concepts at management-relevant scales, empowering managers and practitioners to conduct proactive, strategic landscape management within their area of influence. The concepts of proactive, strategic landscape-scale management behind 'Defend and Grow the Core' from the Sagebrush Conservation Design are scalable from the biome level to local landscapes (Fig. A7).

Application of the Sagebrush Conservation Design and lessons learned:
Threat-Based Strategic Conservation builds upon a solid foundation of existing science, including the SCD framework, Threat-Based Land Management, lessons learned from locally-led collaboration in Oregon such as the Harney County Wildfire Collaborative, and other general principles for strategic landscape management planning. The workshop format consists of a curriculum centering core principles for strategic conservation, the Defend and Grow the Core framework, and threat-based land management, followed by a hands-on workshop discussing how to apply these concepts in a real landscape. The core principles emphasize elements like centering the 'why' of management to frame

what will be done on the ground and help prioritize actions, and identifying the relevant scale for strategic conservation planning based on both the ecological and social stakeholder dynamics.

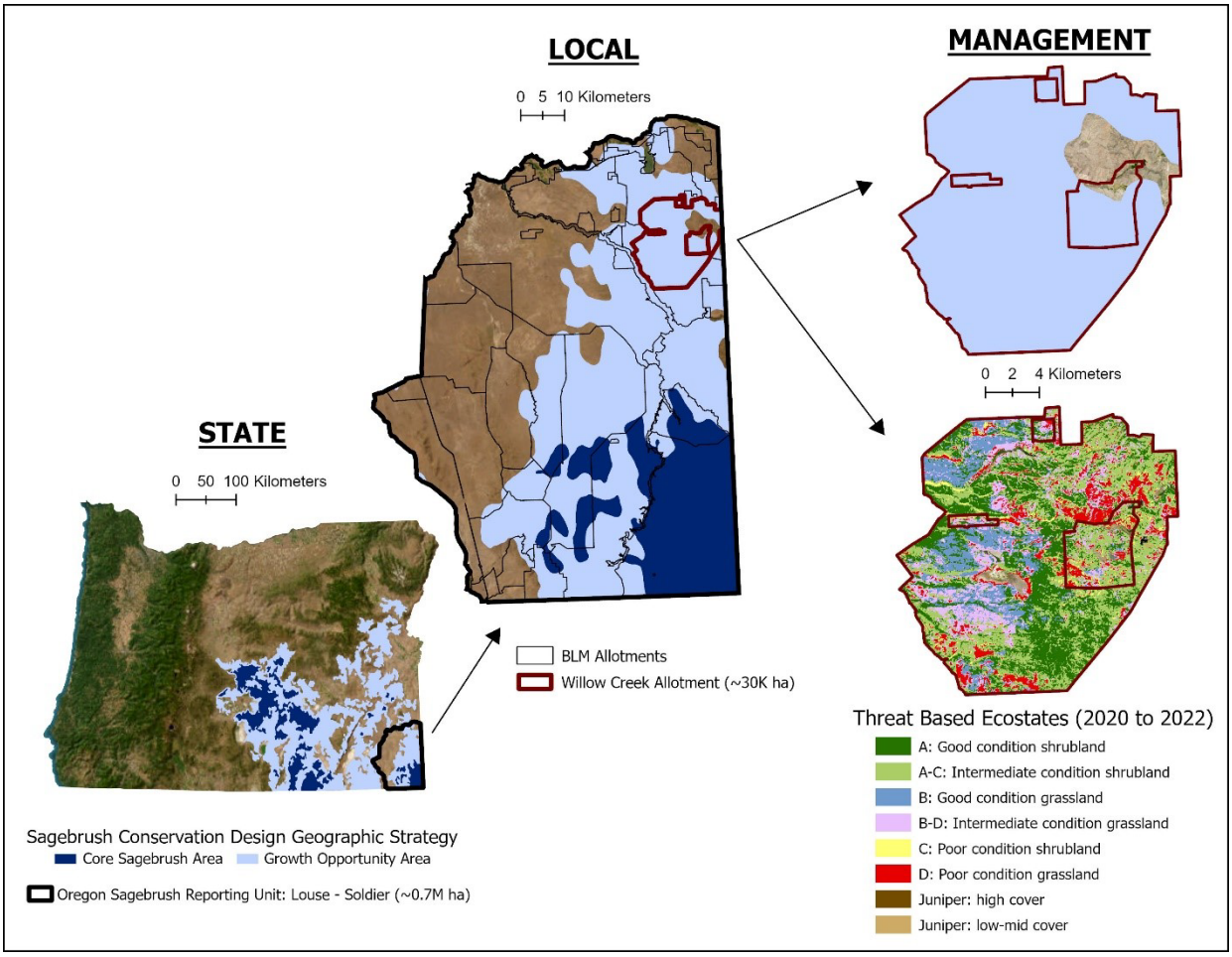


Fig. A7. The strategic, proactive concepts behind 'Defend and Grow the Core' from the SCD can be applied at multiple scales. Growth opportunity areas near core in SE Oregon are evaluated at management-relevant scales through threat-based ecostate maps to help identify more localized 'cores' mapped as state A and adjacent threats and growth opportunities.

Additionally, we emphasize that maps and technology are not an end point but are tools to help achieve your goals and understand your 'why', and that strategic conservation is not a map but is a mindset. After the introductory content, participants are introduced to the SCD maps and threat-based ecostate maps for a focal landscape (generally 200,000-500,000 acres in size) that is used for the workshop exercise. The SCD maps and ecostate maps both provide a snapshot of rangeland condition that is applicable at different scales; the SCD maps help place a landscape in the broader state-wide or biome-wide context, and threat-based ecostates identify primary threats to sagebrush rangelands from invasive annual grasses, fire, and conifer encroachment at more localized scales. 'Defend and Grow the Core' is used as a common language to communicate a spatial strategy for proactive management, and threat-based ecostates are introduced to better understand the specific localized threats.

Finally, using the SageCon Landscape Planning Tool, participants are led through a series of leading questions designed to spark conversation about strategic management for the focal landscape. At each step, an example is provided to the whole group, and then small groups discuss the following questions:

- Where are the core sagebrush areas, growth opportunity areas, and other rangelands in your landscape?
- What are the primary threats in and around larger blocks of core sagebrush areas? Are there areas where it will be especially important to limit threats or contain infestations?
- How might you change your map of core or growth opportunity areas given other factors like resistance and resilience, fire risk, roads)? Are there places where stopping fire is critical to protecting core?
- What are your priority areas for management, and where would you start? How would you protect your investments?

Small groups are facilitated and encouraged to discuss their responses to the questions and offer differing visions of how you might approach the challenge of defending and growing the core, prioritizing threats, and protecting investments. At the end, each small group shares with the broader group their thought process and lessons learned from the exercise (Fig. A8).

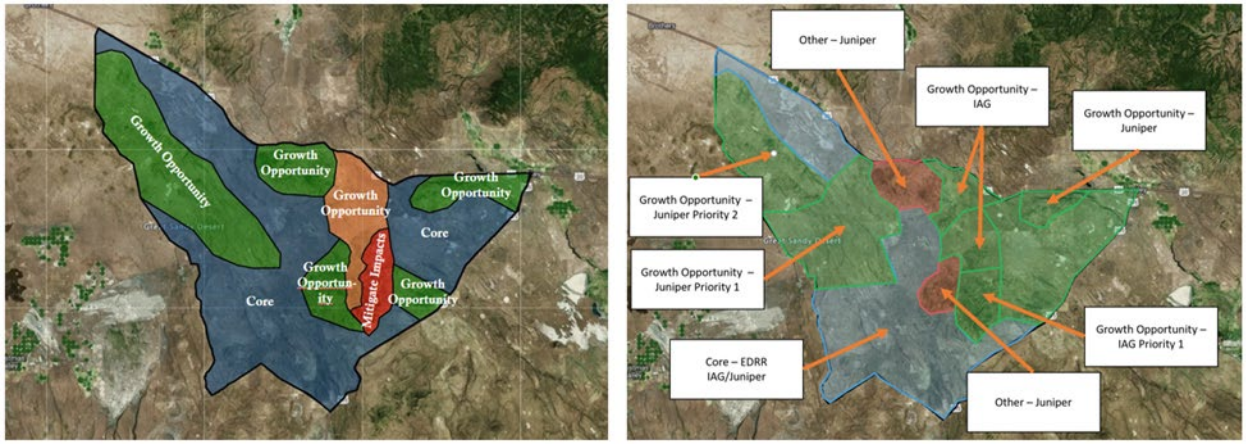


Fig. A8. Example maps from the 2022 SageCon Summit workshop show two (of many) approaches to dividing a landscape of approximately 200,000 acres in Central Oregon into zones based on the concepts of the Sagebrush Conservation Design and informed by threat-based ecostate maps and other local datasets.

Case Study: Nevada's Sagebrush Habitat Plan and Strategic Action Plan

This Case Study Illustrates Step 3: Define Priority Areas for Investment.

Integration of SCD with many different data sets and targeted conversation that is more species-specific or resource-specific.

Background: To better prioritize and coordinate conservation to address sagebrush degradation in Nevada, Executive Order (EO) 2021-18 directed the Nevada Department of Wildlife (NDOW) to collaboratively establish a Nevada Habitat Conservation Framework to provide for habitat conservation, restoration, rehabilitation, and protection. The Department, in coordination and discussion with multiple agencies, decided on an approach similar to that of the Oregon SageCon partnership that will utilize SCD ecosystem integrity products in conjunction with more detailed threat-based ecostate maps. By combining these approaches, we hope to provide managers and decision makers with tools that will assist with prioritization and design

at multiple scales *and* that will allow users to overlay their own 'value layers' and identify habitat-based threats to those values in an area of interest. These could include, for instance, species-specific habitats or resource-specific layers.
Nevada conceptualized an approach to conservation planning that is two-pronged to address the need to:

1. Identify, protect, and grow core sagebrush communities to preserve ecosystem function for a variety of wildlife and other values; increase connectivity between cores strategically.
2. Identify and manage primary ecosystem level threats to sagebrush communities and the resource values they support at a variety of scales whether those values exist in 'Core', 'Growth Opportunity', or 'Other' areas.

NDOW's current efforts to utilize threat-based approaches build on previous work within the Department to identify remnant unburned sagebrush habitat that supports multiple species of conservation concern such as greater sage-grouse, mule deer, pygmy rabbit, Lahontan cutthroat trout and pronghorn. These "Don't Let It Burn" priority maps were developed in 2021 to inform actions around the Department's priorities.

NDOW's hope is that adopting an updated threats-based approach built on vegetation states will allow any resource manager to adopt a similar method to identifying areas that may now, or in the foreseeable future, represent bottlenecks to the resource of interest. For instance, overlaying mule deer migration corridors on the ecostate maps can assist with identifying areas where stop-over habitat may have management concerns based on depleted perennial understories or pinyon-juniper encroachment.

SCD ecological integrity maps have been adopted for guiding high-level investment and conservation strategies based at defending remaining intact sagebrush habitat and growing cores that will serve as the basis for identifying strategic areas for conservation actions. The goal is to defend cores, grow cores, and increase connectivity between cores by mitigating threats and strategically implementing restoration and rehabilitation actions.

Ecostate maps, based on the SageCon 'ecosystem framework to prioritize the primary threats to intact upland sagebrush rangelands', have been developed for the state in partnership with Oregon SageCon. These ecostate maps have been masked to Landfire biophysical settings that are likely to have supported sagebrush habitats in the past to match methodology from the Nevada State Wildlife Action Plan (SWAP). This allows for a cohesive framework for quantifying primary threats to sagebrush habitats within the state at multiple scales and additionally sets a baseline for conservation actions based on current and anticipated future conditions.

The final step in this process will be linking a suite of management guidelines, strategies, and practices to both plant community management and wildlife management. For instance, explicit management suggestions for managing critical winter habitat for mule deer in sagebrush systems that have crossed ecological thresholds (and are therefore unlikely to be restored to high-quality intact sage communities) will be outlined. General management guidelines "connecting the 'why' with the proposed treatment" could result from a similar process so that any and all resource managers are able to adopt similar approaches.

Application of the Sagebrush Conservation Design and lessons learned:

- *Using data at the appropriate scale to inform decision making.* Utilizing SCD layers with threat-based ecostate layers to provide a common language of land management and conservation prioritization is a new approach that will require ongoing outreach and education. Decision making that prioritizes healthy rangelands *and* fish and wildlife species and other values, such as recreation and agricultural economies, will require and foster a big-picture collaborative process that ties to on-the-ground action. SCD, ecostate, value and threats maps/layers will be used to inform broad planning approaches and used in tandem with boots-on-the-ground field assessments.

- *Linking ecosystem threats and 'health' to resource values.* Ecological linkages between landscape health and resource values can be complex, difficult to tease out and understand, and even more difficult to translate. This approach is meant to be simple enough to provide a common language and approach for shared strategic investment and planning, and complex enough to accurately capture trend, condition and threats to the basic vegetation community processes that support wildlife and other values on the landscape. Because of this, no single species or value is explicitly addressed, and adopting a shared goal of managing baseline ecosystem traits may be beneficial and necessary even if this approach requires additional species-level actions and partnerships.

- *Resisting, Accepting, and Directing Ecosystem Level Change.* Resisting ecosystem change through management actions is familiar to most land managers and decision makers and forms the basis of most management related policies and actions. We inherently accept change through prioritization of resources and by explicitly or implicitly ranking the importance of various values like human use and wildlife populations. Frank discussions around winners and losers are rarely addressed but are required for landscape-scale prioritization schemes. Incorporating the 'durability' of restoration and conservation investments in the face of ongoing land use change, climate change, and other disturbances also is difficult to address and needs to be further developed for meaningful, durable investments to allow ecosystems to continue to support healthy wildlife and plant populations as well as sustainable human use.

Case Study: Washington's Shrubsteppe Restoration & Resiliency Initiative

This Case Study Illustrates Step 4: Develop a Strategic Implementation Plan.

Stakeholder-developed goals to meet the Governor's mandate to support human communities, address fire impacts, conserve landscape integrity, and protect species of greatest need.

Background: Wildland fires in Washington are becoming increasingly more intense and frequent, compounding the ecological impacts of climate change and habitat fragmentation, and seriously threatening already at-risk wildlife populations. In September 2020, more than 600,000 acres of Washington shrubsteppe habitat were lost in one day. These burned areas were critical to several high priority declining at-risk species, including greater sage-grouse, Columbian sharp-tailed grouse, and Columbia Basin pygmy rabbit. In response, the Washington State Legislature appropriated state general funds through a legislative proviso to the Washington Department of Fish and Wildlife (WDFW) to restore and protect shrubsteppe habitat in Eastern

Washington amid the threat of wildfires. Specifically, the proviso directed WDFW to restore shrubsteppe habitat and associated wildlife impacted by wildfires, on both public and private lands, and develop a long-term strategy for shrubsteppe conservation and fire preparedness, response, and restoration to meet the needs of the state's shrubsteppe wildlife and human communities. Spatial priorities for shrubsteppe conservation were expected by the Legislature as part of this long-term strategy.

To meet this charge, WDFW formed a steering committee in partnership with the Washington State Conservation Commission (SCC) and the Washington Department of Natural Resources (DNR) to make decisions on how to use new state funding to benefit wildlife by restoring shrubsteppe habitat, implementing species-specific recovery actions, and supporting working lands in Eastern Washington. An advisory group with representatives from local, state, federal, Tribal, agricultural, and conservation organizations provided recommendations to the steering committee on delivery mechanisms, location priorities, and restoration program development. This program is now called the Washington Shrubsteppe Restoration and Resiliency Initiative (WSRRI).

Working with a third-party neutral facilitator, the WSRRI Steering Committee and long-term strategy advisory group agreed to develop a 30-year conservation strategy with goals and objectives and are actively working through action development to meet them. Draft goals and objectives focus on supporting human communities, addressing fire impacts, conserving landscape integrity, and protecting species of greatest conservation need. Conservation actions are being developed through several small topical groups of subject matter experts and conservation practitioners, to align each goal and objective with strategic actions; these topical groups include habitat restoration, grazing, voluntary habitat protection, and others. One of these groups is focused on identifying spatial priorities, to meet the expectations of the state legislature, link the strategy's actions to place (locations on the landscape), and better align appropriate management action with ecological conditions and conservation threats. WSRRI is co-producing spatial priorities with our partners at TerrAdapt (https://terradapt.org/). TerrAdapt is a conservation non-profit focused on monitoring, projecting, and prioritizing areas for conservation.

Application of the Sagebrush Conservation Design (SCD) and lesson learned:
The biome-wide SCD was available in the first year in which WSRRI started its strategic planning. It was reviewed and evaluated by WSRRI partners for suitability for application to Washington as spatial priorities. The SCD provides a good example of collaborative dynamic habitat quality mapping *and* matching specific conservation actions to locations based on ecological integrity values and other mapped threats, both important to WSRRI. One of our first steps was presenting the SCD and associated spatial products to our advisory group and WDFW's habitat and wildlife biologists. These presentations served many purposes, but two main functions revolved around getting feedback on how this plan and data models Washington's habitat, but also in helping our groups think about landscape scale conservation in a dynamic way, rooted in metrics of ecological integrity and a threats-based framework. Essentially, it provided an example to both educate collaborators and elicit feedback to more efficiently create a strategy that reflects Washington's needs for resilient ecological and social communities.
The feedback from advisors and biologists also revealed some deficiencies and concerns around the SCD product and methodology preventing WSRRI from directly adopting the SCD as it's spatial priorities. These included the following:

- In the SCD model, across Washington, no land is mapped as Core habitat, yet we know much of the Columbia Plateau is critical to the ongoing survival and recovery of several listed and at-risk species.
- Lands enrolled in the Conservation Reserve Program were masked out of the biome-wide product as agriculture, but these are demonstrably critical for many species populations, and

have been and will continue to be the focus of tremendous investment by our state's conservation community.

- The 2 km kernel used to smooth the data and locate large areas of high quality shrubsteppe may be too large in Washington, due to the highly fragmented shrubsteppe habitat coupled with annual grass cover across the Columbia Plateau. Some feedback suggested that a relativized value of annual grass to perennial grass (similar to threat-based ecostate maps) might be more appropriate for mapping spatial priorities in Washington because many areas support both moderate amounts of annual grass cover but also contain high perennial grass cover.
- The SCD does not address connectivity between patches of Core habitat. "Connecting the core" is critical in a fragmented landscape to maintain the functionality of core over time.

To chart a path forward from the various rounds of sharing and receiving feedback, the long-term strategy advisory group decided on a set of broad scale habitats that should guide our initial spatial prioritization and conservation of the shrubsteppe system in WA. These habitats include 1) upland (xeric) shrubsteppe habitat, 2) wetlands, wet meadows and riparian (mesic) habitat, and 3) sage-grouse habitat. There are other species addressed in the long-term conservation strategy, and they and their associated habitats may be good candidates to include in spatial prioritization going forward. Once the main habitats were identified, TerrAdapt and WDFW created working groups (one for each habitat) to embark on an almost year-long process, to identify criteria, prepare input data, generate draft spatial priorities (maps), revise them after review, and produce final maps for the long-term strategy.

To map the three habitat types the working groups have been guided by the SCD recipe and have adopted much of the same language to communicate the delineation of habitat (Core, Growth Opportunity areas, and management areas (Other Rangeland Areas in SCD). To prioritize habitat based on ecological integrity, we have included many of the same ingredients found in the SCD, such as fractional cover products on human development, perennial grass/forb, annual grass/forb as well as shrub cover. Many of these fractional cover products are generated by TerrAdapt and tailored specifically for the State of Washington. Essentially, we use the same ingredients but a different brand. Next, to integrate these data layers into ecological integrity metrics for each habitat type we are also applying user-defined response curves as described by the SCD. Once each of the habitat types have been mapped, we will bring them together to provide an overall spatial priorities map, but allow for end users to overlay other important spatial datasets similar to the interactive Sagebrush Geospatial Layer Visualization Map (https://gs-portal-fws.hub.arcgis.com/apps/378ca52aa510491b84a30d0d9fa25a5c/explore).

Ongoing: At the time of writing, WSRRI and TerrAdapt are approximately only one third of the way through our process to identify spatial priorities for shrubsteppe conservation in Washington. Expected final products include core (protection actions), growth opportunity (restoration actions), and connectivity (barrier mitigation actions) for all three habitats, as well as a synthesis product that combines them. These products will be housed in the TerrAdapt tool (terradapt.org) and we will train partners in their use and application for long-term strategy implementation. Trainings and continued development of our spatial prioritization will be important to both improve our understanding of how these datasets guide a variety of use cases, as well as their ability to monitor how our conservation strategy and specific actions are working overtime.

Due to Washington's patchwork of ownership, it is fundamental that this strategy stays highly collaborative in nature. We expect that spatial prioritization of the landscape and the associated ecological integrity data will provide a common metric or language for improved landscape conservation

planning and guide management action across mixed ownership. Due to the dynamic nature of the landscape, we will continue to update the spatial priority maps to reassess where resources can be best applied, in order to increase our probability of successful conservation over time.

Stakeholder Outreach, Communications, and Training Resources

The case studies in Section 6 are examples of how the SCD can be applied to strategic sagebrush conservation planning. They also illustrate the importance of intentional stakeholder convening efforts, training resources to ensure stakeholder teams are effectively, efficiently, and appropriately using the SCD in their work, and the use of communication mechanisms to develop awareness, support, and durable outcomes. The following narrative and links provide examples of successful approaches and tools for communications and training.

Communications

Overall Communications: When communicating with stakeholders about the Sagebrush Conservation Design map products or the 'defend and grow the core' strategy, it is critical to consider the audience. Care should be taken to tailor communication to the needs, circumstances, and abilities of the audience:

- What level of knowledge does the audience already have about this information?
- What level of knowledge do they need? Do they need general awareness of these tools or the ability to use the tools to implement projects?
- What is the decision space of the audience?

This fact sheet provides an overview of the Sagebrush Conservation Design. Additional communication tools such as webinars, videos, and workshops (see SageCon case study) may be necessary to effectively communicate about these tools. Real examples of how these tools were used can be excellent ways to communicate their utility. The case studies in this Guide may help serve that purpose.

Communicating about Defend and Grow the Core: When communicating the 'defend and grow the core' strategy, it is important to note that the Sagebrush Conservation Design defines core habitats based on a limited, but ecologically relevant, set of indicators. Stakeholders value specific sagebrush landscapes for many reasons (for example, recreation, wildfire risk mitigation, livestock forage production, cultural values). Simple word choices such as 'defend **your** core' can help garner stakeholder buy-in and mitigate alienation of stakeholders who may be essential for successful sagebrush habitat conservation. While the concepts underlying the SCD are intuitive (maintaining positive aspects of sagebrush rangelands like sagebrush and perennial grass and forb cover while eliminating undesirable threats), the math behind the SCD algorithm is complex and not intuitive. It is important to emphasize the former while being transparent about the latter.

Communicating about Map Products: When communicating about the Sagebrush Conservation Design map products, emphasize their role as discussion-support tools. That is, these tools should support discussions among land managers and other stakeholders about sagebrush habitat conservation; they do not make decisions or provide a 'right answer.' These tools complement the existing toolbox of map products including local data products. For more information to support communication about the guidelines for using map products in sagebrush habitat conservation and management including technical considerations, refer to Guiding principles for using satellite-derived maps in rangeland management.

Training

Targeted Live Training: Offer live trainings (something similar to *Threat-Based Strategic Conservation*; see Case Study above) toward a geographic area of interest. Some of the lessons learned and key ingredients for success in these workshops so far include the following best practices:

- Help participants think big by providing background in key principles and concepts. Providing a common language(s) such as "Defend and Grow the Core" and/or "ecostate A, B, C" (from Threat-Based Land Management and associated ecostate maps) helps participants communicate clearly and stay focused on the primary threats to sagebrush rangelands.
- Walk through an example, then provide a hands-on exercise. During the exercise, ensure facilitators are available to help navigate the tool and ask leading questions designed to spark conversation. In Oregon's workshops, participants drew by hand on laminated maps.
- Ensure there is enough time for conversation, and allow time for reflection at the end.
- Keep in mind that many mapping tools are best used to facilitate discussion among partners about landscape-scale goals, values and strategies. Avoid an excessive focus on the tools and maps, as they are not an end point in themselves. The conversation and shared learning sparked by the maps is where participants seem to have 'aha' moments.

This live training model can be expanded and honed to respond to partner interest and adapt to multiple locations, audiences and formats throughout the sagebrush biome. Future next steps may include refining and developing additional content for potential additional elements or modules and helping partners adopt these workshops using additional tools and datasets. Additional modules and content may take multiple formats, such as an online course, presentation materials delivered through train-the-trainer workshops, facilitator guides or instruction manuals, multimedia content such as videos, and/or other formats.

Other Training/Recorded Presentations and Other Reference Materials:

- Sagebrush Geospatial Layer Visualizations
  https://gs-portal-fws.hub.arcgis.com/apps/378ca52aa510491b84a30d0d9fa25a5c/explore
- A Sagebrush Conservation Design to Proactively Restore America's Sagebrush Biome
  https://www.usgs.gov/publications/sagebrush-conservation-design-proactively-restore-americas-sagebrush-biome
- Grassland and Sagebrush Conservation Portal
  https://gs-portal-fws.hub.arcgis.com/pages/sagebrush
- Conservation in the Sagebrush Biome – A Framework for Conservation Action
  https://www.wlfw.org/sagebrush
- A Toolkit for Managing Invasive Annual Grasses in the West
  https://westgov.org/images/editor/FINAL_Cheatgrass_Toolkit_July_2020.pdf
- Institute for Managing Annual Grasses Invading Natural Ecosystems – IMAGINE
  https://uwagnews.com/institute-for-managing-annual-grasses-invading-natural-ecosystems

Chapter B. Increasing Capacity for Sagebrush Conservation

By Patrick Bixler,[1] Regina M. Buono,[1] Alan Clark,[2] Ali Duvall,[3] Maureen Essen,[4] Mathew Holloran,[5] Shawn Johnson,[6] Lori Reed,[7] Thomas E. Remington,[8] San Stiver,[8] Jennifer Thomsen,[6] Catherine Wightman[9]

[1]University of Texas
[2]Utah Division of Wildlife Resources, retired
[3]Eco Alliances for Change, LLC
[4]U.S. Department of Agriculture, Forest Service
[5]U.S. Department of the Interior, Fish and Wildlife Service
[6]University of Montana
[7]Intermountain West Joint Venture
[8]Western Association of Fish and Wildlife Agencies
[9]Montana Game, Fish and Parks, currently Northern Great Plains Joint Venture

Introduction

The cumulative effects of various types of sagebrush habitat loss and degradation have created a sense of urgency to prevent further loss and declines in sagebrush dependent or associated species such as sage-grouse, pygmy rabbit and mule deer. Collaborative conservation efforts to address threats of loss, fragmentation, and degradation of sagebrush habitat increased significantly after 2010 due to the listing of the greater sage-grouse as a "warranted but precluded" candidate species of the Endangered Species Act (ESA), alongside other petitions and findings for sagebrush-dependent and obligate species.

Despite federal, state, and local government efforts as well as those of NGOs and private partners, key threats to the sagebrush biome such as invasive species and fire, conifer expansion, energy development, free-roaming equids, and conversion to cropland continue to consume or degrade sagebrush across the biome. The Sagebrush Conservation Design (SCD; **SCD framework**) tool was used to analyze recent trends in loss of sagebrush ecological integrity. This analysis indicated that millions of acres of additional conservation efforts requiring billions of dollars in additional investment would be required to stabilize declining trends.

Inadequate financial and human resources and related capacity to effectively address threats and restore this working landscape are increasingly a substantial barrier to long-term conservation efforts. Sustained funding for conservation efforts is a critical need, but increasing capacity to spend it effectively (for example, boot on the ground, grass seed, drills, sagebrush seedlings, herbicide applicators, strategic planning efforts, etc.,) is equally critical. Strategic approaches to increasing all aspects of capacity for sustained conservation of the sagebrush biome are needed.

This chapter is premised on four critical assumptions about the future of the sagebrush ecosystem:

1) There remains a lack of understanding and appreciation for the social and ecological benefits of the sagebrush ecosystem, and consequently, the need for system-wide conservation is also poorly understood and appreciated.

2) The current level of resources supporting sagebrush habitat conservation is insufficient to address environmental and human drivers of change and degradation and an increased infusion of capacity, cooperation, and networks is needed at multiple scales.

3) While regulation and policy frameworks will continue to play a necessary role, sustaining the sagebrush ecosystem will depend on generating new opportunities, partnerships, and models for voluntary, incentive-based collaborative conservation with diverse stakeholders.

4) As federal conservation funding continues to meet continued competition with other national priorities, alternative financial and investment approaches will need to be created through partnerships with corporations, non-governmental organizations, donors, private landowners, and foundations.

It should be apparent from these assumptions that in addition to increased funding and physical capacity to deliver sagebrush conservation, that our entire approach to sagebrush conservation must change and continue to evolve if we are to be successful. The purpose of this chapter is to review and recommend strategic approaches to implement these changes to increase capacity for sagebrush conservation.

Current Capacity for Sagebrush Conservation

Efforts implemented by state, NGO, and Federal agencies since 2010 for sage-grouse can serve as a first order approximation of sagebrush conservation investments and capacity. The Western Association of Fish and Wildlife Agencies (WAFWA) coordinated a Conservation Report with federal, state and NGO partners, which tallied conservation efforts by activity and acres treated for greater sage-grouse between 2010 and 2019. Conservation efforts are catalogued in a proprietary software program titled the Conservation Efforts Database—Sagebrush Ecosystem Module.

The Conservation Efforts Database (CED) provides a national registry of conservation actions/efforts by ecosystem. Efforts are reported by location, activity, sub-activity, implementing partner, status of the effort, and year. Capacity of conservation entities can be tracked by budget allocations and the number of acres treated by partners, by location, by activity, and by year. Efforts may be tracked by summary reports from the CED or ad hoc within the tool. Summary statistics show that partners delivered an average of about 1.1 million acres of sagebrush protection and restoration activities annually (Table B1).

The Bipartisan Infrastructure Act of 2021 (BIL) devoted 1.4 billion dollars to ecosystem restoration, including sagebrush ecosystems, allocable over 5 years. As part of this total, the Fish and Wildlife Service (FWS) was allocated $10 million dollars per year for five years for sagebrush restoration. The Department of the Interior (DOI) received $905 million for Ecosystem Restoration and $1.5 billion for managing Wildland Fire. The sagebrush biome will have to compete with other priority ecosystems for restoration funds and with forested habitats and the wildland-urban interface for fire reduction funding. In fiscal year 2022, DOI allocated $9 million in ecosystem restoration funds to support over 40 projects in Idaho and 7 other western states to restore and conserve strategic areas within the sagebrush ecosystem. The impact of these funds won't be known until they have been expended and the system has time to respond, but sustainability beyond the five-year period is a capacity issue.

Table B1. The acres (ac) and miles (mi) of specific sub-activity types of conservation actions within the three Activity types (Protection, Restoration and Conifer Removal) on public and private lands.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Subactivity Totals
Sub-Activity	**PROTECTION ACTIVITIES**										
Conservation Easements	32,244	45,543	129,931	48,257	27,762	140,142	125,476	220,025	282,938	121,354	1,173,672
Land Acquisition	968		38,715	6,028							45,711
Fuel Breaks (ac)	6,968	6,873	14,895	6,585	11,353	724	32,525	63,881	61,943	90,694	296,441
Fuel Breaks (mi^2)	491	350	470	869	352						2,532
Total Activity acres	40,671	52,766	184,011	61,739	39,467	140,866	158,001	283,906	344,881	212,048	1,518,356
Sub-Activity	**RESTORATION AND CONIFER REMOVAL ACTIVITIES**										
Conifer Removal	61,793	77,380	80,484	102,931	179,728	269,765	330,605	353,031	188,306	52,173	1,696,196
Noxious Weed Treatment	10,448	9,362	32,411	45,737	207,935	622,053	301,303	340,909	309,263	3,242	1,882,663
Annual Grass Treatment	89,137	124,424	73,652	112,615	25,665	191,473	35,346	411,182	225,074	58,401	1,346,969
Fuels Management	10,208	7,536	6,856	12,902	66,397	105,782	92,086	45,959	60,350	11,062	419,138
Vegetation Mgmt/Habitat Enhancement	171,500	242,994	312,317	772,836	389,548	499,870	310,804	393,501	424,469	233,407	3,751,246
Riparian, Wet Meadow or Spring Restoration	19,133	1,385	30,563	27,409	16,701	17,638	28,245	17,899	9,959		168,932
Energy Development Reclamation	n/a					1,103		442			1,545
Total Activity acres	362,219	463,081	536,283	1,074,430	885,974	1,707,684	1,098,389	1,562,923	1,217,421	358,285	9,266,689
Total Conservation Acres	402,890	515,847	720,294	1,136,169	925,441	1,848,550	1,256,390	1,846,829	1,562,302	570,333	10,785,045

The figures summarized in Table B1, and for a 5-year period, additional projects funded by BIL, indicate a substantial capacity and commitment towards sagebrush conservation. That said, addressing the threats to sagebrush is a very long-term problem and additional and sustained funding and capacity will be required to succeed given that trends in both sagebrush ecological integrity and sage-grouse populations continue to decline. It is also imperative that we make effective and efficient use of the funding and capacity that we do have. This means focusing efforts on the areas that provide the large majority of the ecosystem services (including grazing and wildlife habitat) and on those areas where we can be successful. This can be accomplished through effective partnerships that utilize the Defend and Grow the Core decision making framework informed by the Sagebrush Conservation Design (see Chapter A). Funding is only one aspect of capacity for sagebrush conservation. Difficult as it is to increase funding in the face of other pressing conservation and social problems critically in need of support, funding may be the simplest of the capacity issues to resolve.

Difficult as it is to increase funding in the face of other pressing conservation and social problems critically in need of support, funding may be the simplest of the capacity issues to resolve.

Sagebrush Conservation is a Complex Problem

Edward Game and his colleagues noted in 2014 in the Journal *Conservation Letters* that: "Conservation is not rocket science; it is far more complex." Natural resource conservation in general, and sagebrush conservation in particular, are inherently complex problems that have multiple causative factors that vary widely over time and space. The complexity of resolving threats to sagebrush is compounded by interactions among threats (the invasive annual grass/fire cycle for instance), by diverse land ownerships, and the fact that responsibilities and authorities to address these threats reside (and overlap) across local, county, state, tribal and federal governments and among private individuals and corporations. Regulatory solutions to land uses that threaten sagebrush are difficult on private land, and create winners and losers on public land. While there are few champions for invasive annual grasses or wildfire, reductions in free-roaming equids and even conifer removal can engender opposition from groups with different values.

…successfully addressing complex rangeland problems will require the formation of partnerships and networks of partnerships (comprised of those with authority, responsibility, and knowledge over land or threats) and an adaptive management process that "learns by doing".

Chad Boyd and Tony Svejcar[1] pointed out two consequences of the complexity of rangeland management: 1) no single conservation entity can handle all aspects of conservation tasks; and 2) significant knowledge gaps exist and will continue to exist. They advocated that successfully addressing complex rangeland problems will require the formation of partnerships and networks of partnerships (comprised of those with authority, responsibility, and knowledge over land or threats) and an adaptive management process that "learns by doing". Strategic approaches to monitoring and adaptive management in sagebrush systems and forming partnerships are described in Chapter C and Chapter D, respectively.

Government versus governance

The distinction between government and governance has been widely accepted across a variety of management sectors, including conservation and natural resources. Moreover, there is increasing evidence of a shift from a government to a governance approach in cases of wicked or complex problems. The following section describes both these frameworks in terms of who is involved in decision-making and shares associated examples. Understanding the distinction between these two approaches is important as the entities involved define the parameters of management activities.

Government

Government centers on state actors, such as public agencies, representatives and their associated regulations and norms. With government, power to make decisions and direct resources is primarily held by state actors. Government-centered approaches are primarily associated with activities like issuing grazing permits, fire suppression, fuels control, regulating land uses such as oil and gas development, regulating hunting and commercial harvest, etc. Enabling laws and resulting policies provided for strong centralized authority that rests near the top of agency administrative hierarchies.

[1] Boyd, C.S., and T. J. Svejcar. 2009. Managing complex problems in rangeland ecosystems. Rangeland Ecology and Management, 62:491-499. https://doi.org/10.2111/08-194.1

While not always popular, this model of conservation has been generally successful for these relatively simple problems. However, situations previously dominated by government control (for example, monitoring water quality) are increasingly being replaced by situations that involve a suite of interrelated networked entities. Given the flurry of activity around sage-grouse and sagebrush management over the last decade and the increased involvement of non-state entities, it is likely that sagebrush management is also engaged in such a shift. An effective example of this is the Rangeland Fire Protection Association program (RFPA, see Case Study 12) that evolved in Oregon and is spreading to adjacent states.

Governance

Contrast government, focusing on a single entity, with governance, focusing on a suite of entities. Broadly speaking, governance is a set of formal and informal mechanisms, such as policies, procedures, and norms, among a set of networked entities, like agencies, non-governmental organizations (NGOs) and individuals. Arrangements of mechanisms and entities arise based on specific social and biophysical contexts to allocate resources, distribute power and control across scales and define how decisions are made and who makes them. Governance is often associated with situations requiring individual and collective action, where interdependent entities coordinate among each other to increase beneficial outcomes. Due to this coordination, separations between public and private entities become blurred. In sum, governance focuses on defining the parameters of action by distributing power across networked government, private, NGO and other stakeholders and emerges as a result of negotiated, either formally via contract or informally via social contract, dynamic relationships between partners.

Governance is regularly associated with complex natural resource (or wicked) problems because of the need for coordination and cooperation among the diverse set of entities involved in addressing them. For example, complex problems like managing wildfire, water, and invasive weeds affect both privately and publicly owned entities and lands. Activities by any one of these entities to address these issues, such as a prescribed burn or diverting in-stream water flows, will likely have consequences for other entities. Similarly, coordinating activities among entities involved in these complex problems, like collectively planning watershed restoration projects across jurisdictions and ownerships, can yield better outcomes as compared to focusing solely on planning within a single jurisdiction or ownership. In managing or conserving ecosystems and biomes, like sagebrush, analogous characteristics of interdependence among entities and the desire for both individual and collective action are apparent. Consequently, governance approaches involving a variety of entities across scales and the public (including tribal) and private sectors are an appropriate fit for addressing issues associated with managing the sagebrush biome.

Sagebrush Conservation Capacity

Capacity has been defined as the "ability to perform functions, solve problems and set and achieve objectives"[2]. This definition applies to organizations, communities, and individuals. Capacity is dynamic, developed iteratively over time, rarely built from scratch, adaptive, and inherently encompasses the values of those engaged in the conservation effort. For the purpose of this chapter, we propose a broad definition of sagebrush conservation capacity that encompasses the ability to conduct actions that are intended to maintain or improve the sustainability of the sagebrush ecosystem so that society can continue to derive ecosystem services from this landscape now and well into the future.

Capacity is dynamic, developed iteratively over time, rarely built from scratch, adaptive, and inherently encompasses the values of those engaged in the conservation effort.

We believe that building the capacity of individuals and organizations to actively engage in conservation is the most effective means of making lasting contributions for natural resource sustainability. However, this capacity cannot be accomplished without first enabling the people who work and live in the sagebrush landscape and those that benefit from the services it provides, to develop and use the competences required to build individual capacities. Establishing and sustaining entities of all types that actively seek and take the responsibility for conservation in the sagebrush landscape enhances organization and community capacity. When individuals, communities, and organizations work collectively and in concert they are more effective.

Ultimately, all conservation is local. To be accomplished effectively and sustainably, conservation needs to be an integral facet of a community's identity—it needs to reflect the values of the community and meet the needs of its individuals. In this way, conservation moves from being seen as an impediment to being viewed as an investment in the sustainability of the community where one resides. Landscape-scale conservation, in practice, can be thought of as the stitching together of local management actions such that the accumulation of those actions results in functioning landscapes. Local-level programs, guided by or that support regional and biome-wide objectives, conducted across the breadth of an ecosystem represent the fundamental way we can successfully and sustainably engage in active conservation of that ecosystem.

Ultimately, all conservation is local. To be accomplished effectively and sustainably, conservation needs to be an integral facet of a community's identity—it needs to reflect the values of the community and meet the needs of its individuals.

[2] Fukuda-Parr, S., Lopes, C., and K. Malik. 2002. Capacity for development. New solutions to old problems. United Nations Development Program and Earthscan Publications.

Conservation capacity building must therefore integrate local needs with broader ecological paradigms such as Defend and Grow the Core and the Sagebrush Conservation Design (see Chapter A), and vice-versa. This multi-scale vision of capacity building should be built and maintained from the bottom up to establish ownership and trust and thereby ensure that active aspects of conservation are prioritized in the spatial hierarchy long-term.

This multi-scale vision of capacity building should be built and maintained from the bottom up to establish ownership and trust and thereby ensure that active aspects of conservation are prioritized in the spatial hierarchy long-term.

A major component of building conservation capacity is that the conservation actions identified to create a sustainable sagebrush landscape must be based in science, and must have demonstrated real-world conservation impact long-term. The development of conservation capacity for the sagebrush landscape that incorporates science must include practices or approaches that embrace shared discovery such that the organizations, communities, and individuals trust the tools developed to assist in their decision making initially and as the program adapts, and continually learn more about the issues important to the diversity of stakeholders and each other while they are actively engaged in conservation. This type of experiential learning is absolutely essential to building relationships and trust so that conservation capacity building efforts ultimately are implemented across the landscape and are sustainable over the long term needed for conservation success more broadly.

Four components of conservation capacity are commonly described, these include fiscal, human, organizational, and structural. Aspects and constraints of each are reviewed.

Fiscal conservation capacity (funding, capital)

Fiscal capacity includes having access to the financial and in-kind resources to cover the administrative, materials and equipment costs needed to achieve organizational objectives and implement change. It is foundational in that in almost all cases other aspects of capacity require adequate funding to obtain. Unfortunately, given the long-term nature of capacity building, contemporary annual budget or funding cycles pose challenges for organizations and government agencies seeking to effect changes. Funding tied to a 'use it or lose it' annual budget process will not provide the resources required to build individual, community, or organizational capacity. Additional constraints for government agencies can include existing rules and procedures established for programs. However, linking annual funding to a well-developed conservation strategy can allow for incremental steps that will enable organizations to implement large-scale capacity building, while still supporting operational activities. Partnerships can lead to diversified and more flexible funding and larger funding pools that can overcome some of these constraints.

Partnerships can lead to diversified and more flexible funding and larger funding pools that can overcome some of these constraints.

The paper that described the SCD framework stated that an additional 1.3 million acres of successful conservation would be needed annually to offset sagebrush losses, and described the magnitude of needed investments as comparable to that of wetland conservation; millions of acres and billions of dollars over a 30-year period. The WAFWA-coordinated 2006 Greater Sage-grouse Comprehensive

Conservation Plan[3] recognized that substantially increased funding would be needed to implement conservation actions for greater sage-grouse and suggested a North American Sagebrush Ecosystem Conservation Act (NASECA). Patterned after the successful North American Wetland Conservation Act (NAWCA), it would be a congressionally created fund that would renew annually and be allocated to conservation projects by a Council comprised of government and NGO representatives. Although pitched to several congressional western congressional representatives or their staff, no legislation has emerged. A conceptually similar bill was introduced by Senator Ron Wyden (Oregon) in 2022, called the North American Grasslands Conservation Act, which includes sagebrush rangelands as grasslands that would be eligible for a portion of $290 million dollars each year to be allocated over a 5-year period (2022-2026). At biome scales, it is apparent that congressional action to create significant, long-term and sustainable funding is likely the only successful path.

At regional/state scales several governor and legislatively initiated efforts have substantially increased funding and other capacity (or soon will) for sage-grouse and/or sagebrush conservation including in Oregon (SageCon, see Case Study 4), Wyoming (see case studies 6-8), Washington (Washington's Shrubsteppe Restoration & Resiliency Initiative, described as a case study within Chapter A) and Nevada (Nevada's Sagebrush Habitat Plan and Strategic Action Plan, described as a case study within Chapter A). Involvement by Governors in initiating these efforts adds a level of gravitas, ensures that state agencies take the effort seriously and increases participation by industry, NGOs, landowners, and other stakeholders. The Utah Watershed Restoration Initiative (case study 2) is also an example of a highly successful state program that effectively pools disparate funding sources, including legislative appropriations and federal funding, through one state-led project evaluation and grant program.

Colorado has developed an innovative program to improve infrastructure that improves efficiency of water delivery, irrigation, or water quality that potentially could be employed by states to fund the large initial investments required to treat invasive annual grasses or restore burned areas in sagebrush. Colorado has developed numerous grant and low-interest loan programs to incentivize these improvements that tap revolving loan funds to pay for infrastructure development, low-rate interest payments to fund operating costs, while principal payments are reinvested over time. Severance taxes are the underlying source of revenue to fund several of these grant and loan programs. Investment of severance taxes to enable sagebrush conservation seems especially appropriate given energy development has significant impacts to the sagebrush biome and its inhabitants.

The need for additional societal investments in sagebrush conservation and ameliorating the diverse array of threats is so compelling it is clear that an "all of the above" funding strategy will be necessary. In addition to increasing agency budgets through the usual mechanisms, there are other, newer approaches to funding environmental conservation that may have utility for the sagebrush biome particularly at state scales. These include impact and community investments.

The need for additional societal investments in sagebrush conservation and ameliorating the diverse array of threats is so compelling it is clear that an "all of the above" funding strategy will be necessary.

[3] Stiver, S.J., Apa, A.D., Bohne, J.R., Bunnell, S.D., Deibert, P.A., Gardner, S.C., Hilliard, M.A., McCarthy, C.W., and M.A. Schroeder. 2006. Greater Sage-grouse Comprehensive Conservation Strategy. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming. https://ir.library.oregonstate.edu/concern/technical_reports/h415pg504

In 2014, with founding sponsorship from JPMorgan Chase & Co., TNC formed NatureVest, a comprehensive conservation finance platform. NatureVest's mission is to engage private capital to rapidly scale critical conservation work around the world by creating investment opportunities in a wide variety of sectors that deliver environmental results and financial returns for investors. To achieve this, TNC sources and structures investments that support The Nature Conservancy's mission to raise capital from investors looking to generate both financial returns and conservation outcomes. TNC intends to source and put to work at least $1 billion of investment capital for measurable conservation outcomes in the next three years in 4 investment areas: forests and carbon, ocean protection, sustainable agriculture and water, and green infrastructure for cities. Perhaps mitigating impacts of energy development and mining could make sagebrush conservation an attractive opportunity for NatureVest or similar efforts.

There is potential to use mitigation banking as a vehicle for investment in sagebrush restoration, but current metrics in use by states that have mitigation programs don't lend themselves to this. The sagebrush ecological integrity metric used in the Sagebrush Conservation Design (SCD framework) could potentially prove more flexible.

At local and project scales sagebrush conservation is typically dependent on government funding, programs, or grants. Private funding is possible, but the capacity to effectively engage with foundations and private donors is a long-term process built as much on relationships as on the strength of the conservation program seeking funding. Grants for capacity building in early stages of communities developing conservation capacity are critical in addition to funding for direct project expenses. Crowdfunding through sites such as Indiegogo or Kickstarter may be a way to provide match or otherwise augment traditional funding sources.

Human conservation capacity

Human capacity development must include actions that develop both knowledge and skills and the will (for instance, interest, patience, and persistence) to implement the desired changes. Training staff in new skills without carrying out the necessary follow-up to make sure those skills are being utilized appropriately will not enhance conservation capacity. Some best management practices to enhance capacity building include long-term, multi-level approaches that involve coaching, mentoring, and mechanisms for employee and stakeholder feedback.

Hiring employees with adequate conservation training is becoming increasingly challenging for organizations given the wide range of possible conservation careers and the diverse spectrum of skills needed to perform them. Recent studies have identified 'miss-matches' between training available to early-career conservationists and the expectations and demands of the evolving sector, which extend beyond a disciplinary scientific background of traditional, analytical and technical conservation skills to include communication, network building, managerial and business know-how, and tech savviness.

As capacity increases, conservation becomes more integrative, interactive and inclusive. As the distinctions between the science and practice of conservation become blurred, the demand for training in practical, transferable and 'soft' skills beyond traditional conservation science training will increase. This training must go beyond traditional academic approaches

…training must go beyond traditional academic approaches and include leadership, strategic thinking, decision-making, persuasion, inter-personal communications, and conflict resolution.

and include leadership, strategic thinking, decision-making, persuasion, inter-personal communications, and conflict resolution. Project management skills have been identified as particularly lacking in conservation training, and practical, project-based learning is advocated as a means to impart leadership and decision-making skills as well as the analytical abilities needed to plan, set realistic goals and communicate effectively[4]. Because of an increasingly diverse stakeholder base, conservation will require increased staff capacity for multi-directional communication between various stakeholders.

Building organizational conservation capacity therefore must also focus on implementing actions that develop individual, pre-career and early-career employees through targeted interventions aimed at enhancing and diversifying existing capabilities of long-term employees. Capacity interventions may include internship opportunities and practical placements with conservation organizations and government agencies.

Leadership has been described as "the most important attribute in the conservation toolkit"[5]. Conservation, like many other fields, is experiencing a general shift from a top-down paradigm of individual 'leaders' towards a broader understanding of 'leadership' as a process where shared power and responsibility, accountability and multiple leadership styles and roles for creating change are emphasized. This transition is reflected in the different types of leadership described in the conservation literature including: collaborative leadership, adaptive leadership, and transformational leadership. Recommendations for developing organization, community, and individual conservation leadership capacity are lacking in the literature. Intergenerational relationship building and mentoring by senior conservation leaders is encouraged. Collaborative leadership additionally requires collaboration skills, including the ability to coordinate networks and facilitate knowledge sharing.

Focusing only on staff development without addressing issues in other areas, such as outdated computer systems or a physical infrastructure that does not allow staff to implement new skills or innovative practices, will reduce the likelihood of attaining the goals of building human conservation capacity. The training and support necessary for staff to grow and diversify requires a physical and psychological work environment that facilitates and promotes that growth.

Organizational conservation capacity

Organizational conservation capacity involves the interaction, collaboration, and communication among people within the organization, as well as with those the organization serves and collaborates with. This includes organizational culture, partnerships, and social and communication networks. Collaboration, as defined initially in most dictionaries, refers to its original context as used in war: "working with the enemy." The original definition has contemporary pertinence in that it still reflects the numerous challenges as well as the potential benefits of inter-organizational collaboration in addressing the complexity of social-ecological issues. However, for an organization or community to be effective at collaboration, individual capacities such as interpersonal skills and effective cross-cultural

[4] Martinich, J.A., Solarz, S.L. and J.R. Lyons. 2006. Preparing students for conservation careers through project-based learning. Conservation Biology, Volume 20, Number 6, pages 1579-1583. https://doi.org/10.1111/j.1523-1739.2006.00569.x

[5] Dietz, J.M., Aviram, R., Bickford, S., Douthwaite, K., Goodstine, A., Izursa, J.L., Kavanaugh, S., MacCarthy, K., O'Herron, M. and Parker, K., 2004. Defining leadership in conservation: a view from the top. Conservation Biology, Volume 18, Issue 1, pages 274-278.

communication must be present. Schmidt and others [6] recommend collaborative skill development for graduate students in three areas: i) teamwork – by attending to a process, jointly developing research questions and keeping team members accountable; ii) problem-based learning – discovery and inquiry through the experience of solving complex problems; and iii) scaffolding experiences – mentoring and support that is decreased over time to gradually encourage self-sufficiency.

These capacities have been lumped under the term "social learning." Social learning describes the way people learn in a social context through observation of others and the consequences of their actions. Social learning contributes to collaboration by forming and strengthening personal and professional relationships. The use of small group exercises (for example, sage-grouse local working group processes, SageCon workshops referenced in Chapter A) is a well-recognized contemporary means of social learning that, when facilitated by a trained and experienced facilitator, can enhance social and interpersonal skills, build community and individual capacity to resolve conflict, and increase interdependence, trust, group processing abilities, and individual accountability and responsibility. The desired skill sets to enhance social learning at the individual level within an organization or community include:

- Communication skills: abilities to listen and communicate clearly, effectively and persuasively are needed in conservation, and are foundational for interpersonal skills and the ability to work with people from different perspectives, disciplines and backgrounds.
- Interpersonal skills: abilities to build diverse personal networks, function in a team, collaborate, negotiate and resolve conflicts. Conservationists are increasingly working together and with others in different fields to address complex problems, with capacity increasingly developed through relational modalities involving mentoring and other forms of interaction.
- Boundary crossing skills: skills that enable individuals to work across and within science, policy and practice, including abilities to be aware, open-minded and respectful of diverse perspectives and different ways of doing things (methods, world views, etc.).

Structural conservation capacity

Structural capacity exists independently of the people working within the organization and includes elements like policies, standard procedures, and practices. Increasingly, awareness of the heterogeneous nature of interactions between science and policy is leading to more context-sensitive processes of knowledge creation and policy construction. Understanding the needs and context in which the knowledge will be used requires willingness and capacity to work across disciplines and sectors. This will require conservation organizations to interact more broadly with other fields of knowledge, form relationships across boundaries and learn to appreciate other methods and perspectives.

Problems, research processes, and solutions should be jointly framed (or co-produced) with science and policy to improve the likelihood that outputs are useful and relevant. Consequently, increased interaction between conservation organizations, affected communities, and interested stakeholders is key for the development of competence for evidence-informed policy participation. Conservation capacity building initiatives should facilitate these social interactions. These actions should emphasize increasing awareness of policy cycles, the importance of timely communication of results, the formation

[6] Schmidt, A.H., Robbins, A.S., Combs, J.K., Freeburg, A., Jesperson, R.G., Rogers, H.S., Sheldon, K.S. and E. Wheat. 2012. A new model for training graduate students to conduct interdisciplinary, interorganizational, and international research. BioScience, Volume 62, Issue 3, pages 296-304. https://doi.org/10.1525/bio.2012.62.3.112012

of personal and professional relationships, importance of networks in facilitating connections, and windows of opportunity.

The four types of capacity are interdependent, and growth in one area is dependent on growth in the others. Consequently, while a particular capacity-building initiative might focus on one type of capacity, all four types of capacity must be "aligned and addressed" if the organization is to meet its goals for change.

Building Capacity for Sagebrush Conservation Across Scales

Adaptively managing complex ecosystem problems: Who does what?

Gaining traction on complex ecosystem problems such as sagebrush type conversion and recurring fire due to invasive annual grasses will mean moving away from the top-down and often practice-based focus of rangeland conservation. With complex problems, practices must work in support of an ecologically-based strategy that accounts for environmental variability in space and time. Because of the dynamic and persistent nature of invasive plant problems (particularly invasive annual grasses), the management strategy itself must be flexible, and set within an adaptive framework that uses on-going monitoring information to inform locally made decisions regarding changes in strategy over time. Shifting conservation focus to adaptive management is, for a variety of reasons, often easier said than done. For example, consider Bureau of Land Management use of Emergency Stabilization and Rehabilitation funds following wildfire. Historically, these funds have been allocated for use within specific timelines that may preclude adaptively-timing the application of practices such as re-seeding to be consistent with locally favorable biotic and abiotic conditions. This is in contrast to the need for local decisions regarding the nature and application of practices used in addressing complex problems.

Because of the dynamic and persistent nature of invasive plant problems (particularly invasive annual grasses), the management strategy itself must be flexible, and set within an adaptive framework that uses on-going monitoring information to inform locally made decisions regarding changes in strategy over time.

Productively allocating conservation roles across spatial scales (for example, project, local, state, regional, and biome-wide scales) starts with an assessment of problem types and their influence on the different roles and responsibilities of conservation entities. For relatively simple problems, regional/national scale policies and administrative actions can define high-level guidance that is implemented through local scale actions. For example, the issue of anthropogenic development in sage-grouse habitat is amenable to influence through a variety of regional/national scale administrative policies that establish guidelines for different types of development within sage-grouse habitat (Table B2) that are augmented by state regulatory authorities. These actions would in turn be influenced and informed by science operating at concomitant scales. Implementation of policies and actions would ultimately play-out at local scales, however, the local implementation would be strongly directed by larger scale guidance. For more complex, ecosystem-based problems, management actions will be the product of local scale knowledge but will be empowered by actions, policies and funding priorities at the regional/national scale. For example, management actions to ameliorate invasive annual grasses will be

adaptively defined at local scales by management entities capable of understanding and acting on the unique attributes of the problem (Table B2). In this case the role(s) of regional/national entities is to

Table B2. Generalized conservation roles for local and regional/national scales when using the historical top-down approach to address simple problems (top row) vs. using an adaptive approach to address a complex ecosystem problem (bottom row). Adapted from Boyd and others, 2014.

	Conservation Roles	
Problem Type	**Regional/National Scale**	**Local Scale**
Simple *e.g., anthropogenic development of sage-grouse habitat*	Policy/administrative decision-making	Directed action based on programmatic guidance
Complex Ecosystem *e.g., exotic annual grass invasion*	Empowering conservation at more local scales	Defining/implementing management actions & Adaptive decision-making

create the decision space necessary for local decision-making and to empower local management. Creating decision space can be synonymous with explicitly recognizing the difference between simple and complex ecosystem problems within large scale management planning and enabling policy documents. Empowering management at the local scale can be indirect through production of science-based products for technical support at local scales (for example, the Sagebrush Conservation Design and the Resistance and Resilience matrix), or direct through financial or logistical (for instance, equipment and expertise) support of local management entities.Resolving conflicts created when top-down strategies and policies conflict with local scale management of complex problems has been both difficult and frustrating to those involved. These frustrations often center around bureaucratic inertia. In other words, it's not that the employees of an agency don't recognize issues at the policy/management interface, it's more that the organizational structure and within-agency culture and traditions can create a threshold for change that is difficult to internally surpass. A potentially effective approach for ameliorating such situations is the use of working groups comprised of a meaningful cross-section of management and science specialists. A good example of this would be the working group that developed and published the Sagebrush Conservation Design. Led and supported by the Fish and Wildlife Service but under the umbrella of the WAFWA coordinated Sagebrush Conservation Strategy, this group of managers and spatial ecologists from state, federal, academia, and NGOs created a paradigm changing Sagebrush Conservation Design, then collectively introduced it to high-level decision makers in a way no single entity could have accomplished. It has become the go-to framework for Federal allocation of BIL dollars, and is now being incorporated into state-wide sagebrush planning

…organizational structure and within-agency culture and traditions can create a threshold for change that is difficult to internally surpass.

efforts in Washington and Nevada and complementing ongoing planning and implementation efforts in Oregon through SageCon.

Another relatively recent example is the WAFWA Wildfire and Invasive Plant Species Working Group, that developed and published a report on science and policy gaps surrounding management of sage-grouse habitat. In that report, the group noted discrepancies between existing policy and more local management needs (including use of ESR funds described previously) and impactful policy changes have resulted from the publication of that report in 2013 (Wildfire and Invasive Species in the West: Challenges That Hinder Current and Future Management and Protection of the Sagebrush-steppe Ecosystem (oregonstate.edu)) and an update to that report by the same group in 2018 (WILDFIRE AND INVASIVE PLANT SPECIES IN THE SAGEBRUSH BIOME – WAFWA). In both examples, the cross-professional and interagency make-up of the groups helped generate sufficient momentum to, if not overcome, at least reduce the bureaucratic inertia that had previously limited policy effectiveness. Similarly, collaborative pilot projects and management initiatives have also been used to minimize cross-scale policy/management conflict. These efforts allow participating agencies to experiment with local or situational flexibilities at small spatial and/or temporal scales without necessarily altering relevant policies. An example of this is the collaborative partnership that formed to rehabilitate the 280,000 acres that burned in southwestern Idaho and Southeastern Oregon in the 2015 soda fire[7]. This partnership ensured that state and federal lands were managed together so that vegetation treatments, drill seeding, and aerial grass seeding were largely seamless across federally and state-owned land boundaries. This group is learning by doing through extensive and rigorous monitoring of the Soda Fire landscape conducted through a partnership with USGS. Lessons learned are likely to result in changes to BLM's ESR (Emergency Stabilization and Rehabilitation) handbook. This partnership both built off previous partnerships and relationships formed for greater sage-grouse and appears to be spinning off new partnerships and relationships. If designed correctly, both lessons learned and the power of collaborative relationships can be used as a foundation for creating more effective policy direction (see Table 2) over time and for larger geographies.

Building capacity for conservation is a process that aligns beliefs and new or refined practices with desired goals for the future. This occurs among and within organizations, communities, and individuals. To be effective, building capacity requires deliberate and planned change. Although most organized conservation efforts engage in planning, these efforts often fall short in plan implementation and adaptation, generally because the capacity to pursue objectives, evaluate outcomes, and sustain programs is unavailable long-term.

Building capacity for conservation is a process that aligns beliefs and new or refined practices with desired goals for the future.

There exists a substantial disconnect between broad-scale and local-scale conservation efforts, and this disconnect is largely limiting active conservation of ecosystems. Because active conservation actually occurs at local scales, efforts to bridge this disconnect need to focus on the communities, organizations and individuals engaged in conservation and build up from there. Yet, many of the elements of

[7] Reviewed in Meredith, G.R., and M.W. Brunson. 2022. Effects of wildfire on collaborative management of rangelands: A case study of the 2015 Soda Fire. Rangelands, Volume 44, Issue 5, pages 306-315. https://doi.org/10.1016/j.rala.2021.03.001

conservation necessary for sustained success are not readily available to these local groups, limiting these groups' ability to successfully pursue long-term conservation of the regions within which they are working. Local-scale conservation efforts need the capacity to grow and sustain their efforts in the form of directly applicable science-based planning and monitoring tools, direct coordination among other local-scale and broader-scale efforts, outreach campaigns to engage communities and broader human populations, the ability to effectively communicate with and recruit potential participants in the effort, a presence in city, county and state policy arenas, assistance securing necessary funds, etc. In other words, building conservation capacity is a product of empowering and supporting a series of local-scale efforts across the focal ecosystem, and ensuring that these local efforts complement and build on one-another. Through coordination of a series of local-scale efforts, landscape-scale conservation can be achieved. One model for better coordination of local-scale conservation efforts and filling in some of the policy, planning and funding gaps of local efforts is the High Desert Partnership in Harney County, Oregon. This 501-C3 non-profit is described in Case Study 13 of this volume.

To ensure effective engagement with stakeholders at the local-scale, capacity and the tools necessary to build capacity must be grounded in local programs and promoted by local entities. Local engagement is not a product of simply providing the tools and expertise necessary to address the many aspects of a successful conservation program. Local groups require "ownership" of these tools and supporting efforts—this ownership leads to the durability of local conservation programs while ensuring the tools and efforts are directly relevant to the management approaches being pursued through those programs. As such, developing broader-scale capacity for the sagebrush conservation strategy as a whole is going to require the ability to effectively engage with local entities pursuing conservation. Further, several species that rely on sagebrush-dominated habitats are prime examples of landscape-scale species in that they require large, interconnected and diverse patches of sagebrush distributed across landscapes that can often include tens or hundreds of thousands of acres. As such, management decisions made at local scales could have consequences for wildlife populations that extend far beyond the decision area itself, and conversely, management decisions affecting other areas may impact populations of landscape species locally. It is important to recognize that site-specific decisions must be fully informed as to the potential consequences of those decisions at larger spatial scales. The considerations of landscape-scale dynamics are important aspects of local efforts, and the capacity to effectively engage groups pursuing active conservation so that these large-scale dynamics are considered in local decision making is a critical role of the sagebrush conservation strategy.

The capacity to engage with local entities should be pursued by state and federal agencies partnering with and providing support to organizations that are engaged in local efforts that have goals related to sagebrush conservation. Promoting a holistic vision and allowing for growth and diversification by providing support (for example, financial, analytical, data, outreach expertise, etc.) to existing conservation efforts (as compared to initiating distinct efforts through this strategy) is recommended. Building conservation capacity for the broader sagebrush conservation effort could potentially be accomplished by supporting the NGO community, through mitigation efforts (for example, conservation banks, habitat exchanges, etc.), through promotion and expansion of Local Working Groups, grazing associations, Cooperative Weed Management Associations, Rangeland Fire Protection Associations, etc. Further, we recommend that landscape-scale and range-wide efforts to build capacity be focused on generating the tools and efforts necessary to ensure local efforts are complementary, and addressing ecological principles that act at scales broader than the general focus of local groups (for example, defend, grow, and connect the core, maintain and connect population strongholds, genetic dispersal, etc).

Effective conservation partnerships at local, regional/state, and biome-wide levels, and across these scales will be required to solve the complex problem of sagebrush conservation. These collaborations of those with the diverse authorities, responsibilities, and interests in addressing threats or that benefit from intact sagebrush systems are also integral to increasing conservation capacity. Because these collaborative conservation partnerships are so critical, we developed or sought out case studies from successful partnerships that are currently involved in sagebrush conservation or that can serve as models. It is our belief that if these examples are emulated at scale across the biome that we can succeed in the long term. Case studies are provided at biome-wide (Southeast Conservation Adaptation Strategy, Case Study 1), Regional/State (Utah's Watershed Restoration Initiative, Oregon Watershed Enhancement Board (OWEB), Oregon SageCon Partnership, Voluntary Conservation Through Candidate Conservation Agreements with Assurances in Oregon, Wyoming Sage-grouse Implementation Team, The Idaho Cheatgrass Challenge, and Colorado Firefighting Air Corps; Case studies 2-6, 11), and local scales (Douglas Core Area Restoration Team (DCART), Cooperative Weed Management Areas, Oregon (and Idaho) Rangeland Fire Protection Associations, Ranchers Stewardship Alliance, The Harney County Wildfire Collaborative, The Wet Meadow Restoration and Resiliency Building Project, Wyoming Conservation Landscape Initiative (WLCI); Case Studies 7-10, 12-15)

Chapter C. Adaptive Management and Monitoring

By Zachary Wurtzebach,[1] Thomas E. Remington,[2] Kevin Doherty,[3] Alexander V. Kumar,[3] Aleta Nafus,[4] Thomas Rodhouse,[5] Lief Wiechman[6]

[1]Center for Large Landscape Conservation
[2]Western Association of Fish and Wildlife Agencies
[3]U.S. Department of the Interior, Fish and Wildlife Service
[4]U.S. Department of the Interior, Bureau of Land Management
[5]U.S. Department of the Interior, National Park Service
[6]U.S. Geological Survey

Introduction

The threats to the sagebrush biome, the interactions among those threats, the compounding effects of climate change, and the impacts of conservation action or inaction on numerous and diverse stakeholders creates an incredibly complex and uncertain management environment. An adaptive management construct where feedback loops reduce uncertainty over time, limited management resources can be more easily prioritized, and alternative management scenarios can be rigorously evaluated would improve effectiveness and reduce costs over time. Chapter two of the Science Framework for Conservation and Restoration of the Sagebrush Biome (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 2. Management applications | US Forest Service Research and Development (usda.gov)) and Chapter S of Part I of the Sagebrush Conservation Strategy (https://wafwa.org/sagebrush-conservation-strategy/) review specific aspects of monitoring in support of adaptive management and structured decision making. In this Chapter, strategies are described to operationalize a biome-wide monitoring and adaptive management program that focuses on several key elements. These are: 1) the need for a holistic and ecosystem-centered approach to establishing quantifiable objectives for success across the sagebrush biome; 2) the need for an adaptive monitoring approach to track trends and progress towards ecosystem objectives at multiple scales; 3) a structured decision-making support system to predict future trends in sagebrush in response to both threats and management actions; and 4) the need for adequate funding, staffing, and capacity to support adaptive monitoring and adaptive management programs and structures.

Objective Setting and Adaptive Management

In an Adaptive Management and Monitoring System, information flows and supports collaboration across local, state, and biome scales (Fig. C1). Common objectives and priorities are identified. Biome-wide monitoring contextualizes local decisions. Local efforts, learning, and needs inform state and biome-wide decisions and actions. Local, state, and biome scale adaptive monitoring and coordination together provide the necessary inputs for a robust structured decision-making system that informs dispersed decision-making to achieve shared objectives and landscape priorities.

Ecosystem-integrity approach and objective setting. One key element of the monitoring and adaptive management construct described here is a holistic ecosystem management framework for establishing quantitative objectives for sagebrush conservation that can support the strategic allocation of resources and all-lands coordination. To date, conservation actions and multi-scale monitoring across the sagebrush biome have been largely organized around protecting or improving habitat for sage-grouse. While the imperative of sage-grouse conservation has led to investment and innovations in multi-scale vegetation and species monitoring, limitations to this approach are increasingly evident. One issue is the lack of quantitative objectives for evaluating progress. While it is apparent that existing policies and conservation actions in place for sage-grouse have not yet succeeded at stopping or reversing declining trends in sage-grouse populations[8], it is not apparent what changes to policy or level of conservation investment might be needed to stabilize and reverse those trends. At present we can only make somewhat educated guesses as to needed changes because there are no rangewide objectives for sage-grouse populations or biome-wide objectives for sagebrush conservation. Most state plans lack quantitative objectives and/or a time frame by which objectives will be realized. In the absence of quantitative objectives, the definition of success becomes a moving target that is difficult if not impossible to appropriately resource or evaluate.

In the absence of quantitative objectives, the definition of success becomes a moving target that is difficult if not impossible to appropriately resource or evaluate.

Another key limitation of the sage-grouse paradigm is its scope and scale. Sage-grouse are not always an effective "umbrella species" for many other sagebrush obligates, such as pygmy rabbits or pinyon jays, whose populations are also declining. A narrow focus on sage-grouse core areas can be problematic for sage-grouse. Sage-grouse populations in Wyoming core areas are projected to decline because of development impacts outside core areas[9]. Finally, the sage-grouse conservation model neglects the importance of ecosystem services provided by functioning sagebrush systems, which are an important consideration for conservation efforts. Population and habitat objectives for sage-grouse are certainly appropriate at project, local, regional and even range-wide but in the latter context may be better nested within sagebrush objectives rather than in lieu of.

The Sagebrush Conservation Design (SCD; SCD framework, Chapter A) creates a holistic, ecosystem-management framework for objective setting in the sagebrush biome. This framework better reflects the needs of other sagebrush associated species than current prioritization constructs in use today that were developed specifically for sage-grouse, such as Priority Areas for Conservation (PACs), Sage-Grouse Core Areas, or Priority Habitat Management Areas (PHMAs). Using the SCD framework, objectives for retaining *x* acres of core sagebrush by year *y* could be developed at a biome scale by a sagebrush network governance group, by land management agencies, or by aggregating conservation objectives from individual states.

[8] Coates, P.S., Prochazka, B.G., O'Donnell, M.S., Aldridge, C.L., Edmunds, D.R., Monroe, A.P., Ricca, M.A., Wann, G.T., Hanser, S.E., Wiechman, L.A., and Chenaille, M.P., 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, 243 p. [Also available at https://doi.org/10.3133/ofr20201154]

[9] Heinrichs, J.A., O'Donnell, M.S., Aldridge, C.L., Garman, S.L., and Homer, C.G., 2019, Influences of potential oil and gas development and future climate on sage-grouse declines and redistribution: Ecological Applications, v. 29, no. 6, p. e01912. [Also available at https://doi.org/10.1002/eap.1912]

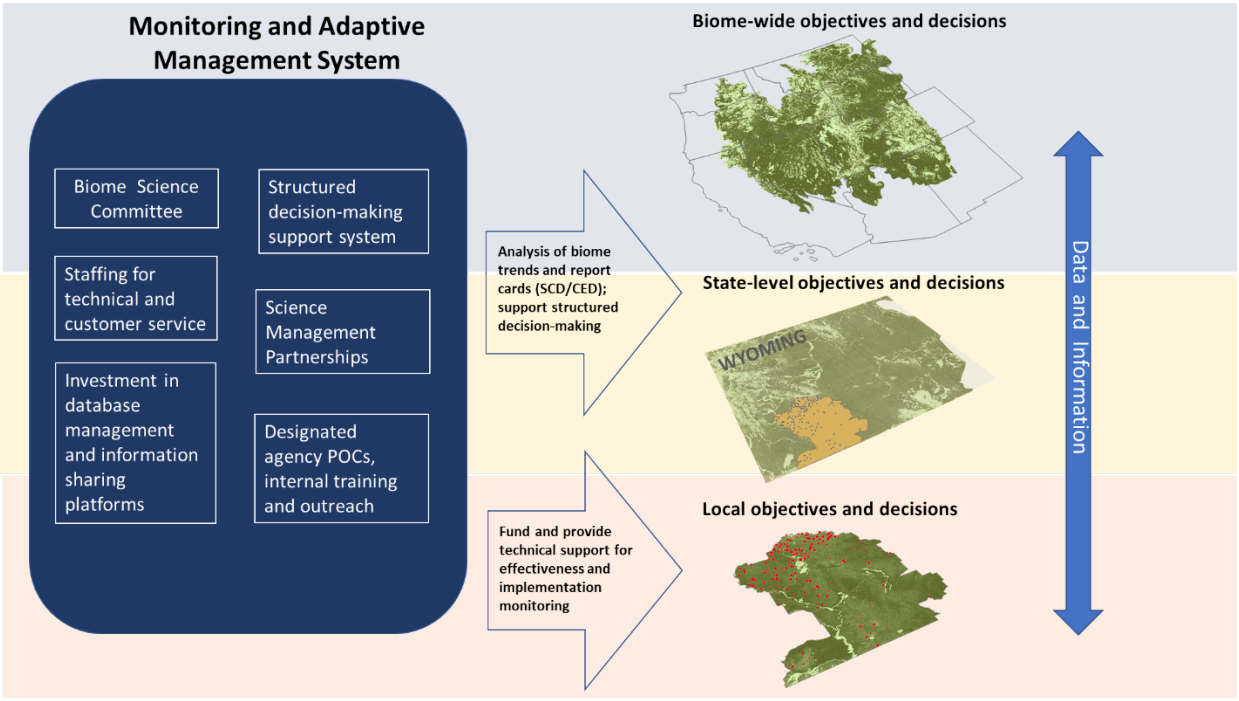


Figure C1. Depiction of how local and broad scale monitoring informs a structured decision support system which informs local and broad scale decision making.

Dispersed decision making

Our strategic approach to implementing an adaptive management and monitoring construct for the sagebrush biome also reflects that decision-making in the sagebrush biome is dispersed across numerous governmental and non-governmental entities, each with their own interests and objectives. For instance, both the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) are mandated to manage for multiple use and sustained yield, the National Park Service's (NPS) mandate emphasizes preservation and recreational use, and the U.S. Fish and Wildlife Service (USFWS) National Wildlife Refuge System is directed to prioritize wildlife conservation above other uses. State agencies also have management-relevant legal mandates and policies that, while sharing many commonalities, often vary in their details and priorities. While biome-scale monitoring datasets and structured decision-making processes outlined below are relevant for decision-making within distinct management institutions, many decisions, particularly at local scales, will require context-dependent monitoring approaches tailored to specific goals and objectives. Indeed, monitoring is most effective when it is designed to advance key agency mandates and is supported by policy and funding.

Implementing an adaptive monitoring system

Given these considerations, a strategic approach is advanced where decision making relative to sagebrush conservation remains dispersed and within the discretion of responsible officials or individuals, but is coordinated around common objectives and landscape prioritization and monitoring frameworks (SCD, see **SCD framework**.), and informed by context-dependent monitoring approaches. An attempt is made to balance jurisdictional differences in monitoring that support state or agency management needs with standardized approaches for monitoring and data management that can support "all-lands" coordination for sagebrush conservation across scales.

Two fundamental scales are differentiated, broad and local, for monitoring and adaptive management based on available and applicable datasets, monitoring strategies, and the decisions they support. The broad scale extends from the sagebrush biome extent down to the mid-scale (states), and broad-scale monitoring encompasses datasets and approaches that are important for informing strategic resource allocation decisions, and coordination for all-lands sagebrush conservation. Local scale refers to the sub-state scale at which local planning and management activities occur, such as BLM Field Offices and planning areas, counties, and HUC watersheds. These two monitoring scales are linked together through their associated outcomes (Fig. C2). Key datasets and approaches are highlighted at these different scales in the sections below. These approaches recognize that monitoring implementation should be adaptive: additional datasets and monitoring approaches will be identified over time in response to changing social and environmental conditions; new management objectives and questions will arise; and methodological and technological innovations will occur.

Monitoring implementation should be adaptive: additional datasets and monitoring approaches will be identified over time in response to changing social and environmental conditions; new management objectives and questions will arise; and methodological and technological innovations will occur.

Monitoring to support broad-scale decisions

Ecological Integrity Monitoring. The purpose of broad scale monitoring is to assess the current status and trends in sagebrush ecological integrity, and to track progress against objectives. The SCD Report Card (see Chapter A), augmented by other remote sensing products such as the Range-wide Analysis Platform (RAP) or the Rangeland Condition Monitoring, Assessment, and Projection (RCMAP) datasets, can serve as the primary broad-scale monitoring component for the sagebrush biome. It can report out changes annually in the amount of Core Sagebrush Areas, Growth Opportunity Areas, and Other Rangeland Areas, and attribute changes to stressors. It can be re-scaled from biome-wide to state, ecoregion, district, or other landscape designation.

Implementation Monitoring. Tracking conservation efforts within the sagebrush biome is essential for many reasons, including accountability for conservation commitments and management actions. For our purposes, implementation information will be obtained from the Conservation Efforts Database (CED, accessible at: conservationefforts.org). This is a spatially explicit database of conservation actions undertaken within the sagebrush biome that is widely utilized by state and federal agencies and NGOs. The CED efficiently captures data related to conservation actions and plans being implemented on public and private lands throughout the sagebrush ecosystem.

Spatial information entered into the CED is linked to one or more threats driving sagebrush habitat loss and degradation. The CED collects data from disparate datasets and summarizes it into a 'common currency' to help evaluate effectiveness at multiple scales. The CED is an important tool, along with scientifically rigorous, post-conservation monitoring, for implementing landscape-scale adaptive management. The CED has an interactive map feature that displays other spatial information to provide context for conservation planning. The data collected in the CED will directly inform the SCD Report Card by providing information on the rates of implementation and potential gain to offset sagebrush loss and degradation. This dataset can also be used to evaluate where conservation actions for sage-grouse are

having population-level responses through integration with the Targeted Annual Warning System[10]. Spatially explicit information on conservation actions captured in the CED is also an essential input, along with the effectiveness of these actions, into the Sagebrush Trends Model discussed below.

Wildlife Monitoring. While the SCD report card represents a "coarse-filter" approach to ecosystem monitoring, it is important to continue and potentially expand "fine-filter" monitoring of sagebrush obligates and sagebrush-associated species of conservation concern that rely on niche habitats, or which may be declining for reasons unrelated to the quality or amount of sagebrush habitat tracked by the SCD. These include greater sage-grouse, pygmy rabbits, and migratory songbirds. At ecoregional or state scales there are many other species of greatest conservation need that may warrant monitoring. A review of information gaps and monitoring needs is therefore recommended.

Monitoring to support local decisions

Monitoring and adaptive management strategies at local landscape scales are both linked to and distinct from broad-scale monitoring and adaptive management strategies. Broad-scale spatial products and monitoring datasets such as the SCD or the sage-grouse hierarchical monitoring framework are highly relevant for planning and decision-making at local landscape scales. However, integrating these products and datasets with field-based quantitative and qualitative monitoring information, local measures of ecological integrity, and local ecological knowledge is essential. At the same time, monitoring data related to project implementation and management effectiveness will need to be "rolled up" to evaluate progress towards biome or state level objectives. Ensuring that project treatment data is entered into the CED is therefore essential across jurisdictions and ownerships. However, because management activities are typically implemented within specific jurisdictions, management effectiveness monitoring strategies will inherently involve standardized approaches utilized by specific agencies (for example, BLM's AIM Program and Indicators of Land Health Framework) or private actors (for example, Land PKS). Given the high cost and significant expertise needed to implement effectiveness monitoring at local scales, prioritizing when and where to collect additional monitoring data and/or utilize research-management partnerships is critical. Figure C2 shows how broad-scale monitoring is linked with local landscape-scale monitoring through various intermediary products including developing the SCD report card, conducting research, engaging with partners and implementing conservation actions. It also describes a monitoring decision tree that can be particularly useful in determining when effectiveness monitoring should be employed or whether other actions are needed.

Given the high cost and significant expertise needed to implement effectiveness monitoring at local scales, prioritizing when and where to collect additional monitoring data and/or utilize research-management partnerships is critical.

[10] Coates, P.S., Prochazka, B.G., O'Donnell, M.S., Aldridge, C.L., Edmunds, D.R., Monroe, A.P., Ricca, M.A., Wann, G.T., Hanser, S.E., Wiechman, L.A., and Chenaille, M.P., 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, 243 p. [Also available at https://doi.org/10.3133/ofr20201154]

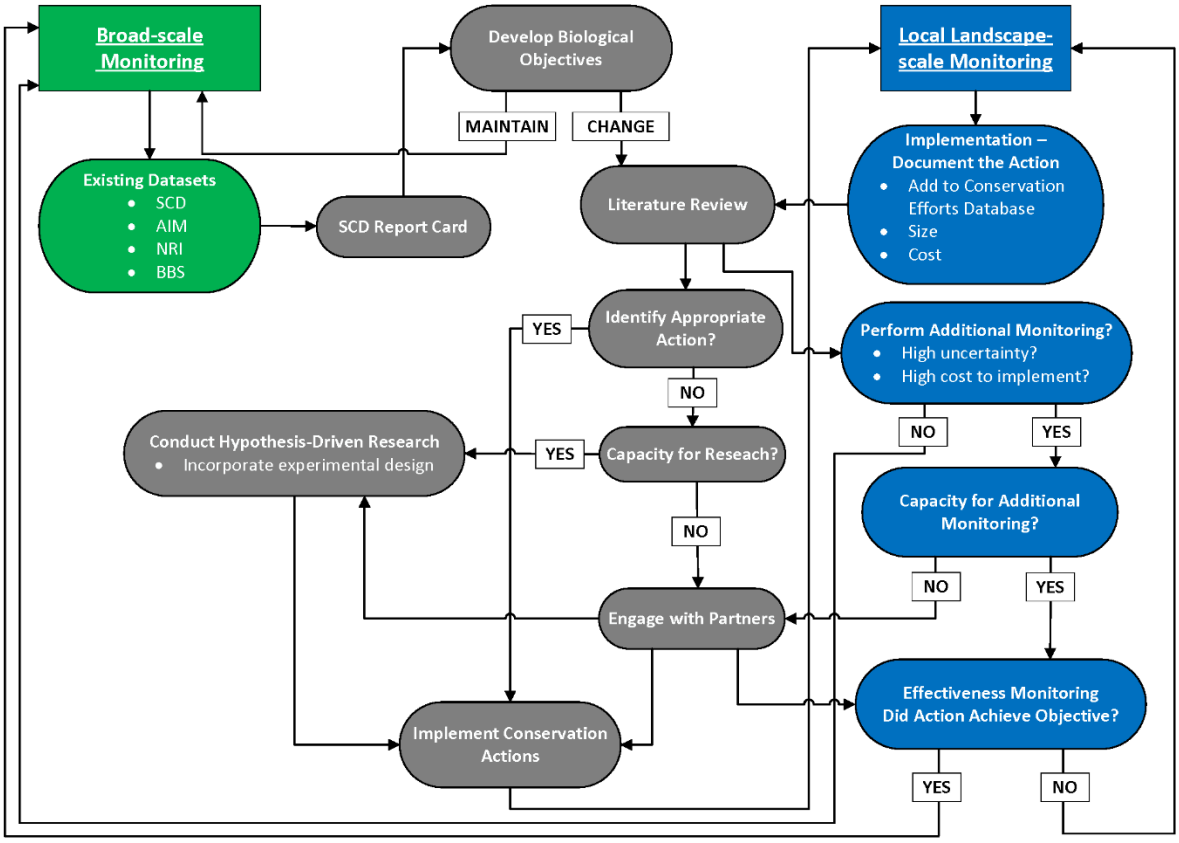


Figure C2. Decision tree to aid in making monitoring efficient and effective.

Structured decision-making support system

The SCD Report Card can report out annually on relative progress in meeting conservation objectives to retain or grow sagebrush cores, but we can evaluate the feasibility of, and relative conservation investment needed to achieve conservation goals, only if we can estimate future gains and losses to the biome. This will require understanding or prediction of conservation efforts necessary to defend Core Sagebrush Areas (CSAs), enhance Growth Opportunity Areas (GOAs), ensure connectivity between these areas, and ensure CSAs and GOAs are durable under a changing climate. The SCD Report Card estimate of rate of past CSA losses can be a first approximation of loss into the future, but trend models should be refined via spatial statistical modeling to project losses further into the future. For example, remaining CSAs and GOAs likely do not have the same spatial risk profile to landscape level threats such as fire, invasive annual grasses, and human modification (such as cropland conversion) as areas that have already been lost. Therefore, conservation planning efforts could be more precise if modeled spatial variation is incorporated into future efforts. Lastly, we need to understand the durability of our conservation design to climate change. Specifically, we need to know where climate induced changes are predicted to occur and how climate change will affect trends in this ecosystem.

Support for adaptive monitoring and adaptive management programs and structures

Multi-scale monitoring and adaptive management are costly and challenging to implement. They require significant investment in human, financial, and technological resources--and carefully structured social and technical processes. One key recommendation for implementing the monitoring and adaptive management strategy is investment in dedicated staff who can provide customer service, outreach, and

technical support around the use of the SCD and CED—two fundamental datasets for establishing objectives and evaluating progress over time. A model for such a staffing structure is found in the Southeast Conservation Adaptation Strategy (SECAS; see Case Study 1). SECAS utilizes a staff of 14 Fish and Wildlife Service employees to provide technical support and customer service to state agencies, NGOs, and private landowners around the use of the SECAS Conservation Blueprint. This is a geospatial product that identifies conservation priorities across the Southeast, and that can generate monitoring reports for end-users that integrate diverse datasets. An investment in staffing to maintain and support the expanded use of the SCD and of the CED among diverse partners will be particularly important for evaluating progress towards achieving conservation objectives.

Another recommended investment is in centralized and user-friendly online platforms that can promote data and information sharing related to sagebrush conservation. Such a platform could integrate or link to relevant datasets and monitoring information, and provide resources and technical assistance to sagebrush conservation partners. SageDAT, created by a USGS-led collaborative, is a data-sharing platform that provides users access to publicly available data relevant to the sagebrush biome, curated collections, including a collection for the Conservation Strategy, and a catalog of web-based decision support tools and databases (can be accessed at: SageDAT). The development of Integrated Data Platforms can be streamlined and facilitated by a collective dedication to data sharing among public agencies, and investment in staffing and adoption of policies for integrating agency datasets.

Given the technical expertise needed to implement robust monitoring and adaptive management strategies, investment in collaborative science-management partnerships is also recommended. Science-management partnerships are essential for leveraging technical innovations in data collection, data management, and analysis that can support broad-scale assessment and monitoring. At local scales, science management partnerships are often critical for the implementation of robust adaptive management strategies that reflect local objectives. Financial and technical support for collaborative monitoring efforts, the use of threat-based decision-making frameworks, knowledge sharing initiatives, and communities of practice are also recommended for supporting adaptive decision-making at local scales. However, given the cost involved, such investments cannot be made everywhere.

To coordinate and prioritize strategic investments in monitoring and adaptive management, we recommend creating a sagebrush biome science advisory committee. The science advisory committee could be staffed with senior research scientists and experts from federal and state agencies, and NGOs, and would be responsible for supporting objective setting, coordinating science-management partnerships, identifying key research and information gaps related to monitoring, and prioritizing strategic investment in data management, staffing, and adaptive management at local scales.

To coordinate and prioritize strategic investments in monitoring and adaptive management, we recommend creating a sagebrush biome science advisory committee.

Chapter D. Sagebrush Partnerships

By, Melanie Knapp,[1] Monique Mullenaux,[1] Dana Goodson,[1] Brett Brownscombe,[2] Cristina Eisenberg,[3] Thomas E. Remington,[4] Patricia Deibert,[5] Karen L. Prentice,[6] Ali Duvall,[7] San Stiver,[4] Kenneth E. Mayer,[4] Shawn Johnson,[8] Tomer Hasson,[9] Brian Rutledge,[10] Susan Hayman[11]

[1]National Center for Environmental Conflict Resolution, Udall Foundation
[2]Portland State University
[3]Oregon State University
[4]Western Association of Fish and Wildlife Agencies
[5]U.S. Fish and Wildlife Service
[6]U.S. Department of the Interior, Bureau of Land Management
[7]Intermountain West Joint Venture
[8]University of Montana
[9]The Nature Conservancy
[10]National Audubon Society
[11]Ross Strategic

Introduction

The continued steep declines in Core Sagebrush Areas and in sagebrush obligate species such as greater sage-grouse suggest a need to increase conservation efforts beyond those developed after 2010 in response to the greater sage-grouse listing petition. Responsibility and authority to address threats to the biome such as fire, invasive annual grasses, and oil and gas and other energy development is spread across Federal and State government agencies, Commissions, and counties. This fact, plus the conservation capacity of local communities invested in sagebrush and the ecosystem services it provides suggests these increased conservation efforts would be more effective if they were better coordinated across those with authority and responsibility and those stakeholders affected by the outcomes.

Recognizing the need for better coordination of landscape scale conservation efforts, the Association of Fish and Wildlife Agencies created the President's Task Force on Shared Science and Landscape Scale Conservation in 2016. This group produced a resolution passed by the AFWA Executive Committee in 2018 that recommended eleven guiding principles for landscape scale wildlife conservation (available at AFWA_Resolution_on_Landscape_Conservation-2018_FINAL-updated.pdf (fishwildlife.org), among them:

1. Landscape-scale conservation partnerships should consider a governance model that includes a steering committee or board of directors made up of state fish and wildlife agency directors and leaders of federal agencies or their designees that can set policy and when appropriate include private landowners, private conservation organizations, tribes, academic institutions and other diverse stakeholders to optimize conservation outcomes.
2. Landscape-scale conservation partnerships should seek to conserve ecological integrity that supports healthy and functioning natural communities and working landscapes that conserve fish and wildlife, particularly species of greatest conservation need.

3. Landscape-scale conservation partnerships are complex and require trust, a dedicated coordinator, technical and science development staff and communication expertise. Regular communication from top-to-bottom and bottom-to-top should be a priority.
4. Landscape-scale conservation partnerships should agree on a long-term vision and goals and clear, specific, practical and measurable objectives, performance measures and outcomes to guide work and ensure accountability.
5. Planning, funding and implementing on-the-ground conservation is important to the success of landscape-scale conservation partnerships and should recognize the important role of private landowners, nonprofit organizations and other stakeholders in achieving collaborative and cost-effective outcomes. Technical and management staff from governmental and non-governmental organizations should help direct and deploy implementation.
6. Landscape-scale conservation partnerships should develop and use the best available applied science that is shared, transparent and collaboratively obtained.
7. When possible, landscape-scale conservation partnerships should build upon existing landscape conservation planning and management initiatives undertaken by Migratory Bird Habitat Joint Ventures, Landscape Conservation Cooperatives, watershed organizations and similar partnerships.

A Final Report from this Task Force[11] reaffirmed these guiding principles and also recommended that "new and existing regional partnerships establish strong structural and operational relationships with their regional AFWAs (Associations of Fish and Wildlife Agencies, for example, Western Association of Fish and Wildlife Agencies [AFWA], and that these partnerships work collaboratively with the regional associations to identify and promote shared science priorities and conservation actions."

One example of a landscape scale conservation partnership hosted by a Regional Wildlife Association is the Southeast Conservation Adaptation Strategy (SECAS, see Case Study 1), a regional conservation initiative spanning the Southeastern United States and Caribbean. SECAS was started in 2011 by the states and territories of the Southeastern Association of Fish and Wildlife Agencies (SEAFWA) and includes the federal agencies of the Southeast Natural Resource Leaders Group (SENRLG). SECAS recently established a quantitative and time-stamped goal of 10% or greater improvement in the health, function, and connectivity of Southeastern ecosystems by 2060. It's primary planning document, the Southeast Blueprint stitched together a series of smaller subregional plans. SECAS is embarking on a new approach that uses consistent methods and indicators across the vast majority of the Southeast. WAFWA could, in a similar fashion, create a broad umbrella partnership structure to oversee and better coordinate all of its conservation efforts, including the Sagebrush Initiative, Western Grassland Initiative, Western Native Trout Initiative, Wild Sheep Initiative, and efforts related to conserving Migration corridors.

WAFWA, in partnership with BLM, and the John S. McCain III National Center for Environmental Conflict Resolution, (National Center), part of the Udall Foundation explored the concept of a sagebrush network governance (hereafter, partnership) structure. As part of these efforts, the National Center, working in coordination with a Core Team consisting of representatives from WAFWA, IWJV, BLM, USFWS, and the

[11] Mawdsley, J. R., Scott, D. P., Johansen, P. R., and Mason, J. R. (eds.), 2020. AFWA President's Task Force on Shared Science and Landscape Conservation Priorities: Final Report. Association of Fish and Wildlife Agencies, Washington, D. C. 74 pp

University of Montana, conducted a situation assessment (*Sagebrush Biome Partnership Governance Assessment,* available at*:* *Sagebrush Conservation Strategy – WAFWA*) of individuals from NGOs, user groups, and Tribal, Federal, and State agencies to identify the needs, issues, priorities, and obstacles associated with a sagebrush biome partnership. Not surprisingly for such a diverse group, support for a partnership governance structure ranged from strongly enthusiastic to opposed, but the most common response was supportive with caveats. Caveats primarily focused around respecting jurisdictional authorities and maintaining local autonomy. Other themes heard from assessment interviewees highlighted the need for continuity, increased and dedicated resources and staffing, the need for broad participation at all levels and coordination across scales, the need to build on successes while also leaving room for innovation, and attention to data, monitoring, and landscape prioritization.

The National Center also completed a research report (*Review of Models for Sagebrush Biome Partnership Governance; available at Sagebrush Conservation Strategy – WAFWA)* that reviewed and provided lessons learned from other large landscape collaborative partnership models. These lessons learned from successful partnerships closely aligned with the AFWA guiding principles listed above. They included attention to goals and measurable impact - having a compelling vision and agreed-upon quantitative goals that are viewed within the larger system context to appropriately evaluate their success. In addition, successful partnerships have an effective system to track and report on progress as well as adjust goals and management approaches over time, balanced and inclusive representation, access to needed knowledge and scientific or technical information, sufficient and sustainable funding, dedicated leadership and staffing, a structured approach to decision-making and conflict resolution, attention to relationship building and incentives for involvement at all partnership scales.

Lessons learned…included attention to goals and measurable impact - having a compelling vision and agreed-upon quantitative goals that are viewed within the larger system context to appropriately evaluate their success.

Sagebrush Partnership Model Development

Following the assessment and research reports, facilitation team members from the National Center and Ross Strategic guided sagebrush biome stakeholders and Tribal partners through a collaborative process from March to July 2021 to develop the potential partnership models best suited for conservation efforts in the sagebrush biome. Methods, participants, and findings are fully described in a Final Report (*Sagebrush Partnership Model Development Final Materials*; available at: *Sagebrush Conservation Strategy – WAFWA*).

Participants were first asked to identify biomewide and midscale functions desired from a partnership structure (see Functions Tables D1 and D2 at the end of this chapter). The Drafting Work Group then constructed alternative models that could accomplish these functions based on input or support from the assessment interviewees, Partnership Models Report, Advisory Group members, and workshops. These models are intended to stimulate thought and discussion and serve as a starting point for decision makers to develop a partnership structure in concert with stakeholders. Although we show linkages from biome and mid-scale structures to the local level, we did not describe partnership structural

options at the local (community or project level) scale because of a broad consensus for the partnership to support and facilitate conservation actions at that scale but maintain autonomy and independence at that level.

*Option assumptions and guiding principles***.** The options developed for a partnership structure at biome-wide and mid-scales assume those responsible for - or deeply committed to - sagebrush conservation would stand up these structures, namely State and Federal agencies, NGOs, and Tribes. All these entities have strengths in collaborative conservation, and we view all these models as potentially viable approaches to improving coordination and enhancing effectiveness. The models are presented as independent alternatives but any of these biome-wide alternatives could be paired with any of the mid-scale options or potentially integrated into more hybridized concepts.

All the models assume substantial additional funding for sagebrush conservation in the future. A significant function of this partnership and these structures is to distribute those funds from the biome-level through the mid-scale to local communities and projects in a manner that maximizes probability of achieving mid-scale and biome-wide scale conservation objectives. There is strong concurrence among all participants that additional funding (and related partnership coordination) is necessary to conserve sagebrush so that we can continue to derive ecosystem services from it and keep sagebrush obligates like greater sage-grouse and pygmy rabbits off the Endangered Species List. The ability for partners to obtain or leverage additional funding through the partnership is also a strong and needed incentive for participating in the partnership. Historically for large-scale conservation efforts, this funding has been Federal and Congressionally appropriated from a variety of sources. It is anticipated that all partners including industry, NGOs, and State and Local Governments will contribute significant funding and other conservation capacity to sagebrush conservation in the future.

These partnership models are designed to enhance and improve effectiveness of voluntary, collaborative conservation efforts, and are not intended to substitute for regulatory aspects of government agencies such as issuance of permits for grazing, oil and gas development, mining, or renewable energy development permitting by State, Federal, Tribal, or Local Governments, etc. There is a hope, however, and perhaps an expectation, that with an improved understanding of human and wildlife needs from the sagebrush system and the threats to that system, along with common objectives for conservation, that some of these positive conservation aspects will "spill-over" and indirectly impact how agencies at all levels approach threats to sagebrush.

Partnership models are designed to enhance and improve effectiveness of voluntary, collaborative conservation efforts, and are not intended to substitute for regulatory aspects of government agencies.

To the extent possible and practical, we sought to use existing conservation structures rather than create new ones and believe the structure that is implemented should build on and integrate successful aspects of existing effective conservation models (such as the Utah Watershed Restoration Initiative [see Case Study 2], Oregon's SageCon [see Case Study 4], the Wyoming Sage-grouse Implementation Team [see Case Study 6], the Sage-grouse Initiative, etc.).

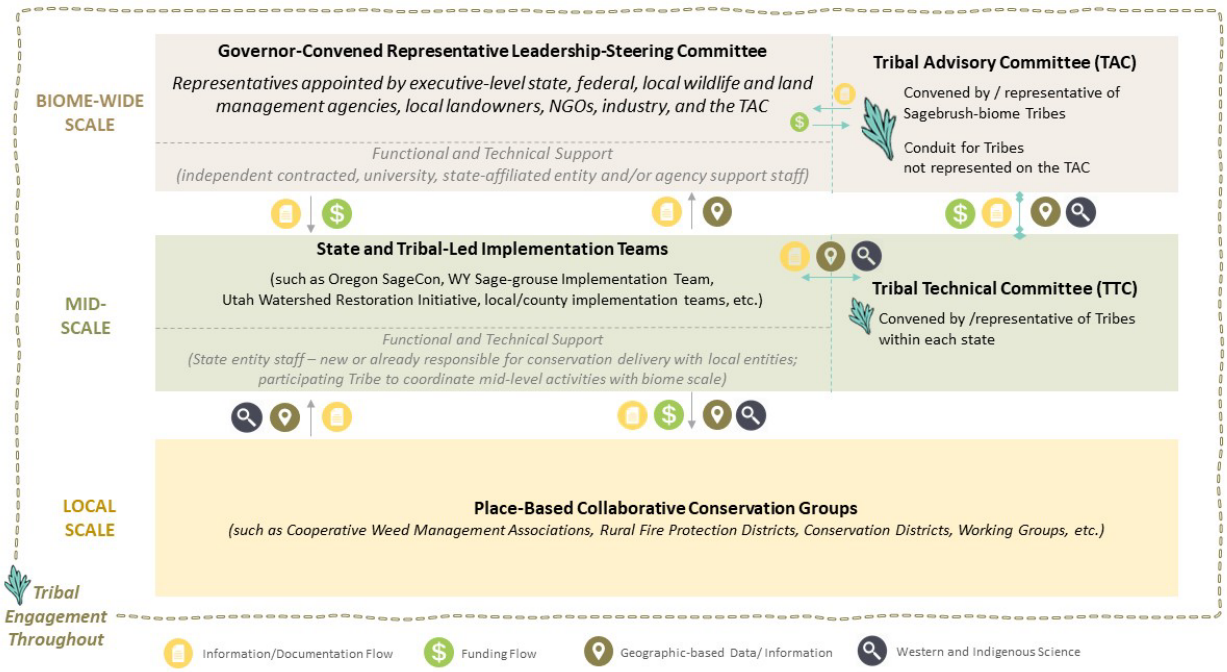
Option 1: Governor-led

In this model, Western State governors and Tribal leaders convene the biome-wide coordinating committee and governors and Tribal leaders from each State would establish a Sagebrush Conservation Coordinating Committee as well as State/Tribal Implementation Teams that function at the mid-scale. Representation on these groups would be diverse, broadly representing stakeholders and those in a position to address threats. Presumably, in States that already have programs in place for sage-grouse or watershed conservation (Oregon SageCon, Utah Watershed Restoration Initiative, Wyoming Sage-Grouse Implementation Team, etc.), these programs, with slight modifications to increase diversity of representation and focus (sagebrush vs. sage-grouse for instance) could serve as the mid-scale coordinating and/or implementation team. In this model, governors and Tribal leaders, with Federal representation and support, would oversee sagebrush conservation objective setting, planning, and implementation, including monitoring and adaptive management, at the biome and State/Tribe level. Decisions about how best to allocate Congressionally appropriated funding would be made by the Sagebrush Biome Conservation Coordinating Committee consistent with objectives and plans they develop, and distributed (and matched to some degree) through States and Tribes.

Advantages: This model recognizes that Governors and Tribal Leaders as CEOs of their State or Tribe are the ultimate conveners and can compel participation and increase the attention their State or Tribe pays to threats to sagebrush. Governors and Tribal Leaders oversee Departments and/or Commissions responsible for oil and gas and renewable energy permitting, mining and mine reclamation, noxious weeds (including invasive annual grasses), fire suppression, and management of State or Tribal lands and wildlife. State or Tribal response to many/most of the significant threats to sagebrush aggregate at the level of Governor or Tribal Leader, and this broad authority and influence lend credence to an invite to participate, so level of participation likely to be high ranking individuals. This is a natural extension for those States and Tribes with active programs to conserve sagebrush landscapes and takes advantage of existing strong connections to local communities at the State or Tribal level.

Disadvantages: Governor/Tribal Leader dominance at the biome scale diminishes Federal involvement and potentially impact, a serious concern when well over half the sagebrush occurs on Federally owned or administered lands. There may be a tendency to develop 13 (or more if Tribes develop independent plans) different sagebrush plans and objectives and presume the sum of those cumulatively conserves sagebrush which is very unlikely to be the case. Maintaining focus and continuity over time may be difficult with elected officials, given frequent turnover and the inevitably of priorities and policies shifting with each new administration. There is no regional planning or coordinating structure in this model above the State level, which may impede, or at least reduce the incentive for a coordinated response across States and Tribes to regional issues such as the invasive annual grass and fire cycle in the Great Basin.

Conceptual Wireframe Model #1: Governor-Convened Representative Group



Option 2: NGO-led

Conservation NGOs would convene the biome-wide Sagebrush Conservation Coordinating Committee and provide staffing at the biome level. It is unlikely any single existing NGO will take this on alone, given the scope, scale and complexity of the conservation needs and the potential for this to compete for, rather than complement existing funding. A new non-profit NGO focused specifically on sagebrush conservation could be formed. Representation on this Coordinating Committee would be broad as well, and this group would develop biome-wide conservation goals and priorities, develop and administer a monitoring and adaptive management construct, and make decisions about distributing funding to local scales after a review of rankings and priorities established at the mid-scale. A Congressional appropriation directly to this group is possible, as are obtaining other funds through grants, charitable contributions, member contributions, mitigation banking, etc.

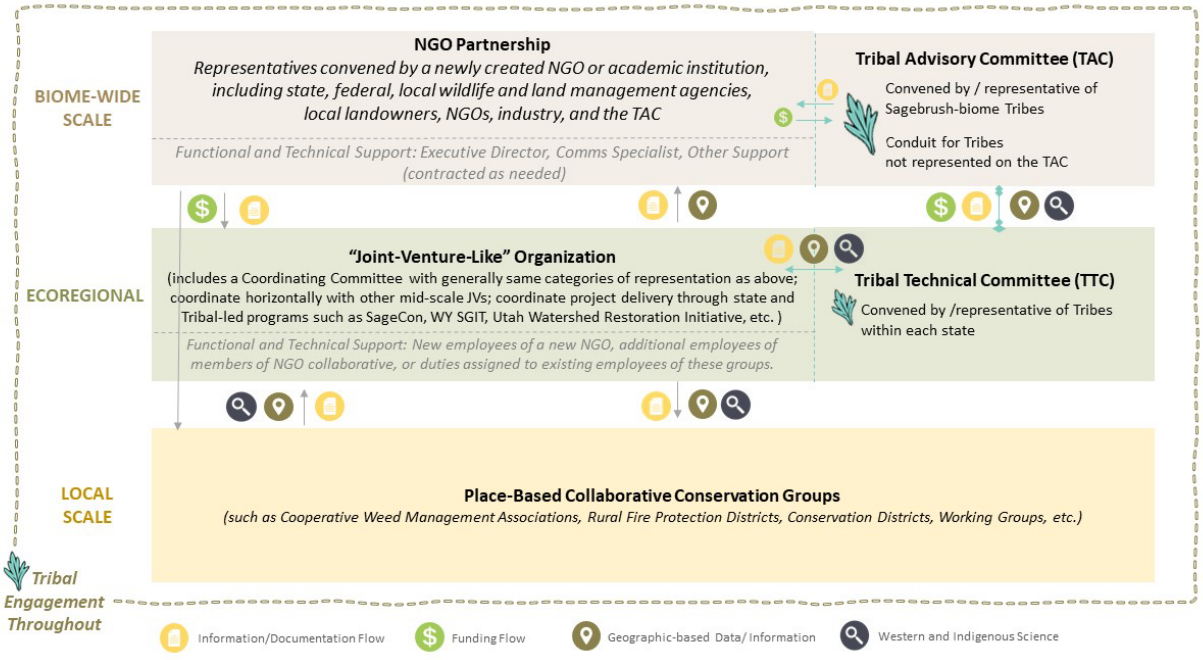
This model has a split mid-scale, a regional or ecoregional group (several States, constructed around ecological or sociological aspects of sagebrush conservation, or both) to develop regional objectives and priorities that step down from the biome-wide objectives and priorities and to evaluate and rank proposals submitted from local scales against those objectives and priorities. The other mid-scale structural component is a State/Tribal implementation group that would be responsible for administering conservation grants to local entities. Again, in States that already have programs in place for sage-grouse or watershed conservation (Oregon SageCon, Utah Watershed Restoration Initiative, Wyoming Sage-Grouse Implementation Team, etc.), these programs, with slight modifications to increase diversity of representation and focus (sagebrush vs. sage-grouse for instance) could serve as the mid-scale implementation team.

Advantages: NGOs can move quickly and respond nimbly to challenges, more so than Government can for a variety of reasons. An NGO-led Coordinating Committee is probably the most likely to develop

strong, litigation-proof objectives and priorities for sagebrush conservation since they are relatively free of political pressures. Similarly, assuming this new NGO entity is viewed as a 3rd party neutral advocating for sagebrush and human uses/needs from that landscape, this model may be relatively freer of partisan influences to derail it. Turnover of staff within this model, assuming equitable pay, is likely to be low. This structure may facilitate interaction and coordination from biome through mid to local scales given that many of these NGO groups that may form this new entity already have staff stationed in State offices or local communities. It may be easier for an NGO to raise funds than for a government entity as people may be reluctant to contribute to the government.

Disadvantages: State, Federal, Tribal and industry reps will likely participate in Coordinating Committees established by an NGO group at biome and mid-scales because of the importance of the issue and consequences if we don't act. However, the level of representation from these groups may be lower than if a Governor and Tribal Leader or the Secretary of Interior or Secretary of Agriculture were to ask. Congress may be reluctant to appropriate funding directly to a new NGO collaborative without a proven track record. With more staff level participation, the potential for objectives and priorities to bleed over into agency/Tribal regulatory actions will be reduced.

Conceptual Wireframe Model #2: NGO Partnership



Option 3: Federal Government led

This option is probably the most traditional, and in many respects resembles the structure used to implement the North American Waterfowl Management Plan and administer funding under the North American Wetland Conservation Act. It envisions a Federal entity developing and maintaining a biome-wide Steering Committee with diverse representation. This Steering Committee would set policy, including establishing biome-wide goals for sagebrush conservation and identifying priority areas for conservation. This group would approve distribution of Federal funds to local projects based on rankings established at the mid-scale. Several options make sense for which Federal entity coordinates the

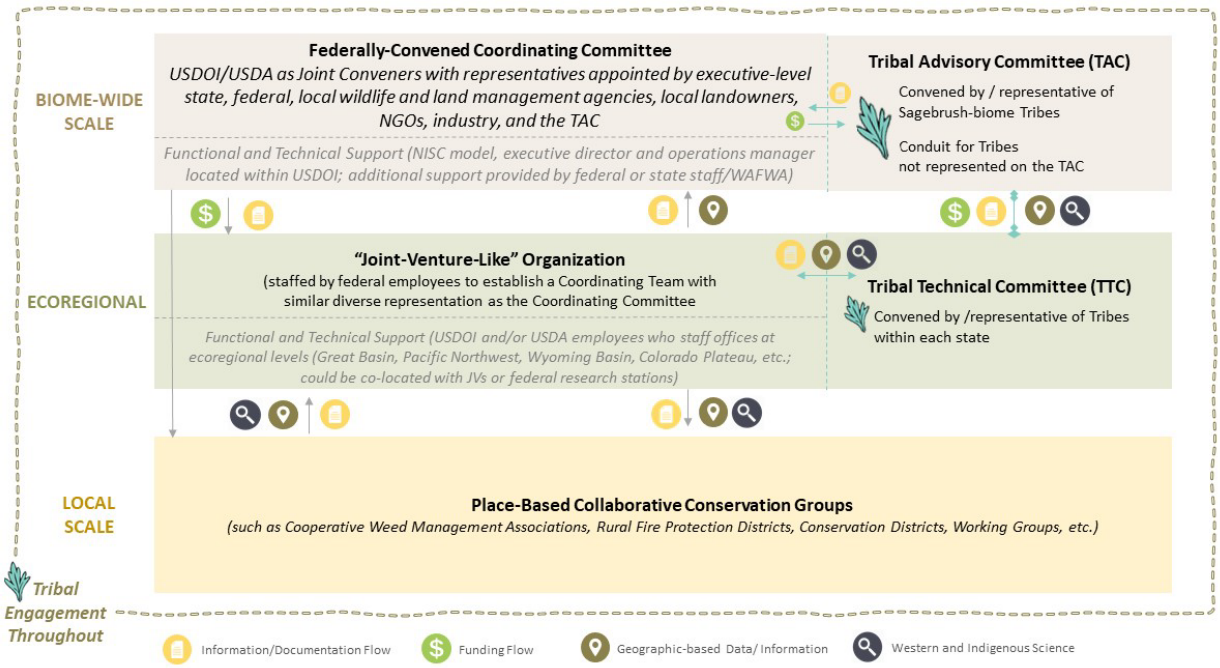
biome-wide partnership effort, including the U.S. Fish and Wildlife Service (USFWS), the Bureau of Land Management (BLM), USDA's Natural Resource Conservation Service (NRCS), and the National Fish and Wildlife Foundation (NFWF). Alternatively, in recognition that authorities and responsibilities are vested within and across agencies of both USDI and USDA, a partnership effort could be housed in one or the other and supported by an MOA between these Departments.

This model also has a split mid-scale, a regional or ecoregional group (several States, constructed around ecological or sociological aspects of sagebrush conservation, or both) to develop regional objectives and priorities that step down from the biome-wide objectives and priorities and to evaluate and rank proposals submitted from local scales against those objectives and priorities. The other mid-scale structural component is a State/Tribal implementation group that would be responsible for administering conservation grants to local entities. Again, in States that already have programs in place for sage-grouse or watershed conservation (Oregon SageCon, Utah Watershed Restoration Initiative, Wyoming Sage-Grouse Implementation Team, etc.), these programs, with slight modifications to increase diversity of representation and focus (sagebrush vs. sage-grouse for instance) could serve as the mid-scale implementation team.

Advantages: Biome-wide scale structure could be stood up relatively quickly and managed very competently by Federal agencies if there is high enough level support given their experience in these areas and their size. The Landscape Conservation Cooperatives are both an example of this, and a cautionary tale that both support from collaborators for this structure and additional dollars for conservation delivered through the partnership are necessary components. This partnership structure keeps administration of Federal funding at biome-wide scale within Federal oversight and takes advantage of structures/systems already in place to deliver grants to mid and local scales.

Disadvantages: Federal oversight means sagebrush conservation efforts have some potential, unless mandated explicitly by Congress, to wax and wane with changes in administrations. Federal agencies with regulatory responsibilities (USFWS – ESA, Migratory Bird Treaty Act, etc.; BLM – Mineral right leasing, grazing and other land use permitting, etc.) may be put in awkward positions when regulatory and voluntary, collaborative conservation aspects conflict.

Conceptual Wireframe Model #3: Federally Convened Coordinating Committee



The participants in the partnership models development process have expressed the hope that these products will be a springboard for further discussion among the larger sagebrush community about the formation of collaborative partnerships, followed by decision-making around forming partnerships.

Table D1. ELEMENTS OF PARTNERSHIP STRUCTURE IN COMMON ACROSS OPTIONS	
Tribal Engagement	For the biome scale, create a Tribal-convened Tribal Advisory Committee (TAC) [initially convened by Confederated Salish and Kootenai Tribes or another Tribe with similar capacity], composed of Tribal representatives currently active in sagebrush conservation across the biome. The TAC will choose and accept a facilitator who is Native American. The purpose of the TAC is to provide the biome-level partnership table with advice and recommendations, and to serve as a conduit to and from Tribal Nations not represented on the TAC. Mid-scale Tribal representation would be accomplished through the creation of a Tribal Technical Committee (TTC), initially convened by each State, to invite participation from one representative from all the Tribes in the State as they have interest and capacity in doing so. Group members will be currently active in sagebrush conservation across the biome, with associated technical skills. The TTC will choose and accept a facilitator who is Native American. The purpose of the TTC is to provide mid- scale level advice to the TAC, and to serve as a technical conduit to individual Tribal Nations not represented on the TTC.
Diverse Representation	The partnership structure tables at the biome and mid-scales would include representation from Tribes, commercial business, industries, WGA, State and Federal wildlife and land management agencies, conservation NGOs, policy-level decisionmakers, Local/county representatives, and landowner interests. Level of agency representation may vary by option / model, see below. State, NGO, and potentially Tribal representation may need to rotate for a manageable size.
Level of Representation	At biome scale, there is a continuum of options from (a) top executives of departments, NGOs, Tribes, etc., (Secretary of USDOI, USDA, governors, etc.,) to (b) agency and NGO heads (Director of BLM, Director of USFWS, Director of Nevada Department of Wildlife) to (c) senior management levels of agencies, NGOs, and Tribes (Under Secretary of Interior for Lands and Minerals, BLM Wildlife or Lands Chief, Assistant Director for Habitat, Nevada Department of Wildlife, etc.) to (d) appointees designated by any level described here. Input is needed on which of these options (or integrated combinations) is most desirable. At mid-scale, representation would fall to appropriate regional leadership (Regional Director of USFWS or designee, State Wildlife Agency Director or designee, etc.).
Project Funding	Funding provided at Federal level on an annual or earmark basis (Congressional appropriation with integration into Federal budget process). This would be “new” funding. Anticipate other funding sources/in-kind funding opportunities from partners at all scales (e.g., State, NGO, private), as well as a cost-share requirement to match Federal dollars for conservation projects. A mechanism is needed to provide gap funding until a more established funding mechanism is in place. A redirection of existing conservation funds to this “higher need” by Federal and State agencies and NGOs, supplemented with conservation grant funding, could serve as seed money to get this off the ground while also moving the needle on sagebrush conservation.

Table D1 (cont.). ELEMENTS OF PARTNERSHIP STRUCTURE IN COMMON ACROSS OPTIONS	
Science, Technical, Communications Support	A team of scientific and biome-wide experts (Science Advisory Committee) or other means (contract with USGS, university, etc.) of obtaining GIS support, other technical support, and inputting new science and data into planning and adaptive management constructs (including monitoring) over time will be necessary, particularly at the biome scale. Communications, both external and within the Sagebrush Partnership, is also a needed function that could be handled through a Communications Support Team formed from participating entities or be assigned to partnership staff. The intent is that science, technical, and communications efforts would both feed-up / be informed by the mid- and local scales as well as feed-down / inform the mid- and local scales. Science-based technical advice is essential for establishing range-wide priorities amidst political changes. Ensuring standards that reflect conditions throughout the biome, rather than biome-wide standards that don't reflect different ecologies, is critical.
Funding for Partnership Administration	At the biome and mid-scales, funding for administering the partnership table would need to be secured and would be new across all models. Funding would be provided at Federal and/or State level on an annual or earmark basis (from existing agency budgets) or through "dues"-assessed members. Like the other models, the NGO model could be a recipient of such Federal and/or State funding or "dues" funding, or it could be supported through direct capacity building grants (from the philanthropic or government sector) at the startup, eventually shifting to indirect on pass-through grants or State-Federal funds.

Table D2. ELEMENTS OF PARTNERSHIP STRUCTURE THAT VARY ACROSS OPTIONS				
Role	**Description**	**OPTION 1 – Governor Convened Representative Group**	**OPTION 2 – NGO Partnership**	**OPTION 3 – Federally led Coordination Committee**
Biome Level Convener / Leadership—Steering Committee	Entity or entities that have the authority or gravitas to bring people together to a partnership table, command attention, and motivate engagement. Need not be one entity / person—could be jointly shared. "Leadership intent" to mid-scale	Governor-convened biome-level group with representatives appointed by executive level of State and Federal wildlife agencies, NGOs, industry, Tribal Nations (appointed by TAC). Options: • A set of governor's representative of different views, and capable of behaving in a bipartisan manner • Governors in partnership w/ Secretaries (Interior and Agriculture) • Governors in partnership w/ DOI, USDA, plus BIA / DOI	Biome-level coordinating group with an NGO as the convening entity (form a new NGO, rather than have an existing NGO lead). Would require: • Endorsement/support of Governors / Tribes / Federal entities • Include a strong "back out provision" • Come from an invitation or request from governing bodies or Federal agencies Options: • Retooled WAFWA as the NGO • Could be convened by a neutral party	Federal agencies convene biome-level coordinating body. USDOI/USDA as joint conveners. States help set priorities.

Table D2 (cont.). ELEMENTS OF PARTNERSHIP STRUCTURE THAT VARY ACROSS OPTIONS				
Role	**Description**	**OPTION 1 – Governor Convened Representative Group**	**OPTION 2 – NGO Partnership**	**OPTION 3 – Federally led Coordination Committee**
Biome Level "Functional Support" / process and project management	Entity that would ensure functional meeting organization, facilitation, and work getting done on behalf of partnership members between meetings; facilitate the "governance" and funding side (create the "safe space" for collaboration for all); tees up/Implements/helps inform the big picture decisions; communication and outreach specialist functions that support mid/local scale effort	Options: • Contracted entity (private independent entity or university-affiliated) • Staff from WGA or State-affiliated entity w/ capacity • Fed/State/other "career" agency staff (institutional knowledge) as well as other dedicated process-oriented/communications staff	Options: • Paid executive director, communications specialist, and support staff (grant specialist, accounting, etc.) as needed. • Contracted facilitation or process management roles	Options: • NISC model, executive director and operations manager located within the Office of the Secretary at the U.S. Department of the Interior. • Federal and/or State staff with existing agencies (or entity like WAFWA) provides support • Contract out certain roles solely dedicated to partnership
Mid-Scale Level Coordination (the role may be combined with "mid- scale level functional support" for some options)	Entity or entities that have the relationships to motivate engagement and bridge the biome and local scales. Need not be one entity / person—could be jointly shared.	States/Tribes. Project delivery coordinated through State-led programs such as Oregon SageCon, WY Sage-grouse Implementation Team, an expanded Utah Watershed Restoration Initiative and similar new or derivative programs in other States.	"JV-like," organized at ecoregional level. Establishes a Coordinating Committee to 1) establish objectives that step down from and support biome-wide objectives; 2) rank project proposals for funding consideration; 3) develop and implement communications	"JV-like" organized at ecoregional level and staffed by Federal employees to establish a Coordinating Committee to: 1) establish objectives that step down from and support biome-wide objectives; 2) rank project

Table D2 (cont.). ELEMENTS OF PARTNERSHIP STRUCTURE THAT VARY ACROSS OPTIONS				
Role	**Description**	**OPTION 1 – Governor Convened Representative Group**	**OPTION 2 – NGO Partnership**	**OPTION 3 – Federally led Coordination Committee**
Mid-Scale Level Coordination (the role may be combined with "mid- scale level functional support" for some options) (cont.)	Entity or entities that have the relationships to motivate engagement and bridge the biome and local scales. Need not be one entity / person—could be jointly shared. (cont.)		Plan. Generally same categories of representation as above. Stay connected with other mid-level "JVs" (either through biome direction or through mid-level horizontal coordination, stay connected with local scale through NGO and agency contacts at that level. Project delivery coordinated through State-led programs such as SageCon, WY, WY Sage-grouse Implementation Team, an expanded Utah Watershed Restoration Initiative and similar new or derivative programs in other States.	proposals for funding consideration; 3) develop and implement communications plan; Generally same categories of representation as above. Stay connected with other mid-level (either through biome direction or through mid-level initiative.

Table D2 (cont.). ELEMENTS OF PARTNERSHIP STRUCTURE THAT VARY ACROSS OPTIONS				
Role	**Description**	**OPTION 1 – Governor Convened Representative Group**	**OPTION 2 – NGO Partnership**	**OPTION 3 – Federally led Coordination Committee**
Mid-Scale Level Functional Support	Objective entity/third party that would ensure functional meeting organization, facilitation, and work getting done on behalf of partnership members between meetings; facilitate the "governance" and funding side (create the "safe space" for collaboration for all). "Staff Role"—two or three people who know where conservation actions are happening, ensure reporting is being uploaded into a shareable database, QA/QC upload of data, facilitate/coordinate local collective action	Presumably, State entities (governor's office or DOW) already have staff responsible for conservation delivery with local entities, would be a need to add a responsibility to existing staff or a new staff person within each State and participating Tribe to coordinate mid-level activities with biome scale.	Could be new employees of new NGO, additional employees of members of NGO collaborative (TNC, Audubon, Sierra Club, etc.), or duties assigned to existing employees of these groups.	USDOI and/or USDA employees who staff offices at ecoregional levels (Great Basin, Pacific Northwest, Wyoming Basin, Colorado Plateau, etc.). Could be co- located with JVs (IWJV, Prairie Pothole, Northern Great Plains) or Federal Research Stations.

Table D2 (cont.). ELEMENTS OF PARTNERSHIP STRUCTURE THAT VARY ACROSS OPTIONS				
Role	**Description**	**OPTION 1 – Governor Convened Representative Group**	**OPTION 2 – NGO Partnership**	**OPTION 3 – Federally led Coordination Committee**
Authority	Level of authority the partnership body has with respect to funding or other decisions, etc.	Prescriptive at the biome and mid-scale	Advisory for Federal funding/priorities, but prescriptive for NGO-specific (unless provisions provided in statute…e.g., Congress specifies)	Prescriptive at the biome and mid-scale in that projects supported must support goals established at biome and ecoregional scales.
Interim/Transition Steps Required	Steps that may need to be taken when initiating the new partnership (in addition to rows above identifying clarity needs around funding availability and how functional support will be provided)	Place / time for governors to come together to set this up (could be at the request of a higher power / Sec. of Interior, or on their own via WGA) Process and structure for governors to make appointments	Need entity with the standing to establish the new biome-scale NGO entity and compel participation (e.g., EOC, TNC, IWJV, WGA, WAFWA). NGOs could move quickly with capacity building grant(s) and this model could be a transitional step ultimately replaced by one of the other models or it could persist.	Secretary or Congressional - level action to direct the creation of the entity (and potentially analogous acts in State legislatures). Clarity on convener (joint at the Fed. level; with States / govs)? FACA exempt or FACA-chartered?
Operating Principles	The intended "charge" or direction for partnership body members (i.e., the north-star people would be expected to work for and represent)	• Shared objectives and values that transcend boundaries • Understanding of the challenges/opportunity of economic impacts	• Shared objectives and values that transcend boundaries likely achievable with mainstream NGOs • Understanding of the challenges/opportunity of	• Top-down structure and government administration may impede development of shared objectives and values that transcend boundaries

Table D2 (cont.). ELEMENTS OF PARTNERSHIP STRUCTURE THAT VARY ACROSS OPTIONS				
Role	**Description**	**OPTION 1 – Governor Convened Representative Group**	**OPTION 2 – NGO Partnership**	**OPTION 3 – Federally led Coordination Committee**
Operating Principles (cont.)		• "Watershed agreement" that makes it difficult to back out later; this may be important to making it not politically dependent in the long term • Dependable, predictable funding	economic impacts may shift towards primary funder • "Watershed agreement" may be difficult in this model and viability will likely depend on achieving progress.	• Understanding of the challenges/opportunity of economic impacts, • A "watershed agreement" is very achievable in this scenario given Federal funding leverage and ability to tie success to not warranted decision for sage-grouse.
Data Mechanisms (could be a role of mid-scale functional support)	To ensure accountability and for effectiveness monitoring to support adaptive management – QA/QC assurance check, contact for local le	Accountability aspect (did local groups do what they proposed to do with funding) could be assigned to local agency staff who are likely cooperating on proposals anyway. Effectiveness monitoring roles negotiated through partnership.	Reliance on local employees of affiliate NGOs to collect and forward data to ecoregional mid-scale; need to make it a condition of project funding to obtain assistance from others.	In addition to reliance on local collaborators, USDOI and USDA bureaus can assign data collection and reporting to their employees.

Table D2 (cont.). ELEMENTS OF PARTNERSHIP STRUCTURE THAT VARY ACROSS OPTIONS				
Role	**Description**	**OPTION 1 – Governor Convened Representative Group**	**OPTION 2 – NGO Partnership**	**OPTION 3 – Federally led Coordination Committee**
Authority/Mechanism Required	This mechanism would be used to evaluate the viability of the model options	Governors and Tribal leaders have broad authorities to create something like this but would have to get agreement across most or all of 13 States through an entity such as WGA which could be difficult and/or time consuming. New funding at national or State level would require legislative approval.	Authority vested in NGOs now in that consistent with mission, easy to do, agencies, Tribes, industry, etc., would likely participate initially but not likely to surrender any of their own authorities to the biome or mid-scale entities and "bleed-over" into other agency policies and programs likely to be minimal.	State and Federal governments have a rich tradition of supporting collaborative conservation, so authorities and mechanisms in place; constraint may be their regulatory authorities may in some respects get in the way.

Section II. Strategies to Address Threats or Restore Sagebrush Communities

Introduction to Threat/Conservation Topic Narratives and Tables

Each threat or conservation challenge chapter contains an introductory narrative establishing the rationale and contextual basis for addressing that challenge. Many strategies address, influence, or respond to multiple threats. These overarching strategies are described first, followed by threat specific and restoration strategies. Detailed information on individual threats and other conservation challenges was provided in Part I of the Sagebrush Conservation Strategy (Sagebrush Conservation Strategy—Challenges to Sagebrush Conservation (usgs.gov)) and can be accessed in that volume. Strategies are presented within tables as strategic themes (in bold) followed by bulleted action items that can contribute to accomplishing that strategic theme. An assessment of the organization/entities most appropriate to lead in the implementation of each action item is provided, as well as a description of other significant actions or needs required to implement the action. Examples of significant needs to implement actions include development of a new program, need for a significant new funding source, change in policy, development of enabling legislation, etc.

Chapter E. Overarching Strategies

By Thomas E. Remington,[1] Kenneth Mayer,[1] Karen Prentice,[2] Steven Hanser,[3] San Stiver,[1] Patricia Deibert,[2] Lief Wiechman,[3] John Tull,[4] Lindy Garner[4]

[1]Western Association of Fish and Wildlife Agencies
[2]U.S. Department of the Interior, Bureau of Land Management
[3]U.S. Geological Survey
[4]U.S. Department of the Interior, Fish and Wildlife Service

The most significant overarching strategies are described in Table E1, and relate to: acceptance and implementation of the Sagebrush Conservation Design to Defend and Grow core sagebrush areas (a guide to doing so is provided in Chapter A); increasing capacity for sagebrush conservation, particularly funding, the subject of Chapter B; implementing an Adaptive Management and Monitoring construct described in Chapter C; and standing up a collaborative partnership structure consistent with options described in Chapter D to coordinate conservation efforts at landscape scales.

Table E1. Overarching strategies.

Key Overarching Strategies and Actions	Lead Entities	Needed to Implement
Use and refine Sagebrush Conservation Design (Chapter A) to more effectively and efficiently protect sagebrush against threats and restore degraded sagebrush rangelands:		
• Incorporate the sagebrush biome landscape conservation design into planning to protect resilient habitats, grow resilient habitats and mitigate impacts across all landownerships in the sagebrush ecosystem	BLM, USFS, Tribes, States, Land Managers, collaborative entities of above and NGOs	Unprecedented collaboration
• Refine and adopt common definitions and maps of sagebrush core areas, growth opportunity areas, and other rangeland areas from the Sagebrush Conservation Design	Land management agencies, USFWS, state wildlife agencies	
• Re-scale sagebrush biome conservation design map products to ecoregional or state levels and identify Core	State Wildlife Agencies, USFWS	

Key Overarching Strategies and Actions	Lead Entities	Needed to Implement
Sagebrush Areas, Growth Opportunity Areas, and Other Rangeland Areas to support planning efforts at those scales		
• Refine spatially explicit maps from Sagebrush Conservation Design effort to identify areas where treatments (control invasive annual grasses, conifer removal, seeding, etc.) or other management actions (e.g., decommissioning infrastructure, wild equid management) can transition areas back into sagebrush core areas	Land management agencies, USFWS, state wildlife agencies	Interagency team or contract
• Assess relative risk/probability of loss of biome-wide or state/regional core areas from threats in the future; e.g., invasive plants or annual grasses, fire, conifer expansion, anthropogenic disturbance, cropland conversion, etc.	Land management agencies, USFWS, state wildlife agencies	Interagency team or contract
• Elevate the status of sagebrush ecosystems to reflect imperiled status by using agency specific designations in land use planning processes or within programmatic eligibility criteria; for example, the Secretary of Agriculture can establish core, and grow the core areas as Critical Conservation Areas within the Regional Conservation Partnership Program (RCPP), or make limited sagebrush core areas eligible for the CRP Program, or refocus SGI to the Sagebrush Conservation Initiative; National environmental organizations could elevate the Sagebrush Biome as priority areas for conservation emphasis; the NFWF Sagebrush Core Program could be expanded, etc.	Agencies, NGOs	
Increase collaboration and better coordinate conservation activities across the sagebrush biome:		
• Create an exploratory committee to investigate interest in, and possible approaches to, a collaborative conservation partnership structure relative to sagebrush conservation (see Chapter D) or all WAFWA initiatives, or both	WAFWA and/or Dept. of the Interior/Agriculture	
• Stand up Sagebrush Partnership Structure consistent with recommendations of exploratory committee	WAFWA, Federal and State Agencies, Tribes, NGOs, USDI/USDA, etc.	Dedicated funding
• Set quantitative objectives for how much core sagebrush will be retained by year y at biome and ecoregional/state scales	Sagebrush governance group, and/or Federal and State Agencies	
Implement an adaptive monitoring approach to track trends in ecological integrity and wildlife and progress towards goals, track conservation implementation and effectiveness, and inform decision making:		
• Support ongoing report card and durability aspects of the Sagebrush Conservation Design	USGS, USFWS, BLM, USFS	Dedicated funding
• Continue to support, and expand where needed, agency specific monitoring programs such as AIM, FIA, NRI, NPS Vital Signs I&M, etc.	USFWS, BLM, USFS, USGS, NRCS, NPS	
• Consider new policies to support data standardization and implementation as needed within management institutions	USFS, USFWS, BLM, NPS, NRCS	Interagency monitoring team?

Key Overarching Strategies and Actions	Lead Entities	Needed to Implement
• Ensure that conservation actions in the sagebrush biome on public and private ground are entered into the Conservation Efforts Database (CED)	USGS, BLM, USFWS, NRCS, USFS, NPS, state agencies, NGOs, Industry	
• Create an interagency/interdisciplinary team to evaluate degree of uncertainty around effectiveness of sagebrush restoration efforts and make recommendations where and how increased effectiveness monitoring should be implemented, and how, including funding recommendations	USGS, USFWS, USFS, NPS, BLM, state agencies, Partners	
• Expand efforts to track effectiveness of conservation actions, particularly restoration efforts	USGS, BLM, USFWS, USFS, NRCS, NPS, state agencies, NGOs, Industry	Additional research funding
• Continue to operationally support range-wide sage-grouse lek count database and hierarchical cluster analysis tool	BLM, USFS, USGS, States, WAFWA	
• Develop and implement range-wide pygmy rabbit occupancy survey	State Wildlife Agencies	Agreement on protocols
• Expand IMBCR monitoring efforts to cover the full extent of the sagebrush biome and continue efforts to derive trend data from both BBS and IMBCR	Bird Conservancies, USGS, USFWS, USFS, NPS, BLM, state agencies, Partners	
• Review existing monitoring approaches for regional/state sagebrush obligates or species of greatest conservation need, including Gunnison sage-grouse, Columbian sharp-tailed grouse, etc.	State Wildlife Agency SWAP Coordinators, USWS, USGS	
Create a structured decision-making support system for the sagebrush biome to predict conservation needs, better coordinate actions, and increase effectiveness:		
• Develop a sagebrush trends model, a dynamic version of the SCD that can predict future trends in core sagebrush and response to management	USFWS, BLM, USGS, ARS, Universities	Funding for contracts(s)
• Develop sub-models for the sagebrush trends model to estimate loss/recovery of sagebrush for each threat (including climate change) based on spatial statistical modeling	USFWS, BLM, USGS, ARS, Universities	Funding for contracts(s)
• Develop models to estimate response to management actions (retention of core, or transition of growth opportunity areas to core) based on the CED and effectiveness monitoring	USFWS, BLM, USGS, ARS, Universities	Funding for contracts(s)
Create an architecture with adequate funding, staffing, and other capacity to support adaptive monitoring and adaptive management programs and structures:		
• Create a standing biome science advisory committee to inform objective setting, identify additional research/monitoring needs, and coordinate and make recommendations on monitoring and AM strategies at broad and local landscape scales	WAFWA, Sagebrush Partnership Group	
• Ensure dedication to open access, transparency, and data sharing among public management entities while addressing privacy and confidentiality concerns of private landowners	USFWS, BLM, USFS, USGS, NRCS, NPS	

Key Overarching Strategies and Actions	Lead Entities	Needed to Implement
• Create centralized and accessible platforms for data and information sharing. Develop strategies and enabling policies for integrating different agency and organizational datasets	USGS	
• Invest in staffing for tech support and customer service similar to the SECAS model (see Case Study 1). Dedicated people with skills are needed to make this work	USFWS, BLM, USFS, USGS, NRCS, NPS, States	
• Provide targeted or grant-based funding for science-management partnerships, local knowledge sharing collaboratives, and communities of practice	USFWS, BLM, USFS, USGS, NRCS, NPS, States	
• Identify points of contact in management agencies who can provide internal outreach and training for sagebrush monitoring and adaptive management (for example, AIM leads)	USFS, BLM, NPS, FWS, NRCS, State agencies	
• Work with partners to convene collaborative workshops around the use of the SCD, CED, and monitoring and adaptive management strategies for sagebrush conservation at state and sub-state levels	USFS, BLM, NPS, FWS, NRCS, State agencies, NGOs, Tribes, Industry	
Increase capacity to deliver conservation at local scales:		
• Identify core areas that lack local collaborative conservation groups capable of implementing conservation actions (such as conifer removal, invasive species management and monitoring, restoration, etc.)	IWJV SCC	
• Create collaborative groups (for example, CWMAs, see Case Study 10) where needed through educational efforts that identify need, illustrate examples of successful models of collaborative conservation at local scales, and identify sources of funding and technical and other assistance	States, NGOs, Communities, landowners	Consistent funding and leadership
• Create and support umbrella collaborative entities (for example, Oregon High Desert Partnership [see Case Study 13], BLM Healthy Landscapes Initiative, Utah Watershed Restoration Initiative [see Case Study 2]) that can foster fledgling local collaborative conservation groups, obtain and coordinate funding, manage contracts, etc.	States, NGOs, Communities,	Consistent funding and leadership
• Develop approaches to recognize, reward, and promote local conservation groups and celebrate successes	State and Federal agencies, NGOs	
• Encourage and incentivize a broadening of focus of single-threat local groups (for example, Rangeland Fire Protection Associations [see Case Study 12] or Cooperative Weed Management Associations [Case Study 10]) to focus on healthy sagebrush and addressing multiple threats	Agencies	
• Develop state level programs that can aggregate multiple funding sources and streamline contracting to support sagebrush restoration projects (similar to the Utah Watershed Restoration Initiative model [see Case Study 2] in other states). Examples of potential funding sources that can be pooled include: receipts of “Governor’s tags”, hunting licenses sold through auctions or raffles; severance	State Wildlife Agencies, or DNRs	State policy changes and potentially enabling legislation

Key Overarching Strategies and Actions	Lead Entities	Needed to Implement
taxes, legislative or other grants, lottery proceeds, SWAP funding, etc.		
• Develop mechanisms to incentivize place-based collaborative conservation efforts in the sagebrush ecosystem. Examples include prioritize funding, recognize/reward employee participation in local, place-based collaborative conservation efforts, compensate non-government participants, etc.	Agencies, NGOs	
Increase the capacity for the development of CCAA and CCA agreements with landowners, and remove barriers associated with lack of funding for long-term monitoring of these agreements and for needed restoration practices:		
• Create a dedicated fund within USFWS for capacity grants to be used by partners to develop CCAA agreements with landowners	USFWS	
• Create a dedicated fund within BLM for capacity grants to districts to increase capacity to develop CCA agreements	BLM	
• Reallocate a portion of USFWS partners funds for needed restoration efforts to bring lands enrolled in CCAA agreement up to standard	USFWS	
• Create a Conservation practice or program within the USDA Farm Bill to fund or cost-share conservation practices needed to bring lands enrolled in CCAA or CCA agreements up to standard	USDA	Does this require enabling changes to the Farm Bill?
• Create a congressional appropriation to USFWS, BLM, and NRCS for these purposes	Congress	Congressional budget action
• Appropriate funds at federal, state, or County levels into a revolving account to generate interest to fund annual monitoring and maintenance activities over the 30-year life of CCAA agreements	Federal, state agencies and/or Counties	Policy changes and/or enabling legislation
Increase funding for sagebrush restoration and conservation at local scales:		
• Develop a consistent and durable federal funding source for sagebrush conservation and restoration, e.g., NASECA	Congress	Enabling legislation
• Launch individual giving campaigns and crowdfunding campaigns for sagebrush conservation efforts on partner websites, for example non-governmental organizations, non-profits, and place based collaborative conservation groups	NGOs	
• Develop a mechanism to direct a portion of tax and royalty revenue on projects within the sagebrush ecosystem towards sagebrush restoration and conservation actions	State and Federal Governments	State and Federal enabling legislation
• Develop a proposal for sagebrush restoration through the Pittman-Robertson Multistate Conservation Grant Program	WAFWA	Adoption at Business Meeting

Chapter F. Strategies for Restoration of Sagebrush Plant Communities

By Alexandra Urza,[1] Amanda Hendrix,[1] Danny Summers,[2] Mary Manning,[1] Brynne Lazarus,[3] Bill Davidson,[3] Cara Applestein,[3] Matt Germino[3]

[1]U.S. Department of Agriculture, Forest Service
[2]Utah Division of Wildlife Resources
[3]U.S. Geological Survey

Restoration of sagebrush landscapes is critical in growing the core and reducing threats to further loss of sagebrush ecosystems. There are many "low-hanging fruit" opportunities to improve restoration success in sagebrush steppe. The area treated is on one hand large, but on the other hand *very* small compared to the area impacted or threatened by increased fire and invasives. The primary needs are to increase success of treatments and successfully treat more area. Greater restoration effort and greater rates of success would be required for "no net loss", and continued restoration advances of degraded or threatened habitat now can help offset the likely but unpredictable impacts from fire and invasives elsewhere. Additionally, either active (herbicide, seeding) or passive (grazing adjustments) interventions done now to bolster resistance and resilience would minimize risk of further habitat loss after potential future fires, with the added benefit of enhancing many ecosystem services even if subject sites do not reburn.

It is challenging to establish desired perennials in the dry conditions and with competition from exotic invasive plants that prevail in sagebrush steppe. Overcoming historically low success rates will require improving our "skill" in addressing the impacts of climate/weather, livestock grazing, invasions, and technological shortcomings on restoration success. These challenges are compounded by the vast land areas that are in need of restoration and limited resources available, combined with incomplete knowledge on how to best plan and implement restoration to achieve success. Given these challenges, we have structured suggested strategic approaches to improve restoration success and volume into three thematic areas (Table F1):

1. **Motivate restoration and establish collaboratives***,* which would increase the amount of restoration done. There are examples of local cooperatives, leveraged funding, and interagency positions that have provided unambiguous advances for dealing with fire and invasions. These are also needed for restoration, and could quickly generate benefits to defend and grow core sagebrush areas;
2. **Improve the way restoration is done**, which entails encouraging restoration to be done in an adaptive-management style for both individual projects but also the broader programs that the projects are part of. In light of uncertainty, we must treat each intervention as an experiment and learn from it. Motivations need to emphasize the quality of outcomes, for example, meeting treatment objectives that are formulated with SMART criteria, and are not simply valued as "acres treated". Skillful restoration treatments that address the well-known challenges to treatment outcomes will increase restoration success;
3. **Improve plant materials***.* There are numerous opportunities to improve tools for restoration related to selection of plant materials that are likely to establish, persist over long time frames, and fulfill desired ecosystem services. Stimulating adequate supply of appropriate seed is a critical need.

A key consideration for restoration is prioritizing the investments, which was a motivation for the development of the resistance and resilience paradigm and the Sagebrush Conservation Design (prioritize areas that both need intervention but are also likely to respond positively to intervention).

Table F1. Restoration strategies.

Key Restoration Strategies and Actions	Lead Implementers	Needed to Implement
Motivate and establish restoration collaboratives and broader participation to increase restoration output and success:		
• Establish CWMA analogs (or expand them to CWMAs) for seed collection, increase, evaluation, storage and use, plan projects across administrative boundaries (for example, UT WRI has interagency regional teams, NFWF funding stimulated restoration in CWMAs)	Counties with NRCS?	**Funding** and **staff** T/E are limitations
• Train interested RFPAs in restoration techniques and enable them with tech support, potentially enabling permittees to invest in and implement restoration on their allotments	Counties	Funding and staff T/E are limitations, Policy/reg change needed
• Engage university participation such as in curricula, internships, remove barriers to participation	All, universities	Funding
• Incentivize restoration of sagebrush steppe		
• Motivate and enable permittees to do restoration and invasives control on their allotments	BLM, States	Would need **policy/reg** change
• Streamline NEPA process, including categorical exclusions	Federal agencies	Helps overcome **policy/reg** limitations
• Improve restoration equipment sharing among agencies, NGO's, and contractors, for example, Utah WRI owns/maintains equipment that is loaned to other agencies or contractors to implement treatments. Can lower costs by enticing more bids	State and Federal agencies, NGOs	Would need **policy/reg** change?
• Jointly fund well-paid positions that build restoration capacity with close integration to fire, fuels, invasives, and grazing programs	State and Federal agencies	Helps overcome **staff** limitations
• Make NRCS funds for private land restoration more accessible (currently onerous 9-step application); (NRCS/partner agency biologists exist to help with applications; create matching funds to incentivize)	NRCS	Policy/Program change
• Create separate and "banked" pools of funding for restoration that cannot be diverted, and stimulate leverage funding with it	State and Federal agencies	Policy/Program change
• Invest in native seed warehouses and equipment storage at strategically located state and federal facilities, e.g., USFWS refuges, State WMAs, National Park Units, etc. to provide local agencies with a "one stop shop", increasing efficiency and reducing replication. Emulate CPW and Utah WRI example (see Case Study 2)	State and Federal agencies	Capital Equipment investment

Key Restoration Strategies and Actions	Lead Implementers	Needed to Implement
• Advance/preparatory identification of teams that can address future post-containment management of megafires with an **adaptive management** response	Federal agencies	Structural staffing change
• Create Communities of Practice for Restoration, such as USGS's CoP's for Fire, Invasives, and Sagebrush/sage grouse	Federal/State agencies and NGOs	
Increase the effectiveness of restoration efforts by improvements in the way restoration is done:		
• Establish uniformity in restoration objectives among agencies (contrasting objectives from different agencies is a challenge, such as RE prospects vs. feasibility of using native seeds	Federal land management agencies	Development of common standard/framework?
• Redirect restoration goals to focus more on the **quality**, rather than the **quantity**, of restored acres. Establish performance metrics around the effectiveness of the treatments and/or that they occur in the right location	All	Requires p**olicy** and **knowledge** change
• Develop and implement statistically based **adaptive management** process for restoration projects that informs follow-on treatments with an overall metric of successful ecological outcomes. Develop guidance for restoration objectives and metrics. Create a funding structure of 3-5 years to allow for follow-up treatments following initial entry	All (especially Federal agencies)	Policy change?
• Continue to develop the LTDL and LTET and modules to help in planning restoration and enabling learning from actual restoration trials (adaptive management at the whole-biome level), expand to include other agencies	USGS, with BLM, add FWS, State programs	Sustained funding (to USGS LTDL/LTET team)
• Modify BAER/ES&R requirements and expectations to restore burned lands to specific ecological conditions. Allow for sustained funding and project extensions beyond one year if necessary to meet the expressed desired ecological outcomes. Allow "lift"		Policy/reg?
• Establish common metrics for restoration success	Federal agencies	
• Foster the "hand off" of restoration projects to routine programmatic management of the sites by range/fuels/wildlife departments to ensure that subsequent management is consistent with the intent of the restoration; relates to focus on *quality* of restoration outcomes	Federal agencies	Implementing policy
• Create peer-review programs where restoration practitioners review each other's project proposals	Land management agencies	Implementing policy
• Protect restoration investments by adjusting grazing (VIRTUAL FENCING! timing of resumption, stocking rates, season of use) during the entire period that vegetation is recovering, until perennials are mature and able to withstand utilization without risking loss of perennial bunchgrasses	All	Still some **knowledge** gaps, would require **policy/reg** changes

Key Restoration Strategies and Actions	Lead Implementers	Needed to Implement
• Protect restoration investments from (re)invasion using PROVEN herbicides		Additional research and increased funding
• Protect restoration investments from reburning (fuel breaks, strategic suppression including w/ maps to help avoidance of dozers/backburning/etc, including fire-suppression avoidance protection zones that are areas restored and intact islands)	All	Increased funding
Enhance plant materials available for restoration projects to improve restoration success:		
• Develop local seed transfer zones to increase native seed availability of local graminoid and forb species for shrublands. Use local plant community classification as a basis for their development and identify locations for local seed storage	Federal agencies	Additional research or science to support
• Incentivize the conversion of cropland to the production of native seed that supports "native seed cooperatives." Such cooperatives would help ensure locally adapted and stored seeds are available to federal and state agencies when they need them	Federal agencies	New program, additional funding and potentially staffing
• Create decision support tool or framework for decisions on use of native vs nonnative plant materials	Feds (with all agencies)	
• Identify fire suppression avoidance areas that would be excluded from performing suppression tactics (for example, hand/dozer line installation, retardant application, back-burning) within the identified area. These areas would receive high prioritization for protection from fire and would provide a natural seed source, reducing reliance on imported seed	Federal land management agencies	Fire policy change
• Map and actively protect and maintain the islands of unburned sagebrush within burned areas as important sources of locally adapted seed	Federal land management agencies	
• Incorporate pollinator services, palatability, and other ecosystem services into native plant criteria		Policy change
• Establish a "Collaborative Native Plant Materials Program" that is integrated at CWMA scale to cooperate with federal, and state agencies, local governments, tribes, academic institutions and the private sector to assess local need for native plant material and collaboration on Native Plant Material development including seed collection, increase, evaluation, storage and use		New Program and potentially staffing

Chapter G. Strategies for Addressing Invasive Plants

By Michelle Cox,[1] Slade Franklin,[2] Lindy Garner,[3] Mike Ielmini,[1] Dan Tekiela[4], Kenneth E. Mayer[5]

[1]U.S. Department of Agriculture, Forest Service
[2]Wyoming Department of Agriculture
[3]U.S. Department of the Interior, Fish and Wildlife Service
[4]University of Wyoming
[5]Western Association of Fish and Wildlife Agencies

Managing invasive plants to protect sagebrush ecosystems is an immediate and collective priority and requires diverse and expanding coalitions that include state, federal, and local governments, tribes, non-governmental organizations, and private landowners. These collaborative efforts require a series of planning, policy-related, communication, and science-based management and restoration strategies to protect the benefits of the sagebrush biome.

Specifically, invasive annual grasses and the wildland fires they fuel are the single biggest challenge to sustaining healthy landscape-scale sagebrush ecosystems. Climate change is exacerbating the problem and creates conditions that disadvantage native species and promote the establishment and spread of invasive plants. How climate change may impact probability of future invasions in the sagebrush biome is not well understood, but changes in mean surface temperatures and precipitation and atmospheric concentrations of greenhouse gases will likely affect invasive species in several ways. It will be critical to incorporate climate change factors when planning where, when and how best to invest in conservation activities to protect and restore sagebrush habitats.

Invasive annual grasses, such as cheatgrass, have greatly increased the fuel load in sagebrush ecosystems and other native plant communities across the West at enormous scales and rates. Coupled with the aberrant weather patterns and increasing drought caused by climate change, these invasions have led to significant increases in wildfire frequency, scale, and intensity; destroying wildlife habitat, threatening public safety and infrastructure, and affecting economies at local, state, and regional levels. Two other invasive annual grasses with little forage value, medusahead rye and ventenata grass, are also expanding steadily across the West, similarly enabled by climate change and fueling rangeland fires. A recent paper documented that while fire needs cheatgrass in arid, fuel-limited sagebrush landscapes, cheatgrass does not need fire to successfully invade and transition sagebrush rangelands to grassland states.[12] This paper made it clear that a reactive approach of suppressing sagebrush fires and restoring burned areas will not be effective at reducing the spread of invasive annual grasses, and that a proactive approach of treating areas invaded by annual grasses early before they have transitioned will be most effective at conserving sagebrush rangelands and minimizing impacts of fire and costs of suppression and restoration.

Invasive plants are a substantial and expanding threat to Western landscapes, yet are often a lower priority when resources are allocated to increase management capacity. Responses to invasions at any level are mostly reactive, often when these infestations are already well established, and have

[12] Smith, J.T., B.W. Allred, C.S. Boyd, K.W. Davies, A.R. Kleinhesselink, S.L. Morford, and D.E. Naugle. 2023. Fire needs annual grasses more than annual grasses need fire. Biological Conservation 286 (110299). https://doi.org/10.1016/j.biocon.2023.110299

surpassed the level where effective control or eradication can be accomplished at a lower cost (short term and long term). In some instances, invasions have become so well established and pervasive that successful management options are extremely limited.

Although the interface between invasion, fire, restoration, and grazing is nearly inseparable, this section will exclusively focus on plant invasion and the best strategies to mitigate their impacts. The strategies in Table G1 have been selected as the highest priority strategies needed to Defend and Grow core areas from the threat posed by invasive plants. Other initiatives and assessments such as the Western Weed Action Plan, the National Invasive Species Committee and Wildland Fire Leadership Council Memorandum on Integrating and Coordinating Wildland Fire and Invasive Species Management Efforts, and the Department of the Interior Science Framework have significant action items that align with this effort. Strategies consistent with these other efforts are identified below. Slowing the spread of invasive annual grasses and fire across sagebrush rangelands will require a significant increased investment in detection capacity and resources and use of advanced technology at landscape scales. Based on the Western Governors' Association (WGA) Invasive Annual Grass Management Toolkit (FINAL_Cheatgrass_Toolkit_July_2020.pdf (westgov.org)), 243 million acres of Western rangelands, including those in the sagebrush ecosystem, are still only lightly or not invaded. *Now* is the time for all partners to increase invasives management efforts with an emphasis on early detection of, and rapid response to, invasion in core sagebrush rangelands. WGA also determined that 100 million acres of Western rangelands are mildly/moderately invaded. Growth opportunity areas, or other rangeland areas adjacent to core areas with mild to moderate invasion levels require swift, aggressive management and restoration actions to prevent these transition areas from degrading into heavily invaded states. Lastly, WGA has identified 2 million acres of Western rangelands that are highly degraded, yet have access to wildland fire resources for fuel suppression, attack and post-fire restoration. These coarse data can provide a spatial assessment from which to base programmatic budgeting and strategically focus partnership collaboration. Subsequently step-down conservation efforts can be prioritized, with regional and local spatial distribution information on invasions helping managers identify areas and management activities to defend sagebrush cores, expand native plant communities (grow), and reduce impacts in Other Rangeland Areas.

Strategies are organized into three strategic themes: 1) Increase awareness of invasive plants as a critical threat to the sagebrush biome in order to elevate their priority for funding and management emphasis by federal, state, tribal, and private partners; 2) Collaborative planning efforts based on biological/ecological boundaries and invasion principles of prevention and early detection and rapid response; and 3) Increase the capacity to manage invasive plants at regional and local scales through increased resource investment, federal leadership, and policy changes.

Table G1. Strategies to address invasive plants.

Key Invasive Plant Strategies and Actions	Lead Entities	Needed to Implement
Increase awareness of invasive plants as a critical threat to the sagebrush biome in order to increase funding and conservation emphasis:		
• Communicate and commit to fully implement the Western Weed Action Plan's current and future funding, policy/regulation, communication/collaboration/data sharing, and research action items for a collaborative call to action by agencies, tribes, and private sector at all scales	State and Federal agencies, Universities, NGOs, NASDA,WAFWA	Outreach Plan, Agency and Organization commitment

Key Invasive Plant Strategies and Actions	Lead Entities	Needed to Implement
• Support communication and implementation for invasives and fire action items identified by the joint task team between the National Invasive Species Council (NISC) and Wildland Fire Leadership Council (WFLC) as bureau priorities that will better integrate invasive species and wildland fire communities and increase cooperation on spatial management planning, research, prioritization tools, policy and invasive species management implementation	Federal Bureaus, NAISMA, State Foresters	
• Leadership guidance to develop and promote invasive species as a programmatic priority for conservation and restoration management delivery, monitoring, and research	State and Federal agencies, Universities	Inclusion in programmatic guidance
Implement a defend and grow the core (high ecological integrity areas) approach to management of invasive plants:		
• Develop a unified geographic strategy utilized by all partners to defend and grow the core by maintaining native perennial plant communities through prevention, early detection and rapid response in core areas, implementing early aggressive management for mild and moderate invasions in high priority areas, and reducing impacts to prevent spread in heavily invaded priority areas	Local, State, Federal agencies, Private landowners, Tribes	
• Identify across the range, the threshold invasion levels for varying ecological site conditions that trigger management actions to prevent further degradation in sagebrush core and transition areas	Land management agencies, County programs, USGS	Localized research and consistent long term monitoring data.
• Implement a consistent and unified process/approach for collecting, maintaining, and sharing data related to invasive plant occurrences (inventories) and management (prevention and control) activities at multiple spatial scales. The use of the Early Detection and Distribution Mapping System (EDDMapS) has been widely recognized as a primary tool through which this strategy can be implemented by sagebrush conservation stakeholders	All sagebrush land managers and jurisdictions	Requirements for identifying invasion locations, tracking of management actions, sharing of data
• Prioritize detection and mapping of invasive plant populations across the landscape, from coarse to local scale, particularly with respect to high priority areas for sagebrush conservation. Identify and fill invasive plant distribution knowledge gaps	Sagebrush partnership, Federal land management agencies, States, Counties	Increased capacity for conducting inventories and geospatial technical data management
• Develop an early detection monitoring and rapid response framework for sagebrush core areas at risk of invasion from invasive annual grasses and other invasive species of concern. Components of this framework should include: 1) EDRR monitoring for state-listed noxious weeds, watch list species, and novel new invaders; 2) a unified approach to responding to reported EDRR infestations (e.g., Incident Command System); 3) clear definition of how ownership and partnerships establish who is the responsible party for management response in a timely manner, and that minimizes redundant treatment from multiple stakeholders, and 4)	Regional partnership networks, Federal agencies, States, and CWMAs	Agreement on sagebrush cores and spatial assessment of invasion risk

Key Invasive Plant Strategies and Actions	Lead Entities	Needed to Implement
identification of metrics that can be compiled and communicated as credit for core areas protected, wildland fire fuel loads that did not accumulate, economic losses that didn't occur, etc.		
• Implement consistent, long-term invasive species management to ensure success and durability of restoration efforts	All landowners, CWMAs	Consistent line-item funding. Less reliance on grants
Increase investment in capacity to implement science-based actions to prevent the spread of invasive annual grasses and to restore degraded sagebrush:		
• Identify where local implementation teams, Cooperative Weed Management Areas (CWMAs) or regional partnership networks are missing for areas important for defending and growing sagebrush core areas. Identify and leverage federal, state, industry and private funding opportunities and establish CWMAs where capacity and leadership are available, including providing a consistent and reliable source of funding at both the federal and state level	National Association of Invasive Plant Councils	
• Create or identify a coordinating entity to assist with leveraging shared priorities across boundaries among local implement teams.	State Departments of Agriculture, DOI Keystone Initiative, Western Weed Coordinating Committee	
• Empower landowners, permittees and recreational users to address infestations through increased regulatory flexibility. States and Feds work together to develop invasives equivalent of RFPAs and deal with jurisdictional constraints in areas where CWMAs or Weed and Conservation Districts are not effectively addressing infestations	Federal agencies, State Legislatures	Legislation to address liability concerns
• Pursue additional opportunities under the NRCS Regional Conservation Partnership Program (RCPP) to work with multiple landowners and stakeholders at broader scales to ensure invasives and fire are integrated into these programs	NRCS	
• Dedicate resources for additional National Environmental Policy Act (NEPA) compliant planning for invasive plant risk assessments and management implementation	CEQ, Federal Land Management Agencies	NEPA training, Good Neighbor Authority agreements
• Develop new and leverage partnership opportunities with industry to protect lands from invasion thereby supporting carbon sequestration value of intact sagebrush rangelands	Industry, federal agencies, NGOs	

Chapter H. Strategies for Managing Altered Fire Regimes

By, Michele Crist,[1] Shawn Espinosa,[2] and Doug Shinneman[3]

[1]U.S. Department of the Interior, Bureau of Land Management
[2]Nevada Department of Wildlife
[3]U.S. Geological Survey

Wildland fire is an important sagebrush ecosystem process occurring throughout the sagebrush biome. Historically, fire cycles were variable across the sagebrush biome ranging from decades to hundreds of years due to differing geography, climate and weather patterns, and vegetation fuel loadings. Over the past few decades, the scale of uncharacteristic frequent fire has increased, especially in the drier and lower elevation landscapes of the sagebrush biome where fire was relatively infrequent. This uncharacteristic fire cycle is due to the pervasive and expansive influence of fire-prone exotic grasses (for example, cheatgrass inducing the 'invasive-grass fire cycle'), an increase in human ignitions, development and land use, and an increase in fire-weather conditions and longer fire seasons under a warming climate. There is generally wide agreement in the scientific literature that sagebrush fire regimes are altered from historic trends, with more frequent, larger, and/or more destructive wildfires affecting ever larger portions of the sagebrush biome. Minimizing these trends and addressing the impacts of altered sagebrush fire regimes has become a key strategy in conserving sagebrush ecosystems across the western United States.

A recent paper indicated fire was responsible for about 23% of recent type conversions from sagebrush to annual grassland states in the Great Basin[13]. Halting or reversing these trends in the Great Basin and elsewhere will require major investments in wildland fire management to reduce fire risk. Wildland fire management is multi-faceted and includes large-scale pre-fire planning, wildfire prevention, and fire suppression operations in conjunction with vegetation management (fuels reduction, ecosystem restoration, and post-fire recovery). Strategic approaches in wildland fire management will help focus available resources in the places that will maximize sagebrush conservation return on investment.

Wildland fire management strategies that increase fire resilience of native sagebrush ecosystems and resistance to invasive annual grasses are outlined in the Science Framework Part 2, Section 4.1 (https://www.fs.usda.gov/treesearch/pubs/57911). In this section, we outline more strategies developed from a stakeholder engagement workshop and other fire management expertise that focus on four aspects of wildland fire management: 1) Wildfire Prevention, 2) Pre-fire Planning, 3) Fuels Management and 4) Wildfire Operations. These key strategies are aimed at mitigating the factors that promote uncharacteristic fire on sagebrush landscapes. To be effective, these strategies need to be combined with strategies defined in the Science Framework Part 2 and with other strategies proposed in the invasives management and restoration sections. When placed in the context of Defending and Growing Core Sagebrush Areas, these actions collectively should be part of the broader strategy to maintain the necessary ecosystem processes and connectivity that allow sagebrush ecosystems and sagebrush dependent species to adapt to increasing pressure from factors that have a strong influence on sagebrush wildfire regimes, such as anthropogenic land use and development and fluctuations in climate.

[13] Smith, J.T., B.W. Allred, C.S. Boyd, K.W. Davies, A.R. Kleinhesselink, S.L. Morford, and D.E. Naugle. 2023. Fire needs annual grasses more than annual grasses need fire. Biological Conservation 286 (110299). https://doi.org/10.1016/j.biocon.2023.110299

Table H1 provides management strategies and actions aimed at mitigating the factors that promote uncharacteristic fire in sagebrush identified by the stakeholder workgroup. See the Restoration (Chapter F) and Invasive Plants (Chapter G) chapters for specific post-fire recovery and restoration strategies.

Table H1. Altered Fire Regimes Strategies

Key Altered Fire Regime Strategies and Actions	Lead Entities	Needed to Implement
Prevent wildfires through actions to reduce human ignitions:		
• Develop a comprehensive spatial analysis of human ignitions/causes, correlating with geography, time of year, ignition sources, etc., to assist with temporal resource deployment, and to identify where human ignitions have the biggest impact on fire characteristics (e.g., predictive model of fire frequency comparing human vs. lightning)	USGS, US Dept of Ag (Firelab); USDI Joint Fire Science Program	
• Increase fire prevention through education (e.g., "One Less Spark" campaign). Create and increase targeted fire education campaigns about fire effects in the sagebrush ecosystem. Funding could be prioritized by community risk. Campaigns tailored, prioritized messaging to address ignition sources, timing, etc., utilizing the most effective communication methods and platforms for each community	Federal land management agencies, State forestry or fire agencies	Dedicated funding
• Evaluate common causes of human ignition, develop mitigation measures (e.g., brown strips along highways) and/or implement and enforce appropriate restrictions such as bans on fireworks, exploding targets, armor-piercing or tracer ammunition, range or public land shooting closures, especially during periods of high fire danger or after wetter than average years when fuel fine loads have increased, or additional safe shooting facilities to discourage random and sporadic use on federally managed lands	State Transportation Departments, Counties, shooting range managers, land management agencies	
• Engineering to prevent wildland fires including working with power companies to ensure poles and transmission lines are constructed and maintained properly, especially in areas where repeated failures occur and ignite fires. Engineering also includes designing and maintaining recreation sites to ensure they are void of flammable vegetation that can ignite from human activities	Utility Companies (ROW), land management agencies	PUC regulations?
• Create and enforce policies requiring greater responsibility and accountability for wildland fire ignitions across public lands, including imposing penalties—such as loss of access for both public and special use permittees and/or civil penalties. Work with states which may be able to incorporate these policy aspects more effectively	Land management agencies, States	State level administrative action or legislation
Manage fuels to reduce fuel loadings and fuel continuity to reduce severity and rate of spread of fires:		
• Develop spatially-zoned wildland fire and invasive plant management strategies that reduce the establishment and spread of invasive plants that fuel wildfires, degrade native ecosystems, and increase the probability of losses from wildfire. Identify resource allocation and management actions	Land management agencies and partners, State Departments of Agriculture, County	

Key Altered Fire Regime Strategies and Actions	Lead Entities	Needed to Implement
required to implement both invasive species and wildland fire management strategies	Weed Districts, CWMAs, Wildland Fire Leadership Council, National Invasive Species Council	
• Use the Sagebrush Conservation Design framework (see Chapter A) and fire risk assessments for prioritizing fuels management activities to defend core and growth areas	Land management agencies, States, partners	
• Utilize fuel reduction treatments to reduce the continuity of cheatgrass cover in or adjacent to core sagebrush areas and/or GOAs where there is significant cheatgrass cover to reduce fuel connectivity and slow or stop fire spread between cheatgrass patches and into intact native vegetation	Land management agencies, land managers, States, private property owners, partners	Funding and increased pre-fire planning
• Develop tools to identify where to strategically locate fuel breaks and fuel break networks based on factors such as native vegetation type, terrain, susceptibility to exotic invasion, and land ownership without negatively impacting sagebrush and sagebrush-dependent species (for example, USGS-USFS research in progress)	USGS, land management agencies, States and partners	Funding
• Strategically manage fuels to reduce fuel loads where appropriate. Use spatially explicit information to determine where fuels reduction can reduce the risk of fire spread without causing damage to intact sagebrush. For instance, improve modeling capabilities to help prioritize placement of fuel breaks and fuel treatments, and to project changes in fire behavior	Land management agencies, States, partners	
• Investigate alternative grazing strategies by altering season of use. In some more fire prone areas, perhaps fall grazing could be used to reduce residual fuels and reduce late spring/early summer ignition sources the following year	Land management agencies/permittees, USGS or Universities	
• Increase coordination between State DOTs, Counties, energy regulators to use new BIL (Bipartisan Infrastructure Law) resources and authority to reduce fire invasive species along roads and energy corridors to reduce probability of ignitions and spread of both fire and invasive species. Explore options for increased funding of this work where appropriate	State DOTs, Counties, land management agencies	Cooperative agreements
• Enhance monitoring that provides critical information on the effectiveness of management actions, including fuels management and post-fire restoration treatments. Monitoring data should be used to evaluate changes in (1) vegetation, fuels, and fire characteristics and (2) ecosystem response to management actions implemented to address ecosystem threats such as invasive annual grasses	Monitoring programs within land management agencies; U.S. Geological Survey	Increased emphasis on monitoring, particularly effectiveness of treatments; Funding
• Focus on limiting further spread of highly ignitable invasive exotic species fuel beds. Implement greater focus on controlling invasive species along roads and energy corridors to reduce chance of ignition, especially by vehicles, and spread of invasive exotic fine fuels. Improve understanding	State DOTs, land management agencies	

Key Altered Fire Regime Strategies and Actions	Lead Entities	Needed to Implement
(through research and monitoring) of the role of various levels of livestock grazing (e.g., light, moderate, heavy) in spreading fire-prone exotic species in intact sagebrush		
• Include rangeland fire management in State Forestry Action Plans which will allow them to compete for USFS, State and Private Forestry Grants, which is larger than the entire DOI fuels management budget	State Forestry Departments	
• Create and fund a DOI grant program analogous to USFS State and Private Forestry Grant Program to better manage rangeland fire. For example, access funding provisions in the Infrastructure Law for Community Wildfire defense or other partner opportunities	USDI	Enabling policy change to create new program
Enhance suppression operations through pre-fire planning:		
• Increase capacity of tankers, crews, and other necessary fire-fighting resources available to state and federal entities to match the need for both forest and shrubland fires in all years, not just 'bad' fire years. For example, single engine aerial tankers may be instrumental in recon and reducing fires at initial attack; pre-staging during high Preparedness Levels or after dry-lightning storms (see Case Study 11)	Federal and State Governments	Substantial increase in appropriations for this purpose
• Increase and pre-position more water tankers and other fire resources in areas with more frequent fires (make tankers available in areas adjacent to where resources are staged as needed). In remote areas, establish a rotation system for pre-positioning remote fire-fighters. Increase moving and locating fire suppression resources in response to expected oncoming weather fronts to address lightning ignitions	Federal and State fire-fighting agencies	This has already been occuring for years – more funding would enhance these efforts
• Increase the use and availability of mapping products to identify suppression priorities for intact sagebrush and to respond to incidents and assign resources at multiple scales. Fire managers can distribute fire risk assessments and other geospatial data layers to dispatch offices, incident commanders, fire crew bosses, and other fire responders	Federal and state fire-fighting and wildlife agencies	Increased coordination and sharing during pre-fire planning assessments
• For rapid response, combine results of wildland fire risk assessments with National Interagency Fire Center (NIFC) Predictive Services seven-day potential fire forecasts to inform where to pre-position fire crews, equipment, and aircraft in areas predicted to experience fire ignitions and large fire growth	Federal and state fire-fighting and wildlife agencies	
• The road network is a key element for quick wildland fire response. It also functions as a fuel break network by disrupting fuel continuity across large scales. Prioritizing roads in travel planning for fire management access and maintenance that are in close proximity to core sagebrush areas and at high risk of fire will contribute to an effective response to fire	Land management agencies	
• Pre-plan to identify access routes across private lands necessary to reach public sagebrush lands. Work with local	Federal and state fire- fighting and	Increased coordination

Key Altered Fire Regime Strategies and Actions	Lead Entities	Needed to Implement
fire departments and landowners to consider legislation to enable access	wildlife agencies, RFPAs	
• Where beneficial and ecologically appropriate, expand construction of trailheads, parking lots, etc. that both benefit community uses and use as fire staging areas to complement local community fire protection	Land management agencies, State agencies, Counties	
Utilize pre-fire planning to enhance suppression capacity across jurisdictions and within fire-affected communities:		
• Enhance the effectiveness of Rangeland Fire Protection Associations (RFPAs, see Case Study 12) and Volunteer Fire Departments through capacity building and by expanding training/certification opportunities. Develop national guidance by USDA for National Forests to cooperate with and support RFPAs (in addition to states and BLM)	State forestry or fire agency, Federal fire-fighting agencies, USDA	USDA RFPA Policy and guidance
• Enhance community pre-planning programs that focus landowners on what is directly around and adjacent to their land and homes/buildings. If there is a Community Wildfire Protection Plan, include the adjacent area for planning	States and Counties	
• Maximize efficiencies within rural communities by linking partners in cooperative weed management areas (CWMAs) with RFPAs due to their complementary goals and often-overlapping need for community resources (staging areas, storage, equipment, etc.)	States, Counties, local communities and landowners	
• Incentivize cost-sharing/funding for rural residents to create fuel breaks on locally owned lands, participate in suppression activities, and acquire necessary personal protective equipment and fire suppression equipment for residents. Possibly tie in existing partners programs (e.g., NRCS/EQIP) for fuel treatments, training, certification	Federal agencies, States, Counties	Potentially new incentive programs
Utilize pre-fire planning to enhance suppression benefits to sagebrush ecology:		
• Develop and implement and/or enhance existing strategies (e.g., BLM Fire Planning Manual/Handbook and the FMP guidance/template) for fire suppression activities that could be unique to sagebrush ecosystems. Develop standard language for Agency Administrators to use for IMTs for leader's intent	Federal agencies	
• Expand scientific research into fire-behavior, fuel dynamics, fire effects, and pre-suppression/suppression activity effects/effectiveness specific to sagebrush ecosystems. Research should be carried out across environmental gradients (especially those that represent relative resistance to invasion and resilience to fire) and be co-produced with land and fire managers whenever possible	Federal land management agencies	Increased or reallocated research funding
• Increase funding to more aggressively monitor fuels treatments in sagebrush (including fuel breaks) to verify desirable outcomes are occurring and inform maintenance schedules	Federal land management agencies	Increased funding for monitoring programs

Key Altered Fire Regime Strategies and Actions	Lead Entities	Needed to Implement
• Assess wildfire risk and effects on other natural communities within the sagebrush biome that provide habitat for sagebrush dependent and other at-risk wildlife (e.g., riparian communities, pinyon-juniper woodlands) or are at a high risk to wildfire	Federal land management agencies, USGS	
• Develop Fire Hazard Severity Zone maps similar to those used in CA for risk to property, etc., to assign hazard score in critical sagebrush habitats based on factors that influence fire probability and fire behavior	Land management agencies, State fire agencies (e.g., Cal Fire)	
• Resolve the Tort claim and firefighter labor issues that are hampering the creation of rural fire protection associations (RFPAs). Example: NV Legislation requires RFPAs to have liability insurance (could be state funded?)	States, except Oregon and Idaho	Enabling legislation
Improve early detection of wildfire to facilitate suppression efforts:		
• Create a voluntary community effort that provides radios to individuals deployed to established lookout areas to watch for lightning and smoke during storms	States, local communities	
• Establish "Crowd-source" fire reporting by developing a cell phone application, or adapting satellite-linked devices such as "Spot" or "In-Reach" to report fires when they are detected	Federal land management agencies	
• Deploy drone-based or satellite-based infrared sensors to search for fires when thermal anomalies are present. If fire is detected, preplanned resources for ground-truthing/responding are alerted. Work with DOD to accomplish these objectives, including use of unmanned aerial system (UAS) and FireFly/FireGuard: a novel and highly successful joint effort made by civilian and defense agencies (and may be especially useful for remote areas)	Federal agencies, States, DOD	
• Strategically deploy early detection camera networks in fire-prone, high value landscapes	BLM, USFS, State fire agencies	
• Increase signs for fire reporting such as "Report Wildfires 911" emergency hotline so that motorists can report wildfires observed from highways or interstates, especially within the Great Basin. Signs could be placed intermittently along roadways to remind motorists of the number and to report	States, State transportation departments	
Increase effectiveness of active fire suppression/ fire-fighting:		
• Minimize burnout of intact sagebrush islands to provide postfire refugia for recovery; ensure teams from other parts of the country are briefed on appropriate suppression strategies for sagebrush conservation objectives	Federal and State fire-fighting agencies	Increased coordination before and during fires
• Suppression practices recommended to help preserve large patches of sagebrush during fire incidents include: (1) extinguish fire edges and hotspots within the burn perimeter, especially around unburned islands; (2) apply suppression strategies and tactics that retain large interior islands of unburned sagebrush within the burn perimeter; (3) consider direct rather than indirect line when locating firelines, as safety and fire behavior allow; and (4) when safety is not an issue, direct suppression efforts to the front of a fire	Federal and State fire-fighting agencies	Increased coordination before and during fires

Key Altered Fire Regime Strategies and Actions	Lead Entities	Needed to Implement
• Enhance active firefighting efforts through use of UAS/drones or satellites (e.g., FireFly/FireGuard) to track fire perimeters at night. Develop drones with the payload capacity to handle retardant and use for drops in heavy smoke or during the night to more actively combat fires	Federal and State Fire-fighting agencies	
• Effectiveness of aerial suppression efforts could be increased by enhancing pilot availability, increasing the air tanker fleet, and expanding hours of operation	Federal and State Fire-fighting agencies	
• Rely more on aerial resources (e.g., SEATs) for initial attack (see Case Study 11, Colorado Fire Fighting Air Corp)	Federal and State Fire-fighting agencies	Funding to purchase aircraft

Chapter I. Strategies for Addressing Conifer Expansion

By Mary Manning,[1] Thomas E. Remington,[2] Doug Shinneman,[3] and Tyler Thompson[4]

[1]U.S. Department of Agriculture, Forest Service
[2]Western Association of Fish and Wildlife Agencies
[3]U.S. Geological Survey
[4]Utah Department of Natural Resources

While unprecedented partnerships have formed in recent years to implement targeted conifer removal in some priority sagebrush landscapes, the pace and scale of restoration is currently just keeping up with rates of expansion. Achieving a net gain in sagebrush ecosystems will require accelerating targeted restoration while reducing risks of invasive plant species (particularly annual grasses) and uncertainties related to impacts on woodland-dependent species of concern. Strategies to address conifer expansion in sagebrush ecosystems are presented in Table I1 and are focused around five major themes: 1) enhancing conifer management planning; 2) increasing capacity and funding; 3) improving accountability and tracking; 4) capitalizing on wildfire opportunities; and 5) increasing communications.

Several actions are identified to ensure sagebrush restoration efforts are conducted as part of a holistic, watershed approach. Sagebrush shrublands and pinyon-juniper woodlands are both important native ecosystems supporting dependent wildlife species of conservation concern, cultural values, and a myriad of ecosystem services. Both ecosystems are threatened by invasive plant species, altered fire regimes, climate change, and increases in woodland density. While beyond the scope of the Sagebrush Conservation Strategy, a comparable comprehensive plan is recommended to guide conservation and management of pinyon-juniper woodlands beyond the shrubland-woodland ecotone where sagebrush restoration is focused. In the interim, strategies are included to reduce management uncertainty around potential impacts of targeted conifer removal on woodland species of high concern, specifically the pinyon jay, in the portion of the sagebrush biome where the resource issues overlap (for instance, predominantly the Central Basin and Range Ecoregion).

Relative to other restoration practices in sagebrush ecosystems, targeted conifer removal has been well-studied and shown to be effective at restoring or maintaining a variety of ecosystem functions and sagebrush-dependent wildlife habitats. Therefore, strategies call for increased funding and capacity for targeted restoration of early phase conifer expansion especially in and around sagebrush cores. Coupling accelerated implementation with well-funded outcome-based monitoring and tracking ensures continued accountability and adaptive management. A communications strategy is also needed to convey conservation outcomes more effectively to diverse audiences.

Wildfires currently account for about one third of all reductions in conifer cover, but invasive species and degraded habitat conditions after fire may preclude sagebrush-dependent wildlife from using otherwise suitable habitats. Strategies seek to capitalize on wildfire as an opportunity to partially achieve restoration goals. In particular, prioritizing post-fire rehabilitation on historic sagebrush shrublands impacted by conifer expansion provides a strategic window of opportunity to put plant communities on a desired recovery trajectory through invasive species control, native seeding and shrub planting, and conifer seedling removal. Wildfires also present an opportunity for strategic fire management planning where federal and state land management agencies, Rangeland Fire Protection Associations (see Case Study 12), and other partners work together to adopt pre-fire plans that allow wildfires to burn in conifer expansion areas where cheatgrass or other invasive species are not prevalent, and where infrastructure and other resource values won't be impacted.

Table I1. Conifer Expansion Strategy Summary

Key Conifer Expansion Strategies and Actions	Lead Entities	Needed to Implement
Enhance conifer management planning to achieve healthy sagebrush and pinyon juniper woodland communities:		
• Reduce management uncertainty around pinyon-juniper management and pinyon jay in the central Great Basin through co-produced science and monitoring to better understand pinyon jay response to targeted conifer removal and determine effective silvicultural prescriptions for improving pinyon jay habitat quality in persistent woodlands	Land management agencies, USGS, universities	
• Support development and use of pinyon jay core area maps and other decision support tools that help land managers achieve needs of sagebrush and woodland-dependent species	Land management agencies, USFWS	
• Establish a collaborative partnership to develop a comprehensive conservation strategy to manage for the health and resilience of persistent pinyon-juniper woodlands and other dry conifer forests	Land management agencies, State wildlife agencies, NGOs	Task Force?
• Prioritize proactive treatment of early phase conifer expansion in historic sagebrush shrublands along woodland/forest ecotones to expand sagebrush core areas	Land management agencies, States, NGOs	
• Ensure that conifer removal is targeted, and continues to avoid historic old-growth conifer woodlands. Support development and training on ecological site concepts (ESDs) and other tools to help design site-appropriate treatments across the shrubland to woodland continuum	Land management agencies, States, NGOs	
• Incorporate sections within conifer management plans that acknowledge and mitigate the risks of increasing annual grasses (and other invasive species) with treatment. Mitigating measures should be clearly articulated to stakeholders so it is clear this risk is not being ignored	Land management agencies, State Programs, NRCS, NGOs	
• Develop a science-informed business plan that articulates a path to meet conifer expansion and pinyon juniper woodland management goals for the west. Specify where, how much, when, and who	Pinyon-Juniper Woodland Task Force	Create Pinyon-juniper Task Force
Increase capacity and funding for conifer management to better exceed expansion rates:		
• Continue to advocate for funding that supports conifer removal efforts by communicating needs and outcomes to legislators	NGOs, States, landowners	
• Augment USFS/BLM sage-grouse and fuels funds with funds from other sources for conifer reduction treatments	USFS, BLM	
• Reach out to collaborative groups and potential contractors with shared interests in conifer removal, and train and equip interested groups to conduct targeted conifer removal treatments. This strategy may be particularly effective for early detection and rapid response in sagebrush core areas. Examples include Rangeland Fire Protection Associations (see Case Study 12), Conservation NGOs (e.g., Mule Deer Foundation Chapters), and landowner groups (e.g., Ranchers Stewardship Alliance in Montana see Case Study 14).	NGOs, States, NRCS	Training program and curriculum?

Key Conifer Expansion Strategies and Actions	Lead Entities	Needed to Implement
• Stand up a NEPA strike team focused exclusively on conducting environmental analyses for priority conifer management projects to increase efficiency of compliance with NEPA and other regulatory constraints. (There are large level NEPA documents for certain BLM districts to do this type of work. Scale this up to state level or larger)	BLM, USFS, USFWS	-
Implement an adaptive management construct that improves our ability to meet conservation objectives and increases accountability:		
• Develop a spatial tracking system to quantify conifer reduction/expansion and report findings back to local partnerships regularly	Land management agencies, USFWS, NRCS, or USGS	
• Support outcome-based evaluations of conifer removal treatments co-produced by managers and scientists. Encourage adoption of standards allocating some percentage of implementation funding to science and monitoring	Land management agencies, USGS, Universities	Development of guidelines for funding effectiveness monitoring
Capitalize on wildfire opportunities to increase the amount of conifer expansion controlled or restored to functional sagebrush plant communities:		
• Employing strategic fire management planning to identify areas, conditions, and times where wildfire could be allowed to burn to reduce conifer expansion without increasing invasive weeds, impacting infrastructure or other resource values (for example, see BLM Boise District's Juniper Mountain Strategic Fire Management Plan)	Land management agencies, State fire management agencies, wildlife agencies	Interagency/ Interdisciplinary Team
• Capitalizing on post-fire rehabilitation opportunities in burned areas of conifer expansion to restore native sagebrush plant communities. Identify opportunities to accelerate sagebrush and native perennial graminoid and forb recovery after fire, reduce invasive species, particularly cheatgrass, remove remaining conifer seed sources, and restore native sagebrush plant communities	Land management agencies	
Increase acceptability of, and ultimately the amount of conifer expansion addressed:		
• Develop and execute a comprehensive communications strategy to help land managers communicate more effectively (internally and externally) about conifer expansion in sagebrush ecosystems, and its relationship to persistent dry conifer woodlands and forests	IWJV, SageWest, Partnership Structure	

Chapter J. Strategies for Addressing Mining and Energy Development in the Sagebrush Ecosystem: Increasing the Effectiveness and Efficiency of Implementing the Mitigation Hierarchy

By Patricia Deibert,[1] Patrick J. Anderson,[2] Daniel Manier,[2] Matthew Holloran,[2] Mona Khalil,[2] Shawn Espinosa,[3] Jon Holst[4]

[1]U.S. Department of the Interior, Bureau of Land Management
[2]U.S. Geological Survey, currently U.S. Department of the Interior, Bureau of Land Management
[3]Nevada Department of Wildlife
[4]Theodore Roosevelt Conservation Partnership

The sagebrush ecosystem hosts a diverse array of mining, fossil-fuel and renewable energy development opportunities, including rare earth (critical) minerals. These commodities provide essential resources for local, state, and national economies, but extraction activities have potential effects on other important values, including wildlife, recreation, and ecosystem services essential to rural economies and lifestyles (for example, ranching). Use and management of sagebrush habitats are subject to multiple levels of regulatory control (Federal, State and County governments), and affect landowners, abundant and diverse wildlife, broad and scenic landscapes, and the heritage of the western United States. Differences in the current condition and ecological potential of rangelands and wildlife habitats, including land use and disturbance history, create considerable complexity in habitat values and responses to management actions, including reclamation.

Highly volatile market prices for coal, oil and gas, and other commodities make planning and pro-active conservation actions difficult for mining and energy companies. Uncertainties in cost and timing of reclamation or mitigation introduce additional challenges for minimizing impacts. Strategic approaches to addressing these challenges are constrained by a lack of knowledge on direct effects, indirect effects, and cumulative impacts. The sagebrush ecological integrity metric and the Sagebrush Conservation Design tool can be used to better inform the mitigation hierarchy (avoid, minimize, mitigate).

Successful management and conservation of multiple uses, including but not limited to mining and energy development, within the sagebrush biome requires a multi-scaled perspective cumulatively incorporating local through landscape-scale relationships. Addressing this challenge will require not only scientists to identify important habitats and landscapes, but the active participation of all stakeholders that receive an ecosystem service. Engaging meaningful participation is challenging as the long-term benefits in sagebrush ecosystem are difficult to observe, requiring considerable patience, persistence and commitment. However, multi-scaled planning for energy development would benefit: improved understanding of potential impacts (development resistance) across landscapes; effects assessments (value affected); and mitigation (action) for conservation (plan) in addition to supporting the Defend and Grow concept.

The strategies presented in Table J1 are intended to facilitate development of actions that address the natural resource conservation and management challenges associated with mining and energy development in the sagebrush ecosystem. Where possible they are pro-active rather than relying on restoration and compensatory mitigation after development has occurred, although those actions have important roles. Being pro-active provides opportunities for local communities and industries to

conserve wildlife, sagebrush habitats and associated ecosystem services while minimizing the potential for future regulatory restrictions, such as a listing decision under the Endangered Species Act of 1973, as amended. While these strategies were developed to inform mining and energy development, many of these strategies are applicable to other anthropogenic land uses. Strategies focus on 5 themes: 1) strengthen measures to avoid high value (core and growth areas) sagebrush habitats; 2) manage development to minimize disturbance to wildlife species and communities; 3) improve effectiveness of compensatory mitigation; 4) improve effectiveness of reclamation (and restoration where feasible/appropriate relative to mining and energy development); and 5) improve application of the mitigation hierarchy (particularly avoid and minimize aspects) to increase effectiveness.

Table J1. Mining and Energy Development Strategies

Key Mining and Energy Strategies and Actions	Lead Entities	Needed to Implement
Strengthen measures to avoid high value sagebrush habitats:		
• Develop a dynamic mapping tool to identify areas of major, moderate, and minimal conflict considering distribution of sagebrush obligate species. This tool should provide examples of applying these categories to the "avoid, minimize and mitigate" construct and use of these categories during the land use planning processes (e.g., RMP revisions). SCD Core, Growth, Other map can serve as a proxy for this tool in the short term	USGS, State wildlife agencies	Recurring funding to update tools, incomplete understanding of sagebrush obligate needs, creating a map useful to field application
• Create/use existing framework (e.g., SFA, NCA, SCD core areas or other designation) for designating set-aside areas where no new anthropogenic disturbance will occur. This framework should describe in detail needed tools (existing and new) and develop a strategy to make these tools more effective	Land management agencies with support of state wildlife agencies and elected officials	Acceptance and support from political entities at all levels and stakeholders.
• Invest in technologies that will allow for remote extraction of mineral resources, particularly rare earth/critical minerals, similar to directional drilling for oil and gas	Industry, land management agencies, political leadership	Incentives for participation, research, funding
• Provide incentives to localize and/or co-locate (with existing permanent disturbance) renewable energy development (e.g., solar shingles on residences and businesses) to reduce the need of building commercial facilities	Private Industry, elected officials	Motivation for reduced incomes for power companies
• Modify regulations (e.g., 1872 Mining Law) that limit the ability to provide conservation of sagebrush obligates and their habitats and increase flexibility for decisions makers	Congress, NGOs	Political interest in addressing regulations
• Recognize the equivalency of wildlife habitat as a public land use	Federal land management agencies	Support from public land users and politicians
• Use special designations such as ACECs, HMAs, etc. to manage conflicting uses in high ecological integrity sagebrush areas. Permanently protect from disturbance areas identified as critical habitats which cannot be restored if disturbed	Federal land management agencies	Support from land users; resolution of differing models

Key Mining and Energy Strategies and Actions	Lead Entities	Needed to Implement
• Improve applied/actionable science relevant to decision making for avoiding impacts. For example, revisiting and implementing avoidance buffer distances to more effectively eliminate direct and indirect impacts to ecosystem services and sagebrush wildlife species throughout the sagebrush biome	Land management agencies, USGS/researchers	Clear research on efficacy of stipulations and best management practices
• Develop and implement approaches to improve the consideration and incorporation of science in NEPA and/or other applicable planning documents so that impacts are more effectively avoided	Land management agencies, USGS/researchers	Research, access to data
• Generate a framework and the tools necessary to move management decisions from broadly applied stipulations to locally or regionally informed management guidelines	Land management agencies, USGS/researchers	Access to data; cross-scale coordination
Manage development to minimize disturbance to wildlife species and communities:		
• Develop tools and strategies that incorporate optimization model results into planning to explicitly consider tradeoffs and locate areas where there may be less impact and areas with greater potential resilience	Land management agencies, industry	Identification of alternative areas that provide desired resource; political willingness
• Refine/clarify the area (scales) for thresholds regarding disturbance and density of disturbance within a particular landscape that is meaningful to desired objectives. Initiate additional research to consider disturbance limits for sagebrush dependent wildlife and sagebrush ecosystem services	Land management agencies	Research
• Develop and incorporate approaches to predict and manage cumulative and collateral impacts of all aspects of energy developments (e.g., exploration, construction, production, restoration) more effectively and holistically. For example, incorporating risk assessments, implementing invasive annual grass management plans, incorporating exploratory stages of energy development, etc., into all energy development management and decision documents	Land management agencies	Research
Improve the efficacy of reclamation of developed and disturbed habitats:		
• Recognize the diversity of stakeholders, use existing groups or create new ones to increase coordination, cooperation and foster a landscape perspective. Within these groups develop and foster communication by: o Understanding each entities' engagement interests and roles; o Identifying commonality of reclamation goals, and integrating landscape conservation and planning with reclamation goals; o Ensuring engagement of a broad range of stakeholders when implementing a reclamation strategy and practices	WAFWA, Land management agencies, Industry, State Resource Agencies, Researchers, Governance structure	Need a landscape scale perspective; effective communication; governance structure to provide best management practices; different expectations for outcomes (e.g., what constitutes good restoration)

Key Mining and Energy Strategies and Actions	Lead Entities	Needed to Implement
through the use of existing initiatives and agency-industry meetings; ○ Directing and informing regionally influential efforts (e.g., reclamation bonds below); ○ Creating regionally specific efforts/initiatives to address local conservation priorities; and ○ Creating and disseminating compiled best management practices.		
• Develop a national standard for reclamation specific to sagebrush ecosystems designed to achieve long-term effectiveness across landscapes. The standard should be flexible to incorporate local instruction memorandums, local site potential and local conditions, and native seed resources. Standards could be improved to shorten successful reclamation trajectories and applied at landscape scales	Landscape ecologists; restoration ecologists; climate change scientists; land management and state regulatory agencies	Changing dogma to allow for updating standards; lack of information (research) for understanding restoration trajectories given stressors such as climate change; funding
• Create, enact and enforce an updated, comprehensive bonding structure that applies to all non-coal and mining activities that fully covers costs of reclamation (vs. simply plugging, etc.), and/or improves habitat conditions ultimately resulting in durable restoration of the permit area, provides consistency for operators, and support for habitat restoration	Economists, Land management agencies, state permitting agencies	Identifying inflation adjusted costs for full reclamation (durability, resources [e.g., seed source availability])
• Develop criteria and indices to support prioritizing reclamation of orphaned wells/roads and other infrastructure within sagebrush habitats to enhance landscape scale function to provide the highest conservation benefit	WAFWA, governance structure, land management agencies, researchers	Competing objectives for prioritization Identifying existing applicable research; challenges in using immediate funding resources (capacity, time)
• Establish an enforceable structure and methodology to collect sufficient and standardized pre-development baseline, interim, and final reclamation information to allow for and inform accurate and adequate reclamation for all mining and energy disturbances within sagebrush. These data should be housed in a database available to all practitioners and researchers	Researchers, Land management agencies, state energy permitting authorities	A rigorous and consistently applied process to collect pre- and post-disturbance information
• Expand the understanding of mechanisms of mining and energy disturbance impacts on habitats and wildlife to improve reclamation practices. Important examples include: ○ Expanding our knowledge of ecosystem response and reclamation potential based on ecosystem site characteristics;	Researchers, land management agencies, wildlife managers	Technical transfer of research to application; changing culture

Key Mining and Energy Strategies and Actions	Lead Entities	Needed to Implement
○ Identifying habitat implications of reclamation beyond the footprint of disturbance; ○ Understanding and planning for the durability of restoration and reclamation at the landscape scale; ○ Distinguishing between "well-functioning habitat" (biological) from acceptable for reclamation obligations (legal); and ○ Aligning monitoring data to address mechanisms and trends at multiple scales		
• Improve adaptive management in reclamation and restoration in the arid and highly variable environments of the sagebrush ecosystem by improving monitoring data collection, standardization, sharing, and analyses. Consider establishing land management, researcher, and industry forums to share reclamation/restoration information, discussions on best management practices, lessons learned, and developing a "lessons learned and decisions" database	WAFWA, land management agencies, state agencies, industry	Research and tool development; funding; culture around "proprietary" information relative to reclamation approaches
• Improve infrastructure siting to maximize potential for successful reclamation incorporating landscape characteristics (e.g., ecological site potential, future anthropogenic disturbance, climate driven changes in sagebrush and understories, current conservation areas, areas to improve habitat and/or connectivity)	Researchers; land management agencies	Research and tool development
As the last step in the mitigation hierarchy, ensure compensatory mitigation provides true compensation for actual impacts from mining and energy:		
• Expand existing sagebrush and sagebrush-dependent species conservation programs that have a preservation focus (e.g., BLM PHMA strategy) to more directly and holistically incorporate sagebrush habitat enhancement and restoration as conservation tools into the framework implemented through those programs. Compensatory mitigation programs should be tied to these efforts to address more cooperatively past, current and potential future impacts to sagebrush habitats across all scales and related efforts	State wildlife agencies (and groups formed to manage sagebrush habitats [e.g., SGIT in WY), Federal land management agencies	Ability to restore and enhance sagebrush habitats
• Build on approaches developed for existing compensatory mitigation programs (e.g., habitat banking, habitat exchanges) to create an innovative sagebrush compensatory mitigation framework for restoring sagebrush habitat function and/or enhancing habitat quality that can be adopted to regionally-specific situations throughout the sagebrush biome. The Sagebrush Ecological Integrity metric may be a useful proxy for habitat value in this framework. The framework should address (at a minimum): ○ Clear path establishing and verifying that mitigation efforts are offsetting impacts (i.e., comparability of objectively-derived metrics that clearly quantify impact	Mitigation holders, mitigation drivers (those requiring mitigation)	Ability to restore and increase the quality of sagebrush habitats

Key Mining and Energy Strategies and Actions	Lead Entities	Needed to Implement
and offset [i.e., the "value" of mitigation as it relates to the full impact being offset]); ○ Cost, timeliness, durability of mitigation credits; ○ Ensuring that direct and indirect impacts are offset; ○ An adaptive management strategy and monitoring requirements for effective implementation of that strategy; ○ Approaches to engage a diversity of stakeholders; ○ Understanding local compensatory mitigation and sagebrush habitat enhancement programs, and approaches to building from/complementing these programs; and ○ A clear approach to incorporating multi-scaled ecological processes into informing the prioritization and effectiveness monitoring of compensatory mitigation projects (e.g., address the gap between site-level reclamation or restoration and landscape-level habitat function)		
• Explore and pursue opportunities to strengthen federal, state and local authority to require compensatory mitigation for offsetting impacts associated with anthropogenic disturbance to sagebrush habitats. Work with a diversity of stakeholders (e.g., industry, agricultural, NGO) to increase buy-in, transparency and durability of rule changes	Mitigation banks, NGS	Political acceptance and support of mitigation requirements
• Investigate approaches to more directly link local and regional sagebrush habitat enhancement, restoration and reclamation efforts and compensatory mitigation programs to ensure complementary activities and increase synergy and landscape effect of efforts cumulatively	Mitigation bank holders, landscape ecologists, sagebrush governance	Landscape maps/strategy
Improve application of the mitigation hierarchy (avoid, minimize, offset) to increase effectiveness, allowing for adaptive management to improve minimization/avoidance techniques as energy/other disturbance types continue to evolve:		
• Improve data sharing/collection (e.g., central database, potentially building on existing tools) to assess the impacts of mining and energy development	Governance entity	Governance, capacity, funding, resolution of differences of methodology betw een existing efforts; may need incentives for participation
• Develop a shared value of conserving the sagebrush ecosystem without requiring consistency in underlying motivations. Considerations: ○ Recognize the value of current partners in conservation and find ways to continue their support; ○ Build a regional collaboration (people/ coalition building); and	Governance entity; permitting agencies	Methods to quantify values of conservation

Key Mining and Energy Strategies and Actions	Lead Entities	Needed to Implement
○ Develop regional vision for landscape including wild lands (hunting, fishing, ORV, bike, hike, etc.), domestic (towns, rural, estates, and industrial/energy), community economic stability, etc.		
• Identify data gaps of ecosystem services and methods to resolve those gaps. Examples of research needs: ○ Impacts of noise associated with mining and other energy facilities and effectiveness of mitigation efforts; ○ Indirect effects of energy development and disturbance response curves for multiple sagebrush obligate species; ○ Efficacy of mitigation actions to minimize disturbance (e.g., seasonal timing restrictions, noise baffling, etc.), including efficacy in different environmental conditions; ○ Economical value of ecosystem services, including the identification of the value of what is lost and how the mitigation hierarchy may address those losses (i.e., monetize the services and the returns)	Researchers	Funding, accurate identification of conflicts, ability to apply results on the ground.
• Evaluate emerging energy industries (e.g., solar, wind, geothermal) to determine direct and indirect impacts (including lifespan of project, reclamation needs, etc.) and develop new avoidance and minimization measures or adjust existing tools accordingly	Researchers, permitting agencies	Funding, willingness of industry to participate
• Develop a review process that flags relevant research for on the ground conservation and applicable delivery methods and ensure the information is expeditiously provided, in a useful format, to implementers	USGS	Capacity, time, funding, understanding what is relevant
• Ensure monitoring data are collected and shared with appropriate entities to address data gaps and inform adaptive management	Permitting agency	Funding, Capacity, communication mechanism
• Explore options for educating “new” industry players about meeting expectations for local, regional, and state-level conservation commitments and actions especially in situations where they are different from other areas of operation	State, permitting agencies, industry	Open minds, knowing what to recommend
• Explore incentives or special recognition for companies that engage in conservation actions that go above and beyond requirements. Tactics could include: ○ Explore the certification of energy produced from a given project based on level of impact accrued as a result of developing that energy (similar to LEED certification for buildings); and ○ Increase public acceptance by connecting industry’s role in their community(ies) to environmental values in addition to social values such as jobs, education, etc. through meaningful local conservation actions	State, permitting agencies, industry, NGOs	Requires a landscape strategic plan; requires project level quantification of impact (minus effects of mitigation)
• Explore ways to funnel and track partner contributions back to support ecosystem services (local economies and communities)	States	Economic analyses

Key Mining and Energy Strategies and Actions	Lead Entities	Needed to Implement
• Increase the effectiveness of conservation banks/State Conservation Credit systems and replicating them across states and beyond select focal species. Identify lessons learned from existing programs throughout the biome and adapt them to the needs of a region	State wildlife agencies (and groups formed to manage sagebrush habitats [e.g., SGIT in WY), Federal land management agencies	Ability to restore and enhance sagebrush habitats
• Increase productive dialogue among stakeholders using a third-party neutral facilitator. Support/empower a third-party entity, such as an NGO, to facilitate dialogue among stakeholders with the goal to develop best practices and conservation solutions that are developed with industry and community buy-in	State wildlife agencies (and groups formed to manage sagebrush habitats [e.g., SGIT in WY),	Ensuring long-term commitment; funding; capacity
• Encourage/require companies to prepare development plans within a landscape that emphasize maintenance or conservation of priority sagebrush core/connectivity. Identify incentives (streamlined NEPA/ timelines for development, etc.) to work with other companies/operators in landscape to maximize conservation while allowing for development of minerals on leases & protection of proprietary/ confidential information. Key considerations: o Community development of shared conservation and development goals; o Incentivize through relaxed restrictions; e.g., streamlined NEPA; and o Develop in less valuable sagebrush habitats, where value also considers local economies.	Permitting agencies, legislatures, landscape ecologists	Engagement of companies and elected officials at state and federal levels, capacity, funding

Chapter K. Strategies to Improve Management of Grazing

By Myra Black,[1] Mary Manning,[1] Patti Novak-Echenique,[2] Shawn Espinosa,[3] John Tull,[4] Charlie Clements,[5] and Duane Coombs[6]

[1]U.S. Department of Agriculture, Forest Service
[2]U.S. Department of the Interior, Bureau of Land Management
[3]Nevada Department of Wildlife
[4]U.S. Department of the Interior, Fish and Wildlife Service
[5]U.S. Department of Agriculture, Agricultural Research Service
[6]Cabal Cattle Company, LLC

Grazing, by domestic livestock and/or native ungulates, rodents, and lagomorphs occurs on every acre of sagebrush. With the exception of most National Parks, grazing of federal lands by domestic livestock has been encouraged since settlement and has led to the formation and sustenance of many communities throughout the West. Historical overgrazing and range degradation led to a series of laws and reforms including the Taylor Grazing Act of 1934 (43 U.S.C. 315), which established grazing districts, a permit system to limit numbers of livestock, and grazing management to reduce grazing impacts. The Federal Lands Policy and Management Act and the National Forest Management Act, both enacted in 1976, are the most recent public lands management laws re-affirming grazing as one of the appropriate uses of Federally owned and administered lands. These acts also re-affirm management policies of multiple use and sustained yield, which requires consideration of all resources and productivity in perpetuity.

The sagebrush plant communities encountered by settlers moving West have changed over time, in some places dramatically. The expansion of cheatgrass and ensuing fire cycles have reduced the amount of sagebrush and perennial grasses in many areas, and particularly in the Great Basin, resulting in landscapes dominated by annual grasses and prone to more frequent large-scale wildland fires. Conifers have expanded into sagebrush at higher elevations and lower elevations, reducing sagebrush and forage, and impacting watersheds. We now have a much better understanding of ecological states and transitions in many sagebrush areas of the west and resistance of sagebrush plant communities to invasive annual grasses and resilience to disturbance. We also have a better understanding of climate change impacts and potential adaptation strategies. Sagebrush evolved in the arid landscapes of the Western U.S., but climate change has brought, and will increasingly bring, warmer temperatures and changes in the amount and timing of precipitation, including prolonged droughts and decreased snowpack, which will impact forage production and the resistance and resilience of rangelands.

These emerging concepts of ecological states and transitions, resistance and resilience, and climate adaptation have not been fully integrated into grazing programs or permits, although some progress has been made in areas critical to sage-grouse. However, there are still grazing permits that need further environmental analysis to establish base-line monitoring data and desired future conditions for overall allotment management. New environmental analysis would allow for incorporation of adaptive management measures for future flexibilities for permittees and land management agencies. Completion of allotment evaluations is constrained by significant capacity issues within Federal land management agencies, for example, of the 782 BLM allotments in Nevada, only 330 (42%) have completed evaluations.

This Strategy, and others (Idaho Cheatgrass Challenge, WGA Invasive Toolkit) are adopting a management paradigm of "Defend the Core, Grow the Core and Reduce Impacts" (see Chapter A, this document), and strategies for grazing should be considered in this context as well. For instance, terms and conditions within grazing permits such as timing and duration, stocking rate, and periods of rest are likely to vary substantially to support management objectives on healthy sagebrush cores vs. areas transitioning to annual grassland states vs. reduce impacts areas that have already transitioned to annual grassland states. Here we outline strategies for grazing management that consider ecological states, resistance and resilience, and climate adaptation principles in sagebrush core areas, sagebrush non-core areas, and reduce impact areas. Strategies related to managing grazing to improve restoration success or to use targeted grazing as a tool to reduce fuels or control invasive annual grasses are described in the restoration, fire, and invasive annual grass sections, respectively.

Table J1. Grazing Strategy Summary

Key Grazing Strategies and Actions	Lead Entities	Needed to Implement
Reform grazing programs to better maintain healthy sagebrush rangelands:		
• Increase staffing capacity of both the BLM and USFS to increase effectiveness of grazing management on public lands (e.g., capacity to address grazing permit/lease renewals, enforcement of the terms and conditions of permits, sub-lease agreements and the ability to conduct allotment evaluations in a timely fashion)	DOI and USDA	Increased priority for Rangeland Programs budget and staffing.
• Contract with experienced vegetative monitoring crews that are familiar with sagebrush ecological sites and states to increase land management capacity	BLM, USFS, USGS, NGOs, Contractors	
• Re-evaluate carrying capacity and/or permit terms and conditions of allotments, particularly for those that have transitioned away from reference conditions and are trending downward within Core Sagebrush Areas or Growth Opportunity Areas	BLM, USFS	Elevated priority as a work objective within Rangelands programs.
• For those allotments that have transitioned to an annual grass state, re-evaluate management objectives (ephemeral vs. perennial allotment) to help ensure adjacent allotments do not suffer the same fate or potentially consider them as an allotment targeted for minimization of fuel loads to protect adjacent allotments	BLM and USFS	Determination that allotments have transitioned (use of remote sensing tools, e.g., Ecostate Time Series in SageCon's Oregon Explorer, RA, RCMap)
• Implement changes to the Farm Bill (USDA-FSA) drought/disaster assistance programs to better incentivize effective conservation practices. These changes could be linked to actual conservation efforts rather than payouts or simple compensation. For example, to receive compensation, a drought recovery plan could be developed to institute management action that lessens upland and riparian impacts. Consider pragmatic changes so that insurance programs are less risky	USDA-FSA https://www.fsa.usda.gov/programs-and-services/index	

Key Grazing Strategies and Actions	Lead Entities	Needed to Implement
• Consider converting current "common" allotments (BLM) where multiple permittees graze a single allotment into a single permittee allotment within Sagebrush Core or Growth Opportunity Areas. These classifications often create management issues that are difficult to track for field offices	BLM	
• Re-evaluate season of use, duration, frequency and intensity of grazing of allotments where management objectives are not being met in Core Sagebrush Areas or Growth Opportunity areas	BLM and USFS	
• On State Trust Lands within Core Sagebrush or Growth Opportunity areas, encourage the inclusion of wildlife habitat management objectives into management directives for those properties	State Lands Agencies, State Legislatures	Enabling policy and potentially legislation
Incorporate principles of adaptive management and greater flexibility in grazing programs to maintain and improve rangeland health:		
• Identify ways to provide for variation of season of use on public land pastures that could maximize vegetation productivity and resource value	BLM and USFS	Potentially Grazing Policy changes
• Implement and incorporate adaptive management measures for sustainable grazing into terms and conditions of grazing permits (e.g., DOI/BLM Outcome Based Grazing Authorization Demonstration Projects). USDA-FS employs allotment specific adaptive management decisions based on desired condition objectives. Incorporate efficient methods to assess vegetation condition, ideally using remote sensing techniques and tools, into the adaptive management workflow *(see Nevada Rangeland Monitoring Handbook, 2018)*	BLM and USFS	
• Expand educational efforts to increase participation through expanded educational efforts in the NRCS Conservation Stewardship Program on private land and the NRCS Environmental Quality Incentives Program (Conservation Incentive Contracts) on both private and federal lands. These programs incentivize permittees to manage for resistant, and resilient rangelands, including addressing drought	BLM, NRCS, USFS, Extension offices	
• Determine what/where existing grazing systems work on the landscape to achieve vegetation objectives and work through agency processes (e.g., USFS environmental analysis; BLM Land Health Assessment and EA) to replicate those terms and conditions on neighboring allotments or allotments with similar characteristics	BLM, USFS, USGS and ARS	
• Explore options for targeted grazing to take advantage of early season green-up of invasive annual grasses or reduce residual material in the fall to moderate fuels for the following spring/summer and help mitigate impacts of potential wildfire. This may require reduced use during the	BLM, USFS, USGS and ARS	

Key Grazing Strategies and Actions	Lead Entities	Needed to Implement
late spring and summer to reduce impacts to native deep rooted perennial bunchgrass and riparian systems		
Mitigate for extended drought to reduce impacts to sagebrush rangelands:		
• Develop an interagency guidance document with decision trees/management flows to apply during varying degrees of drought or other management critical issues	USFS, ARS, BLM, USGS, NOAA	Interagency cooperation
• Develop allotment contingency plans for drought, fire and flooding or periods of extreme run-off and include in terms and conditions of permit. Likewise, develop a drought or fire recovery plan (both short term and long term). Some mitigating strategies or actions are included below	BLM, USFS	Likely increased staff capacity
• Encourage use of livestock management strategies to proactively address drought or other natural disaster situations. For example; graze somewhere else, lease additional pasture, try to graze areas this year that did not get much or any grazing use last year, adjust timing of grazing, delay turnout to allow forage plant recovery, minimize duration of grazing in available pastures and spread use across pastures, consider stockpiling forage for emergency use (grass-banking), etc.[2]	DOI and USDA, Private Landowners (Permittees)	
• Assess vacant allotments and the potential for them to be "grass-banked". Permittees could apply for use when drought conditions have reduced forage on their permitted allotments or when a fire or other natural disaster has affected use of those allotments	BLM, USFS, Private Landowners (Permittees)	
Utilize best grazing management practices that maintain healthy rangelands:		
• Manage livestock grazing to maintain a balance of native perennial grasses, forbs, and biological soil crusts to allow natural regeneration and to maintain resilience and resistance to invasive plants and continue to exhibit a native perennial bunchgrass component. Areas with low to moderate resilience and resistance may be particularly vulnerable (cells 2A, 2B, 2C, 3A, 3B, 3C) referenced in the "Science Framework for the Conservation and Restoration Strategy"[1]	DOI and USDA Private Landowners (Permittees)	
• Implement existing management tools such as herding, riparian riders, strategic supplement placement and temporary fencing when feasible. Options may exist for using alternative grazing species (e.g., goats) to reduce undesirable species in specific areas at specific times	BLM, USFS, NRCS, Private Landowners (Permittees)	
• Implement grazing strategies that incorporate periodic rest during the critical growth period, especially for cool season grasses, to ensure maintenance of a mixture of native perennial grasses. This strategy is important across all sites, but particularly essential in areas with low to moderate resilience and resistance supporting sage-grouse habitat (cells 2B, 2C, 3B, 3C)[1]	BLM, USFS, NRCS, Private Landowners (Permittees)	

Key Grazing Strategies and Actions	Lead Entities	Needed to Implement
• Use Candidate Conservation Agreements and Candidate Conservation Agreements with Assurances to include appropriate grazing management strategies that maintain and improve land health within sagebrush landscapes	USFWS, States, SWCDs, etc.	Capacity to develop, implement and monitor
• Develop best management practices for livestock grazing post fire. Restoration investments need to be supported by grazing adjustments intended to complement restoration goals (e.g., rest, season of use, alternative allotment/grass bank sites, alternative grazing species, targeted grazing)	USDA-ARS, USGS	
• Develop best management practices for livestock grazing post reclamation. Reclamation investments need to be supported by grazing adjustments intended to complement reclamation goals (e.g., rest, season of use, alternative allotment/grass bank sites, alternative grazing species, targeted grazing)	USDA-ARS, USGS	
Recognize and use emerging technologies and innovative techniques to manage livestock and rangelands:		
• GPS/shock collar virtual fencing can be a valuable tool with respect to meeting riparian use and targeted grazing objectives	BLM, USFS, NRCS, Private Landowners (Permittees)	
• Convert invasive annual grasslands into more functional stands (e.g., Siberian wheatgrass, crested wheatgrass, Anatone bluebunch) that land management agencies can draw on when needed for alternative grazing areas. These alternative grazing areas need to consider their landscape functionality, climate resilience, and invasion and escape risk. (Direct areas under the RAD framework)	BLM, USFS, USGS, ARS	
• Increase the profitability of ranching via supply chains and production to potentially include local processing plants and niche markets. For example, consider programs like Audubon's Conservation Ranching Program or similar approaches	State Agriculture Agencies and Producers	
• Develop, test, and incorporate new and emerging technologies for monitoring (e.g., remotely sensed data and methods)	USGS, NRCS, ARS, State Agriculture Agencies	Research investments, co-production of tools

[1] Chambers et al. (2016) Science Framework for the Conservation and Restoration Strategy of the Department of the Interior Secretarial Order 3336.

[2] Mosley, J. Grazing Management During and After Extended Drought. Department of Animal and Range Sciences, Montana State University.

Chapter L. Strategies to Address Land Use Conflicts

These strategies were identified by a diverse group of stakeholders through a virtual stakeholder engagement process. There are numerous challenges to managing land use in sagebrush habitats; diverse landownerships, multiple levels of regulatory control from Federal to State to County governments, uncertainty about the level of disturbance tolerated by sagebrush systems and species, and voluntary decisions by private landowners. Conserving sagebrush landscapes benefits society and local communities. However, to conserve the sagebrush biome, land use decisions and strategies will need to balance disparate wildlife species needs and human community needs.

Strategies are presented for managing multiple land use activities in the sagebrush biome to maintain sustainable ecosystem services for humans and wildlife. Strategies were identified with respect to three over-arching themes: 1) the need for profitable markets for sagebrush conservation; 2) the importance of empowering local collaboratives to make and support land use decisions that minimize disturbance to the sagebrush ecosystem; and 3) the value of landscape planning informed by tools such as the Sagebrush Conservation Design that accommodates regional differences. The need for improved communication and trust among stakeholders is a critical element across all themes. Establishing a profitable market for sagebrush conservation and restoration may include payments for ecosystem services, policy adjustments, and voluntary incentive programs. Improving the profitability of sustainable grazing might involve business improvements to the supply chain, niche marketing of sustainably produced beef, adaptive management and increased grazing flexibility on public lands, and incentives to engage younger producers. Conservation easements are an important voluntary tool, especially when targeted in areas most vulnerable to conversion. However, conservation easements can be limited by public misconceptions and the current method of valuation being tied to real estate versus resource values.

Managing land use decisions through local partnerships, such as county planning groups, continues to be the most successful strategy for conservation. Opportunities exist to expand these existing collaboratives to address emerging topics relevant to the sagebrush system. New tools, technology, and industry standards for development in the sagebrush system can be included in plans to minimize disturbance. Working with industry and special interest groups to message around the ethics of responsible recreational use can also help to minimize disturbance in the sagebrush system. There are some good examples of local interest groups taking responsibility for the stewardship of popular recreation areas, which can serve as a model for other communities. Using science to plan at the landscape-scale is important for achieving the common vision of sagebrush conservation, leveraging funding, and identifying the right conservation approaches for a given area. It is important that locally credible spokespeople communicate the relevancy, value, and function of landscape-scale planning to local groups. Setting achievable targets and recognizing that compromise is inherent in successful collaborations will help link landscape goals to local implementation.

Table L1. Land Use Strategy Summary

Key Land Use Strategies and Actions	Lead Entities	Needed to Implement
Increase conservation opportunities in production agriculture:		
• Engage in communication with producers and ranchers to understand their business needs and increase participation in conservation	University and/or County Extension	
• Improve the utility and application of conservation easements through outreach on misconceptions and refinement of the tool for better adoption (e.g., adjusting valuation and/or targeting)	Land Trusts or others offering easements	
• Make "growing sagebrush" profitable as a functioning rangeland		
• Consider making native sagebrush rangelands converted to cropland ineligible for federal crop insurance	USDA-NRCS	Policy/program change
• In areas at high risk of conversion of sagebrush to cropland, provide financial incentives to ranches with an NRCS approved management plan that includes conservation of sagebrush	USDA-NRCS	
• Explore the options for payments for ecosystem services enhanced through treatment of privately owned sagebrush landscapes (above and beyond cost-share)	USDA-NRCS	Enabling policy and or legislation
• Add a provision to the Conservation Reserve Program for payment to ranchers in areas suitable for cropland conversion for not converting sagebrush for 10-20 years	NRCS/FSA	Require changes to Farm Bill?
Improve local outcomes through landscape planning and targeted conservation:		
• Communicate with local groups on landscape perspectives; build trust by engaging subject experts and those willing to work collaboratively	Federal and state agencies, NGOs	
• Set achievable targets, balancing strategy at landscape scales with opportunity at local scales	Federal agencies, States	
• Work with industry on voluntary versus regulatory conservation and mitigation	Renewable and extractive industries, NGOs	
• Work with community youth groups, e.g., 4-H, and non-traditional groups, e.g., Sagebrush in the Prisons, to enhance restoration capacity and understanding	Land Management Agencies, States	
Reduce the impacts of local development and recreation:		
• Engage local working groups and other locally organized groups to help identify strategies to manage development at local scales	Counties, States	
• Develop new and refine existing tools that help consistently evaluate impacts to the sagebrush biome (for example, help identify sagebrush values and functions, assess implications of cumulative development on the landscape)	USGS, Universities	Research Funding
• Develop industry standards for all infrastructure (for example, expand APLIC guidelines to other industries)	Industry	
• Engage the recreational industry and special interest groups to message responsible uses and the ethics of recreation	Recreational Industry	
• Engage local recreational groups to take responsibility for managing and minimizing impacts to local recreational areas	Counties, States	

Chapter M. Strategies to Adapt to a Changing Climate

By John Bradford,[1] Mary Manning,[2] Brian W. Miller,[1] Katherine Renwick,[2] and John Tull[3]

[1]U.S. Geological Survey
[2]U.S. Department of Agriculture, Forest Service
[3]U.S. Department of the Interior, Fish and Wildlife Service

Broadly, climate adaptation is the process of adjusting to actual or expected climate and its effects. Adapting natural resource management to climate change may include altering resource management activities, modifying land use practices, facilitating species adaptation, and potentially accepting shifts in the ecosystem services provided by resources.

As temperatures continue to rise, and precipitation patterns shift, climate adaptation has been identified in several government and agency documents as a necessary component of resource management and governance in the 21st century.

- National Climate Assessment (https://nca2014.globalchange.gov/)
- DOI climate action plan 2021 (https://www.doi.gov/sites/doi.gov/files/department-of-interior-climate-action-plan-final-signed-508-9.14.21.pdf)
- https://www.nps.gov/subjects/climatechange/index.htm
- https://www.fs.usda.gov/ccrc/home
- https://www.fs.usda.gov/ccrc/adaptation/adaptation-approaches
- R1 Climate Change - Community Home (sharepoint.com)
- Sustainability and Climate | US Forest Service (usda.gov)
- https://www.blm.gov/about/how-we-manage/climate-change
- https://www.fws.gov/home/climatechange/
- https://www.bia.gov/bia/ots/tribal-climate-resilience-program

As these documents make clear, climate change can, and should, be incorporated into resource management decisions and operations at all scales, from broad planning at landscape, regional, and national levels to specific site-level land treatment decisions. Broad conceptual frameworks for climate adaptation exist and can be used to help policymakers and resource managers think differently about natural resource management. This involves a fundamental shift from managing based on historical conditions and dynamics toward anticipating future conditions that may represent a dramatic departure from the past. This anticipatory resource management can recognize climatic changes that are already being observed and can capitalize on short-term (for example, seasonal) and long-term (for example, multi-decadal) predictions of both climate and ecological dynamics.

At the most basic level, climate adaptation begins with integrating climate impacts into broad planning and prioritization efforts, which include Climate Smart Conservation[14], the USDA Forest Service's Climate Response Framework (Forest Adaptation Resources: climate change tools and approaches for land managers, 2nd edition | US Forest Service Research and Development (usda.gov)), and the National Park

[14] Stein, B. A., P. Glick, N. Edelson, and A. Staudt. 2014. Climate-smart conservation: putting adaption principles into practice. 0615997317, National Wildlife Federation.

Service's Resist-Accept-Direct (RAD) framework[15]. A common feature of these frameworks is to embrace long-term trajectories of ecosystem structure and function to reconsider the services that can be expected from various areas. This can be formally structured in a landscape conservation design effort in which Defend, grow, and mitigate are mapped, and these ideas are very consistent with the broader frameworks, particularly RAD.

The climate adaptation actions identified below have been synthesized from a wide variety of existing sources. These include broad frameworks and scoping, regional conservation and planning products focused on sagebrush ecosystems and other nearby biomes, and individual climate-related research studies within the sagebrush region. Chapter L, Climate Adaptation, in Part I of the Sagebrush Conservation Strategy (Sagebrush Conservation Strategy—Challenges to Sagebrush Conservation (usgs.gov)) includes an appendix (M1) that lists sources describing these climate adaptation strategies. These documents provide additional details and justification for the actions identified below, which include general strategies (bold) and in some cases more targeted approaches and specific tactics. To maximize effectiveness, these climate adaptation actions should be integrated into specific resource-management or decision-making processes (for example, grazing or fire management plans), and prioritized within a Defend and Grow the core construct.

Within the sagebrush biome, climate adaptation strategies will, for the most part, represent modifications to existing activities addressed in other parts of this report, including fire suppression, grazing, conservation planning, mining and energy development, restoration, etc. However, in some instances, more fundamental changes to management activities and goals will be required.

Table M1. Climate Adaptation Strategies

Key Climate Adaptation Strategies and Actions	Lead Entities	Needed to Implement
Engage in adaptive management to promote responsive management in the context of changing conditions:		
• Support long-term adaptive management teams with mandates to alter management in response to monitoring data	Land management agencies	Sustained and predictable staffing and funding
• Monitor land treatments, and continuously evaluate success	Land management agencies, researchers	
• Monitor pollinators (for example, research, tech transfer, education, citizen science projects, and monitor existing populations)	Land management agencies, researchers	
• Monitor for climate-driven changes in habitat composition in core and connectivity areas	Land management agencies, researchers	
• Recognize that climate impacts may be most evident post-disturbance (press or pulse)	All	
Use scenario planning to promote plans and decisions that are robust to uncertainty:		Co-production and participatory approaches that

[15] Schuurman, GW, DN Cole, AE Cravens, S Covington, SD Crausbay, C Hawkins Hoffman, DJ Lawrence, DR Magness, JM Morton, EA Nelson, and R O'Malley. 2021. Navigating ecological transformation: Resist-Accept-Direct (RAD) as a path to a new resource management paradigm. BioScience. https://academic.oup.com/bioscience/advance-article/doi/10.1093/biosci/biab067/6429752

Key Climate Adaptation Strategies and Actions	Lead Entities	Needed to Implement
		enhance trust, salience, and legitimacy, and promote open-minded thinking about potential impacts and solutions
• Use a small set of relevant, challenging, plausible, and divergent scenarios of climate change and its impacts to support policy and decision making	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Examine how well long-term climate projections, particularly the widest plausible range of future conditions, are considered by existing policies and agency objectives	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Consider long-term suitability for intact sagebrush plant communities (for example, sagebrush, perennial graminoids, native forbs) in planning conservation and land treatment decisions	Manager-researcher partnerships	Additional research/science
• Recognize that historical patterns of ecological resilience and resistance to disturbance and invasive species will shift, potentially in unprecedented ways, as climate changes	Manager-researcher partnerships	
• Avoid potentially large mis-investments in areas where sagebrush is not expected to be present in the future	Manager-researcher partnerships	Additional research/science
• Identify and protect or restore sites near the leading edge that could serve as future sagebrush habitat under a ~~a~~ range of plausible scenarios	Manager-researcher partnerships	Additional research/science
• Consider revising management goals, not just actions, to be successful in the face of climate change. For example, in some areas, it may be impossible to resist exotic grass invasion and ecological transformation with management activities, and accepting or directing ecological change may be necessary	Manager-researcher partnerships	
Reduce non-climate stresses that hinder the ability of species or ecosystems to withstand or adjust to climate change:		
• Restrict recreational access in areas that show signs of excessive wear on natural resources in order to allow for revegetation or soil stabilization	Land management agencies	Outreach and education
• Identify and manage (e.g. close, obliterate, re-route) non-system/user-created routes (roads and trails)	Land management agencies	Outreach and education
• Assess and consider restricting human activities such as agricultural conversion, heavy livestock grazing, and continued urban and exurban development, especially in core and connectivity areas	Land management agencies	Outreach and education
• Minimize adverse impacts of wildfire to avoid long-term impacts to ecosystem structure and composition, potentially by using fuel breaks and fire suppression, and/or by identifying fire refugia for priority conservation	Land management agencies	Landscape-scale strategies

Key Climate Adaptation Strategies and Actions	Lead Entities	Needed to Implement
• Recognize and control nonnative invasive species to minimize ecological transformation to invasive-dominated plant communities, potentially by conducting integrated weed management and similar techniques	Land management agencies	Landscape-scale strategies
Protect key ecosystem features including geophysical stages, organisms, or areas that represent important "underpinnings" or "keystones" of the current or future system of interest:		
• Manage for basic ecosystem health, i.e., all the attributes of resistance and resilience and fire avoidance	Manager-researcher partnerships	Additional research/science
• Provide a large reserve based on a species' known optimum conditions to preserve a species	Land management agencies	
• Identify areas with high diversity or other desirable attributes that can be set aside as a reserve on an existing ownership	Manager-researcher partnerships	Additional research/science
• Coordinate with partners to manage an at-risk species or community existing on a variety of suitable sites	All	Landscape-scale strategies; education and outreach
Ensure connectivity among landscape features (for example, land corridors, stream connections) that facilitate movement of water, energy, nutrients, and organisms among resource patches:		
• Use conservation design and similar approaches to vulnerability assessments that integrate exposure and sensitivity at multiple scales: states, biomes (for example, BLM Rapid Ecosystem Assessments and/or ongoing Sagebrush Conservation Design, see Chapter A)	All	
• Maintain or create corridors for species migration	Land management agencies	Landscape-scale strategies
• Consider the potential for species adaptation when identifying corridors to promote passive climate adaptation opportunities	Researchers (e.g. USGS, ARS, USFS universities)	Additional research/science
• Develop a network of partners (including farmers or ranchers) to define shared conservation goals and work with partners to achieve connectivity goals at the landscape level	All	Outreach and education
Maintain and restore structure and function in ecosystems that have been degraded or compromised, in order to restore desired structures (for example, habitat complexity) and functions (for example, nutrient cycling):		
• Use soil amendments like soil crust to restore or improve soil quality and stability	Land management agencies	
• Inoculate soils with mycorrhizae to increase native plant establishment, diversity, and survival	Land management agencies	
• Restore wetlands within grass dominated areas to help store and naturally release water from intense rain events	Land management agencies	
• Promote the occurrence and growth of early-season native plants	Land management agencies	

Key Climate Adaptation Strategies and Actions	Lead Entities	Needed to Implement
Support evolutionary potential by protecting a variety of species, populations, and ecosystems in multiple places to hedge against losses from climate disturbances and, where possible, manage these systems to assist positive evolutionary change:		
• Identify areas with a high diversity of geology, landform, vegetation, or soils for increased protection or conservation	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Restore or increase a community type on a variety of soil types and across a range of topographic positions	Land management agencies	Landscape-scale strategies
Protect refugia by identifying and preserving areas less affected by climate change as sources of "seed" for recovery (in the present) or as destinations for climate-sensitive migrants (in the future) by:		
• Identify sites that are expected to be more resistant to changes in climate (for example, high soil water recharge, short drought periods during the growing season, and few hot days) as refugia for maintaining native plant communities into the future, particularly in the trailing edge of the sagebrush range	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Develop a network of reserves with adjacent landowners with shared conservation goals	Land management agencies	Landscape-scale strategies; outreach and education
• Identify and protect focal areas for regeneration and recovery following a disturbance	Manager-researcher partnerships	Additional research/science
• Promote seedling survival (including preventing fires, conifer encroachment, and exotic annual grass invasion) in refugia	Land management agencies	
Relocate organisms by transplanting organisms from one location to another where they will be more suited to future climate conditions:		
• Consider assisted migration of species and populations from hotter/drier (lower elevation/lower latitude) locations that are expected to perform well in future conditions	Land management and wildlife agencies	Agency/political acceptance and support; additional research/science
• In areas where sagebrush is unlikely to persist, consider directing change by encouraging native non-fire promoting shrubs and perennial grasses whose future distribution overlaps with the trailing edge of sagebrush	Land management and wildlife agencies	Agency/political acceptance and support; additional research/science
Consider modified grazing practices to ensure long-term economic sustainability and avoid land degradation under altered climate and drought conditions:		
• Consider altering grazing regimes, including modified stocking rates, applying rotational grazing, and using protein supplements	Land management agencies	Agency/political acceptance and support
• Build resilience to episodic droughts that decrease forage through programs like grass banks, drought insurance, spatial bet-hedging, etc.	Land management agencies	

Key Climate Adaptation Strategies and Actions	Lead Entities	Needed to Implement
• Where possible and accountable, increase flexibility in livestock operations to be responsive to greater variability in future drought and forage production	Land management agencies	Agency/political acceptance and support
• Consider using seasonal drought forecasts (for example, GrassCast or the Ecological Drought Forecaster) to anticipate forage dynamics in coming seasons	Manager-researcher partnerships	Education and outreach
• Create and use livestock movement guides (within-season triggers) and promote nimble response to changing conditions to maintain and/or enhance plant and soil conditions (end-point indicators)	Manager-researcher partnerships	Agency/political acceptance and support
• Use targeted grazing or virtual fencing technologies to address contemporary vegetation management challenges (for example, control invasive exotic and noxious weeds and undesirable species, reduce fire risk)	Land management agencies	Agency/political acceptance and support
Modify restoration practices to recognize changing conditions:		
• Target restoration for areas that are expected to be climatically suitable in the future	Land management agencies	
• Recognize past trends and future trajectories in relevant and prevailing conditions (for example, Resistance and Resilience) when planning restoration treatments	Manager-researcher partnerships	
• Develop and use seasonal forecasts of plant establishment to minimize drought-induced restoration failure	Manager-researcher partnerships	Additional research/science
• Consider seeding multiple years in a row to maximize probability of seeds experiencing favorable conditions that support plant establishment	Land management agencies	
• Identify and use a selection of climatically appropriate seed sources, ideally selected to include species and/or genotypes that can thrive in conditions expected in coming decades (for example, https://seedlotselectiontool.org/sst/)	Manager-researcher partnerships	Additional research/science
• Use non-traditional strategies to enhance seed establishment, including seed coatings, seed pillows, etc.	Land management agencies	
• Consider planting rather than seeding for small areas to create a sustained seed source (for example, nucleation planting/restoration island designs)	Land management agencies	
• Where possible, use techniques to increase soil moisture and seed establishment success (for example, ConMods, seed coatings, pitting, mulch)	Land management agencies	
• Use mapping programs to match seeds collected from a known origin to planting sites based on climatic factors	Land management agencies	
• Build ecological forecast models that predict outcomes from land treatments, particularly restoration efforts. Capitalize on observations of outcomes (for example, monitoring data) to iteratively improve forecast models	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Enhance flexibility in policy and agency rules allowing nimble responses to fluctuating conditions in restoration treatments	Land management agencies	Agency acceptance and support

Key Climate Adaptation Strategies and Actions	Lead Entities	Needed to Implement
• Explore feasibility and appropriateness of utilizing non-native species for restoration in locations where long-term suitability of natives is sharply declining	Manager-researcher partnerships	Additional research/science
Develop guidance for more specific approaches and tactics in sagebrush ecosystems:	Co-production and participatory approaches that enhance trust, salience, and legitimacy, and promote open-minded thinking about potential impacts and solutions	
• Enhance adoption of climate adaptation efforts by refining and clarifying currently identified specific actions	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Develop and utilize climate-informed seed zones for critical restoration species	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Synthesize information about plant establishment requirements (drought and temperature) and operationalize establishment forecasts for important species and native plant materials	Researchers (e.g. USGS, ARS, USFS, universities)	Additional research/science
• Incorporate information about the consequences of long-term climate and drought trajectories into planning tools for resource management agencies. This is particularly important for tools used to plan restoration seeding treatments	Researcher-manager partnerships	
• Build menus or decision trees of specific adaptation approaches and tactics for sagebrush ecosystems, similar to those developed for other systems (for example, https://forestadaptation.org/adapt/adaptation-strategies)	Researcher-manager partnerships	
• Recognize that incorporating climate adaptation is necessary to achieve success in a range of management objectives, including invasive species control, wildfire suppression, grazing sustainability, and restoration success	All	Education and outreach

Section III. Case Studies of Successful Collaborative Conservation

We sought out, and describe below, examples of case studies of successful conservation programs or approaches to challenges facing the sagebrush biome that if replicated and scaled up will increase our capacity to conserve the sagebrush biome. While some programs or approaches may be replicable in kind in other areas, these case studies are intended primarily to serve as examples of a philosophy of conservation: Local development of conservation goals, and locally led, collaborative implementation of science-based conservation actions to meet them. Hopefully these can trigger thought and discussion about what local ownership and collaborative approaches to conservation could look like in your area.

Case Study 1- Southeast Conservation Adaptation Strategy

Overview: Program Description
The Southeast Conservation Adaptation Strategy (SECAS) is a regional conservation initiative spanning the Southeastern United States and Caribbean. SECAS was started in 2011 by the states and territories of the Southeastern Association of Fish and Wildlife Agencies (SEAFWA) and includes the federal agencies of the Southeast Natural Resource Leaders Group (SENRLG). In 2020, SECAS also added three conservation nonprofit members. Each organization designates a Point of Contact to serve as their liaison and work collaboratively to identify priority actions, provide technical input, and focus the work of the partnership.

At the highest level, SECAS is governed by an Executive Steering Committee comprising five SEAFWA state directors and the U.S. Fish and Wildlife Southeast Regional Director. The Committee is an official committee of SEAFWA. Its purpose is to provide oversight and strategic direction by helping guide the actions of SECAS staff and designated Points of Contact (POCs) to support, promote, and improve the products and services of the partnership. Committee members also communicate the priorities and activities of SECAS among SEAFWA agencies, other state and federal agencies, and partner organizations.

Capacity for SECAS includes a full-time SECAS Coordinator and numerous additional staff devoted to science coordination, GIS support, Blueprint user support, and communication roles. The U.S. Fish and Wildlife Service funds these staff positions as an investment in the relationships, people, products, and services that deliver value to SECAS partners.

Drivers: Shared Vision or Problem/Motivation
SECAS emerged in response to the unprecedented challenges facing Southeast natural and cultural resources, including increasing urbanization, energy development, and climate change. Recognizing these challenges are too vast for any one organization to overcome alone, SECAS was created to strengthen collaboration among the agencies and organizations responsible for sustaining natural and cultural resources into a changing and uncertain future. To do that, SECAS brings together conservation partners from every sector around a shared vision for the future: a connected network of lands and waters supporting thriving fish and wildlife populations and improved quality of life for people.
SECAS was also established to ensure that individual subregional conservation planning efforts, initially developed through the Landscape Conservation Cooperatives (LCCs), contributed to a coordinated

regional strategy to define the landscape of the future to sustain fish and wildlife in the Southeast, specifically described as “an ability to add things up ecologically on the landscape.”

Innovation: Overcoming Barriers and Challenges

The Southeast Conservation Blueprint has always been the primary product of SECAS and a major focus of innovation. SECAS embraces several novel approaches in Blueprint development and implementation. One is a “lean startup” philosophy borrowed from the tech industry, which emphasizes rapid cycles of testing and improvement with a goal of maximizing learning. In the Blueprint, this manifests as an annual revision cycle that captures updated data and input from new partners. We publish a list of known issues with each version of the Blueprint that transparently documents all known shortcomings and helps prioritize future improvements.

Another novel approach is our investment in Blueprint user support. SECAS continues to increase its user support capacity, dedicated to helping conservation practitioners apply the Blueprint to their decisions and use it to help bring in new resources to accomplish their work. As conservation professionals are increasingly inundated with new tools and prioritizations to inform their decisions, the availability of support staff can make the difference between a plan that’s used to make a difference on the ground, and a plan that sits on the shelf. Working closely with Blueprint users provides valuable insight into which improvements will best clear barriers to using the Blueprint. User support staff incorporate that feedback into the Blueprint revision cycle and advocate for users’ needs. User support staff also apply techniques from the field of user experience and user-centered design to improve the Blueprint’s online interfaces. Our commitment to user support helps ensure equitable access to the Blueprint, so everyone can use it without needing technical expertise or access to specialized software. Today, SECAS is taking advantage of the momentum created by 30x30 to continue updating the Blueprint using these innovative approaches, increase user support capacity, and expand engagement with key and overlooked constituencies.

Assessments: Results and Evaluation

SECAS recently completed a holistic assessment of how SECAS is adding value to partner organizations and sustaining progress toward meeting its vision and goal. The final report provides a comprehensive evaluation of the partnership. The project found that SECAS provides value in two key ways: 1) as a forum for collaboration, and 2) as a hub for decision-support and information-sharing.

SECAS also measures its success by tracking progress toward an overarching goal: a 10% or greater improvement in the health, function, and connectivity of Southeastern ecosystems by 2060. Every year, we synthesize the most recent 3-6 years of data available from existing regionwide monitoring programs to determine which ecosystems and indicators are on track to meet the goal, and which ones may be falling through the cracks. In this way, the success of SECAS as a partnership hinges on how well we galvanize collective action by the conservation community to effectively sustain our natural and cultural resources into a changing future.

Endurance: Effort and Evolution over Time

Over the past decade, SECAS has grown significantly in formality and visibility. It began largely as a lightweight wrapper around efforts to align the subregional products of the Southeast and Caribbean LCCs. SECAS added additional structure as needed, like a vision statement, designated points of contact

for member organizations, a full-time coordinator, and a website. In recent years, it has become a much more formal partnership with the addition of the 10% goal, structured governance, new user support staff, a monthly newsletter, and more.

As the partnership itself has evolved, so has its primary product, the Southeast Blueprint. Up until now, the Blueprint has stitched together a series of smaller subregional plans, many of which originated as LCC products. Today, SECAS is embarking on a new approach that uses consistent methods and indicators across the vast majority of the Southeast. This improved Southeast Blueprint is planned for release in Fall 2022. With this new approach will come opportunities for new partners across the region to participate in Blueprint development and implementation.

Remaining Barriers/Challenges
The SECAS Futures Project recommended 5 short-term actions to address remaining barriers to the success of SECAS. All of these recommendations have been implemented. These were:

1. To ensure continued overall performance and value-add: Recommend that the Steering Committee be made permanent, and that periodic assessments of SECAS' performance and governance are one of the committee's duties.
2. To ensure continued focus on coordination and delivery of value: Recommend making the SECAS Coordinator a full-time permanent position, and continuing to support SECAS technical and coordination capacity.
3. To maintain relationships and continuity under changing conditions: Recommend creating a succession plan and onboarding materials to ensure continuity and momentum in the face of leadership and staff changes.
4. To improve overall understanding and communication while maintaining informal governance: Recommend creating a SECAS Statement of Shared Purpose that provides the regional goal and vision, structure, leadership commitments, roles and responsibilities, and focus areas.
5. To play a broader coordinating and convening role: Recommend conducting a social network analysis to better understand existing relationships and connections among partners.

New challenges on the horizon for SECAS are: 1) to successfully implement the new 2022 Blueprint modeling approach, which will require scaling up subregional methods, indicators, and expert review strategies to the entire Southeast, and 2) to successfully capitalize on the momentum of America the Beautiful to advance the ongoing work of the partnership.

Case Study 2 - Utah's Watershed Restoration Initiative

Overview: Program Description
The Watershed Restoration Initiative (WRI) is a partnership-based program in Utah to improve high priority watersheds throughout the state. WRI is sponsored by the Utah Partners for Conservation and Development and is in its 12th year. The Watershed Program focuses on improving three ecosystem values: 1) watershed health and biological diversity, 2) water quality and yield, and 3) opportunities for sustainable uses of natural resources.

WRI has been operating since 2006. Oversight of WRI is provided by the Utah Partners for Conservation and Development (UPCD). UPCD is made up of the heads of Federal (BLM, USFS, NRCS, USFWS, NPS, BOR) and Utah State (UDAF, USU Extension, SITLA, DNR, DEQ) natural resource management agencies in Utah. UPCD provides high level oversight and support for WRI including development and approval of project ranking criteria. Administration for WRI is provided by a Watershed Program Director in Utah DNR funded by the Utah Legislature and 3 employees in the Division of Wildlife Resources. Support staff for finding and administration is also provided by various UPCD partner agencies. Administrative activities include maintaining a comprehensive project database, funding management, technical assistance, and outreach. When it comes to conducting projects, WRI is a bottom-up initiative where project planning, review, and ranking occur at a local level. Five regional teams elect their own leaders, establish focus areas, review, score and rank project proposals using a comprehensive project prioritization score sheet, and assist their members in implementing projects.

Since its inception, over 500 WRI partners have completed 2,119 projects improving over 1.8 million acres and 1,200 miles of streams with over $248 million in direct funding and over $28 million in In-kind funding. In the current fiscal year, WRI has approved 294 projects on 414,060 acres with over $77 million in direct funding and nearly $10 million in in-kind funding.

Drivers: Shared Vision or Problem/Motivation

Although there were many threads and issues that came together to form the Watershed Restoration Initiative, the most apparent starting point was a Joint Resolution adopted by the Utah Partners for Conservation and Development. The resolution was titled: “Regarding The Need For Increased Efforts In Management And Restoration Of Shrub-Steppe And Great Basin Sagebrush Ecosystems”. At that time, Utah had experienced severe drought, sagebrush die-offs, and declines in mule deer and sage grouse populations. The UPCD recognized that current efforts scattered geographically and programmatically had not and could not resolve this crisis. The resolution called for actively managing these natural systems cooperatively. Scattered programs by multiple agencies were brought together to focus on this challenge. Although initially only focused on shrub-steppe ecosystems, the resolution allowed agencies to cooperatively address management problems by combining efforts and resources to take on other ecosystems beyond shrub-steppe and species in need of active management.

Innovation: Overcoming Barriers and Challenges

The challenge facing the Initiative as the number of projects dramatically increased was how to pool funding and ensure funding was applied on the ground, how to select and administer projects and how to share credit for successfully completed projects. WRI developed approaches to address all these challenges. First, due to a grant initially from NRCS, and later support from the Utah Legislature, no overhead is applied to projects. Staff to oversee the initiative and provide technical assistance needed to complete a project are funded from the grant or provided by one of the partners. All funding brought by partners is applied to projects on the ground.

A second innovation is the administrative structure which is top-down for some tasks and bottom-up for others. The top-down components are completed by the Initiative administration under the oversight of the UPCD. Administration provides a project ranking system, a project database and management system, fund management system, centralized seed purchasing, contracting for services including

treatments, seed application, archeology clearances, and workshops and training in new techniques. The bottom-up management is coordinated by five regional teams that rank projects using an established project ranking system, identify priority areas across jurisdictional boundaries, provide technical assistance and project review. Projects are funded based strictly on their rank as determined by the regional teams. The WRI is structured to be self-perpetuating without becoming overly bureaucratic.
A third innovation regards how credit for successful projects is shared among funding agencies. The goal was to ensure that all project participants share credit for projects when completed. The Initiative's operative word is "we". The Initiative noted that they do not promote empire building, but rather sharing.

Endurance: Effort and Evolution over Time
Success of the WRI program is measured in a variety of ways. Miles of streams restored to properly functioning condition and acres of habitat rehabilitated are tracked and reported to partners and funders. The number of funding partners participating in projects and funding provided to match base funds is tracked and reported. Projects are monitored to make sure ecosystem objectives are met on an ongoing basis. Research is conducted to evaluate the degree to which priority wildlife species are utilizing habitat created or restored by WRI projects, and if vital rates increase for sage grouse, mule deer and other species. Research is also underway to determine if restoration projects, particularly the removal of invasive conifers, increases the availability of ground water and stream flows.
WRI has been built to respond to new priorities and challenges. An initiative that started to address sagebrush die-offs has evolved and transformed to take on new and diverse ecological challenges. For example, stream and riparian restoration are now major components of the initiative. Wildfire prevention projects are completed to reduce the acres burned in catastrophic fires. A water development effort has been added to the Initiative with new funding provided by the Utah Legislature. WRI funds and coordinates much of the phragmites (an invasive wetland grass) control work on the Great Salt Lake.

WRI has grown and been successful because it has built capacity in a number of areas using a problem-solving leadership model. The focus of WRI leadership is to quickly identify and overcome barriers that would impede progress. WRI looks to the various strengths of its partners to provide capacity where it is lacking. For instance, complying with multiple layers of government contracting requirements can be a bottleneck. The state of Utah has an efficient contracting process so most contracts are run through the Division of Wildlife Resources (DWR). The State also contracts for companies to complete archeological clearances for WRI projects on federal, state and private properties. Federal agencies have the ability to sign multi-year cooperative agreements to provide funding for projects and move that money to state agencies in the WRI. Because of its experience with handling federal funds including Pittman-Robertson and Dingell-Johnson excise tax programs, DWR is able to provide the accounting services needed for a major initiative. DWR has a history of completing habitat projects and dedicates trained staff to WRI. Other agencies, both federal and state as well as NGOs, also dedicate trained staff to plan and complete projects.

Contracting services have been used to build flexible conservation capacity which can be adjusted depending on projects approved and funding obtained. Regional teams provide the main link between participants to build a sense of belonging to a larger effort. Teams meet at least 2-3 times a year to

review projects and complete project ranking and also conduct 1-2 field tours of projects to see what worked and what did not.
WRI will be maintained over time, although it will likely expand and contract depending on budgets and agency priorities. In order to sustain the initiative, WRI strives to:

1. Stay relevant across the political spectrum;
2. Follow rules and laws and maintain integrity – make sure audits are clean;
3. Continue to be useful to partners;
4. Look for new partners who could support and benefit from work (for example, water districts);
5. Maintain and support old partners;
6. Increase outreach to the public; and
7. Remember an attack on one partner is an attack on all.

The WRI has survived the roller coaster through several cycles of funding and changing priorities but the leadership constantly has eyes open to the future. The WRI is constantly adapting over time based on an evaluation of its effectiveness, new challenges, and new priorities and objectives.

Remaining Barriers/Challenges
The most difficult on-going challenge or barrier is bureaucratic. Diverse funding sources bring a myriad of restrictions, match and reporting requirements that must be tracked and complied with. Other challenges include unanticipated events such as government shutdowns, extreme fire or weather events, etc., although the flexibility conferred by multiple partners creates the opportunity to shift staff and resources as needed.

Case Study 3 - Oregon Watershed Enhancement Board (OWEB)

Overview: Program Description
The Oregon Watershed Enhancement Board (OWEB) supports local conservation projects and capacity using a stable source of state funding. OBEB emerged from a grassroots movement of ranchers and conservationists in 1998 and slowly grew into a permanent state agency that grants funds to support local voluntary restoration based on the best available science and cultural knowledge. OWEB provides support for capacity building, project design and execution, and post-project monitoring and requires an in-kind or cash-based 25% match. OWEB can fund projects for as long as six years. However, most funded projects receive two to three years of funding.

Drivers: Shared Vision or Problem/Motivation
The motivation and momentum for creating OWEB stemmed from attempts to keep the spotted owl and salmon off the endangered species list and related voluntary approaches to conservation across jurisdictions.

Innovation: Overcoming Barriers and Challenges
Despite the need for educational activities, this type of work is not eligible for OWEB funds. To address this, OWEB works collaboratively with other state and federal partners to support educational activities. In addition, OWEB receives a very limited operating budget, making it challenging to evaluate OWEB and

OWEB programs. To address this, the agency has hired contractors and worked with universities to evaluate OWEB and OWEB programs.
OWEB staff have observed that local capacity limitations are a key barrier to completing important voluntary restoration projects and achieving agency goals. Consequently, OWEB designed a new line of funding to support building local conservation capacity. These are characterized by OWEB staff as social grants that address capacity and conservation governance. This funding line supports building and maintaining partnerships, developing governance documents, or strategic action plans. OWEB staff believe this may be the most important OWEB innovation.

OWEB has identified lack of agency transparency as an issue, from grant application to award. In response, they have worked to improve transparency by sharing evaluation criteria, composition of review teams, and by identifying conflicts of interest. In addition, most project and program metrics monitored by OWEB are ecological, monitoring social outcomes has been a key gap. To address this, they recently released their first RFP to better understand the social components of funded projects and outcomes.

Endurance: Effort and Evolution over Time
OWEB has been quite successful and will likely be sustained over time. Much of this success and confidence in long-term sustainability is due to the broad and deep support for OWEB. This support has been demonstrated by county-level initiatives passed throughout the state as well as legislative support that grants OWEB 7.5% of annual state lottery funds. As a result, in the current biennium, OWEB has a $105 million budget. This budget includes the lottery funds as well as funds from NRCS, Oregon Department of Forestry, and NOAA. In fact, the NOAA Pacific Coastal Salmon Recovery Fund, an annual competitive grant, generates one-third of the budget for OWEB.

Remaining Barriers/Challenges
While it seems the capacity for OWEB to continue funding conservation activities into the future seems likely, challenges remain surrounding how OWEB supported efforts can possibly change social components related to conservation, including how funding related to building capacity can build longer-term capacity for local organizations completing conservation activities.

Case Study 4 - Oregon SageCon Partnership

Overview: Program Description
The Oregon SageCon Partnership works collaboratively to promote resilient rangelands and address threats to the sagebrush ecosystem and sage-grouse in Oregon. Through implementation of the 2015 Oregon Sage-Grouse State Action Plan and Governor's Executive Order 15-18 SageCon set an ambitious vision for "all hands all lands" conservation of sage-grouse and sagebrush ecosystem health coupled with rural community resilience. To accomplish this vision, SageCon ties diverse partners together across scales, jurisdictions, and public and private sectors to mobilize resources for implementation, achieve connection of conservation actions at landscape scales, focus efforts collectively, track and communicate progress toward shared outcomes, and empower locally-led collaboration. More information about SageCon can be found at https://sageconpartnership.com/.

Drivers: Shared Vision or Problem/Motivation

SageCon came together in 2012 because populations of the greater sage-grouse were declining and at risk of a listing under the Endangered Species Act. Partners in the state came together under a shared understanding consisting of several foundational "pillars of agreement": 1) the primary threats to sage-grouse and sagebrush in the state are wildfire, invasive annual grasses, and conifer encroachment; 2) all stakeholders face real problems as a result of these threats, 3) the challenges are dynamic, varied and interrelated, and require flexibility to effectively manage them; and 4) no single entity can solve these problems alone. Although these foundational pillars are still broadly supported by partners, motivations and drivers have broadened from a focus on the sage-grouse listing decision to the broader ecosystem dysfunction driving the decline of sage-grouse along with other negative outcomes for both people and nature. Without the motivation of a crisis, implementation of the state Action Plan has lacked urgency and stakeholder engagement has declined.

Innovation: Overcoming Barriers and Challenges

SageCon coordinates across an extremely wide range of partners from federal and state agencies, local entities and governments, Tribes, landowners, conservation, business and economic interests, and other stakeholders, which presents a challenge in building a collective vision. Building trust has been a key component to keeping a wide range of partners at the table, and although staff and partner turnover can be significant and challenging, a focus on building and maintaining relationships has kept the Partnership together over the last decade.

The Partnership also endeavors to balance top-down and bottom-up communication and coordination across multiple levels ranging from local implementers to statewide programs and staff to statewide leadership to regional coordination beyond Oregon. The Action Plan articulated multi-tiered strategies and actions, but the Partnership is still working to build an effective partnership structure that serves to support locally-led collaboration. SageCon coordination has primarily occurred through statewide coordination staff that are not connected geographically to local implementation, and staffing of coordinator positions for Local Implementation Teams (LITs) has been slow (see the LIT case study). However, as LIT coordination capacity has increased and communication between LIT coordinators and statewide coordination staff has increased, progress has been made toward a more effective partnership model.

Assessments: Results and Evaluation

It can be difficult to measure the effectiveness of broad collaborative groups such as the SageCon Partnership. The state has made some progress toward shared monitoring and assessment, including tracking implementation of conservation actions across all lands through the Conservation Efforts Database, development of rangeland habitat condition and trend maps (Ecostate Time Series maps), and has a robust and long-established sage-grouse monitoring program. A synthesis of this information (among other components) has been compiled in the SageCon Dashboard. However, still lacking is a meaningful assessment of the effectiveness of the Plan, and future focus will be placed on developing shared objectives and tracking progress toward those objectives over time.

Endurance: Effort and Evolution over Time

This Partnership arose out of the urgency created by the threat of an endangered species listing and a desire to do something different - something that did not look like the spotted owl and timber wars of the 1990s where players took opposing sides and felt as though everyone lost. This desire for a different conservation framework remains a noteworthy motivator. It serves to sustain the SageCon Partnership over time, the key role it serves bringing different land managers across scales and sectors together to improve sagebrush ecosystem resilience, reduce threats to sage-grouse, and promote rural community and economic health. Funding for sagebrush conservation work from key entities such as the BLM, NRCS and Oregon Watershed Enhancement Board (see the OWEB case study) have continued over time, and the desire to coordinate actions across jurisdictional boundaries has grown stronger as the need to prioritize and focus on strategic areas has become increasingly evident.

Remaining Barriers/Challenges

The state Action Plan outlines an extremely ambitious list of actions to address threats to sage-grouse and sagebrush rangelands in the state. A 2021 working group reviewed the status of Plan implementation and outcomes of the Plan to date, and identified some key gaps and lessons learned for continued coordination. Although the Partnership can claim many successes and implementation of work on the ground has increased under the Plan, the state is not yet achieving its sage-grouse habitat or population objectives. The group recommended future work to increase our focus on outcomes through an adaptive management approach, address long-term local capacity needs, and increase coordinated and targeted investment in sagebrush conservation.

SageCon has struggled to adequately develop coordination capacity at the local level, particularly staff capacity to coordinate among local partners at the County level through LITs and capacity to administer voluntary conservation on private lands through the Candidate Conservation Agreements with Assurances program (see the Oregon CCAA case study). Some progress has been made, but the scope and scale of action that is needed cannot be achieved without significant and long-term investments in local capacity.

More broadly, SageCon faces challenges in raising public awareness of sagebrush and sage-grouse conservation in a state where the vast majority of the human population and decision-makers are located far from the high desert. In a state focused heavily on forested ecosystems, raising awareness of the importance and vulnerability of the sagebrush ecosystem remains a worthy goal.

Case Study 5 - Voluntary Conservation Through Candidate Conservation Agreements with Assurances in Oregon

Overview: Program Description

As part of the statewide planning related to sage-grouse conservation in Oregon through the SageCon Partnership (see SageCon case study), Oregon developed Candidate Conservation Agreements with Assurances (CCAA) as a voluntary program to provide an incentive to proactively manage habitat for the benefit of sage-grouse. The CCAA is an agreement between the U.S. Fish and Wildlife Service, Soil and Water Conservation Districts and Powder Basin Watershed Council and private landowners in which the landowner agrees to reduce or eliminate threats to a candidate species on lands they manage in

exchange for assurances from USFWS that they will no longer face further regulatory requirements should the species become listed in the future. The aim of the multi-county CCAAs is to maintain and/or improve greater sage-grouse habitat while contributing to the economic sustainability of landowners and maintaining the ranching culture and agricultural way of life in Baker, Crook, Deschutes, Harney, Grant, Lake, Malheur, and Union counties. Because approximately 19% of all sage-grouse habitat in Oregon is in private land ownership, collaboration with landowners is a key component to successful landscape scale conservation efforts.

The Oregon All Counties CCAA Steering Committee (OACSC), is a collaboration of local, state, and federal partners who are committed to working across jurisdictional boundaries on private and public rangeland to reduce or eliminate threats to greater sage-grouse through the CCAA program on private lands. The OACSC is primarily focused on privately owned sage-grouse priority habitat and adjacent state and federal lands. Together, the OACSC and partner agencies are contributing to the ecological goal of restoring Oregon's private rangeland, sage-steppe habitat and to ultimately increase and/or sustain sage grouse populations. The focus is placed to minimize threats of wildfire, exotic annual grasses, juniper invasion and supporting management practices that promote local economic and social needs.

Drivers: Shared Vision or Problem/Motivation

Potential listing of the Greater sage-grouse under the ESA invigorated the OACSC Partnership to boldly embrace opportunities to improve ecological conditions by focusing on privately-owned sage-grouse priority habitat, and developing a Strategic Action Plan that outlined objectives to cover a 30-year timeframe (2015-2045). Specifically, the Strategic Action Plan established a framework for achieving this vision by 1) calling for the development of programmatic CCAAs for all privately owned sage-grouse habitat in Oregon, 2) establishing goals and objectives for enrollment of private lands in the CCAAs, 3) establishing goals and objectives for the implementation of conservation measures to address threats to sage-grouse and sage-grouse habitat on enrolled properties, and 4) setting measurable targets to improve ecological conditions that would uplift sage-grouse habitat quality.

Innovation: Overcoming Barriers and Challenges

As with any new and large-scale endeavor, this effort has required the tireless dedication and creativity of partners to build a program from the ground up, develop an effective partnership structure, and respond to emerging capacity and implementation issues. In an effort to begin implementing the conservation measures identified within CCAA Site Specific Plans and make strides in sage-grouse conservation, Crook, Harney, Lake, and Malheur County Soil and Water Conservation Districts and Powder Basin Watershed Council, began seeking project funding to support private land efforts. Initial success led to funding through the Oregon Watershed Enhancement Board (see OWEB case study) and the Natural Resource Conservation Service. Corresponding actions also occurred on public lands by federal and state agencies including the Bureau of Land Management, Oregon Department of State Lands, and Oregon Department of Fish and Wildlife. Goals for implementation were exceeded within the first six years by the OACSC, however, funding sources for private land have since expired leaving many acres of private land untouched by conservation actions. To effectively plan, implement, and monitor all CCAA land ownership for contracted period of thirty years, stable funding is essential. Maintaining momentum and enthusiasm for the program is vital in reaching ecological goals outlined for sage-grouse recovery. Concurrently, funding to fulfill the thirty-year monitoring obligation is an ongoing concern for

the partnership as it is a critical piece of the conservation effort. It is essential that the OACSC report on improvements and changes in ecological states in sage-grouse habitat over time. It is also critical to understand if conservation actions were effective in meeting long term goals.

Assessments: Results and Evaluation

Through 2021, site specific conservation plans have been completed on 585,103 acres of private land enrolled in CCAAs by 54 private landowners. There are 953,314 acres pending enrollment by 103 remaining landowners, all awaiting site specific plans.

The work of the OACSC is one component of the larger effort to maintain and increase sage-grouse habitat and populations. While the scale of work of the OACSC is that of CCAA-enrolled private lands within the 8 individual counties therewithin, it represents a key portion of the coordinated efforts occurring across eastern Oregon, and the OACSC participates in Local Implementation Teams to coordinate across public and private land and partners (see LIT case study). Our overarching ecological outcome reflects that the CCAAs are contributing to the larger effort and that by strategically planning and implementing conservation treatments at the local landscape scale, we aim to increase the quantity and quality of sage-grouse habitat and ultimately increase sage-grouse populations statewide. Upland and riparian ecological data are collected during private land site visits for each enrolled CCAA property and housed in newly developed CCAA database. This database has streamlined data collection by incorporating the use of tablets in the field and ensuring consistency across all counties implementing the CCAA on private lands. Implementation of conservation actions are tracked for each enrolled property along with changes in vegetation condition as a result of these actions or other events (for example, wildfire), thus allowing all counties to "roll up" reporting to assess the overall effectiveness of the CCAA program in Oregon. This reporting subsequently feeds into the broader tracking and reporting of cumulative actions across all lands and evaluation of trends in rangeland condition and sage-grouse populations across the state.

Endurance: Effort and Evolution over Time

The OACSC is committed to sustaining long-term ecological uplift within our focal geography, with the goal of increasing local sage-grouse population trends by implementing habitat conservation practices. Quarterly, the group meets to discuss relevant issues, to collaborate on annual plans for implementation, to receive training in new and emerging topics, to resolve data gaps, and to assess the effectiveness of work taking place across Oregon. The OACSC has adjusted monitoring protocols and reporting based on field experience over the first 5 years of CCAA implementation.

Over the course of the next 30 years, the partners will follow the administrative and conservation objectives to ensure that the outcomes outlined in the Strategic Action Plan are achieved. It is anticipated that as each outcome is successfully met, the sagebrush ecosystem and sage-steppe habitat will become more resilient and resistant to threats. Collaboration and conservation will remain a key component to maintaining the sustainability of the sagebrush ecosystem but due to our strategic efforts up front, our group will likely be able to reevaluate our priorities in 2045 to determine if sage-grouse and sage-steppe needs will continue as our top priority.

R*emaining Barriers/Challenges*
Long-term funding capacity, maintaining privacy for private landowners, and partnership/landowner momentum remain our greatest challenges as we look into the future. Soil and Water Conservation Districts represent private landowners in each of their respective counties. They are the key connection between landowners and USFWS who developed the CCAA agreement. SWCDs conduct outreach to landowners to engage them in the process of enrolling in CCAAs, which is the primary way in which the Federal Government engages private landowners in conserving candidate species. They are therefore tasked with developing site-specific plans for landowners who enroll thousands of acres into 30-year agreements. It is the obligation of the SWCDs to protect landowner privacy and to monitor acres enrolled in CCAAs for the entire 30-year period.

To meet the long-term goals of the partnership (30-year agreements), the partnership will need solid sources of funding to conduct work at our current pace and scale. Under current obligations, funding falls short of providing services as outlined in existing CCAA agreements, (for example, over 100 landowners are awaiting funding to implement conservation measures). CCAA planning, conservation implementation, and monitoring requires a substantial investment in capacity because of the comprehensive and long-term nature of the program. In the existing scenario when funding runs short, SWCDs must use their operational budgets to maintain sage-grouse programs and keep the momentum moving forward. This impacts other program priorities as funding becomes depleted. This chronic issue is a great concern for the success of these programs and ultimately for recovery of sage-grouse across the state. A stable source of state and/or federal funding would help overcome the barriers of how to continue accomplishing work on the ground while maintaining and/or building capacity of our organization to continue steering the collaborative process.

To accomplish these goals the OACSC realizes there is a need for more outreach and communication about the CCAA program in general. We have found it challenging to strike a balance in maintaining landowner privacy while telling our story effectively to interested stakeholders. We are currently considering a variety of options to inform our enrolled stakeholders and enrolled landowners of the conservation taking place under this program. The question remains, however, where will this funding come from and how do we effectively tell our story so that others will hear and understand our position.

Case Study 6 - Wyoming Sage-grouse Implementation Team

The observations provided in this case study originated from surveys completed by long-standing participants in the Sage-grouse Implementation Team (SGIT) representing the Wyoming Governor's Office, conservation community, agricultural community, industry, and federal government.

Overview: Program Description
Wyoming manages sage-grouse through Executive Order. The Executive Order establishes a conservation framework implemented at the scale of the State with the goal of precluding the need to list the greater sage-grouse as endangered under the Endangered Species Act (ESA). Governor Freudenthal signed the first Greater Sage-Grouse Core Area Protection Executive Order (SGEO) in 2008 (SGEO 2008-2) which he updated in 2010 (SGEO 2010-4). Each successive administration has updated and signed a new SGEO (Governor Mead SGEO 2011-5 and 2015-4; Governor Gordon SGEO 2019-3). The

SGIT was formed in 2007 to serve as the oversight team developing and implementing the current SGEO. The SGIT is comprised of 24 representatives by statute (WY-9-19-101): not less than 2 members from agriculture, mining, oil and gas, and conservation/sportsmen and not less than 1 member from county government, wind generation and transmission, Wyoming Game and Fish Department, Wyoming Department of Agriculture, Wyoming Department of Environmental Quality, Wyoming Wildlife and Natural Resource Trust, Wyoming Oil and Gas Commission, Wyoming State Lands, Wyoming Senate, and Wyoming House, with cooperation and participation by BLM, USFWS, and USFS.

In 2000, the Wyoming Game and Fish Department formed a citizen/agency statewide working group that drafted Wyoming's strategy for sage-grouse conservation. This State Plan, completed and approved by the Wyoming Game and Fish Commission in 2013, was largely reliant on implementation by local working groups (LWGs). The state's eight LWGs submitted individual conservation plans to the WGF Commission between 2006 and 2008. These plans were updated and revised between 2012-2014 to make them consistent with the Wyoming Core Area Strategy (outlined in the Governor's Executive Order. Local Working Groups are charged with implementing local conservation plans for Greater sage-grouse, and whenever feasible, other species that use sagebrush habitats. From 2005-2018, LWGs received approximately $7.4 million to allocate to local sage-grouse conservation projects. The source of this funding was the State of Wyoming General Fund as requested by the Governor and approved by the legislature. Subsequently, the 2017 legislature returned budget responsibility back to the Wyoming Game and Fish Department for the 2018 fiscal year. The Wyoming Game and Fish Commission has allocated $548,000 annually to fund LWG projects. Most LWG projects are cost-shared with multiple partners. Cumulatively, 243 projects have been approved since 2005. Projects include habitat treatments/restoration, improved range management infrastructure and grazing management plans, applied research, inventories, monitoring and public outreach. Insight into facilitating LWGs and lessons learned can be found here: https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1406&context=hwi

SGIT members were appointed originally by Governor Freudenthal. Replacements and individuals to represent emerging stakeholders (for example, wind energy development) are identified and appointed by the current administration.

The SGIT was legislatively codified by the State of Wyoming in 2014. The governance structure of the SGIT is at the discretion of the Governor. Leadership of the SGIT is by chairman, and decision making is by popular vote of designated team members. The SGIT meets approximately 6 times a year, and the public is invited. Day-to-day working capital has remained minimal during the SGIT tenure, with each agency and organization expected to cover the costs of participation. State agencies, primarily the WGFD, have provided staff and technical support (for example, live streaming of SGIT meetings) and meeting space. Travel and per diem are technically available for non-state participants, but there are no examples of these funds being used to attend these meetings.
The State has consistently supported efforts to address emerging and outstanding questions. Over $100M (since inception of the strategy) has been distributed by the State for on-the-ground projects, research and monitoring specific to sage-grouse conservation. These funds have been primarily funneled through the Wyoming Wildlife Natural Resource Trust (WWNRT) and sage-grouse local working groups, with the SGIT providing feedback on the projects funded. A match has generally been required for these project funds. Although distributed funds were not raised by the State specific to sage-grouse, without

efforts by the SGIT these funds would have been less focused on sagebrush and sage-grouse conservation.

Drivers: Shared Vision or Problem/Motivation
Potential listing of the greater sage-grouse under the ESA motivated the State's development of a comprehensive approach to managing its sagebrush habitats for sage-grouse. The urgency to develop the initial SGEO was high due to the potential impacts to the State of a listing. These impacts were seen as primarily economic in nature, with the potential that a warranted listing decision would negatively influence the natural resource extraction and agricultural industries in particular.

Innovation: Overcoming Barriers and Challenges
Effectively and sustainably engaging key stakeholders and getting them to work jointly towards the overall goal was the primary initial barrier to success. Establishing participant commitment to the process and not their agency's or organization's culture, and addressing conflicting priorities among SGIT team members required a series of initial face-to-face meetings with the specific goal of illustrating to team members the benefit of an inclusive effort (that is to say, affirm that the goal [avoid listing] was the same despite differences in culture, priorities, business practices, etc.). Barriers between the State and participating federal agencies were overcome through the use of Instructional Memoranda (IM) and Memoranda of Agreement (MOA).

Early on, those organizing the SGIT failed to recognize that everyone on the team needed to be versed in all aspects of the issues being addressed. Educating participants by developing training (for example, sage-grouse 101; oil and gas 101; mining 101; livestock grazing 101) was critical to overcome this barrier. It was important to establish that participants who dealt with certain issues on a day-to-day basis recognized not all participants were as knowledgeable, and to foster group learning as integral to participation in the SGIT. Other initial barriers to success included a lack of science to address some of the management questions. These were overcome by consulting available experts, promoting original research (for instance, the rigorous identification of priority habitats), using the best available science to make initial management decisions, and including a stated commitment to adaptive management in the SGEO.

The primary ongoing barrier is that the State's conservation strategy is regularly challenged by outside and non-participating entities. Strong public support and the support of the State's governmental representatives have been critical in overcoming these challenges. Maintaining the commitment of individuals in the SGIT and the entities they represent, given participants are volunteers, has been a consistent struggle. Further, because much of the success of the SGEO hinges on the BLM in particular, maintaining federal commitment to the State's goal and process is critical, and has proven more difficult than expected through shifts in federal priorities. Maintaining commitment of participants and federal partners has required constant reinforcement of the State's objectives and strengthening of the SGEO.

Assessments: Results and Evaluation
Anthropogenic metrics specific to the SGEO (surface disturbance and infrastructure density in priority habitats) are tracked by the Wyoming Geographic Information Center (WyGISC) at the University of Wyoming through the Density Disturbance Calculation Tool (DDCT; https://ddct.wygisc.org/). The

Wyoming Game and Fish Department (WGFD) maintains a lek count database to track biological metrics associated with the SGEO. Biological standards of performance, as the collection and analysis of data metrics specific to the effectiveness of SGEO stipulations at maintaining sage-grouse populations in the State, have not been implemented as a part of the strategy. As such, it is unknown if the SGEO and SGIT are providing ecological value. However, more specific performance standards were included as necessary in the 2019 iteration of the SGEO.

Endurance: Effort and Evolution over Time

Fostering an environment where the SGIT is able to meet challenges with a spirit of learning to accomplish goals has been crucial to sustaining the effort. As such, an air of respect among SGIT participants has been absolutely necessary. It was (and continues to be) key that participating agencies and organizations find the right people; promoting individuals that respect the value of differing opinions and are committed to the process and working towards the overall goals of the effort have been instrumental in sustaining the effort.

Consistent and strong endorsements of the SGIT and the process across Governorships, and ready access to elected representatives, have also been key to sustaining the strategy. The SGEO (as a governing policy) has evolved as the species' status and Governors have changed, ensuring that the governing policy of the strategy has remained relevant. Further, processes of decision-making are continually evolving due to new information, advances in technology, and the success of efforts by individuals on the SGIT and the engaged public at introducing conservation principles into the SGEO (for example, standards of performance in the latest SGEO).

Organizational capacity was built slowly and indirectly with industry, federal (USDA, BLM, USFWS), and state-level (WWNRT) funding. The SGIT accumulates information for decision-making through sub-committees appointed on a volunteer basis to investigate and report on specifics more in-depth than the overall team (for example, communication; recommendations for wind energy development in core habitats). The make-up of these sub-committees includes SGIT members as well as members of the interested public knowledgeable on a given subject.

The SGEO is focused towards priority habitats (core areas) identified based on sage-grouse distributions and population sizes throughout the State. Updating these designated habitats spatially every 7 to 10 years is a specified task of the SGIT. The SGIT expends tremendous effort to obtain public input during these remapping efforts, and credits the outreach with helping to sustain State support of the conservation strategy. WyGISC and the WGFD provide technical support for the strategy.
A competent and effective chairman has been essential to maintaining the momentum developed around the original goal of the strategy. A strong leader is important, especially given interactions with the public and a team structure requiring cooperation among sometimes competing stakeholders. In support of the most current SGEO, SGIT has initiated development of operation handbooks which have the potential to build operational capacity and ensure continuity over time.

Remaining Barriers/Challenges

Outside pressures remain as the biggest challenge to the effort. The potential for litigation from groups that have no intention of being part of the process has been a consistent concern. Sustained federal

commitment to the State's goals and process across administrations has more recently emerged as a challenge. Internally, the primary challenge is that the SGIT has not established a clear line of leadership succession. The chairman appointed at the initiation of the effort remains as the chairman, and a "second in command" has not been established. When the current chairman leaves, the SGIT and the effort will suffer given the lack of diversity of leadership and no established approaches to fill the lead position with someone of the same caliber.

It was further noted that the conservation strategy does not address potential future issues proactively. Discussions of potential need and opportunity occur, but implementing solutions given the organizational structure of the program is difficult. For example, shifting focus from sage-grouse to sagebrush habitats in anticipation of other sagebrush species being petitioned for ESA protection in the future has been discussed, but as yet no concrete changes in the SGEO specific to these discussions have occurred. The SGIT recognizes that many currently unknown barriers and challenges undoubtedly exist, and addressing those as they arise to sustain conservation effectiveness is one of the primary functions of the SGIT.

Case Study 7 - Douglas Core Area Restoration Team (DCART)

Overview: Program Description

The Douglas Core Area Restoration Team (DCART) was formed by the Wyoming Governor's office in 2013 to reduce the high level of disturbance in the Douglas County core area (DCA) established for sage-grouse conservation. This core area consists of 66,813 acres of federal, private, and state land in northeastern Wyoming and it exhibits many of the impacts to sagebrush that are typical regionally: some sagebrush has been converted to tillage agriculture or grassland, much of it has burned in several large wildfires, and there is significant oil and natural gas development. The DCART was charged with restoring disturbed sage-grouse habitats within the core area to "suitable" habitats as described in the Governor's Sage-grouse Executive Order (EO). DCART is led by industry and presently includes 27 members from federal and state agencies, non-governmental organizations, environmental consultants, and academia, all of whom participate in planning and project selection and implementation.

Drivers: Shared Vision or Problem/Motivation

The initial primary motivation for formation of the DCRT was concern over potential listing of greater sage-grouse under the Endangered Species Act (ESA) and the impacts this would have on industry, agriculture, local economies and landowners. This effort started in 2008, when then Governor Dave Freudenthal signed Wyoming's first Sage-Grouse EO, which designated "core areas" or key habitats throughout the state where avoiding or minimizing disturbance would protect a large number of greater sage-grouse. One of these, the Douglas Core Area, became a focus of deliberate, coordinated management activities, in large part because the 16% level of disturbance was much higher than the 5% ceiling called for in the Govenor's EO. Although motivations may differ, a common vision is improving/maintaining sagebrush habitats for sage-grouse so that listing is not necessary. There was also a common understanding, if not agreement that through efforts such as these, encompassed within the framework of the Core Area Strategy and disturbance threshold, that this is how oil and gas development, agriculture, and sage-grouse could coexist in Wyoming.

In the case of the Douglas Core Area, problem definition and goals were clearly defined by the need to both minimize additional disturbance and reduce cumulative disturbance in the area below the 5% disturbance cap in the Executive Order as oil and gas development proceeded under valid and existing rights that preceded the EO. A plan was negotiated for responsible development that avoided high quality sagebrush habitat and that prioritized development within already disturbed areas. Chesapeake Operating established a mitigation fund for treatments to compensate for unavoidable disturbance. Since about three quarters of the disturbance to sagebrush in the area was due to previous fires, restoring sagebrush to burned areas where sagebrush had been lost was a common sense, win, win solution that everyone could buy into. Creation of this team by the Governor, in support of his Executive Order, was empowering in that it gave clear direction, authority, and access to state resources and personnel.

Innovation: Overcoming Barriers and Challenges

Since 2014, the DCART has planted over 100,000 sagebrush seedlings in over 6,000 acres of grassland across seven discrete projects in areas that supported sagebrush prior to burning. Accomplishing this required overcoming numerous barriers and challenges. This area of Wyoming is on the sagebrush-grassland ecotone. Sagebrush seed sources adapted to these conditions were not available so the team collected their own seed locally. Establishing sagebrush into perennial grass stands dominated by western wheatgrass is not feasible by conventional drilling techniques, so the team contracted with a local greenhouse to grow out seeds into seedlings. Initial efforts to transplant 16,000 seedlings in November of 2014 were stymied by -20 degree fahrenheit temperatures, so the team had to arrange for storage in green houses over winter.

Techniques for establishing sagebrush into perennial grasslands are not well established, in some respects this group is developing them on the fly. They have relied on an extensive review of the literature and the expertise of TriHydro, an Environmental Services firm. DCART has been committed to adaptively managing this project to improve future effectiveness, evaluating multiple approaches to reduce competition with perennial and annual grasses and to reduce herbivory. These included 1-m2 or 0.0625-m2 fabric mulch, rolls of fabric mulch, no mulch, wood mulch, hemp squares, and herbivory exclosures for variable periods. In addition, the impact of non-local vs. local seed sources, establishing seedlings in native soil vs. a 50/50 mix of native and potting soil, spring vs. fall plantings, planting with hoedad vs. auger on survival of seedlings was evaluated. Another innovative aspect was seeking outside grant funding (NRCS Equip Program) to fund a Masters student at the University of Wyoming to evaluate survival of seedlings planted with different methodologies and at different densities.

The DCART is also innovative and unusual in the degree of community involvement and investment in what is essentially a state regulatory mitigation construct. In an era when litigation to reduce the impacts of oil and gas development is common, the DCART approach and the overarching Core Area Strategy framework that it is embedded within has Industry, state and federal agencies, landowners, and environmentally oriented NGOs working together to restore sage-grouse habitats through collaborative implementation of a regulatory construct.

Assessments: Results and Evaluation
The DCART has overcome numerous technical challenges through a learn by doing approach and implemented a variety of treatments to restore burned areas. Over 100,000 sagebrush seedlings have been planted in seven project areas, which required harvesting over 50 pounds of local Wyoming big sagebrush seed. The DCART also treated over 3,100 acres of cheatgrass in the Douglas and Thunder Basin Core Areas. The group also collaborated with the Nature Conservancy to evaluate the efficacy of seed pods as an alternative approach for establishing sagebrush in post-fire landscapes. An adaptive management approach has guided the overall effort and each individual project. This consisted of an annual review of results and adapting future efforts to key success indicators. While some of these have been constant and some have changed, data was gathered and analyzed on initial, short-, and long-term growth and survival. Additionally, research plots have been established to investigate sagebrush seed germination and recruitment.

The DCART developed the North Burn Management Plan, a long-term plan to enhance and restore sage-grouse habitat within a 5,000-acre wildfire burn in the northern part of the DCA. The group also obtained $265,000 in outside funding to support research and project implementation. This supported two University of Wyoming graduate students who evaluated approaches for outplanting sagebrush seedlings into post-wildfire restoration areas. DCART funded data collection efforts that resulted in a submission to Wyoming Game and Fish for the reclassification of 182 acres of historic disturbance areas within the DCA as successfully restored to suitable sage-grouse habitat.

Endurance: Effort and Evolution over Time
The DCART and the larger Disturbance Threshold standard and metric survived transitions to two new Governors, both of whom issued Executive Orders of their own that made minor improvements to or clarified previous order(s) and affirmed their support. Projects have evolved based on adaptively utilizing approaches that increased success and/or lowered costs or logistical constraints.

Remaining Barriers/Challenges
Time – Sagebrush is a slow-moving ecosystem with quickly moving pressures on the landscape. Recovery timescales are mismatched with political frameworks which are much shorter. Although the adaptive approach utilized improved project success over time, the science of restoring the sagebrush ecosystem is still evolving. Funding is winding down as initial, planned projects are completed. The Douglas Core Area is 93% privately owned, what is going to motivate continued engagement of private landowners?

Case Study 8 - Wyoming Landscape Conservation Initiative (WLCI)

Overview: Program Description
The Wyoming Landscape Conservation Initiative (WLCI) was established in 2007 as a long-term, science-based effort to conserve and enhance fish and wildlife habitats while facilitating responsible development through local collaboration and partnerships across more than 19 million acres in southwest Wyoming. The WLCI facilitates cooperation between land managers, private landowners, industry, and the public to maintain the long-term viability of these communities to bring other partners, science, and financial benefits together to develop and implement conservation actions

and projects. The WLCI concentrates on conservation projects that support the proper functioning and connectivity of sagebrush, mountain shrub, aspen, riparian, and aquatic communities. Partners associated with the WLCI include the Wyoming Department of Agriculture, Wyoming Game and Fish Department (WGFD), six counties which also include weed and pest districts (Carbon, Fremont, Lincoln, Sublette, Sweetwater, and Uinta), nine conservation districts, Bureau of Land Management (BLM), U.S. Geological Survey (USGS), U.S. Fish and Wildlife Service, U.S. Forest Service, National Park Service, and the Natural Resources Conservation Service. The WLCI also works collaboratively with industry and industry associations to develop and implement conservation projects in high priority sagebrush habitats. The WLCI is governed by an Executive Committee composed of government leadership and elected officials who provide guidance and decision-making authority. An interagency Coordination Team manages the daily operations of the initiative and maintains regular contact with partners and stakeholders at the field level. Primary science activities are supported by a USGS science team which conducts research and assessments that help inform and facilitate management decisions associated with fish and wildlife and their habitats and understand cumulative effects of energy development and other drivers of ecosystem change at landscape scales.

The WLCI has two unique collaborative teams. The first is the WLCI Science Technical Advisory Committee (STAC), which is an interagency committee with representatives from WLCI partner agencies that provides guidance to the USGS by identifying and prioritizing research needs of the WLCI. STAC also helps integrate science to inform WLCI management decisions and conservation projects and provide a foundation for adaptive management practices. Our greatest collaborative asset is the second group of teams. These are our four regional Local Project Development Teams (LPDTs). These teams are comprised of land managers and resource specialists from federal, state, and local government agencies, special interest groups, agricultural and other private landowners, and industry that all have a desire to participate in cooperative conservation. LPDTs are the "partners living on the ground," working together to address conservation issues, actions, and priority areas. All four LPDTs collaboratively define issues and needs that inform the WLCI Conservation Action Plan, which defines WLCI conservation priorities and documents conservation actions.

Drivers: Shared Vision or Problem/Motivation

The WLCI area is rich in energy and mineral resources, including natural gas, oil, wind, coal, uranium, and trona (the primary source of sodium carbonate in the United States). Southwest Wyoming supports some of the Nation's most preeminent wildlife habitat, providing home to elk, mule deer, pronghorn, and other species. It also contains some of the Nation's most important and critical sagebrush habitat that supports greater sage-grouse and other sagebrush obligate species such as the pygmy rabbit and sage-steppe dependent songbirds. Southwest Wyoming has extensive public lands, with checkerboard patterns of private and state lands containing landscapes and wildlife that are highly valued by many different user groups and stakeholders. During the early 2000s in southwestern Wyoming, expanding energy and mineral development, urban growth, and other changes in land use combined with landscape-scale drivers (such as climate change and invasive species) presented numerous challenges to resource managers and stakeholders. To address these challenges, the Wyoming Landscape Conservation Initiative (WLCI) was established in 2007 as a collaborative interagency partnership with

two main goals: 1) understanding how key drivers and land-use change affect wildlife and their habitats; and 2) the development and implementation of conservation actions across landscapes in proximity to energy and mineral development to maintain their character and function. With these goals in mind, federal, state, county, and private partners agreed to create a formal partnership, which became WLCI. WLCI was formed with an understanding that initiative decision making would be driven by science when appropriate. The WLCI executive committee quickly worked with USGS to host partner workshops to discuss science needs and priorities which culminated with the development of a science strategy plan. The WLCI Coordination Team worked on the formation of STAC and the LPDTs. WLCI conservation projects are organized across six broad themes: 1) improving resilience and function of priority habitats; 2) maintaining, enhancing and restoring sagebrush communities; 3) maintaining and reconnecting wildlife corridors and passages; 4) improving aquatic habitat and distribution of native fish assemblages; 5) controlling invasive plant species and restoring ecosystem integrity and landscape connectivity; and 6) re-establishing native riparian, wet and mesic plant communities , and wetlands within the sagebrush biome.

Innovation: Overcoming Barriers and Challenges

Building capacity, consistency, and maintaining interest with members of the LPDTs requires constant communication and engagement. The WLCI coordination team addressed capacity and interests by hosting a series of meetings to determine team configuration and placement. This led to the development of the four LPDTs which are designed to work collaboratively to develop conservation priorities and action plans, prioritization processes, and project ranking criteria. The coordination team worked with the Ruckelshaus Institute at the University of Wyoming to help facilitate local team meetings to support engagement by all members with respectful dialog and equal opportunities to provide input and discuss and develop conservation actions to address conservation challenges. Maintaining interest was also improved by holding group field tours of projects, highlighting team accomplishments through press releases, annual reports, and award recognition by WLCI's leadership. Overcoming challenges associated with the integration of science to inform WLCI decisions was addressed by the formation of the STAC and establishment of regular science workshops and science presentations and discussions at WLCI executive meetings and at local team meetings.

Assessments: Results and Evaluation

In the first 10 years (2007- 2018), WLCI partners invested $64 million in the landscape and economies of western Wyoming, leveraging federal funds that average 5:1. In that time, WLCI LPDTs and partners have accomplished: controlling invasive plants on 108,888 acres on high priority sagebrush and shrub steppe habitats; enhancing 70,600 acres that support crucial habitats (for example, winter range, parturition areas) or habitats that support important life stage needs for designated Species of Greatest Conservation Need (SGCN); protected 19,777 acres of migration corridors through conservation easements; and improved movement of big game and other species by removing 312 miles of fence and helping with the construction of two highway underpasses; reduced the threat of conifer encroachment on 27,400 acres of aspen and 8,535 acres in sagebrush; protected 92,803 acres of sagebrush through easements and forage reserves; increased fish passage along 87.2 miles of stream; restored 6.6 miles of in-stream aquatic habitat for Colorado River cutthroat trout and other priority fish species; and protected or improved over 15,000 acres of riparian vegetation.

Endurance: Effort and Evolution over Time

Like other case studies mentioned in this report, WLCI has been very successful and will mostly like be sustained for some time. Interest in southwest Wyoming remains strong because of its important role in supporting the nation's current energy needs and future transition to renewable energies (wind, solar), critical mineral resources and its extensive, mostly intact core sagebrush habitat and greater sage-grouse populations. The WLCI area also includes the longest mule deer and pronghorn migration routes as well as a robust native fishery. Recognition of WLCI successes and its importance to conservation is demonstrated by the long-term commitment by WLCI partners and the long-term funding commitments by their federal and state partner agencies. In addition, the recent partnership with the Wyoming Wildlife Natural Resource Trust to match and leverage funds and to collaborate on sagebrush habitat projects provides additional resources to address common conservation goals and objectives.

Remaining Barriers/Challenges

Direct WLCI funding usually comes from federal agencies which presents numerous challenges. While some of these challenges have been improved by policies like the revised Good Neighbor Authority, others remain. For example, annual federal funding may change quickly based on program origin priorities limiting the kind of projects they may support, funds may arrive late in the year out of sequence with scheduled on the ground activities or must be obligated in a very short period. In addition, these funds can rarely be applied quickly by WLCI when needed, for instance after a wildfire. WLCI has been working to improve these barriers and challenges. A recent partnership with the Wyoming Wildlife Natural Resources Trust provides more funding flexibility regarding timing of funding and leveraging of funding and agreements. However, more work needs to be done to diversify funding sources and improve underlying banking of funds so they can be dispersed more efficiently and timely. The WLCI structure is sufficient to address a limited increase of science and conservation implementation in sagebrush systems associated with increased renewable energy or critical mineral development. However, WLCI would need to build additional capacity of local team participation to effectively do more restoration that has implications at landscape scales. Each LPDT has approximately ten to fifteen active members. If WLCI were to increase or diversify funding, we would have to increase that capacity. One approach being considered by WLCI is to develop a request for proposal process. This would still be based on LPDT priorities but would then reach out to different sources for contracting, engineering, and needed expertise. There would also be additional challenges that comes with diverse funding. The WLCI would need to expand partner commitments and staff to address NEPA requirements to avoid delays to project implementation.

Case Study 9 - The Idaho Cheatgrass Challenge

Overview: Program Description

The Cheatgrass Challenge is a proactive strategy for halting conversion of sagebrush rangelands to annual grasslands. Launched across Idaho in 2020, the Challenge lays out a proactive and strategic statewide approach for tackling the invasive annual grass threat. Science shows that invasive species control is more effective and cost-efficient when done early, before infestations become widespread, and when management responses are informed by the condition of the surrounding area (Fig. 1). With this in mind, Idaho partners leveraged new technology to develop and implement a spatial strategy to scale up the right actions, in the right places, at the right time across ownership boundaries.

Drivers: Shared Vision or Problem/Motivation

Cheatgrass Challenge partners are guided by a shared vision of maintaining productive, working rangelands that are resilient to fire and resistant to invasive annual grass conversion. Invasion of sagebrush rangelands by cheatgrass and other invasive annual grasses, such as medusahead and ventenata, increases wildfire size and frequency resulting in reduced forage productivity, wildlife habitat loss, and threatened rural economies. Lack of proactive and coordinated action is making working lands less productive for each passing generation. There is a common understanding that managing both for the health of our perennial plants, especially perennial grasses, and against invasive annuals is key to maintaining resilient rangelands. Yet, negative impacts of annual grass invasion continue to increase as our application of this knowledge has largely been too reactive, inconsistent, and small scale.

Innovation: Overcoming Barriers and Challenges

Agency leadership, partnerships, and new technology (in the form of remotely sensed vegetation data) have made possible a new approach to tackling invasive annuals. Idaho's strategy starts by taking a big picture view to assess the current condition of rangelands relative to the annual grass problem (see map on reverse). Three coarse region types were identified to help guide management actions (Fig. 2):

Core. These areas represent regionally intact rangelands as characterized by relatively low cover of annual grasses. Local areas of higher annual grass cover may be present within the region, but the overall level of invasion is still relatively low. Local management in these areas is more likely to be effective at maintaining sagebrush rangelands in the long run because of the favorable landscape context.

Annual Grass Region. This region, primarily along the Snake River Plain, is dominated by moderate-to-high cover of annual grasses. Much of the rangelands within this region have already converted to a new annual grassland state. Local areas of lower annual grass cover are present within the region, but their long-term integrity is compromised by occurring in a landscape ecologically driven by invasive annuals. Frequent fires and reinvasion from neighboring areas make maintenance or restoration of sagebrush rangelands extremely difficult.

Transition Zone. Areas between cores and the annual grass region are considered transitioning. These zones are undergoing ecosystem state changes at landscape scales as areas of higher annual grass cover replace relatively intact rangelands. These are important battle fronts for stemming the tide of annual grass conversion, but they are also areas of high unpredictability for management due to the rapid change that is occurring.

Identification of these broad regions allows for implementation of a strategic battle plan to tackle annual grasses:

1. *Defend the Core.* Defending large cores from annual grass conversion is a top priority for management. Anchoring management efforts in cores first reduces the chances of getting flanked. Early and aggressive control of annual grass invasions and promotion of perennial grass health is needed to proactively maintain and build resilience of the core through time.

2. *Grow the Core.* While cores are being defended, a secondary priority is to grow the core by pushing back the transitioning zone. A sustained and multifaceted effort, including large-scale restoration, will be needed in these areas to halt and reverse the regional spread of annual grass conversion.
3. *Mitigate Impacts.* Finally, perpetual management will be required in the annual grass region to mitigate the most severe impacts of the cheatgrass-fire cycle on life and property. Primary actions in this region include asset protection, fine fuels reduction, and rehabilitation and maintenance of perennial grasses.

The Cheatgrass Challenge strategy lays out the preferred direction of management while providing critical landscape context for local efforts to be more effective. However, the strategy's ultimate success hinges on community-based partnerships banding together to develop local prescriptions, coordinate actions, and leverage resources to achieve these regional goals. Through the Challenge, federal, state, and local agencies, along with NGOs, and landowners are improving collaboration at state and local levels to identify priority project areas, leverage available resources, and take coordinated action across ownership boundaries. Project funding comes from multiple agencies and programs all working toward the same goals at ecologically relevant scales.

Assessments: Results and Evaluation

The Cheatgrass Challenge was rolled out in 2020 and projects are in the early stages of development. Partners have identified broad metrics/indicators of success expected as a result of this campaign including:

- Increased stakeholder awareness of the problem and how they can strategically tackle it
- Improved stakeholder coordination and prioritization on annual grass management
- Changed behavior that considers invasive annuals in every land management decision
- Large-scale demonstration projects showing that we can move the needle on invasive annual grasses
- Local vegetation data trending in the right direction (for example, more perennials and fewer invasive annuals)
- Statewide monitoring data showing intact cores are being maintained, improved, and/or are expanding

The Challenge is already serving as a potential model for other western states. Wyoming NRCS and partners anticipate incorporating a similar proactive strategy into a new state-led invasive species initiative. The Western Governors Association's Cheatgrass Working Group, a committee formed under the Western Invasive Species Council, is using the Idaho example to develop an initial spatial strategy for tackling cheatgrass across the entire sagebrush biome.

*Endurance: Effort and Evolution over Time (*N/A – Just initiated)

Remaining Barriers/Challenges

Invasive annual grasses pose perhaps the greatest threat to the continued function of sagebrush rangelands and examples of effective management at large scales remain elusive. Taking a strategic and proactive approach to tackling the problem offers an opportunity to change the current trajectory, but a sustained effort over time will be needed through time. Setting realistic expectations and timeframes for recovery of desired conditions are essential since tackling invasive annuals is a long-term commitment,

not a “one-and-done” land treatment. Maintaining resources and cultural will to stay focused on the strategy will be a challenge to the ultimate success of this effort.

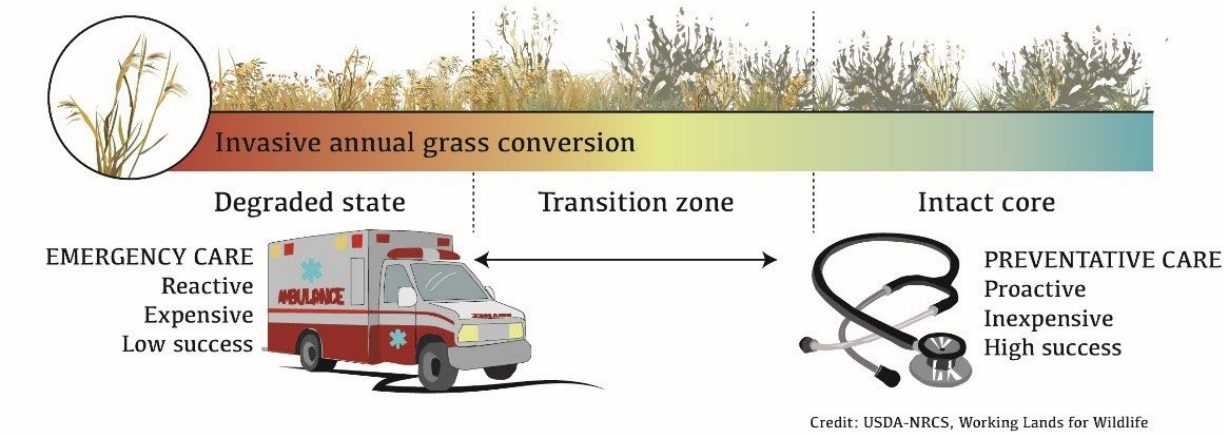


Figure 1. Illustration of expense and relative success of intervention in sagebrush rangelands along a continuum from degraded states to intact core.

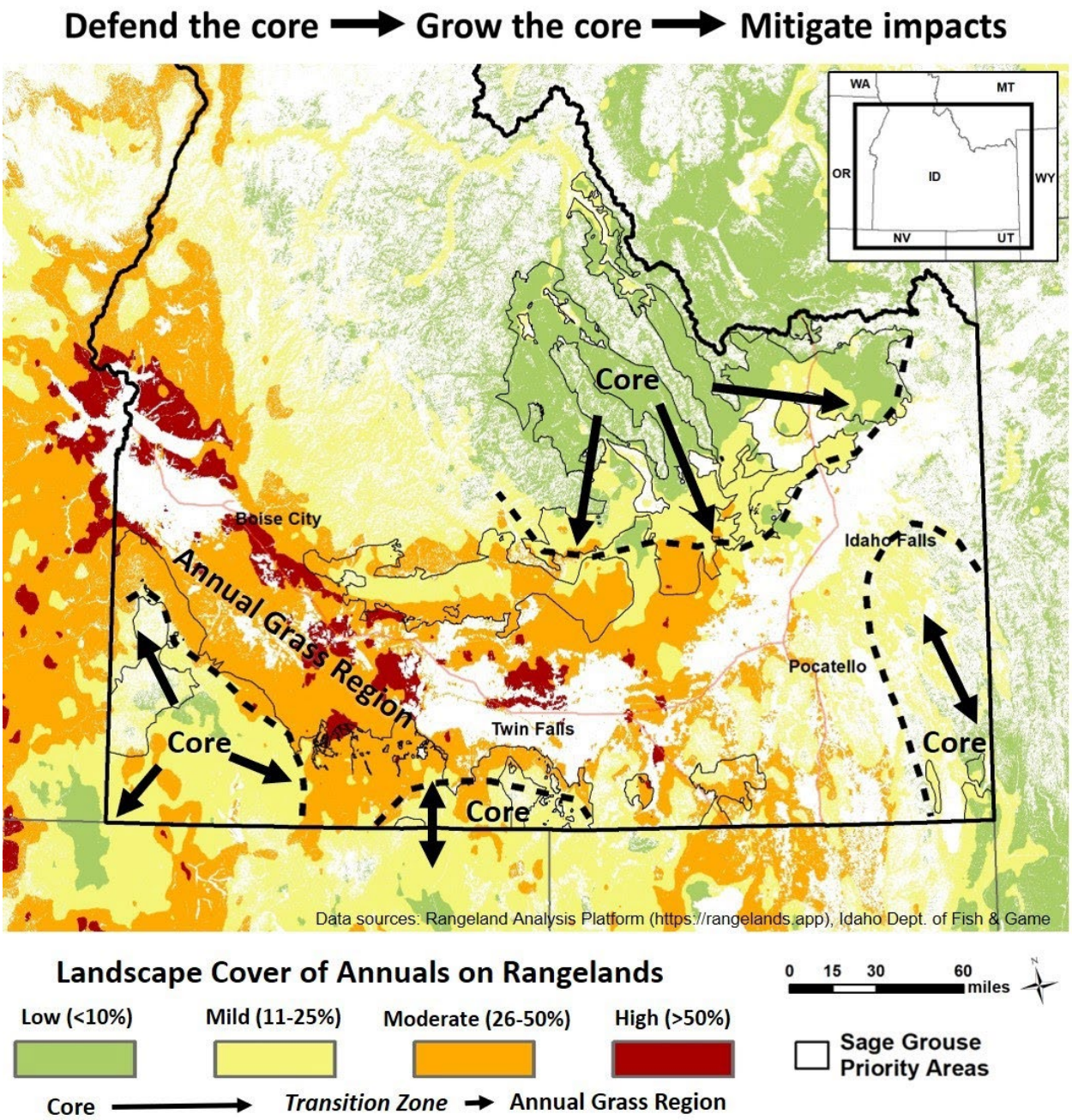


Figure 2. Landscape cover of annual grasses along a continuum of infestation representing core areas with low levels to annual grass dominated areas with high cover.

Case Study 10 - Cooperative Weed Management Areas

Overview: Program Description
Cooperative Weed Management Areas (CWMAs) or Weed Management Areas (WMAs) are cooperative partnerships between neighboring private and public land managers and others that come together to develop and employ strategies to manage weeds collectively within a common area. CWMAs are local, multi-jurisdictional organizations across the country. Locations of CWMAs can be viewed at: https://www.naisn.org/cwmamap/

Drivers: Shared Vision or Problem/Motivation
In some states, county programs may help to coordinate weed control between agencies and neighboring landowners under certain situations. But in most states, management activities are often conducted, or not conducted, through different federal and state agencies and by private landowners, sometimes with no shared, central goals for management or measurable benchmarks to demonstrate progress. Cooperative approaches to weed management have emerged in response to this disconnect in an attempt to make weed control efforts more effective and efficient.

Innovation: Overcoming Barriers and Challenges
The forms and functions of CWMAs are similar to local cooperatives in that both involve a self-governing group of individuals who voluntarily cooperate for their mutual benefit. Although this concept is not particularly innovative, application of this approach to address invasive plants was. CWMAs are often self-supporting entities, and usually bounded by natural rather than political boundaries. Because CWMAs and county programs employ a localized and largely stakeholder-driven approach to weeds, management may be successfully carried out within an adaptive framework, allowing groups flexibility to incorporate new information or changing conditions. CWMAs remove much of the "blame game" for weed spread when everyone works together cooperating across jurisdictional boundaries.

Assessments: Results and Evaluation
Although the value of using such a cooperative approach across the landscape is well accepted, the sustainability and effectiveness of CWMAs is highly variable across the U.S. While some are highly successful and effective, others have failed. The success of a CWMA often depends on the strength of the partnership agreements, the ability to establish common priorities, the individual expertise of the partners, the ability to maintain consistent funding from year to year, and the personalities of the people involved. Faltering or failed CWMAs in the western U.S. are generally attributed to the lack of a coordinator or sustained funding, undefined priorities and measures of success and not having enough staff or volunteers.

Endurance: Effort and Evolution over Time
The operation and types of local programs vary dramatically in their composition and structure, coordination, communication, and cooperator involvement, which can also change from year to year. County weed supervisors are often directly involved in CWMAs, providing expertise and technical support to stakeholders. Steering committees may be appointed and written agreements to cooperate may be established. CWMAs are integrated with state efforts to varying degrees. Many states have legislatively-designated cost-share programs for CWMAs, and may require annual operating plans and

integrated weed management plans to participate. In Nevada for example, the majority of control efforts and accomplishments can be attributed to the CWMA framework, which consists of 24 CWMAs primarily located within watersheds.

Cooperative weed management areas, as well as county weed programs and districts, play an important role in weed management. Although the effectiveness of local programs is sometimes equivocal, their success is critical to long-term ecosystem management on landscapes that vary dramatically in space and time within the sagebrush biome. The different program attributes that may contribute to invasive plant control efficacy include interagency coordination, strong local regulations and enforcement, funding, and volunteer participation. A review of CWMA implementation for the principal sagebrush states follows.

Colorado

Colorado implements noxious weed management primarily through County Weed Districts and weed management programs in its 64 counties. There are currently five CWMAs, or CWMA like groups, primarily based on watersheds. The Upper Arkansas Cooperative Weed Management Area has been in existence and active since 1998. The others are: The Purgatorie Watershed Weed Management Collaborative, and the Yampa River, San Luis Valley, and San Juan Mountain CWMAs. The Estes Valley CWMA formed in 1997, successfully competed for funding, but did not persist beyond 1999.

Idaho

Idaho has 44 county weed programs that are involved with one or more of the state's 33 formal CWMAs. In Idaho, a CWMA is a distinguishable hydrologic, vegetative, or geographic zone based upon geography, weed infestations, climatic or human-use patterns. A CWMA may be composed of a portion of a county, a county, portions of several counties, or portions of more than one state. CWMAs are formed when the landowners and land managers of a given area come together and agree to work cooperatively to control weeds.

The State Weed Coordinator and the other program staff provide support, training, and organizational assistance to the counties and CWMAs throughout the state. Idaho has over 30 CWMAs covering 87 percent of the state. These CWMA's participate in the ISDA cost-share program, which assist local agencies in the fight against noxious weeds. For a CWMA to participate in the ISDA Cost Share Program, an Annual Operating Plan (AOP) and Integrated Weed Management Plan (IWMP) must be developed and submitted. Not all CWMAs participate in the ISDA Cost Share Program. County Weed Superintendents are often heavily involved in CWMAs and local activities.

Montana

Montana has 56 County Weed Districts (CWDs) that serve an important role in organization, implementation, and oversight of local noxious weed management programs. CWDs are also responsible for implementing the Montana County Weed Control Act. Counties coordinate with state and federal agencies on public lands. County weed coordinators are a primary contact for private land managers. The county weed coordinator usually takes on the leadership role of creating Cooperative Weed Management Areas and is usually the lead person applying for a Noxious Weed Trust Fund grant.

Montana promotes the CWMA model, but at present has only 10 CWMAs, primarily in the western portion of the state.

Montana has a unique funding mechanism for invasive plant management. The Montana Wildlife Habitat Improvement Act was passed into law by the 2017 Legislature. The purpose of the act is to make federal funding available to restore priority wildlife habitats by managing noxious weeds. The legislation makes available up to $2M annually in federal Pittman-Robertson Wildlife Restoration funds, which requires a dollar of non-federal matching funds (cash) for every 3 dollars of federal grant funding. Projects are intended to be focused on ecologically-important wildlife habitats with landscape-scale benefits. Grants, which are paid in the form of reimbursed expenses, may be issued for up to five years duration. Priorities for funding include: landscape-scale projects lands that are open to public hunting and involve priority wildlife habitats; noxious weed infestations that directly impact habitat functions; broad partnerships involving multiple landowners; proposals with leveraging beyond the minimum match funding requirement; projects that retain or restore native plant communities.

Nevada

Nevada has 23 CWMAs that cover much of the state. The Nevada Department of Agriculture (NDA) noxious weed program manages multiple federal grants directed towards noxious weeds across Nevada. A wide variety of projects have been funded including educational campaigns, workshops, noxious weed control, re-vegetation efforts, mapping, and restoration projects. Past federal sponsors include Animal, Plant Health Inspection Service (APHIS), United States Forest Service (USFS) State & Private Forestry Program; Bureau of Reclamation; and the Bureau of Land Management. In recent years the only federal funding acquired by the NDA for this program has been from the USFS State and Private Forestry Cooperative Weed Management Cost Share Grant ($28,186 in 2019). CWMAs, along with Conservation Districts (CD) and County Weed Districts (WD) are eligible to compete for this funding.

Oregon

Currently, there are 27 cooperative weed management areas (CWMAs) in Oregon that occupy 85% of the land base, the first was formed in 1994. The structure in Oregon varies from small landowner groups focusing on a specific project to multi-agency organizations under the auspices of the Oregon Cooperative Weed Management Association (ORCWMA). The purpose of ORCWMA is to lessen the impact of invasive plant species and their threat to the economy, environment, and human health by working cooperatively to provide leadership, facilitate information development and exchange, and coordinate regional efforts. CWMA partners develop a comprehensive weed management plan for their area. Locally-driven CWMAs are especially effective at generating public interest in weed management and organizing community groups to support on-the-ground programs.

Utah

Utah currently has 22 CWMAs covering the entire state and extending into adjoining states, although not all are presently active. These CWMAs are well integrated with County weed management programs and state and federal agencies, and access numerous federal and state grants for weed control activities. The Utah Department of Agriculture and Food (UDAF) allocates $2 million annually ($3 million after July 1st) from the Invasive Species Mitigation Fund through competitive grants. In 2019, over $4.3 million in grant requests were received. About 70% of grant requests come from CWMAs, and most funding is awarded to CWMAs. Utah Conservation Districts issue competitive grants for restoration

activities which incorporate invasive species management. Most of the $500,000 to $1 million available annually is awarded to CWMA projects. The Utah Watershed Restoration Initiative also funds invasive species projects for wetland species like phragmites, purple loosestrife, millfoil, etc. Federal partners contribute to CWMA activities as well. The BLM and the U.S. Forest Service have ongoing contracts, managed by the state, with each of the counties ranging from $7,000 to $50,000 per county depending on how much federal land there is in the county and what needs to be treated and restored. CWMAs are also involved with other programs addressing grazing, water quality, fire prevention, rangeland management and agricultural improvement, and overall economic benefit for a county. The Squarrose CWMA is the longest running CWMA in the state, and through partnerships with multiple state agencies, federal agencies, private industry, and private landowners, it has treated over 50,000 acres complete with revegetation on private and federal lands.

CWMAs are heavily involved in outreach to private landowners and training in identification and control of invasive plants, including conducting summer tours of projects and involvement with chemical test plots or invasive plant research conducted by Utah State University. Outreach events are generally well attended and are great for showing success on the ground, which is outstanding for building grassroots participation.

Wyoming

Wyoming has 23 Weed and Pest Districts across the state, associated with the boundaries of each County. These are funded through local taxes supplemented by state appropriations, grants, and other revenue. Each District has representation on a Wyoming Weed and Pest Council, which helps coordinate invasive species lists and control activities across Districts. Wyoming also has 21 collaborative groups addressing invasive weeds; 16 of which are traditional CWMAs, and 4 of which are organized as Cooperative Resource Management Areas (CRMs) that have projects focused on weed control as part of more diverse resource conservation practices. Wyoming, and other Western states have other CRMs that could be effective vehicles for invasive plant detection and control if landowners are made aware of the need.

Wyoming also has a Cheatgrass Task Force as well as the Northeast Wyoming Invasive Grasses Working Group (NEWIGWG), which was established with a goal of reducing, containing, or eradicating Medusahead (discovered in 2016 in Sheridan County and 2018 in Converse County) and Ventenata (discovered in WY in late 1990s, now in Sheridan, Johnson and Campbell Counties) from northeast Wyoming. Wyoming Governor Gordon recently (October, 2019) announced the formation of an Invasive Species Initiative.

Remaining Barriers/Challenges

Either because CWMAs have not been initiated, or because of failure or ineffectiveness of those that have initiated, **there are gaps in cooperative weed management coverage across relatively large geographic areas within some states.** At least within important sagebrush areas, filling in these gaps with effective CWMAs should be a high priority.

Adequately funding CWMAs is an enormous challenge, which was made even more difficult when the National Fish and Wildlife Foundation eliminated its Pulling Together Initiative. This program granted

$24.6 million, leveraged by $54.8 million in grantee matching funds, to CWMAs, Cooperative Invasive Species Management Areas (CISMAs), and Partnerships for Regional Invasive Species Management (PRISMs). CWMAs may receive state and federal grant funding focused on high priority regulated invasive plants (List A and List B noxious weeds), and some county programs depend on state and federal funding for their weed control infrastructure and personnel. Such financial incentives to treat state-wide weed priorities may detract from local programs focusing on locally prevalent species which may or may not be a high priority state-wide, but could provide added value to the conservation of sagebrush landscapes. Many states do not list cheatgrass on their noxious weed list, which may preclude use of state or federal grant money in control efforts, even as a means to reduce wildfire risk.

Case Study 11 - Colorado Firefighting Air Corps

Overview: Program Description
Colorado, in response to increased number, size, and severity of wildfires, has developed a comprehensive program to increase detection and early suppression of wildfires and address gaps in obtaining federal firefighting assets. The Colorado Program, housed within a Division of Fire Prevention and Control, uses Firefighting Air Corps which consists of a combination of exclusive use contracts and specially equipped state-owned aircraft to detect fires and transport firefighting crews to enhance early suppression.

Drivers: Shared Vision or Problem/Motivation
Fighting wildland fires in western states relies on support from fixed wing and rotary-wing aircraft to detect and suppress wildfires, although approaches for obtaining these services differ from state to state. Because of the significant amount of Federal land in the western United States, federally owned and managed aircraft serve as the backbone for aviation support, particularly when large air tankers are needed. Formalized agreements and procedures for states to request these assets are in place, although during peak fire season periods, particularly in bad fire years, competing demands for scarce resources may leave demands unfilled. Western states typically use some combination of ownership and contracting of aviation assets for use on non-federal land or for use when federal aircraft are unavailable. Typically Air National Guard assets are available as a last resort. Idaho for instance doesn't own any aircraft dedicated to firefighting but has "Call When Needed" lease agreements with over a dozen different private aviation companies to provide aircraft for reconnaissance (Orion PC-3), Initial Attack Suppression (Air Tractor 802A/F) and suppression (BFS Chinook CH-47D helicopter). Nevada has extensively retrofitted 3, UH-1H Huey helicopters for suppression purposes. Oregon also contracts for all of its firefighting aviation needs.

Colorado has developed an intricate interagency system of detecting and suppressing wildfires. Since the 1990s, the number, intensity, and complexity of wildfires in Colorado have been growing exponentially. In the 1960s, the average number of wildfires in Colorado was 457 which burned on average 8,170 acres. Fires and acres burned doubled by the 1990s and doubled again between the 1990s and 2000s. In 2018 alone, 6,184 wildland fires burned 250,297 acres. Just the State costs of suppressing fires that exceeded local government capacity were estimated at 168 million dollars in the last decade, in addition to costs incurred by local agencies and the Federal Government. The 2012 Wildfire Season took a devastating toll on Colorado residents, burning more than 600 homes and

personal property. Damage estimates currently total $567.4 million from insurance claims. These trends in fires, acres burned, costs, and associated damage to property prompted Colorado to take a serious look at how to improve effectiveness of the state's fire detection and suppression capability in 2013. An overall conclusion of this effort was: "As a result of Colorado's forest conditions, continued development in the WUI, the lengthening of the fire season and increasing fire severity, and the growing costs to address these realities, there is a critical need to enhance the state's firefighting resources—especially appropriate and efficient aerial resources." The emphasis on aerial resources was due in part to the inability of the Federal Government to fulfill Colorado's need for aviation resources on a nearly year-round basis.

Innovation: Overcoming Barriers and Challenges

Colorado's structure for combatting wildland fires is a cooperative, interagency system involving local, county, state, and federal agencies. Wildland fire protection responsibilities on non-federal lands in Colorado follow a hierarchy of local jurisdiction, to the county sheriff, and finally to the State of Colorado where the Division of Fire Prevention and Control (DFPC) is the lead state agency for wildland fire management.

Utility of Wildfire Aviation

Aviation, just like a chainsaw, is a tool for firefighters to employ during the suppression of a wildfire. Although aircraft are often used to fight wildfires, aircraft alone cannot put them out. Firefighters rely on planes and helicopters to: deliver equipment and supplies; deploy smokejumpers to a fire and transport other firefighters; provide reconnaissance of new fires, fire locations, and fire behavior; drop fire retardant or water to slow down a fire so firefighters can contain it; and ignite backfires and prescribed fires. Ultimately, the goal of suppressing a fire is achieved by removing the source of fuel, rearranging fuel, or removing heat sources. Aviation can aid in this effort by applying suppressants and retardants that reduce the ability of the fire to consume the fuel, thus slowing the fire's progress. During high wind and extreme weather conditions, aviation is often not a usable tool. Many of the memorable and devastating wildfire incidents in recent years occurred during extreme wind events. These incidents were small and manageable before the weather-induced changes removed any capability for suppression or management, making immediate access to aircraft imperative.

Prior to legislative direction and appropriation, Colorado's wildfire aviation capabilities were provided by the federal government with the exception of Colorado's Single Engine Air Tanker (SEAT) aircraft, and rotor-wing assets provided by the Colorado National Guard in some instances. No local agency owned firefighting aircraft, but at least one (Douglas County) contracts for the exclusive use of a Type 2 helicopter during the core wildfire season.

Initial Attack Limitations of Federal Resources

Aviation resources are often not requested during the first few hours after a fire is detected. This is often because the fire's location, size, terrain, and risk have yet to be defined or communicated. Often, firefighters spend a significant amount of time 'chasing smoke' during these first few hours. In addition, local government organizations in Colorado may not make a request to the interagency system because there is an anecdotal understanding that the needed resources are not always available within the needed time frame. Wildfire managers in Colorado recognized that if wildfire response effectiveness is

to be improved, attention and efforts must be focused on early detection and the initial attack response. In this context, initial attack is not defined as a 48-hour window, but as the first few hours immediately after detection of a fire.

Limited Availability of Federal Resources

During the 2009-2013 fire seasons, Colorado made many requests and received many filled (air tanker arrival within 48 orders of being requested) orders from the national, interagency wildfire aviation system. However, over the course of this period, twenty percent of the orders for large air tankers were not filled. This "unable-to-fill" rate increased to twenty-five percent in recent years. Given the 48-hour window for fulfilling delivery, even fulfilled orders may allow some fires to grow in size, significantly increasing suppression costs and difficulty, as well as damages.

Colorado's Wildfire Management Goals

Suppression costs escalate significantly as fire size increases. A wildland fire becomes a local emergency before it evolves into a State, then regional, and then national incident. Colorado's wildfire management program will continue to prioritize the strengthening of first response firefighting forces to safely and effectively suppress wildland fires when the fires are small. Fast, aggressive, initial attack on new fires (for fires where full suppression efforts is the appropriate management response) can reduce the number of mega fires that may burn hundreds of homes and cost millions of dollars in suppression costs, recovery costs, and insured losses. To assist local and County firefighting organizations to achieve this goal, DFPCs objectives are:

1. Generate an incident assessment for every fire within 60 minutes of request or detection.
2. Deliver the appropriate aviation suppression resources to every fire within 60 minutes of the request.
3. Provide on-scene technical assistance and support within 90 minutes of request for support from a local agency.

To support these objectives, and through legislative direction and appropriation, Colorado has obtained through purchase or contract the use of the following aerial firefighting resources:

Multi-Mission Fixed-Wing Aircraft – In order to achieve the goal of generating an incident assessment for every fire within 60 minutes of request or detection of a wildfire, DFPC will operate two State-owned, fixed- wing multi-mission aircraft. This resource performs fire detection, extended attack surveillance and support, and other non-fire mission when needed and appropriate.

Rotor-Wing Aircraft – In order to achieve the goal of providing the appropriate aviation suppression resources to every fire within 60 minutes of the request, DFPC will operate a minimum of two type 2 helicopters with ten-person DFPC helitack crews through 120-day exclusive-use contracts for each aircraft. The aircraft and crews perform a variety of tasks including recon, transport of personnel and supplies, water delivery, and non-fire missions when needed and appropriate. One helicopter will be equipped with night operations capabilities. DFPC anticipates the first helicopter to begin contract on May 15th in Canon City and the second to begin on June 12th in Montrose.

Colorado, in response to a record 2020 fire season, has ordered and expects to put in service in 2022 a Firehawk, a Sikorsky, military-grade helicopter modified to quickly drop water on approaching flames. Firehawks are modern replacements for the 1970s Huey Helicopters. Although expensive (~ $24 million),

they have state of the art electronics, fly much faster, have greater suppression capability and they are safer to fly.

Single Engine Air Tankers (SEATs) – In order to achieve the goal of providing the appropriate aviation suppression resources to every fire within 60 minutes of the request, DFPC will operate a minimum of two SEATs through 150 exclusive-use contracts for each aircraft. DFPC will also administer a "Call-When-Needed" (CWN) program that makes additional SEATs available if the wildfire situation dictates the need for additional resources. The first exclusive-use SEAT contract to begin approximately April 1st, the start date for the second SEAT will be based on early fire activity and fire aviation needs.

Large Air Tankers and Very Large Air Tankers: DFPC currently has CWN contracts in place with Global Super Tanker and Air Strike. These contracts provide options to enhance Colorado's response capacity, but availability of aircraft is not guaranteed and DFPC does not have a dedicated funding source for their operation.

Engines and Modules: DFPC has 6 engines and 4 ten-person modules located at multiple locations around the state. They provide initial and extended attack assistance to local, county, and federal agencies when requested. These resources also perform a variety of training, fuels management, prescribed fire, and other fire program functions. The engines also assist with all-hazard and other responses in addition to wildland fire. The Modules provide the overhead positions for 20-person handcrews and utilizes military veterans and local fire agency personnel to form these crews for extended attack operations.

Battalion Chiefs (BC) and District Chiefs (DC): 14 BC's and 4 DC's provide technical support and assistance on ordering of resources, tactics, and management of incidents to local fire agencies and county sheriffs. Funding Support: DFPC manages and/or provides funding support for large fires (Emergency Fire Fund, Resource Mobilization Fund, and Disaster Emergency Fund) and initial attack through the Wildfire Emergency Response Fund (WERF) and the Colorado Firefighting Air Corps (CFAC) programs.

Closest Available Aviation Resources – DFPC continues to coordinate availability and location of aviation assets with our federal partners to send the closest available resource in our efforts to meet the enabling objectives.

Emerging Technologies - The Center of Excellence for Advanced Technology Aerial Firefighting (CoE; Center of Excellence for Advanced Technology Aerial Firefighting) is the research and development branch of the Colorado Division of Fire Prevention and Control (DFPC), which is Colorado's State fire management agency. A key goal of the CoE is to reduce the occurrence of firefighter fatalities and injuries through enhancement of firefighters' situational awareness during emergency response. The Team Awareness Kit (TAK) smartphone app has been under evaluation by the CoE since 2016 to improve first responder situational awareness, and was first fielded by the CoE with DFPC helitack and handcrew firefighters in 2018 as part of experimental deployments. The CoE has also supported several local fire, search and rescue, and law enforcement agencies in deploying TAK at special events and in operations. USDA Forest Service Fire and Aviation Management funded a proposal by the CoE to develop a TAK

capability for the interagency wildland fire agencies and conduct a pilot project of the TAK app as part of the USDA response to the Dingell Act. The development of TAK for wildland fire centered around creating a TAK server that is integrated with the Enterprise Geospatial Portal (EGP), a system that provides distribution, display, and analysis of geospatial information to support the wildland fire management decision-making process. TAK allows firefighters to see the location of their colleagues, fire engines and aircraft, as well as display maps and intelligence on the fire in real-time. The smartphone app was originally developed by the military to give soldiers a better idea of what was happening on the battlefield. Firefighters using TAK reported improved situational awareness and an ability to make decisions more quickly.

Assessments: Results and Evaluation
The program has proven to be highly successful and provides support and assistance to local, county, and federal agencies across the state.

Endurance: Effort and Evolution over Time
The current DFPC aviation program has been in place since 2014. Stakeholder input, after action reviews, and internal assessments have identified lessons learned and several areas for improving program effectiveness. Colorado DFPC recommended a number of actions to strengthen its firefighting capability following a 2016 strategic planning process, a 2018 report after multiple after action reviews from fires in Colorado and other states, and the 2018 Wildland Fire Advisory Committee working group meetings. Solution #4 related to firefighting aircraft: Expand Current Helicopter, Air Tanker, and Multi-Mission Aircraft Capabilities to Match Colorado's Growing Fire Season.

Remaining Barriers/Challenges
Implementing the 2018 Work Group Recommendations represent remaining challenges, namely: 1) Helicopters: Transition to a Government Owned/Government Operated (GO/GO) model with two Type 1 helicopters with 20-Person Helitack Crews and one Type 3 helicopter with a 12-Person Helitack Crew, all with year-round availability. As described above, a Firehawk helicopter is currently being built to partially address this need. 2) SEAT: Develop a training and reimbursement program for agricultural aerial applicators to assist local agencies during initial attack. Increase current SEAT contracts from 5 months to 7 months. 3) MMA: Increase staffing to ensure that one MMA is available to fly within 30 minutes of a request year-round with two sensor operators on board. Upgrade sensor technology to improve MMA capabilities. Increase training flights to pair with education and awareness efforts for local agencies on MMA use. 4) Large Air Tankers: Evaluate and fund options to work with other agencies and private vendors to bring state-managed large air tankers into Colorado during periods of high fire potential and activity.

Case Study 12 - Oregon (and Idaho) Rangeland Fire Protection Associations

Overview: Program Description
Oregon adopted a different approach to increasing the State's ability for early detection and suppression of fires in rangeland settings. Authorized by the Oregon legislature in the early 1960s, Rangeland Fire Protection Associations (RFPAs) are independent associations of volunteer landowners that provide their own local wildfire protection and are incorporated as non-profit 501 C (3) fire

protection associations. RFPAs organize and authorize landowner participation in fire suppression alongside state and federal agency firefighters (typically, the Bureau of Land Management or BLM). These all-volunteer crews of landowners and other community volunteers have training and legal authority to respond to fires on private and state lands in landscapes where there had been no existing fire protection, and in Oregon are authorized to respond on federal lands as well.

The Oregon Department of Forestry (ODF) base funding for overseeing this program is around $650,000 to support 2 staff, insurance costs, and training. Landowners assess themselves to cover their operating costs on a per ranch or per acre assessment basis. Federal agencies augment- either in kind, or through providing equipment (for cooperative fire agreement signatories), or through firefighting grants. RFPAs in Oregon have generated over $500,000 in funding through fees and grants.

Drivers: Shared Vision or Problem/Motivation

RFPAs expanded greatly following a fire review in 2004 that indicated 6 million acres of rangeland were unprotected, and again following 2012 when 1.2 million acres of high desert burned. Today, 24 RFPAs protect over 16 million acres in Oregon, including core sage-grouse habitat and working lands vital to rural economies. Over 1,000 volunteers participate, over 700 of which have been trained in basic firefighting. Idaho now has 9 RFPAs protecting approximately 7 million acres, and a 2015 law authorizes RFPAs in Nevada as well. A bill to authorize RFPAs in Washington State stalled in Committee in 2019 and 2020 amid opposition from the firefighting union.

Innovation: Overcoming Barriers and Challenges

The innovative aspect of the RFPA model is the way state and federal authority and responsibility for firefighting are integrated with local landowners for mutual benefit. In Oregon, the State through the provides administrative guidance, some administrative cost reimbursement (insurance, etc.), fire suppression training (in coordination with BLM), personal protective equipment (PPE; Idaho only) and facilitates access to federal grants (Volunteer Fire Assistance grants through USFS) and surplus firefighting equipment. The legislature appropriated funds in 2015 to help with equipment acquisition and modification. RFPA members receive basic firefighter training, as well as in radio communications and Incident Command Structure (ICS).

Obtaining agreement on MOU's was challenging, especially around standards- all parties; RFPA's, ODF, and BLM all gave a little to get to the right spot. The Oregon state BLM office created a coordinator position to oversee BLM interactions with RFPAs, indicative of their level of support for this approach. RFPAs sought, unsuccessfully, to obtain similar agreements with USFS for 2019.

Assessments: Results and Evaluation

The benefit of the RFPA system is rapid initial attack. Success on initial attack has been excellent, and has strengthened local relationships between agencies and landowners. RFPAs in Oregon are the initial responders to about 150 fires per year (164, 116, 146, 168, and 114 from 2015-2019, respectively) and provide mutual assistance on an additional 30-50 fires each year. In February and March of 2020, RFPAs responded to and suppressed multiple fires as large as 1,200 acres before Federal firefighting crews were available.

It is not realistic to evaluate success on “an acres that didn’t burn” metric because every fire is different and it is impossible to predict how many acres would have burned had there not been a response by RFPA members (there are no controls). That said, it is instructive to look at trends in acres of sage-grouse habitat burned in each state over the past 8 years and compare trends in Oregon vs. trends in nearby western states (Fig. 3). Success of the RFPA model is due to several factors. The desert region of Oregon has limited and unmaintained roads and terrain is tough. Travel in remote locations is slow, even over short distances. RPA’s locate equipment at ranch’s, business, community centers or county and state facilities, which greatly assists with response. Local ranchers are well distributed across important sagebrush landscapes, they know the area intimately, that and proximity means they can access ignitions rapidly, and they have a strong motivation for suppressing fires before they get large. Benefits of RFPAs that are less obvious are generally improved relationships between ranchers and state and federal agencies, and mutual respect that perhaps was not present in the past.

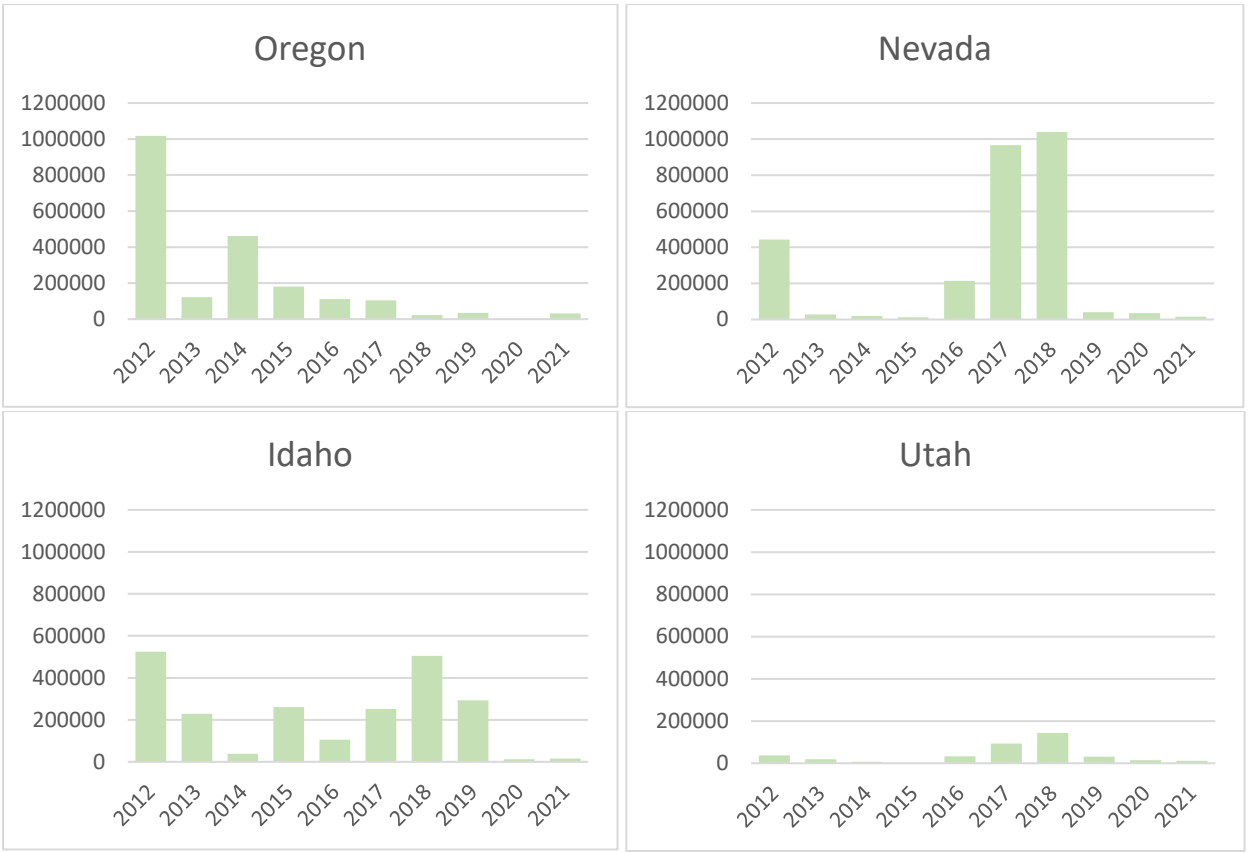


Fig. 3. Declining trends in acres of sage-grouse habitat burned in Oregon between 2012 and 2019 compared to generally increasing trends in nearby states.

Quality of relationships are the foremost measure of success for the RFPAs. The relationship with BLM has not always been perfect, but RFPAs and BLM committed to hard conversations and collaborative listening with a pledge to communication, understanding and working together to achieve the current, very successful partnership. RFPAs have been a huge success in Oregon for fire protection in key sage grouse habitat (Fig. 3). RFPAs directly contribute about $500,000 annually in in-kind contributions of labor and mileage, and another $400,000 in grants and other contributions.

Although the U.S. Forest Service has not signed on to MOUs creating a relationship with RFPAs that enable them to respond on National Forests in Oregon, the value of RFPAs was acknowledged in an After-Action Review Report entitled "Impacts of 2018 Fire Activity on Grazing in Region 4" (USFS, 2019). This report summarized the results of an After Action Review of three large wildfires that impacted rangeland and grazing activity in 2018 in Nevada, Utah and Idaho. Their second of 13 recommendations was: "Establish/support Rangeland Fire Protection Associations (RFPAs)", presumably to enhance early attack capability and to address issues common to these fires including differences in opinion and misperceptions between firefighters and local ranchers as to how and when fires should be attacked, and firefighters and ranchers impeding each others efforts because of a lack of communication and awareness.

Endurance: Effort and Evolution over Time

This program continues to get bigger both within Oregon and in Idaho. The Program has evolved over time, with improved training and better equipment. RFPAs are now asking for more advanced training to enhance their skills. Annually RFPAs come together for a two-day summit in Burns, OR, to network, train and share.

The ODF and BLM have utilized sand table exercises, and provided tactics training for some associations. RFPAs have evolved to take on fire-related activities in addition to fire suppression. For instance, RFPAs now work in collaboration with BLM partners on prescribed burning projects and public fire prevention activities. Several RFPAs have worked with other Federal partners, such as NRCS, to develop formal fire prevention and mitigations plans. Many are members of Fire Protection Cooperatives and CWPP workgroups. Several worked with County Emergency Managers to develop fire prevention plans for the 2017 eclipse. There is interest among RFPAs to be more involved in other resource issues such as restoration of burned areas or invasive weed control.

Lessons learned - RFPAs have succeeded because of a mutual alignment around fire suppression, emphasizing local solutions and relationships; Government plays a supportive role. Initial start-up funding for the program from NRCS and ODF was critical. Support and leadership from the Oregon state legislature and the Governor's office has been and remains important. Keeping the focus on the needs of landowners - equipment (PPE), training and radios- has been key.

Remaining Barriers/Challenges

As with any non-profit, retaining active membership can be a challenge- how to sustain membership and energy into the future? Many landowner members are older, suggesting long term recruitment will be important. Normal turnover in members and volunteers creates a need for continual training. How to maintain an adequate level of funding for equipment, equipment maintenance, and training? NRCS has helped in this regard and remains a key partner. Large fires and out of region teams can create challenges as firefighting teams are unfamiliar with, and consequently unsure about the role of RFPA's. Expanding the role of RFPAs into fire prevention and post-fire restoration would help fill a huge need, but will require additional training, equipment and funding. MOUs with USFS remain a barrier and a challenge. Local fire managers are generally supportive but there has been resistance at higher administrative levels over liability concerns.

Case Study 13 - The Harney County Wildfire Collaborative

Overview: Program Description
Formed in 2014, the Harney County Wildfire Collaborative (https://highdesertpartnership.org/our-initiatives/harney-county-wildfire-collaborative/) is an initiative of the High Desert Partnership that brings together representatives from county, federal and state agencies, local Rangeland Fire Protection Associations, the Burns Paiute Tribe, conservation groups, as well as scientists and ranchers to facilitate conversations around how to fight and prevent megafires in Harney County. The group works together to reach consensus on landscape-scale practices and projects related to wildfire prevention, suppression, and restoration. They explore developing shared science to implement adaptive management in the sagebrush steppe of eastern Oregon.

Drivers: Shared Vision or Problem/Motivation
Between 2012-2014 large catastrophic fires in Harney County burned 1.5 million acres of sagebrush steppe. The Harney County Wildfire Collaborative was formed in response to this devastating loss. Stakeholders and the local community, including federal agencies, saw the need for a different type of conversation around fire to be more effective at fire suppression and expand conversations into more complex restoration issues surrounding how to make landscapes more resistant and resilient to fire. At the time, there were strained relationships between the Federal agencies and the local Rangeland Fire Protection Associations which are often the first responders to rangeland fires.

Innovation: Overcoming Barriers and Challenges
When the Harney County Wildfire Collaborative was formed there were many different perspectives on how fire suppression should be conducted. The first task for the collaborative was to establish shared knowledge of current conditions. This included a review of fire history and how frequency and size has changed through time along with what factors were driving the changes. Based on this shared understanding, engaged stakeholders developed creative ways to share training, communications equipment, and communication protocols. These new ways of doing business and the resulting positive relationships have enabled federal, state and Rural Fire Protection Association resources to work as a cohesive firefighting resource. This effort in coordinating Rural Fire Protection Associations in a boundary of 3.8 million acres with other fire resources is being recognized in Oregon as a significant achievement.

The Wildfire Collaborative is supported by the High Desert Partnership, a 501c3 nonprofit in Harney County that supports multiple collaborative initiatives. Support includes providing a coordinator for the group, communications and professional facilitation, acting as a liaison between funders and partners, and helping the group secure resources. The consistency of support that High Desert Partnership offers helps strengthen the group in a number of ways and the role of the organization is to shepherd the collaborative process so that strong, trusting relationships among diverse partners are established. As a result, the Harney County Wildfire Collaborative has developed a pilot project to alter fuel structure in a Wilderness Study Area utilizing a number of management tools. The group is currently working on a landscape scale restoration project area of over 300,000 acres.

Assessments: Results and Evaluation

The Wildfire Collaborative provides the mechanism that a) leads to the development by consensus of landscape-scale projects capable of being implemented despite the challenges of multiple viewpoints and property ownerships, and b) ensures follow-through and follow-up on vegetation projects. Continuity of the Wildfire Collaborative's work is a crucial piece of the process because landscape scale restoration is not one-and-done. As a result, there is a need to better understand the broader social and economic context of these types of collaboratively planned, landscape-scale restoration projects in Harney County and to strategically incorporate social and economic science into the Wildfire Collaborative's discussions that center on reducing risk of megafires. The Wildfire Collaborative is currently supporting the implementation, monitoring and adaptive management of the Pueblo Mountain Pilot Project and concurrently using information, dialogue, and lessons learned from that project for the plan development and implementation of the Stinkingwater Restoration Project. Scientists with the USDA Agricultural Research Service conduct needed research that provides results for shared science-based management frameworks. This research helps bring diverse stakeholders to consensus and is the feedback loop for adaptive management to occur.

Endurance: Effort and Evolution over Time

As the Harney County Wildfire Collaborative partners continue to collaborate the group is gaining energy in working together and finding the resources to implement landscape scale projects and build shared science through adaptive management. High Desert Partnership is an organization that allows diverse partners to come together, to listen, share ideas and expertise and ensure everyone is heard to help solve complex issues that have much larger implications to improve our communities. The diverse partners realize that what they are achieving together not only betters our communities but sparks a ripple of positive change stretching far beyond the sagebrush.

Remaining Barriers/Challenges

The barriers and challenges associated with bringing diverse groups to work together in solving complex problems will always be coming up and new ones will be on the horizon. These working groups are long-term efforts and managing expectations about the time commitment is a challenge. However, one of the consistent challenges is funding an organization that supports groups in collaboration. Funder models are often driven by projects and metrics that are predicated on accomplishing acres of restoration. But the fact remains that a lot of up-front work in building a collaborative partnership is necessary before restoration is successful. Public-private funding partnerships would help overcome a barrier of how to accomplish on the ground projects while building the capacity of an organization that can shepherd the collaborative process.

Case Study 14 - Ranchers Stewardship Alliance

Overview: Program Description

Nestled in a remote portion of northeastern Montana lies an expansive, intact sagebrush ecosystem that has quietly been maintained by the stewardship of local producers. Bordered by the Missouri River to the south and Canada to the north, the local culture of sustainable ranching in this area has been the driving force behind maintaining the intrinsic values of the sagebrush grasslands. In 2003, this community came together in a more formalized manner to support their ranching heritage.

The Ranchers Stewardship Alliance (RSA) is a coalition of local ranchers and community members living, ranching, raising families, and supporting local schools, churches, and businesses in the sagebrush ecosystem of south Phillips County, Montana and the surrounding area. This coalition works together to shape the future of their community in a manner that represents their values and way of life, and supports wildlife habitat. Currently, supported by agencies and conservation organizations, the RSA is offering cost-share assistance to local producers to encourage and support sustainable ranching practices. They have also established a *Grasslink* that helps connect producers with grass pasture to ranchers looking for additional grazing pasture for their cattle, and have hosted generational transfer planning workshops. Led and organized by local, trusted community members, the RSA is an exemplary model of community-based conservation.

Drivers: Shared vision or Problem/motivation

In 1994, the U.S. Fish and Wildlife Service began steps to reintroduce black-footed ferrets in this landscape. Ferret reintroduction, coupled with declines in black-tailed prairie dogs, mountain plovers, burrowing owls, and greater sage-grouse, and outside influences interested in restoring free-ranging bison to the area, led local community members to be concerned about new, additional environmental regulations that might threaten their livelihoods. Thus, the RSA was born as a forum for local ranchers to work together to conserve their ranching way of life by proactively maintaining wildlife habitat and sustainable, profitable ranching operations.

Concerns about potential listing of species under the Endangered Species Act (ESA) were also a motivating factor. This was magnified in 2010 when the greater sage-grouse was listed as a candidate species under the ESA. With a threatened or endangered species listing determination looming large, the RSA was further motivated to work together locally, especially because the region is arguably Montana's stronghold for sage-grouse. Although greater sage-grouse were found not warranted for listing in 2015, concern that a future ESA listing is a real, tangible possibility remains. In addition to sage-grouse, the larger area supports the greatest remaining densities of Sprague's pipit, nationally and continentally. Sprague's pipit were also listed as an ESA candidate species in 2010 and determined by the U.S. Fish and Wildlife Service to be not warranted for ESA protections in 2015. Other declining grassland birds, such as Baird's sparrow, chestnut-collared longspur, and McCown's longspur, also rely on the sagebrush-grasslands of northeastern Montana. An ESA listing determination for any of these species is likely to have profound implications on the local communities of Phillips and Valley counties. The RSA is looking at these potential pending challenges and continuing their collaborative work on range and landscape stewardship.

Innovation: Overcoming Barriers and Challenges

Members of the RSA were paying close attention to what was happening nationally and locally and were willing to talk with other local community members who worked for conservation organizations and agencies. Building of trust at the local scale among community members was pivotal in building an effective coalition. The Nature Conservancy was particularly effective with helping to advance conservation ranching ideas with their Matador Ranch Grassbank. TNC's Grassbank provides an opportunity for local ranchers to lease grass for their cattle at significantly reduced rates in exchange for following conservation practices on their home ranch. The amount of the reduction is dependent on the

number and type of conservation practices implemented. The Grassbank has become a model of success for helping profitability of enrolled ranchers and expanding a conservation footprint onto privately owned rangelands. Beginning with this positive experience, RSA members were willing to look to other options and partnerships to continue their stewardship work in the area.

Additional partners have become critical to RSA success, as private land funding from traditional sources, (NRCS and FSA), has not been sufficient to meet the need and/or didn't cover certain practices such as perimeter fencing. Once the trust was in place, USFWS and other agencies (principally Montana Fish, Wildlife and Parks [FWP]) stepped forward to provide cost-share funding for range enhancements. Non-governmental agencies, such as TNC, World Wildlife Fund, and Pheasants Forever have been instrumental in providing technical assistance and staff capacity to work directly with individual landowners. The partnership also supported 4 successful proposals for range enhancement cost-share funding to the National Fish and Wildlife Foundation (NFWF).
The volunteer-based RSA quickly realized the need for additional organization capacity to handle grants, projects, and landowner agreements. In 2018, they hired an Executive Director using funding from their NFWF grants, to administer the Alliance. This helped to make sure that RSA was the public lead on projects.

Assessments: Results and Evaluation
RSA received 4 successful NFWF grants in 2017-2019 that have helped conserve over 18,000 acres of sagebrush rangelands. Projects often blend funding from USFWS, NFWF, NRCS, FWP, and private landowners. Staff time was donated by TNC, PF, WWF and state and federal agencies to ensure success. TNC also administers a Candidate Conservation Agreement with Assurances (CCAA) that provides assurances to private landowners with sage-grouse or declining grassland bird habitat. Range enhancements required for CCAA enrollment have often been off-set in part by RSA project dollars, allowing more landowners to take advantage of this regulatory protection from a future ESA listing.
The conservation delivery success provided by RSA allowed agencies to develop special initiatives to support the work and expand the opportunities to other parts of the state. For example, Montana FWP developed a Working Grasslands Initiative that was modeled in large part after basic needs and concepts identified by the RSA effort. FWP provides funding for some RSA projects through this initiative. FWP, through the Working Grasslands Initiative, is now able to offer similar project support outside of the RSA landscape, thereby expanding the influence of RSA's work.

Others are looking to RSA as a model of how to organize around community-based conservation in eastern Montana's rangelands. The Winnett ACES is another local producer group located south of the Missouri River that is using lessons learned from RSA to help frame-up their own conservation work. To date this has included ensuring locally sourced beef products are used in all local school lunch programs and efforts toward establishing their own Grassbank.

Endurance: Effort and Evolution over Time
Recently, conservation funding to support big game migration and connectivity has become available through Department of the Interior Secretarial Order 3362. Original conservation funding was primarily oriented toward declining grassland birds and sage-grouse; however, RSA members recognized an opportunity to expand their conservation impact. Partners prepared a successful proposal to address

fencing and other needs related to maintaining a porous landscape for ungulates. These funds are now available for additional, eligible RSA projects. Members of RSA's Conservation Committee continue to solicit projects and direct each project to the most appropriate funding source(s) regardless of the affiliation of the individual who first negotiated the project. Together the partners continue to look to new and leveraged funding opportunities to support the interest and need on the landscape.

Remaining Barriers/Challenges
RSA has gone through rapid expansion and development as they pioneer partnership-based conservation in their community. The Executive Director resigned recently, leaving the group without paid staff for executive and administrative functions. The group is in the process of reassessing capacity needs and deciding what type of staffing support is most beneficial. Funding is always limited, making job security an issue.

Locally, the threat of potential ESA listings still looms large. National changes in Farm Bill policies and state-based changes in program implementation require that RSA members remain adaptable. Severe weather events may have short-term impacts on the productivity and economy of the area. Climate change could lead to longer-term changes, such as long-term hydrological drought or vegetative changes, that could influence the ability of producers employing conservation practices to remain economically viable and competitive in the agricultural markets.

Although other eastern Montana communities are looking to the RSA as a model, exporting the model is difficult because of different local issues, personalities, and economies. RSA has been successful in large part because it was home grown, meaning other communities will need to find their own drivers, motivation, community leaders, and solutions.

Case Study 15 - The Wet Meadow Restoration and Resiliency Building Project

Overview: Program Description
The Wet Meadow Restoration and Resiliency Building Project (WMRRBP) in the Gunnison River Basin of Colorado is a collaborative effort between public land managers, private landowners (mostly ranchers), environmental and other interested citizen groups to restore damaged sagebrush-steppe biomes. Wet meadows in the valleys and swales of hilly sagebrush-steppe landscapes are a small but ecologically important part of that biome. Grassy areas with almost no sagebrush, usually with a small or intermittent meandering stream, provide forage for grazing wildlife and livestock, and breeding ground for insects which along with forbs are an important food supply for birds – including the threatened Gunnison sage-grouse, which needs both the cover of the adjacent sagebrush and the rich insect/forb supply of the open mesic or wet meadow for raising chicks. They may be narrow riparian corridors, but can widen out into sloping meadows spanning a valley floor.

These mesic meadows are also a fragile part of the landscape, vulnerable to erosion from roads, livestock and wildlife trailing, drought conditions and extreme storm events, with the latter two projected to be more common as the climate continues to warm. Gullies cutting down through mesic/wet meadows act as drains, lowering the water table below the root zone of the herbaceous vegetation, which allows the sagebrush to colonize the meadows, reducing herbaceous cover and the ecological services to the birds, wildlife and livestock.

The WMRRB Project attempts to reverse this loss, employing low-tech structures, ranging from hundreds of small hand-built "one rock dams" (one rock high) to larger equipment-built "plug and spread" structures several feet high. All of these restoration structures are intended to slow or spread out the flow of water within degraded meadows, increasing the opportunities for water to infiltrate, be temporarily stored in the soil profile and eventually raising the water table enough to keep herbaceous plants competitive with the sagebrush, providing forage for wildlife and livestock as well as short-term storage for late-season irrigation water.
It is worth noting a larger context for this project. Most of it takes place in the high headwaters of the Colorado River which is the source of 90 percent of the domestic water supply for some 40 million people, mostly urban, and for irrigating four million acres of agricultural land important in feeding the nation. Every high-altitude water table raised, every flow slowed and temporarily stored in the sponge benefits this entire over-stressed rivershed.

Drivers: Shared Vision or Problem/Motivation
The WMRRB Project began as a convergence between two driving 21st century cultural concerns, one global, the other more local – although a shared vision for addressing those concerns did not emerge immediately. The more local concern was the listing of the Gunnison sage-grouse as a threatened species under the Endangered Species Act, which brought a critical habitat designation for the species. From the early 1990s on, a Gunnison sage-grouse working group has been working collaboratively to recover the species. The other "driver" for the WMRRB Project was the changing climate. The Nature Conservancy of Colorado (TNC) wanted to develop programs around the state that would be proactive in addressing the challenges emerging from a changing climate. This began in the Upper Gunnison with a workshop in 2009, to examine the impacts to date, and to come up with project ideas for either mitigating or adapting to those changes. Since many of those participating in the TNC workshop were already involved to some extent in the Gunnison sage-grouse issue, there may have been a certain inevitability to the workshop group's desire to develop a project that would address emerging challenges to the sagebrush-steppe biome related to the changing climate (and other causes), in ways that would help the Gunnison sage-grouse – with the recognition that improving degraded sagebrush-steppe lands would also benefit other wildlife, livestock, and would increase opportunities for groundwater storage in restored water tables. Part of the "driver" here was TNC's promise to cover project expenses for the first five years.

Both groups continued to work and plan, independently but with some overlapping membership, until 2012, when the TNC group launched the WMRRB Project. The project itself, with its early demonstration sites, may have done more than any form of persuasion to develop a shared vision around both improving grouse habitat specifically and generally making the whole landscape more ecologically resilient for whatever the changing climate did to us.

TNC, on advisement from some of the working group members, had contracted with Bill Zeedyk, a retired Forest Service Wildlife Biologist from New Mexico who had spent decades figuring out how land and water worked together and how to fix places where they didn't. Because he was often working with indigenous communities in Mexico and New Mexico where budgets were often limited, but where they were rich in volunteer labor, his strategies were primarily low-tech (human labor) and low-cost, and involved disarmingly simple structures that, when arranged knowledgeably in the remnant land-shadows of an abandoned stream bed replaced by a gully, either slowing flows or spreading them in sheet flows – in either case, bringing the water back to the surface of the land and giving a boost to the herbaceous matter that insect eaters like the Gunnison sage-grouse and grazing animals needed. Everyone –

ranchers, agency managers, environmentalists, recreationists – saw that these processes would work for their needs.

It is important to note the active participation of field officers of three public-land management agencies: Andrew Breibart of the U.S. Bureau of Land Management, Matt Vasquez of the U.S. Forest Service, and Nathan Seward of Colorado Parks and Wildlife. They were able to bring some serious funding to the project, but in addition, they worked elbow-to-elbow with Zeedyk for ten years, and are now carrying his work forward. When these officers couldn't be available, contractor, Shawn Conner with BIO-Logic, Inc., stepped in for tutorship under Zeedyk. Shawn's amazing work ethic and dedication to the project has helped the group continue to expand and build capacity, but also conduct importance outreach beyond the Gunnison Basin so other partnerships throughout the West can more efficiently conduct their own wet meadow restoration and resiliency building work. Also important was the work of Liz With of the Natural Resources Conservation Service, in bringing in private landholders where activities overlapped public and private lands. NRCS has also worked directly with some ranchers to apply the Zeedyk strategies on their own land and at a national level promote these simple, yet effective techniques through their successful Sage-Grouse Initiative.

Innovation: Overcoming Barriers and Challenges

When TNC announced their interest to work collaboratively with public land managers and ranchers in the Gunnison Basin, many community members questioned TNC's motive with suspicion. As rancher, Brett Redden, compared, "when the government knocks on your front door and says they're there to help, you have to question it" – so it was true with TNC being willing to foot the bill to help create a demonstration project. But as one of the first landowners progressive enough and willing to try these simple restoration structures, Brett quickly saw and noted the interest and desire by youth conservation crews and federal land managers working side by side, to move heavy rock and get their hands dirty for the simple sake of improving the land. Today, Brett is known to carry photos of some of the rock structures built back in 2012 on his cell phone and has helped open the door for many others to explore and consider Bill Zeedyk's restoration techniques.

Another important advocate for the project was Jim Cochran, retired Gunnison County Wildlife Conservation Coordinator and local rancher/hay producer. Jim initially questioned what does a climate adaptation strategy look like, especially a locally led project on the ground and would it work in Gunnison? Following the first spring runoff post-construction at the two demonstration projects, it was clear from the sediment captured behind rock structures and how water was being spread across a formerly desiccated meadow – the sponge was being re-saturated - success. The idea of building resiliency by holding water in the soil profile longer and promoting later season water flows was apparent. Jim commonly voiced that it doesn't matter how you feel about climate change, Bill's restoration techniques were a "no regrets strategy." In the case of the WMRRB Project, the work down on the ground was enough to keep all the diverse interests and factions in the Gunnison Basin on board: everyone benefitted from it.

"Siloization" in the management of public lands is often a problem in landscape-scale programs; jurisdictional boundaries are not necessarily ecological boundaries, and a stream restoration on one management area could not control what would happen where the stream crossed into another management area, which might have significantly different management priorities. The WMRRB Project has not suffered from this kind of barrier – possibly because of the external leadership provided by TNC and their initial inclusive approach of having all agencies and stakeholders at the table from the beginning, but also because of the character, attitude and the community based approach of the people

working on the ground for the public land agencies: they seemed to enjoy support from their agencies in devoting time and resources to the project, trust from private land owners and also the opportunity of working together across jurisdictions on the landscape scale of the project. Due to this approach, it was not hard to treat entire stream reaches regardless of management boundaries.

The Project had a difficult transition to negotiate at the five-year mark. TNC had promised in 2012 to provide leadership and substantial supplemental funding for the first five years of the WMRRB Project; after that, the project would be transitioned to local control and have to find its own way. In 2017 the Upper Gunnison River Water Conservancy District (UGRWCD; a taxing entity) rose to that challenge and found the funding for the group to contract with a project coordinator to replace TNC's Project Coordinator Betsy Neely (not easy); the UGRWCD also provided office space and some staff assistance. Two creative and hardworking contractors have been hired for that position, and have succeeded in keeping the project going while also raising some funding for it, but unfortunately no long-term funding was secured. Recently, in 2021, the UGRWCD decided to create a full-time staff position within the District to manage the WMRRB Project, signaling a long term commitment to the Project.

Assessments: Results and Evaluation
Since its beginning in 2012, the WMRRB team has built over 2,100 structures, restoring approximately 140 acres of wet meadow along more than 32 stream miles in 16 watersheds, enhancing over 1,500 acres of Gunnison sage-grouse brood-rearing habitat. These techniques also provide additional forage for grazing wildlife and livestock and use the "sponge" of the earth to temporarily store water in raised water tables for later-summer release. A constant monitoring process records progress toward a program goal of 20 percent increase in herbaceous matter over a five-year period.

This project serves as an important demonstration of the effectiveness of simple tools for increasing ecological function of riparian meadows in the sagebrush steppe. The techniques have demonstrated significant results that have potential to improve wildlife habitat, hydrologic function and build resilience at a much larger scale. Monitoring plant species cover is important to determine progress towards restoring ecological function, and the WMRRB Project has had a thorough monitoring system in place from the beginning. Renee Rondeau, a conservation planner and ecologist with the Colorado Natural Heritage Program, worked closely with BLM and USFS plant ecologists to create a robust monitoring system for the project to measure site response from the restoration treatments.

Because wetland plants indicate higher soil moisture and provide insect habitat and cover for sage-grouse chicks, the management objective for the Project is to increase the average cover of native sedges, rushes, willows, and forbs (obligate and facultative wetland species) in the treated reaches by at least 20% within five years. To measure progress toward that objective, the partners established over 500 transects on treated and untreated (control) areas. They found that wetland species cover increased by 153% in ephemeral (snow melt driven) systems, and by 49% in perennial (spring driven) systems, compared to a 1% reduction in untreated ephemeral systems and a 5% increase in untreated perennial systems, respectively. Several factors are likely contributing to the variation in response rate including: amount and timing of snowmelt, storm events, sediment load, geology, floodplain width, upstream stock ponds, degree of degradation, and number of years post-treatment.

The techniques have demonstrated significant results that have potential to improve wildlife habitat, hydrologic function and build resilience at a much larger scale. We have trained over 150 natural resource managers from Gunnison and across western Colorado as well as training workshops throughout the western states. The methods are already being adopted and replicated by others

working to conserve habitat for the Gunnison sage-grouse in other populations and in greater sage-grouse ranges. There is abundant interest by local, state, and federal managers and wildlife biologists to adopt and implement these restoration practices. The NRCS has adopted these restoration methods for Farm Bill funding to implement projects on private lands at the national level, and in 2018 published a technical note outlining these techniques (Maestas et al 2018). This has huge potential to benefit both Gunnison and greater sage-grouse, as well as a myriad of other species that depend on these riparian systems within the sagebrush system. These tools have been applied successfully across the southwestern US and have high potential for use in other ecosystems.

Endurance: Effort and Evolution over Time

Now in its tenth year, the WMRRB Project is showing tenacity and stability. A new site to restore is added to the Project's repertoire nearly every year; the Project leaders also have to revisit all of the existing sites to see how the restoration is proceeding, and it is eventually necessary to schedule work days for old sites, to add another layer of rocks to a site's structures as new sediment accrues. It is inevitable that a cloudburst over a sagebrush-steppe valley will create a new gullying action that will have to be dealt with quickly. Restoration in fragile environments with violent weather systems is an ongoing process.

These are some lessons from the first ten years:

- Collaboration and partner engagement are key to ensuring optimal response when working at the watershed-scale across land ownership and management boundaries. **Building trust and establishing credibility with local landowners is essential.**
- Restoration treatments **need planning and design by restoration experts** to ensure effective response. Restoration experts are needed to train and oversee field crews and volunteers in building structures.
- Wetland delineation, permits, agency requirements and landowner agreements should be completed well in advance of work. Consult with the US Fish and Wildlife Service if working within critical habitat of the Gunnison sage-grouse.
- Sharing best practices though trainings with managers and landowners is critical for success and building local capacity.
- Projects require repeat visits to treated stream reaches to monitor effectiveness, determine needs for modification, and maintain structures to ensure long-term success.
- Conducting a climate-informed analysis can identify streams that would benefit from these restoration techniques and can serve as a starting point for field evaluation and prioritization.
- At least five years of vegetation monitoring are needed to document trends in response. Coupling vegetation cover data with repeat photos is a powerful tool to validate success.

Remaining Barriers/Challenges

Capacity remains the biggest challenge to the project. While the UGRWCD has demonstrated their commitment to the program by creating and funding a fulltime staff position to coordinate the project, and land management agencies continue to find funding year-to-year for the program, long-term funding is essential to ensure the project's success. Even when funding is found, there will be a need for workers. The Project has done a lot of volunteer recruiting from Western Colorado University and the public schools; adult volunteer organizations like Wildlands Restoration Volunteers schedule the Project into their summer weekends; local Youth and Conservation Corps teams have also spent weeks on Project sites. The Project leaders continue to expand into new sites thanks in part to the ongoing dedication and commitment of the Wildlands Restoration Volunteers group, who come from across the state to assist with building of Zeedyk structures in early September in 9 of the past 10 years.

In 2017, The Nature Conservancy's Teresa Chapman, GIS Specialist, developed a landscape-scale model to help prioritize stream reaches for restoration. The model assessed restoration need (how degraded the site is), the restoration potential (how much water is available), and the potential benefits to Gunnison sage-grouse. This model identified 541 stream reaches, encompassing 764 acres of degraded wet meadow on 271 stream miles in the Gunnison Basin. To date, the WMRRB has only treated 3.5 percent of the identified reaches, and at the current funding and manpower levels, it will take several decades to treat the remaining reaches. The work is there waiting!