CHAPTER SIX:

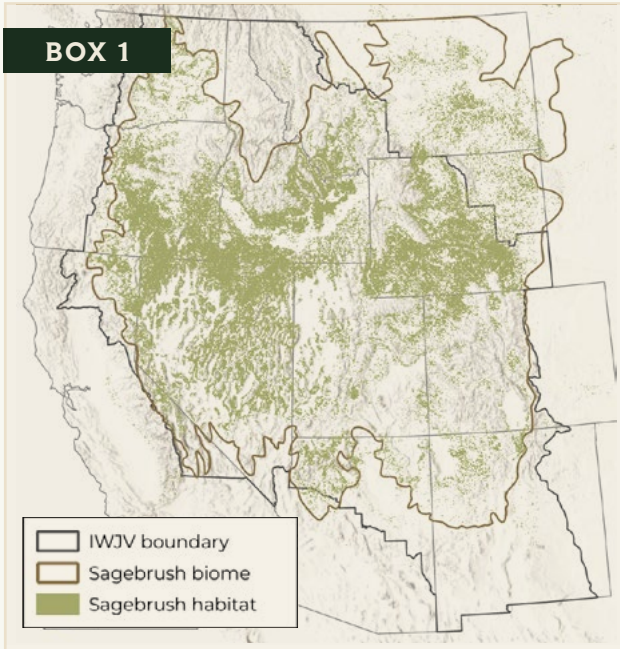
Sagebrush Ecosystems

Introduction

Sagebrush (*Artemisia spp.*) once covered roughly 247 million acres in western North America (Box 1). Today, this threatened landscape is half its original size and shrinking due to large-scale threats like catastrophic wildfire and invasive annual grasses. Sagebrush rangelands provide important wildlife values, including habitat for 350 species of conservation concern. Deep-rooted western livelihoods, from Native American cultural traditions to ranching to big game hunting, all rely on healthy sagebrush rangelands (Box 2)[1].

The IWJV's work in sagebrush rangelands was initiated through a partnership with the NRCS in 2010. In 2016, IWJV expanded this work across ownership boundaries to encompass federal lands managed by the Bureau of Land Management (BLM). The initiative is now known as Partnering to Conserve Sagebrush Rangelands. Through this effort, we have grown the network of sagebrush partners and enacted cross-boundary management and enhancement of sagebrush rangelands for people, wildlife, and the economy.

BOX 1



The Sagebrush Biome

Sagebrush habitat derived from LANDFIRE Biophysical Settings (2016).

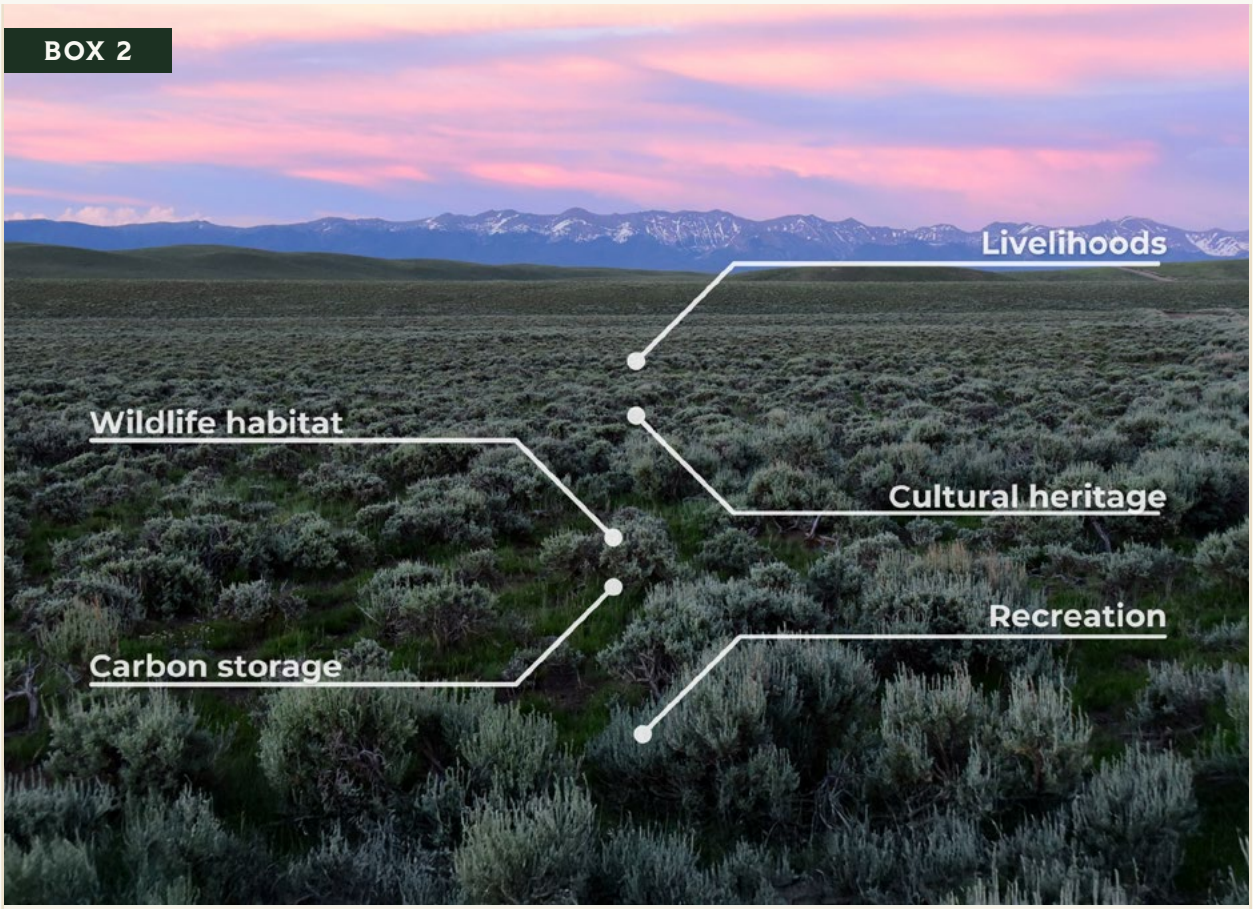
This partnership focuses on:

- Bringing people together to energize and accelerate effective and lasting conservation;
- Catalyzing implementation of on-the-ground projects that work for wildlife and communities;
- Communicating about successful conservation efforts and learning from these achievements; and
- Bridging science and implementation.

Our work in sagebrush ecosystems focuses on addressing fire, fuels, and invasive annual grasses; restoring and retaining riparian and wet meadow habitats; removing encroaching conifers; supporting outcome-based grazing projects; and, supporting efforts focused on big game migration and habitat stewardship (Box 3).

[1] Wisdom et al. 2005

BOX 2



What Do Sagebrush Ecosystems Provide?

Wildlife habitat
Sagebrush steppe is home to a suite of wildlife species, from the iconic Greater Sage-grouse to pronghorn and mule deer. Many of these species are sagebrush steppe obligates, meaning they rely on sagebrush habitats for important parts of their life cycles.

Carbon storage
Shrublands and grasslands contain around 25 percent of carbon stored in western ecosystems[1]. The majority of this carbon resides underground in the form of soil organic carbon. Protecting this carbon from loss via tilling, development, invasive annual grasses, or wildfire is a strong benefit of sagebrush conservation.

Livelihoods
Many sagebrush rangelands are working landscapes, supporting the livelihoods of ranchers, western communities, and more. Intact sagebrush ties people and wildlife together across this landscape.

Cultural heritage
Wide-open spaces are part of the cultural heritage of the West. People have inhabited the Intermountain West for time immemorial, and strong relationships with place anchor people with a wide variety of cultural backgrounds to the landscape.

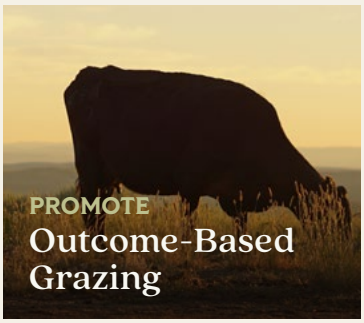
Recreation
Sagebrush steppe is used for recreation by people who enjoy hiking, backpacking, hunting, fishing, rafting, biking, wildlife watching, foraging, and more. These activities support local economies.

[1] Zhu and Reed 2012 (Ch. J)

BOX 3

The IWJV's Sagebrush Focus Areas

Using science, capacity, & communications to...



Sagebrush Ecosystems & Land Ownership of the Intermountain West

The sagebrush biome is known for its expansive yet shrinking extent, diverse vegetation communities, multitude of plant and wildlife species, and important role as a working landscape. Vegetation communities and the wildlife supported vary substantially, from mountain big sagebrush (*A. tridentata subsp. vaseyana*) communities occupying mesic and productive high-elevation sites, to black sagebrush (*A. nova*) communities in dry, rocky areas with sandy soils (Box 4).

The sagebrush biome is generally considered semiarid. Substantial variability in climate, soils, elevation, topography, and disturbance history further define the distinct vegetation communities that compose the sagebrush biome[2]. The sagebrush biome is also characterized by differing natural disturbance regimes and histories of human disturbance. Historically, natural disturbance was driven primarily by wildfire, which varied in frequency, scale, and intensity and was shaped by climate and local topography[3]. The legacies of past and present human disturbances, including land conversion, mining and energy development, tree and sagebrush harvest, overgrazing, and others, also shape sagebrush vegetation communities.

The ecological variability of the sagebrush biome creates habitats for a diversity of species. Many of the Intermountain West's most iconic wildlife species, including Greater Sage-grouse (*Centrocercus*

Continued on next page →

[2] Chambers et al. 2017, Remington et al. 2021 Chapter A, [3] Remington et al. 2021 Chapter J (p115)

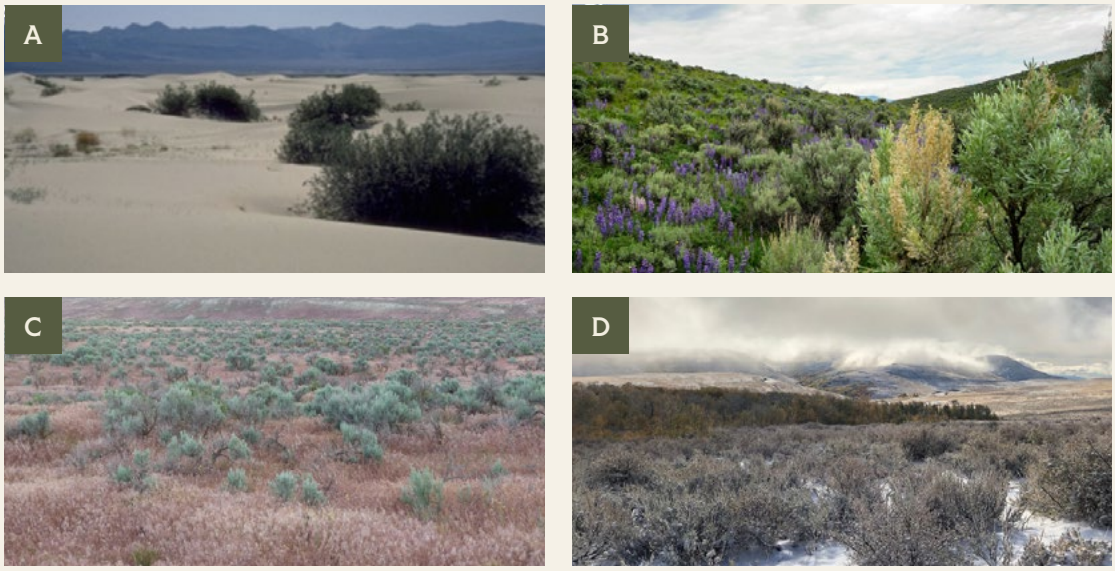
urophasianus), Gunnison Sage-grouse (*Centrocercus minimus*), mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), and pronghorn (*Antilocapra americana*) make their home in the sage. In addition to sage-grouse, there are several sagebrush obligate migratory birds that are emblematic of the biome and the focus of considerable conservation investments, including Brewer's Sparrow (*Spizella breweri*), Sagebrush Sparrow (*Artemisiospiza nevadensis*), and Sage Thrasher (*Oreoscoptes montanus*; Box 5). Research produced and supported by the IWJV indicates that targeted conservation actions for sage-grouse often benefit these other birds[4].

Across land ownerships, the sagebrush biome plays an important role as a landscape of multiple uses[5]. Almost two-thirds of the sagebrush-dominated ecosystems in the United States occupy public lands; of that public land, approximately half is managed by the BLM[6]. The other third of sagebrush habitat is primarily privately owned. These private lands are typically ranchlands in valley bottoms with deeper soils and greater water availability, providing important habitats for wildlife in an arid landscape where water is limited but critical for life. The sagebrush biome supports a multitude of uses and benefits to people, including grazing, Tribal uses, energy development and mining, hunting, and recreation.

A thorough review of the geography of the sagebrush biome, its history, and its ecology can be found in the Sagebrush Conservation Strategy–Challenges to Sagebrush Conservation[7].

BOX 4

Diverse Sagebrush Communities



A. Black sagebrush (*Artemisia nova*) with little understory in the Inyo Mountains, California. Photo: Marc Hosocsky.

B. Basin big sagebrush (*A. tridentata ssp. tridentata*) with a lush understory in southwest Montana.

C. Wyoming big sagebrush (*A. tridentata ssp. wyomingensis*) heavily invaded by cheatgrass (Bromus tectorum) in Malheur County, Oregon. Photo: Bruce Taylor.

D. Mountain big sagebrush (*A. tridentata ssp. vaseyana*) in the Trout Creek Mountains of Oregon.

[4] Donnelly et al. 2017, Holmes et al. 2017, [5] Remington et al. 2021 Chapter B, [6] Knick and Connelly 2011, [7] Remington et al. 2017

BOX 5

Declining Sagebrush Birds

A. Greater Sage-grouse (*Centrocercus urophasianus*), an icon of the sagebrush ecosystem, requires healthy sagebrush habitat. Photo: Jeremy Roberts.

B. The Sage Thrasher (*Oreoscoptes montanus*) needs plenty of sagebrush cover to conceal it while it hunts for insects on the ground. Photo: Tom Koerner.

C. The Sagebrush Sparrow (*Artemisiospiza nevadensis*) holds large breeding territories within intact sagebrush steppe, often returning to the same sites year after year. Photo: Tom Koerner.

D. Brewer's Sparrow (*Spizella breweri*) is the most abundant bird across the sagebrush steppe. Photo: Tom Koerner.

Threats to the Sagebrush Biome

Loss and degradation of the sagebrush biome have garnered substantial focus in recent decades. However, the threats to the sagebrush biome—which include invasive annual grasses, altered fire regimes, conifer expansion, loss of water resources and wet habitats, free-roaming equids, land use change, and more—have not abated, resulting in loss of around 1.3 million acres per year of intact sagebrush habitat over the last 20 years[8]. Below, we provide a brief overview of these threats and their impacts on the sagebrush biome in the Intermountain West, focusing on threats addressed by this partnership: fire, fuels, and invasives; conifer expansion; loss of water resources and wet habitats; and exurban development and land use change. We acknowledge that many of these threats are complex and interrelated but address them separately to discuss the nuances of each. Resources for additional information on each threat are provided below.

[8] Doherty et al. 2022

Landscape Changes

There are rapid ecosystem changes occurring in the sagebrush biome, including more frequent and severe droughts, flooding, and wildfires; altered patterns and modes of precipitation[9]; and increased temperatures. These changes will continue to influence fire regimes in the sagebrush biome through predicted increases in average and extreme temperatures and more xeric conditions. Although it is uncertain exactly how climate change will affect ecosystems in the future, climate projections provide information on likely future scenarios. Average increases in temperature for the sagebrush biome[10] of 1–3°C are predicted by 2020–2050 and 2–7°C by 2070–2100[11]. Largest increases in temperature are expected in the north and northeastern portion of the sagebrush biome. Although predictions for future precipitation are overall less certain, most models suggest slightly increasing mean precipitation. However, the duration and severity of drought is also expected to increase in the western United States[12], especially in the southern portion of the sagebrush range[13]. These predicted changes will likely continue to contribute to larger wildfires as a result of both decreased fuel moisture and increased extreme fire weather[14]. As these changes progress, understanding the impacts on existing and new stressors will be critical to durable management efforts.

Invasive Annual Grasses

Because of their extent, rapid spread, and negative ecological impacts, invasive annual grasses are one of the primary threats to sagebrush ecosystems. Invasive annual grasses, including downy brome (*Bromus tectorum; also known as "cheatgrass"*), medusahead (*Taeniatherum caput-medusae*), and ventenata (*Ventenata dubia*), are rapidly increasing across most of the sagebrush biome, threatening core sagebrush habitats[15]. Although expanding presence of invasive annual grasses are being seen in all regions, susceptibility to invasive annual grasses varies substantially across the sagebrush biome, with warm and dry areas most susceptible[16]. Invasive annual grasses are spreading without fire[17], but the invasive annual grass-wildfire cycle accelerates their spread. Invasive annual grass-dominated systems are more susceptible to wildfire because short-statured annual grasses dry out quickly and create continuous fuel beds, increasing the likelihood of large-scale fires[18]. Invasive species may also outcompete native species where fire occurs, driving a cycle of invasive annual grass dominance and increasing fire occurrence and severity[19]. As threats of invasive annual grass invasion increase, leading to altered and increased wildfire risk, it is increasingly important that sagebrush conservation efforts are strategic, focused on growing core areas, and collaborative[20].

[9] Chambers et al. 2017, Remington et al. 2021 Chapter L, [10] Representative concentration pathways 4.5 and 8.4; see Remington et al. 2021 Chapter L, [11] Palmquist et al. 2016a, Chambers et al. 2017, Remington et al. 2021 Chapter L, [12] Dai 2013, [13] Palmquist et al. 2016b, [14] Remington et al. 2021 Chapter L, [15] Remington et al. 2021 Chapter K, Maestas 2022, Kleinhesselink 2023, [16] Chambers et al. 2017, Maestas et al. 2019, Chambers et al. 2023, [17] Smith et al. 2023, [18] Brooks et al. 2004, Balch et al. 2012, [19] Brooks et al. 2004, Balch et al. 2012, Coates et al. 2016, [20] Maestas 2022

Fuels & Altered Fire Regimes

Wildfire historically played an important ecological role in sagebrush ecosystems, but today, altered fire regimes drive rapid ecosystem shifts that are a central concern for sagebrush conservation and management[21]. Prior to Euro-American colonization, historical fire regimes varied in frequency, scale, and severity throughout the sagebrush biome, primarily influenced by climate and past disturbance on fuel loads[22]. Historically, fire in some sagebrush ecosystems occurred in the early growing season, at roughly 50-year intervals. It resulted in landscape heterogeneity, with native perennial grasses and emergent shrubs dominating burned patches[23]. Indigenous burning was also prevalent for a variety of reasons, such as creating habitat for culturally important plant and wildlife species[24]. Fire remains an important ecological process on the landscape, and prescribed fire an important tool to mimic natural fire regimes. However, contemporary changes in the frequency and intensity of fire are a threat to sagebrush ecosystems.

After colonization by Euro-Americans, fires broadly became less frequent and intense due to wildfire suppression, prohibition of Indigenous burning, heavy grazing, and sagebrush and woodland removal[25]. In contemporary times, fires have increased in size and severity, as widespread invasion by annual grasses has increased fine fuels and fuel continuity, ramping up fire in a fuel-limited system[26]. As a result, between 2000 and 2018, more than six million acres of shrub-dominated ecosystems have burned on federal lands[27], exceeding burned area in forests in 14 of the past 21 years[28]. As fires burn, recovery of native sagebrush and perennial bunchgrass systems varies depending on several variables such as climate, prefire invasive annual grasses presence, and disturbance history. For example, previously invaded, warmer, and drier locations at lower elevations are more likely to become dominated by invasive annual grasses and continue the invasive annual grass-wildfire cycle[29]. Failure to recover after fire results in the degradation of habitats for wildlife; loss of recreational, cultural, and aesthetic values; loss of livestock forage; and reduction in ecosystem function. Wildfire risk reduction is essential for many components of a prospering sagebrush ecosystem, including community protection, economic prosperity, and habitat function and resiliency.

[21] Department of the Interior 2015, Crist 2023, [22] Miller and Heyerdahl 2008, Bukowski and Baker 2013, Remington et al. 2021 Chapter J [23] Miller and Rose 1999, Simic et al. 2023, [24] McAdoo et al. 2013, [25] Miller et al. 2011, Simic et al. 2023, [26] Brooks et al. 2004, Balch et al. 2012, [27] Remington et al. 2021 Chapter J, especially Figure J1, [28] Crist 2023, [29] Chambers et al. 2014, Smith et al. 2023

Conifer Expansion

At the biome scale, pinyon and juniper species are increasing their footprints, both expanding into former sagebrush habitats and increasing in density within existing pinyon-juniper woodlands (Box 6) [30, 31]. Increased tree cover is thought to be a result of climate change, historical management, fire suppression, and tree population dynamics[32], although research on this topic is not conclusive in some areas, and these causes vary spatially. Research has established that expansion of native conifers in historical sagebrush habitats degrades habitat for sage-grouse, a major threat to this species in many parts of its range[33]. Sage-grouse will avoid otherwise suitable habitats even when tree cover is low (>4 percent cover), meaning that a few trees per acre can degrade sage-grouse habitat[34]. As trees expand into sagebrush-dominated landscapes, they also decrease perennial grass, forb, and shrub cover, reducing habitat and forage for sagebrush-dependent wildlife and livestock and making sagebrush systems less resistant to invasive annual grasses[35]. Conifer removal efforts targeting early successional conifer expansion in core sage-grouse habitat have been successful at improving outcomes for sage-grouse[36]. These efforts additionally improve habitats for other sagebrush-dependent songbird species[37]. Across the sage-grouse range, collaborative, partnership-driven efforts are working at the landscape scale to increase targeted conifer removal.

These efforts aim to improve core sage-grouse habitat while balancing the needs of other species (e.g., Pinyon Jays) and protecting areas of old growth pinyon-juniper and culturally important areas for Tribes.

Loss & Degradation of Water Resources

In the West, wet or mesic habitats cover a small fraction of the landscape, yet these habitats are disproportionately important for both wildlife and livestock[38]. Despite their paramount importance as biodiversity hotspots, many springs, streamside riparian areas, and upland ephemeral wet meadows have become disconnected from their floodplains through head cutting, gully erosion, channel incision, vegetation loss, and other forms of degradation, reducing natural resilience to drought and capacity for water and carbon storage[39]. Past management, including improper grazing management, vegetation removal, and development of water infrastructure, has caused degradation and loss of wet habitats[40]. Contemporary management and restoration approaches, such as appropriate grazing and low-tech process-based restoration practices, can be effective at restoring these wet areas[41]. Such methods are gaining momentum, and research shows how their implementation can improve resilience to drought, wildfire, and climate change, as well as wildlife habitat[42]. Widespread degradation provides ample opportunities for wet habitat enhancement across the West, and prioritization is needed to maximize the ecological and human benefits of this work.

[30] Miller et al. 2008, Filippelli et al. 2020, Kleinhesselink 2023, [31] This chapter focuses on expansion of conifers into sagebrush habitats. Local declines of pinyon-juniper woodlands as a result of drought, wildlife, and insect or disease outbreaks is covered in the Forest Ecosystems chapter of this plan. , [32] Miller and Rose 1999, Shriver et al. 2024, [33] Baruch-Mordo et al. 2013, Severson et al. 2017, [34] Baruch-Mordo et al. 2013, [35] Chambers et al. 2014, Morford et al. 2022, [36] Severson et al. 2017, Olsen et al. 2021, [37] Baruch-Mordo et al. 2013, [38] Donnelly et al. 2016, Donnelly et al. 2018, [39] U.S. Environmental Protection Agency 2006, Perry et al. 2011, Norton et al. 2014, Nahlik and Fennessey 2016, [40] Chambers and Miller 2004, [41] Swanson et al. 2015, Wheaton et al. 2019, Norman et al. 2022, [42] Bouwes et al. 2016, Silverman et al. 2017, Fairfax and Whittle 2020, Jordan and Fairfax 2022, Norman et al. 2022

BOX 6

Conifer Expansion Threatens Sagebrush Ecosystem

Historical imagery shows how conifers have been expanding their footprint and infilling existing woodlands over time, like this example in Oneida County, Idaho. Historical images from the U.S. Geological Survey's Single Frame Archive from the 1940s through the 1970s are compared to current satellite imagery. To view historical imagery in more areas, see the Landscape Explorer.

Exurban Development & Land Use Change

Over the last several decades, exurban development and land use change have become increasingly evident in the sagebrush biome. Expansion of both urban and rural communities has increased the footprint of development on the landscape, adding stress and pressure on wildlife and natural resources across the West and rapidly fragmenting intact sagebrush habitat. States in the Intermountain West experienced some of the highest population growth between 2010 and 2020[43], and most of these states continued to grow between 2021 and 2023[44]. Between 2010 and 2020, the states with the greatest increases in rural population were North Dakota, Utah, Idaho, Montana, and Washington, ranging from 8.3 to 12.5 percent population growth over that period[45]. In a study addressing loss of natural vegetation cover on private lands in northwestern states between 2001 and 2011, some regions experienced up to 12 percent loss of vegetation. These changes were mostly accounted for by increases in housing development, followed by cropland conversion[46]. The Landscape Explorer tool from Working Lands for Wildlife uses historical imagery to show striking examples of development and land conversion[47]. Although these changes have brought opportunities for economic growth and for more people to connect with nature, unintended consequences to ecosystems from land conversion and other development, recreation, and other impacts are mounting. Natural resource managers must find solutions that minimize impacts for future generations and preserve the intact, open spaces of the West.

Other Threats to the Sage

A suite of other factors contribute to the loss and degradation of sagebrush habitats. Locally, conversion of sagebrush habitat, unmanaged recreation, growing populations of free-roaming equids, and other factors contribute to the 1.3 million acres of sagebrush lost each year[48]. These threats are covered in greater detail in the Sagebrush Conservation Strategy[49].

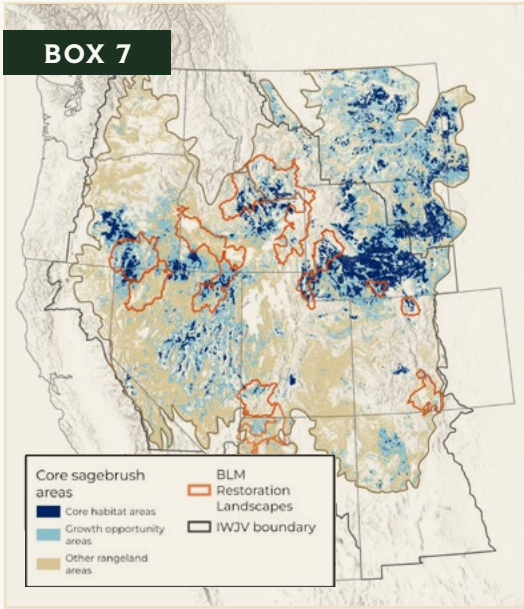
[43] Pew Charitable Trusts 2021, [44] U.S. Census Bureau 2023, [45] Dobis et al. 2021, [46] Hansen et al. 2021, [47] See the Landscape Explorer tool, [48] Doherty et al. 2022, [49] Remington et al. 2021

Priority Geographies

The IWJV supports our partners in implementing strategic, cross-boundary, science-based approaches to sagebrush management[50]. As a partner-driven organization, the IWJV does not prescribe to our partners where they should invest in sagebrush ecosystems. Rather, we attempt to support their efforts in their self-identified focal geographies or the development of geographic priorities when requested. We prioritize our support of managing and conserving intact sagebrush habitats (defending the core) and their expansion, when possible, through active management efforts (growing the core). Core sagebrush habitats are typically characterized as large patches of sagebrush plant communities dominated by sagebrush, native perennial grasses, and forbs and are devoid of trees and major human developments. The IWJV supports our partners in applying a variety of map products that help prioritize and guide the strategic application of conservation efforts. These include the Sagebrush Conservation Design, Threat-Based Ecostate Maps, and many other locally developed map and GIS products (Box 7)[51].

We recognize that effective sagebrush conservation and management requires more than identifying strategic locations based on ecological attributes. A variety of factors contribute to the success or failure of efforts we support. For example, conservation efforts are unlikely to succeed without the support of necessary partnerships, policy, and funding. The IWJV will not only identify priority geographies for our work, but identify which elements of a potential project may require additional attention. For example, perhaps a local collaborative wants to address invasive annual grasses in their geography and has strong partnerships, adequate funding, and a favorable political climate. However, they lack a spatial strategy for addressing the annual grass threat in their planning area. The IWJV Science to Implementation staff could support the effort either directly, by assisting the collaborative with geospatial tools and landscape prioritization, or indirectly, through our network of partners with expertise on this topic (such as the University of Wyoming Institute for Managing Annual Grasses Invading Natural Ecosystems)[52].

BOX 7



Partner Priority Landscapes in the Sagebrush Biome

BLM Restoration Landscapes and Forest Service Wildfire Crisis Landscapes within the sagebrush biome overlaid on sagebrush ecological integrity from the Sagebrush Conservation Design. Blue areas show core sagebrush areas where habitat remains intact, while light blue areas show sagebrush habitat experiencing threats such as invasive annual grasses and conifer expansion. Other rangeland areas are highly degraded and have a low likelihood of returning to intact sagebrush habitat.

[50] Western Governors' Association 2020, Doherty et al. 2022, [51] Doherty et al. 2022, Threat-Based Land Management,
[52] Institute for Managing Invasive Grasses Invading Natural Ecosystems

Conservation Strategies & Practices

IWJV's conservation strategies and recommended practices in sagebrush ecosystems support the goals of our work in the sagebrush biome: to address catastrophic wildfire and hazardous fuels, restore and sustain hydrologic function, remove expanding conifers, promote outcome-based grazing, and support partners on big game conservation efforts (Box 3). These strategies leverage our approach—building partnerships, growing capacity, bridging science and implementation, and engaging in innovative communications efforts—toward these goals.

Conservation Strategies

To address pressing threats to sagebrush habitats, the following overarching strategies will be employed to accelerate effective conservation in a rapidly changing landscape.

1. Build and strengthen relationships

Sagebrush conservation is directly related to the people who live and work in these beloved landscapes. To implement durable and effective sagebrush conservation, actions must result in co-benefits that meet the needs of multiple stakeholders. It is essential to build connections that bridge knowledge, funding, and capacity gaps by exploring shared values that will sustain habitats across the sagebrush ecosystem and migratory bird flyways.

Building relationships with partners working within the sagebrush ecosystem continues to be a priority for the IWJV. Work done prior to this implementation plan has resulted in a strong foundation of partnerships with NGOs, state and federal agencies. We will continue to build connections with partners across professional and jurisdictional boundaries to achieve a vision of catalyzing collaborative conservation efforts that integrate bird and habitat conservation. Priority work will focus on broadening our partnership to identify new stakeholders and additional innovative ways to address the immense challenges this system is facing.

Due to the IWJV's long-lasting partnerships within the sagebrush ecosystem, we will continue to embark on new endeavors to support partners as well as lead efforts to frame new ways of conducting collaborative habitat enhancements and management that benefit communities, wildlife, and habitat well into the future.

2. Accelerate the pace, scale, and reach of sagebrush habitat conservation delivery

Ensuring sagebrush rangelands will be sustained into the future requires an investment in the human capacity needed to implement on-the-ground actions to address current and future threats. Conservation capacity, or the human capital needed to implement projects and facilitate collaborative efforts at a desired pace and scale, is essential to sustaining and increasing the pace of sagebrush work across the Intermountain West. As efforts centered around sustainable sagebrush rangeland management, such as fuels reduction and ecosystem resilience and sustainability, additional capacity will be needed to deliver strategic management and restoration efforts across ownership boundaries. For critical functions like partnership facilitation and project planning and implementation, additional people power connected to local communities is needed to carry forward new and ongoing efforts.

The IWJV has a proven record of establishing and supporting critical partnership capacity for dedicated adaptive management[53]. We will develop capacity in identified priority landscapes that have partner support and planned conservation efforts that can lead to beneficial outcomes for communities and wildlife. As we develop new partnerships and work with existing partners, we will seek out strategic opportunities to support capacity positions that meet the needs of our partners and fill capacity gaps that may be difficult for other organizations to fill.

3. Bridge science and implementation to ensure existing knowledge can be used to strengthen on-the-ground sagebrush habitat management

Bridging knowledge and action is often a challenge in conservation management. Conservation science is not always co-produced and may not address specific needs of managers[54]. Many barriers to the application of knowledge in land management decisions exist within both research and management communities[55]. Science-to-implementation efforts, which transfer science, data, technology, best practices, and other technical information to end-users who influence land management, are often needed to ensure that existing knowledge can be used to strengthen on-the-ground management[56].

Through our Science to Implementation Team, the IWJV has increased our capacity to support our partners in integrating science, data, technology, and other information into their work[57]. Our team will focus on understanding partner needs and applying our service-oriented approach to bridging science and implementation. Across IWJV priority ecosystems, our team will work with research partners to support managers with a variety of technical needs, including spatial targeting of sagebrush ecosystem management for wildlife habitat benefits and other values, outcome evaluation of management practices, and science synthesis and translation of management-relevant topics. Additionally, the Science to Implementation Team will develop and contribute to efforts that increase the technical transfer capacity and skills of others, such as through communities of practice, workshops, and training.

[53] See the Sage Capacity Team, [54] See the 2025 IWJV Implementation Plan Science to Implementation Chapter, [55] 2025 IWJV Implementation Plan Science to Implementation Chapter, [56] 2025 IWJV Implementation Plan Science to Implementation Chapter, [57] 2025 IWJV Implementation Plan Science to Implementation Chapter

4. Use compelling communications to advance proactive, collaborative sagebrush habitat conservation

The sagebrush conservation community needs powerful and creative forms of multimedia to share the interconnected nature of habitats, wildlife, and communities of the West with broad national audiences as well as hyper-local audiences. The IWJV communications program uses numerous strategic planning methods and tools to guide our effective outreach efforts, as detailed in the communications chapter of this implementation plan. In sagebrush communications, we strive to: (1) increase awareness about the BLM-IWJV partnership, (2) engage diverse partners in strategic storytelling about sagebrush, with a shared vision to restore and manage highly valued habitat, and 3) showcase proven models of partnership-driven conservation that benefit wildlife, communities, local economies, and partner goals.

5. Seek additional opportunities to further the IWJV approach

Active management efforts across sagebrush rangelands are extensive both in terms of (1) maintaining and growing the expanse of the existing habitat, and (2) defending against the numerous threats that continually arise and threaten sagebrush function and extent. There is a perpetual need to support efforts, new or old, to continually stay ahead of threats and maintain the future of this habitat. The IWJV's sagebrush program will continue to conduct scoping, work with partners, and support efforts that will further the IWJV approach to multi-benefit, cross-boundary conservation efforts across the sagebrush ecosystem.

Conservation Practices

Within the above conservation strategies and our vision for sagebrush ecosystems (Box 3), the IWJV supports our partners in implementing conservation actions that retain or restore resilient sagebrush habitat and incorporate habitat requirements for sagebrush obligate species into planning and management. Throughout the sagebrush biome, we support a suite of practices, where appropriate, that address the threats outlined above, including:

Addressing fire, fuels, and invasive annual grasses through…

- Herbicide applications and targeted grazing to treat invasive annual grasses in combination with appropriate revegetation approaches, especially in core sagebrush areas.
- Fuels reduction practices aimed at reducing fire intensity or severity or altering fire behavior, especially at the landscape scale. Practices include vegetation manipulation to reduce fine or canopy fuels, such as invasive annual grass treatments, targeted grazing, and targeted conifer removal, with emphasis on practices that have co-benefits for sagebrush plant communities and wildlife.
- Fuel breaks to improve firefighter safety and help protect human communities and intact sagebrush habitats through vegetation removal where appropriate.
- Restoration of native plant communities, especially when recovery is expected to be limited (e.g., postfire), through seeding or planting of genetically appropriate native grasses, forbs, and sagebrush species. Limited use of non-native species to achieve site stabilization or control invasive species where appropriate, with restoration of native species as a long-term priority.

Restoring and retaining riparian and wet meadow habitats using…

- Low-tech process-based restoration practices aimed at addressing riparian and wet meadow impairments like floodplain disconnection and channel incision by mimicking and promoting natural processes. Hand-built structures such as beaver dam analogs, post-assisted log structures, and Zeedyk rock and wood structures are examples. Appropriate structure maintenance and grazing management post-implementation.
- Beaver reintroduction and management to restore or retain ecosystem processes where appropriate.
- Grazing management practices that control the duration, timing, and intensity of grazing to promote healthy riparian and meadow vegetation. Examples of such practices could include fencing, water development, and herding.

Removing expanding conifers through…

- Conifer removal treatments targeted at improving sage-grouse and sagebrush habitat, such as hand cutting in Phase I or II woodlands with sagebrush understories and adjacent to intact habitats. Mastication (i.e., shredding, chipping) and other forms of removal with machinery on a more limited basis where appropriate and when precautions to mitigate increases in annual grasses from ground disturbance are included. Reestablishment of native understory vegetation where needed.
- Prescribed fire as a tool for removing expanding conifers in areas with relatively short historical fire return intervals (<50 years), intact sagebrush plant communities, and minimal invasive annual grasses (e.g., high-elevation, moist, mountain big sagebrush and mountain shrub plant communities). Application of this tool only during cool and low wind days and with as-needed mitigation to offset potential increases in invasive annual grasses postfire.

Supporting outcome-based grazing using…

- Flexible grazing authorizations aimed at allowing operators to better respond to environmental and operational conditions within BLM allotments.
- Monitoring and outcome evaluations to assess the efficacy of outcome-based grazing across a suite of wildlife and vegetation metrics.

Integrating strategies and practices through…

- Spatial targeting of treatments, especially to balance benefits to birds and other wildlife with ecological, social, cultural, and economic objectives. Relevance to people is an important emphasis for our work.
- Leveraging big game migration corridor conservation to benefit sagebrush obligate bird habitat.

Success in the Sage

The sagebrush biome, although a vast and inspiring feature of western North America, is facing its greatest threats ever. Collaboration and partnerships will be the mechanisms that retain this amazing biome for future generations to live in and enjoy and for wildlife populations to thrive in. This work will also maintain the irreplaceable ecosystem services provided by healthy and expansive sagebrush habitats. Numerous partners are coming together to implement an "all lands all hands" approach to manage, conserve, and restore sagebrush habitats. Success for the IWJV will be measured by leadership efforts and support to our partners that work day in and day out to sustain the West's sagebrush biome. Through assisting partners to build capacity to assist with innovative, habitat enhancement, we may influence the pace and scale of sagebrush management and conservation. Through strategic communications, there may be an increased acceptance of active management and partnership efforts. Ultimately, as a partner-driven wildlife habitat organization, our success will happen through partnerships and innovative approaches that conserve and restore the habitats of sagebrush birds and other sagebrush obligate species.