Sagebrush & Climate Change NC CASC Workshop

August 20-21, 2024



NORTH CENTRAL Climate Adaptation Science Center



University of Colorado Boulder



OVERVIEW

What was the workshop?

The North Central Climate Adaptation Science Center's (NC CASC) Sagebrush and Climate Change Workshop occurred on August 20 and 21, 2024 at the University of Colorado Boulder, the NC CASC's university host. The workshop convened experts and partners from a range of agencies, institutions, and geographies to discuss research and synthesis needs in the eastern sagebrush biome in Montana, Wyoming, and Colorado.



Why was the workshop organized?

The workshop was organized to promote discussion and gather input from experts, practitioners and stakeholders/rights holders to inform NC CASC's science synthesis and research efforts on social-ecological transformation in the eastern sagebrush biome (WY, CO, MT) driven by climate change and other anthropogenic drivers. The primary objectives included:

- Convene experts and partners from a range of agencies, institutions, and geographies to discuss research and synthesis needs in the eastern sagebrush biome
- Discuss current management challenges, existing resources, and uncertainties for understanding and responding to threats from climate change and other change drivers
- Identify specific research and capacity needs that will be the focus of an in-depth multi-year working group effort led by the NC CASC



Image credit: Pinyon Juniper Encroachment Education Project (University of Nevada Reno Extension)



Affiliation of Workshop Participants

Back row (left to right): Lauren Barrett, Heather Yocum, Kyra Clark-Wolf, Jamie Halperin, Matt Holloran, Julian Reyes Middle row (left to right): Sarah Whipple, John Bradford, Molly Cross, Lief Weichman, Geoff Bedrosian, Katie Bardsley, Chris Domschke Front row (left to right): Denyse Ute, Jane Wolken, Steph McAfee, Cass Burson, Amy Stillings, Christy Miller Hesed, Imtiaz Rangwala Not pictured: Drew Bennett, Corrie Knapp, Bill Travis, Hailey Robe

We also gratefully acknowledge those who could not attend in person, but provided valuable input: Tina Mozelewski (Conservation Science Partners), Matt Cahill (The Nature Conservancy), David Wood (BLM), Bill Sparklin (USFWS), and Jim Berkey (The Nature Conservancy).

Who was there?

Twenty-four individuals participated in the workshop, including 10 members of the NC CASC, 10 scientists and managers from federal agencies, 2 tribal members, and 2 researchers from the University of Wyoming.



STATE OF THE SCIENCE



The Sagebrush and Climate Change Workshop included discussion on the current state of science regarding social and ecological science for sagebrush ecosystems.

Rapid Climate Assessment Programs (RCAPs)

In preparation for the workshop, the NC CASC conducted two Rapid Climate Assessment projects (RCAPs) to synthesize the state of knowledge on socio-ecological transformations in the eastern sagebrush biome. The assessments were led by two graduate students at the University of Colorado Boulder, Katie Bardsley and Lauren Lee Barrett, and focused on natural science and human dimensions issues, respectively. Based on literature review and conversations with experts, they synthesized the current state of knowledge and identified critical outstanding questions, which provided important background and fodder for discussion during the workshop. An annotated bibliography from these two RCAP synthesis efforts can be accessed at this link.



Ecological transformation in the eastern sagebrush biome

Sagebrush ecosystems cover a large area of the American West; spread across its dry, cold-desert landscape, they function as an important habitat for wildlife. Birds and rodents nibble on flowers and grasses, and the sage grouse, a species experiencing dramatic population declines, relies on intact sagebrush habitat to perform its iconic mating dance.

Not only is ecological integrity of sagebrush ecosystems critical for wildlife, but humans also rely on sagebrush ecosystems for livestock grazing, recreation, water and nutrient cycle regulation, and cultural significance. Since European settlement, there has been a nearly 50% reduction in the sagebrush biome across the western U.S. Historical deterioration of sagebrush ecosystems has been driven in part by overgrazing and land use, sagebrush eradication efforts, and conversion driven by the establishment of invasive species. These already vulnerable landscapes face even greater threats under a changing climate.

Climate change and potential impacts

Across the eastern sagebrush biome, climate change is expected to cause significant warming and increases in cool-season precipitation (particularly in eastern Wyoming and Montana). On average, the region is projected to experience warmer, wetter winters and longer, drier summers, along with increased climate variability from year to year and more frequent severe weather events. Current evidence suggests that these changes in climate could have important direct effects on sagebrush communities, including range shifts and changes in the abundance of different plant species. However, significant uncertainties remain about the potential effects of elevated atmospheric CO₂ and how other drivers might mediate the direct effects of climate change, including disturbance processes (e.g., fire, grazing) and biotic interactions.



Plant Community Responses

	Increasing Temperature	Increasing Precipitation	Increasing CO ₂
Sagebrush	Hotter sites: decrease Cooler sites: increase or no change	May benefit from increasing precipitation, especially during the cool season	Unknown
Cheatgrass	Positive effects when adequate winter/early spring moisture	Timing-dependent: perform best when higher levels of cool season precip and lower levels of summer precip	No significant effect, but may be more beneficial without N limitation/competition
Native perennials	Overall negative impacts Shift from $C3 \rightarrow C4$	Positive effects of increased precip	Limited mixed results, likely minor effects
Pinyon	Generally increases and rang	Unknown	
Juniper	Generally increases and rang J. osteosperma and J. scopu	Unknown	

Table 1: Potential response of different vegetation in the eastern sagebrush biome to future climate change, synthesized from the literature available in the Sagebrush RCAP annotated bibliography (here).

Drivers of ecological transformation:

- Climate change
- Elevated CO₂
- Invasive annual grasses
- Altered fire regimes
- Conifer encroachment
- Grazing
- Human development
- Wild horses & burros

Given these multiple interacting drivers, climate change alone will not be the only factor determining future transformations in the eastern sagebrush biome. For example, invasive cheatgrass generates fine fuels that can facilitate wildfire ignition and spread, which in turn facilitates cheatgrass invasion. This self-reinforcing cycle has transformed large areas of the Great Basin, and similar dynamics could play out in the eastern sagebrush biome under future climate conditions favorable for invasive annual grasses. Climate change and elevated atmospheric CO₂ are also expected to amplify biophysical feedbacks that, for example, could exacerbate the threat of wildfire, invasive grasses and conifer encroachment.

Human dimensions in the eastern sagebrush biome

The eastern sagebrush biome is a patchwork of private and public land, both bustling with activity. Primary land uses include energy development (oil and gas development, coal and mineral mining, geothermal development, and solar/wind farms), urban development, livestock grazing, and recreation like hiking, biking, hunting, and fishing. Federal, state, and Tribal agencies; NGOs; and private landowners have multiple goals for managing sagebrush ecosystems, but they all share the goal of conservation (Table 2).

Ecosystem loss and degradation is not only devastating for biodiversity, but also for the many communities that rely on the vital ecosystem services that sagebrush provides. Sagebrush is home to rural and Tribal communities, and many urban residents Fires clear the way for invasive plants, like cheatgrass, to dominate once diverse ecosystems



Primary Goals	BLM	FWS	FS	NRCS	Private landowners	Tribal Nations	State agencies	NGOs
Conservation	x	x	x	x	x	x	x	x
Recreation	x	x	x			x	x	x
Productive grazing of livestock	x		x	x	x	x		
Historic and cultural preservation	x		x			x	x	
Energy Development	x				x	x	x	

Table 2: Sagebrush Land Use Objectives Across Agencies, Organizations and Tribal Nations, synthesized from the literature available in the Sagebrush RCAP annotated bibliography (<u>here</u>). Agencies: Bureau of Land Management (BLM); U.S. Fish and Wildlife Service (FWS); Forest Service (FS); Natural Resources Conservation Service (NRCS); Non-governmental Organizations (NGOs). "X" indicates inclusion of a particular objective.

also spend time in sagebrush ecosystems through recreational activities. These communities both shape and are shaped by sagebrush ecosystems through livestock grazing, recreation, climate stabilization through carbon sequestration, and water and nutrient cycle regulation. Sagebrush ecosystems are also an important part of regional culture and identity. Considering these communities' input and well-being is essential in developing a successful land management and conservation strategy. Some of the social issues that are most relevant to sagebrush management include:

Understanding and Integrating Local Knowledge and Values: A deeper understanding of local knowledge and how sagebrush is valued in different areas would help resource managers engage with communities and monitor ecosystem changes at the local level.



Anticipating Changes in Rural Economies: As rural communities are experiencing considerable change through population loss, population growth and demographic change, and/or shifting economic drivers, research is needed to better understand how these changes might shift rural values, economies, and livelihoods.



Integrating National Energy and Conservation Priorities: A better understanding of the intersection among climate mitigation strategies, conservation goals, and public and private land use objectives (e.g., fossil and renewable energy development) is needed to identify collaborative ways to minimize harm to both the sagebrush ecosystem and the well being of neighboring communities.



Building the Capacity, Networks, and Expertise to Incorporate Justice Frameworks: New efforts focused on environmental justice, just transitions, and Indigenous knowledge are identified, addressed and integrated into the decision making process to help ensure healthy ecosystems while supporting disadvantaged communities' needs and concerns. This moment presents a strategic opportunity to (re)assess what bureaucratic processes, agency expertise, and local/agency networks are needed to better integrate indigenous knowledge and EJ frameworks into the everyday work of agency personnel.

WORKSHOP OUTCOMES

Photo: NC CASC

Identification of Research, Science Synthesis and Capacity Needs

Participants discussed the state of the science over the course of the two-day workshop. They identified management challenges and outstanding uncertainties, research gaps, and capacity needs for supporting climate adaptation in sagebrush ecosystems, and brainstormed ways to address those issues that could be supported by future involvement from the NC CASC. Major themes related to research, science synthesis and capacity needs that emerged in these conversations include:

Research to address uncertainties in projecting future vegetation responses which account for direct and indirect climate effects and interactions among drivers

Research to evaluate the efficacy of current management practices to promote ecological integrity of sagebrush ecosystems, including how the efficacy of specific management actions could be impacted by future climate change

Research to understand what people value in sagebrush landscapes and what kinds of socialecological transformations may be acceptable, and evaluating tradeoffs and synergies among climate-informed management, social values, and environmental justice considerations

Capacity to develop and sustain tools and datasets at appropriate scales to support climate-informed sagebrush management, including resources to guide their use

Cross-cutting efforts to build and strengthen relationships with stakeholders, rightsholders, and communities across the sagebrush biome

MAJOR SCIENCE QUESTIONS

What are the management challenges with regard to climate change adaptation?

Major barriers for climate-informed management in sagebrush ecosystems that were identified through workshop discussions include constraints related to funding and capacity, challenges of



identifying what data and tools are appropriate for different management applications, and a lack of available information at spatial and temporal scales relevant to management decisions. Additionally, a number of barriers were identified that limit meaningful engagement with Tribes, landowners, and other relevant stakeholders and community members.

What questions need to be answered to support successful management in a changing climate?

How will climate change affect our ability to implement management actions, their effectiveness for achieving desired outcomes, their longevity, or the risks of unintended consequences?

How can we navigate the uncertainties in projecting future vegetation responses, including accounting for direct and indirect climate effects and interactions among drivers?

How transferable are trends and processes currently observed in the Great Basin? What unique considerations are relevant to anticipating ecological changes in the eastern sagebrush biome?

What do we value in terms of services provided by the ecosystems we manage? What ecological transformations are potentially acceptable, to whom, and in what context?

What are the trade-offs in climate-informed resource management and decision making? How do they impact social and environmental justice outcomes?

How can we value and engage with Indigenous knowledge without doing so extractively?

NEXT STEPS

Photo: Intermountain Forest Service, USDA Region 4, Flickr

What are some possible next steps for supporting sagebrush conservation in a changing climate?

Ideas for efforts that could be accomplished in the next several years:

- Synthesis of science and scenarios of future ecological responses that incorporate important uncertainties to inform adaptation planning.
- A library of existing resources and guidance for accessing and using social, ecological, and climate data for sagebrush management. This would provide information about the strengths and limitations of different tools and how they can be applied to inform decisions.
- Development of an adaptation menu with case studies that would provide practical guidance for climate-informed management decision making in sagebrush ecosystems.
- Synthesis of past management actions to evaluate the degree to which their outcomes were dependent on climate or other contextual factors.
- C Listening sessions to understand stakeholder and rightsholder priorities and experiences. These would be facilitated by engagement with existing groups, including Tribes.
- Filling gaps in capacity through a focused workshop model that would convene a group of experts to intensively work with decision makers.
- Training for researchers, managers and practitioners so that they can better understand the decision space for sagebrush management and improve the actionability of their research.

Ideas for longer-term priorities:

- Research to better understand the influence of climate on ecological processes in sagebrush ecosystems and improve 1 projections of plausible future changes across the biome.
- Research to better understand social-ecological connections and areas where conservation can support environmental 2 justice and vice versa in a changing climate.
- Development of new tools and approaches that better meet managers' needs for supporting climate-informed decision 3 making at appropriate spatiotemporal scales.
- Greatly expanded efforts to work with Tribes to develop new guidance and norms for engaging with non-Western 4 perspectives, navigating institutional constraints for respecting data sovereignty, and adopting more holistic approaches to conservation.

How you can get involved:

We welcome additional input on any of these issues. In the near term, the NC CASC will be forming a Science Synthesis Working Group to initiate a two-year effort focused on one or more of the priority research gaps or capacity needs identified from the workshop. Please don't hesitate to reach out with questions, feedback, or if you may want to be involved in this initiative!

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Document compiled and formatted by Hailey Robe (NC CASC)