



Assessing conservation planning in South Dakota: Challenges and opportunities in collaboration, public participation, and climate information

Vivian Hulugh, South Dakota State University

Lauren Redmore, US Department of Agriculture–Forest Service, Aldo Leopold Wilderness Research Institute

Jennifer Zavaleta Cheek, South Dakota State University

CORRESPONDING AUTHOR

Jennifer Zavaleta Cheek

Department of Natural Resources, South Dakota State University

1175 Medary Avenue

Brookings, SD 57006

Jennifer.ZavaletaCheek@sdstate.edu

Received for peer review 4 April 2025; revised 7 November 2025; accepted 7 November 2025; published 15 January 2026

Conflict of interest / funding declaration. The authors have no conflicts of interest to report. This research was supported by the North Central Climate Adaptation Science Center (NCCASC) [G18AC00325]. The opinions, findings, and recommendations expressed in this paper are those of the authors and do not reflect the views of NCCASC or the US Department of Agriculture–Forest Service.

ABSTRACT

Conservation planning protects habitats, supports biodiversity, and sustains ecosystem functions that support human and ecological well-being. Natural resource managers are expected to make sound management decisions and balance competing interests in a social-ecological context. However, they face challenges related to effective collaboration, public participation in decision-making, and the application of climate information. This study describes conservation planning challenges in South Dakota, a predominantly rural state where over 80% of land is privately owned, and natural resources are highly valued. We used an inductive, qualitative research approach, including in-depth interviews with 35 experts and content analysis of 56 conservation plans. Our study identifies the absence of complementary goals among federal, state, and non-profit organizations. Managers have concerns that current methods of public engagement are inadequate and often result in low engagement during the public participation process. Limited understanding and application of climate data were prevalent among managers. Our findings indicate that managers face multiple, complex demands in conservation planning. Conservation outcomes can be more sustainable when collaborative efforts are complementary, public perspectives are incorporated, and clear guidance exists for using climate tools. This study positions relationships as an important social foundation for conservation success. The insights from this study inform policy and practice by offering considerations for improving collaboration, public participation, and the use of scientific data.

Keywords: collaboration, climate information, public participation, conservation planning, natural resource management

INTRODUCTION

Conservation planning is defined as “the process of locating, configuring, implementing, and maintaining areas that are managed to promote the persistence of biodiversity and other natural values” (Pressey et al. 2007: 583), such as sustainable wildlife and fish management and the continued provision of ecosystem services. Conservation planning in the United States is rooted in the Public Trust Doctrine, a

key legal principle that mandates that natural resources are held in trust by governments for the benefit of the public (Sax 1970). The Public Trust Doctrine requires agencies to seek and consider public input in their decision-making processes, ensuring that management reflects the interests and knowledge of the broader community now and into the future. Many legal scholars and some courts have said

that the government's duty to care for public resources also means that agencies should make decisions using the best information available, especially with threats such as climate change that puts resources at risk (Quirke 2016). These legal and governance principles indicate that the conservation of natural resources should consider three interconnected social components: (1) collaboration across public, private, and non-profit actors to manage public resources; (2) public participation to ensure citizens meaningfully influence decisions of how resources are managed; and (3) the use of scientific and climate information to manage resources in an adaptive way. Together, this triad of social considerations can inform effective conservation planning as it recognizes governments' responsibility to the public, the need for broader engagement with the public, and the importance of planning for the changes associated with climate. Using South Dakota as a case study, the goal of this study was to describe how collaboration, public participation, and the use of climate information inform conservation planning with multiple jurisdictional actors that require coordinated efforts.

Collaboration is important for effective conservation planning because many ecological challenges span boundaries and jurisdictions, which require data sharing, joint goal setting, and coordinated management actions across agencies (Mace et al. 2000). Collaboration is a process in which independent actors engage through both formal and informal negotiations to jointly establish the rules and structures that guide their relationships and the actions or decisions they take on shared issues (Thomson and Perry 2006). Several studies from watershed management, fire planning, and ecosystem restoration have documented the benefits of collaboration in conservation planning. For example, shared goals, trust, and open communication were key to successful interagency collaboration in fire planning (Savage et al. 2010). Similarly, clearly defined stakeholder roles and a common vision improved collaborative outcomes across multiple conservation cases (Greer 2017). Collaborative efforts also strengthen responses to threats such as habitat degradation, invasive species, and climate change (Rölfer et al. 2024). No single organization has the authority, knowledge, or resources to address all of the threats to wildlife, so collaboration helps pool stakeholder expertise and resources. Collaboration, or coordinated and integrated efforts across agencies and organizations, can also promote stakeholder buy-in, which is essential for successful implementation and long-term stewardship (Knight et al. 2006), especially in landscapes dominated by private land ownership. Understanding collaboration will help stakeholders build their capacity to work together and increase conservation impact across larger landscapes.

Public participation in conservation planning is beneficial when communities can influence and support decisions about shared natural resources. Public participation involves actions taken to consult and inform the public to allow those affected by a decision to have an input into it (Rowe and Frewer 2000). Public participation, such as through public comment periods, workshops, and advisory groups, improves the legitimacy and fairness of decisions and helps to ensure local knowledge and values are incorporated and conflict is reduced (Reed 2008). Effective public participation integrates local and traditional ecological knowledge and promotes transparent decision-making processes, which can increase the legitimacy of conservation actions, reduce conflict, and build long-term stewardship of lands (Guerrero et al. 2013). Meaningful participation requires that participants can influence decisions; otherwise, it risks being viewed as procedural or symbolic (Rowe and Frewer 2000). Even with different forms of participation, the full range of voices and knowledge systems may not be adequately represented. When a variety of cultural norms, values, and knowledge systems are engaged, participation can facilitate the identification of new management approaches in addition to strengthening support for implementation (Guerrero et al. 2013). Improving public participation is especially critical when conservation efforts occur on multi-use landscapes with high levels of private landownership because meaningful involvement can build trust for long-term stewardship and success. Understanding how natural resource managers engage the public will inform strategies for achieving more representative and trusted decision-making in conservation planning.

Climate change is introducing unprecedented environmental shifts and uncertainty, making proactive and flexible planning increasingly urgent. Conservation planning can be more adaptive to future conditions and climate-related threats when climate information is included in plans. Climate information refers to a "collection of data about the past, current or future state of some climate system properties" (Wiréhn 2021: 2). Climate tools, such as vulnerability assessments and scenario modeling, provide critical data for conservation planning by helping managers anticipate ecosystem changes and design adaptive strategies. Yet, many conservation practitioners face barriers to incorporating climate information into their conservation plans (Yocum and Ray 2019). Some barriers are technical, such as limited expertise in interpreting climate models, insufficient training on available tools, and a lack of clear guidance on how to integrate climate projections into planning decisions (Lemos et al. 2012; Kiem and Austin

2013). For example, Hewitson et al. (2017) identified 42 web-based platforms designed to provide climate data to decision-makers, yet found most are underutilized due to their complexity and the specialized skills required to interpret outputs. Other barriers are social because the adoption of climate tools benefits from relationships between scientists and managers, organizational support, and trust in information providers—all or some of which might be absent (Djenontin and Meadow 2018). Climate tools are relevant, useful, and more likely to be adopted when developed iteratively with intended users, leading to a co-production of knowledge between scientists and decision-makers (Lemos et al. 2012). Therefore, improving the application of climate information requires both tools and capacity that make climate science applicable. Assessing how natural resource managers access, understand, and interpret climate information will provide more information on how to design and deliver climate tools that effectively support conservation decisions.

Together, collaboration, public participation, and the use of climate information represent key social components of conservation planning. Even though all three components of conservation planning have been studied independently, this paper provided insights on how they are interconnected and applied in context. South Dakota offers an important case for conservation planning. South Dakota's landscapes are over 80% privately owned and include nine Tribal Nations, alongside millions of acres of public wildlife areas managed by state and federal agencies (Hanson and Vincent 2020). This land tenure mosaic necessitates coordination among different stakeholders. The results from this study may therefore inform planning efforts in states with similar demographic and land tenure systems.

METHODS

Study site

This study was conducted in South Dakota, United States, an ecologically rich and predominantly rural state. South

Dakota has a population of 924,669 (US Census Bureau 2024), with a strong cultural connection to land and natural resources. South Dakota is home to a variety of federal and state public lands, and many wildlife species, including bison, pronghorn, bald eagles, and prairie dogs, that thrive across its grasslands, forests, and river ecosystems. It is situated in the Prairie Pothole Region, the most productive waterfowl habitat in the world and the primary breeding area for many waterfowl species in North America (Mitchell 2021). According to a Congressional Research Service report on federal landownership, the federal government owns approximately 2.6 million acres in South Dakota, accounting for 5.4% of the state's total land area of 48.8 million acres (Hanson and Vincent 2020). In addition, South Dakota's residents deeply value natural resources, as evidenced by their engagement in outdoor activities such as hunting and fishing, which collectively contribute over \$1.2 billion annually to the economy (Southwick Associates 2022).

Interviews with natural resource professionals

We conducted a purposeful sampling of experts, selecting initial participants who were knowledgeable of conservation planning and who held a range of professional roles across federal, state, and non-profit organizations (Table 1; Stratton 2024). We first compiled a list of relevant agencies and organizations and identified managers, biologists, directors, and field supervisors from a variety of backgrounds and positions through agency websites and our professional networks. Following confidentiality and informed consent protocols with South Dakota State University Institutional Review Board approval (IRB-2305006-EXM), we conducted interviews from May 2023 to January 2024, both in person at participant offices and virtually via Zoom. After each interview, we asked participants to help us identify other prospective participants, using snowball sampling in this way until we reached data saturation at 35 interviews and no additional insights emerged (Hennink et al. 2017; Parker et al. 2019). Interviews lasted for an average of 48 minutes and covered different aspects of collaboration, public participation, and the use of climate information.

TABLE 1. Description of interview participants by organization type, affiliation, and job title.			
Organization type	Organizations	Number of respondents	Job Title
Federal agencies	US Fish and Wildlife Service	8	Project leaders, resource managers, field supervisors, biologists,
	National Park Service		
State agencies	SD Game, Fish, and Parks	23	Park directors, park managers, district supervisors
	SD Parks and Recreation		
	Conservation Districts		
Non-profit	National Fish and Wildlife Foundation	4	Managers, directors
	Ducks Unlimited		
	Tanka Fund		

We analyzed the interviews with MaxQDA, a qualitative research analysis software (Rädiiker and Kuckartz 2020). A grounded theory approach guided our analysis, which involved iterative coding and memo-writing to build and refine categories and themes (Charmaz 2017). Throughout the analysis, we refined our interview questions based on emerging insights. For example, as initial interviews highlighted the challenges of collaboration, we adjusted subsequent questions to probe deeper into examples of successful collaboration. Initial open coding allowed us to identify and organize responses into broad themes related to challenges of collaboration, public participation, and climate information. As we progressed, axial coding helped establish relationships between themes, revealing patterns in how conservation professionals perceive and implement stakeholder engagement and climate information use. This iterative process ensured that our findings were grounded in the data and refined as our understanding of conservation planning evolved (Charmaz 2017).

Collection and analysis of conservation plans

We also collected and analyzed 56 conservation plans from non-profit organizations and federal and state agencies in South Dakota to assess how collaboration, public participation, and the use of climate information was acknowledged (https://openprairie.sdstate.edu/nrm_datasets/25). These plans addressed a range of conservation challenges, including invasive species management, wildlife diseases, habitat preservation, and wildfire management. We sourced plans through the South Dakota Game, Fish, and Parks (GFP) department website and additional searches for documents from the US Fish and Wildlife Service, the National Park Service (NPS), and non-profit organizations. We conducted qualitative content analysis (Forman and Damschroder 2007) to understand what groups of collaborators and the public were involved in the development of plans and how climate models and tools were used. We developed a set of search terms from words such as *collaboration*, *public participation*, and *climate adaptation* that are commonly used in conservation planning literature to identify relevant information in the plans. We also skimmed through plans to identify keywords that are used. We used abbreviations (*collab**, *contribut**, *coordinat**, *participa**, *climat**), synonyms (*partner*, *together*, *cooperate*, *joint*, *public*), and related terms (*model*, *weather*, *prediction*) to ensure that our findings are comprehensive and we captured the differences in wording across the plans. We then categorized the findings to identify recurring themes in collaboration, public participation, and climate information use. The analysis of conservation plans was done alongside the interviews and complemented participants' perspectives as additional evidence. Combi-

ning content analysis of planning documents with interviews helped to highlight gaps and explore issues further in the interviews.

RESULTS

Managers described several key challenges that hindered effective collaboration and decision-making in conservation efforts, which included administrative complexities within federal agencies and the absence of complementary goals among federal, state, and non-profit organizations. In addition, managers believed that public engagement methods were insufficient to ensure broad representation of some groups in the decision-making process. Managers also faced challenges such as limited understanding of complex climate data, which led to reactive decisions. Below, we detail the findings on collaboration, public participation, and climate information, highlighting the challenges and opportunities for improvement for each component.

Differences in organizational priorities created both challenges and opportunities for goal alignment

Major collaborative initiatives in South Dakota included two joint ventures and other networks dedicated to managing grasslands, wetlands, wildlife habitats, and Tribal lands (Table 2). These collaborative efforts brought together government agencies, non-profit organizations, private landowners, and Tribal entities across the Prairie Pothole Region. However, collaboration among agencies and different organizations often faced challenges due to differing missions and priorities. Several managers noted that each agency or organization operated with distinct missions and priorities, often focusing on different species and objectives. One federal manager explained how species of priority differed across government agencies, which limited their ability to plan collaboratively: "Our purpose is slightly different. Like with state agencies, they are really focused on resident species, and we're really focused on migratory bird species, so sometimes planning for those two agencies looks very different." This meant that agencies adopted differing planning approaches. For instance, GFP emphasized recreational activities such as hunting of popular game species, while US Fish and Wildlife Service was primarily concerned with protecting endangered species such as migratory birds. Different planning approaches made collaboration challenging even when agencies share an overarching goal of conserving wildlife. Some managers expressed that this absence of complementary goals and differences in organizational focus limited collaboration potential, even when they understood potential benefits of joint efforts. When asked about some benefits of collaboration, one federal manager described their desire to share data:

Collaboration initiative	Webpage link	Focus of initiative
Prairie Pothole Joint Venture	https://ppjv.org/	Management of waterfowl, shorebirds, other waterbirds, and prairie landbirds
Northern Great Plains Joint Venture	https://ngpjv.org/	Management of grassland, sagebrush-steppe, wetland, and riparian ecosystems, with an emphasis on sustaining and increasing populations of migratory and resident birds
Central Grasslands Roadmap	https://www.grasslandsroadmap.org/	Grassland management
South Dakota Grassland Coalition	https://sdgrass.org/	Management of grasslands on private lands
South Dakota Grasslands Initiative	https://sdgrassinitiative.org/	Grassland management
Intertribal Buffalo Council	https://itbcbuffalonation.org/	Management of buffalo in tribal lands
Midwest Glacial Lakes Fish Habitat Partnership	https://midwestglaciallakes.org/	Fish habitat conservation

TABLE 2. Collaboration initiatives in South Dakota by name, with webpage link and focus of initiative.

We just need really good life history data for species in this region, grassland species in particular, because grasslands are declining. In order for us to do a good job of planning how to recover grasslands and maintain what we currently have, then we need to have good information, and part of that is the value of partnerships [with other organizations or agencies].

Sometimes limited collaboration between federal and state agencies resulted in duplicated work by non-profits. A non-profit manager expressed, “The only thing I can think of that might be a gap would be perhaps duplicating efforts sometimes.” Non-profit managers faced additional administrative challenges when collaborating with federal agencies, which require following strict rules and guidelines. The rules of federal agencies, although necessary for accountability and transparency, were also perceived as barriers to quick decision-making. In addition, stringent government requirements placed some non-profits at a disadvantage in accessing federal funding. For example, one non-profit manager expressed that compliance with federal financial management, administrative and procurement standards, and audit compliance requirements to access federal funds proved a challenge for smaller non-profits with limited staffing and administrative capacity. Perceived red tape deterred some non-profits from collaborating with federal agencies.

Managers also described successful examples of collaboration, such as the Central Grasslands Roadmap (CGR), where agencies and organizations worked across institutions to develop a collective goal (Table 2). One non-profit manager detailed:

Now the grasslands conservation community as a whole has realized that we really need to come together and work a little bit more holistically and cooperatively across all of the different partners, and so we are trying to maybe get away from every agency and partner having their own plan, and everybody coming together and adopting a universal vision through the Grasslands Roadmap.

This suggested that different agencies and organizations could work together to achieve complementary goals despite engaging at different scales and with varied levels of resources.

Public engagement efforts employed several methods but struggled with representation and meaningful participation

Managers described several ways through which they engaged with and received feedback from the public, including organizing public forums, presentations, informational interviews, public comment meetings, commission meetings, city council meetings, opinion surveys, social media, and the *Federal Register* (a daily publication of the federal government that includes agency rules, proposed rules, and public notices).

Despite the availability of different public engagement methods, some managers expressed dissatisfaction with their ability to meaningfully engage with the public. When asked about how effective current methods of public engagement were, one federal manager felt that relying on the *Federal Register* for input from the public might not be the most effective because it was not common for members of the public to engage with public notices. Similarly, another park manager raised concerns about engaging with a wide

variety of people given demographic differences. He shared, “We are talking about different cultures, different ages, sets of individuals, how do we target? How do we engage each level of those differences, to read the information that we’re trying to convey to them?” Although managers shared different methods with which they solicit feedback from the public, they were not satisfied that they received meaningful public engagement.

State managers described additional challenges related to representation during public engagement. A state manager explained that public input often reflects the views of a vocal minority. Some managers used the term “squeaky wheels” to describe people who regularly engage in public participation to voice concern over management issues. Managers perceived that industry interests, in particular special interest groups, were disproportionately represented through the public input process. One manager noted, for instance, that members of special interest groups such as professional fishermen who participate in fishing tournaments were more likely to contribute to conversations on habitat management. Despite managers’ efforts to incorporate broad public feedback, input was not always representative of the general public.

Several managers also described public involvement as limited to basic opportunities for submitting comments rather than meaningful engagement. One federal manager explained, “There is a public involvement component when draft plans are developed, nothing intense like what you are doing with face-to-face interviews, but opening it up to the public, if you want to provide comments, please do so through this email method or letter or call or whatever.” Another manager similarly stated, “If we are not required to get public input on some of those documents, we generally do not, just because it slows down the process for us.” These examples indicate minimal opportunities for active public engagement, with limited involvement early in the planning process.

One state manager offered that he thought surveys could improve broad participation. He shared, “We try to balance the best we can, and I think an important component of trying to address those that are more vocal versus those that are not, is a more scientific based input process like a scientifically delivered survey.” Another state manager described the use of creel surveys to solicit feedback from anglers but also emphasized that open forums allowing direct conversation with the public were the “most valuable piece.” This manager further described the potential of public-formed groups to effectively address community concerns, citing the Walleye Restoration Coalition as an example—a group established by community members

that organizes private meetings, develops budgetary plans for walleye conservation, and presents directly to the state leaders. This suggests that a combination of methods such as the use of surveys and collaboration with public-formed groups have the potential to improve public engagement.

Managers recognized the value of climate data but faced knowledge gaps and limited guidance for effective application

Many managers from both federal and state agencies recognized the potential of climate data and models to improve decision-making, but some lacked knowledge of the tools and terms, or did not know how to access or use the information. For example, some managers did not distinguish between weather and climate data. When asked about “climate data,” three managers understood that to mean weather data, describing *Weather Underground*, *Keloland News*, and Doppler Radar as climate data sources. When asked about how they prepare for climate futures, one state manager said, “We did get weather data from the Weather Underground, we’re talking about, hourly speeds, temperature, precipitation, or no precipitation.” This suggests that although managers acknowledged the value of climate data, there is a lack of understanding of key climate terms.

Yet, six managers shared that they have access to climate resources and are actively using them for conservation planning. Some managers referenced resources from the National Oceanic and Atmospheric Administration, the Habitat and Population Evaluation Team (HAPET) of the US Fish and Wildlife Service, and the Climate Toolbox by the University of California, which collates tools and datasets with historical and future climate-related variables (<https://climatetoolbox.org/>). Despite the availability of climate resources, their integration into federal and state conservation plans was limited, with only 9 of 56 plans using such information to assess impacts on species and habitats.

Some managers described feeling overwhelmed by the available tools and reported uncertainty about how to use them. Some expressed uncertainty about how to choose appropriate climate data and struggled when applying climate tools in decision-making due to a lack of clear guidance. One federal manager explained, “I’m familiar with Climate Toolbox and some of those tools, but I know a lot of our managers are a little overwhelmed getting into some of those tools to use them.” Another federal manager expressed frustration over the lack of guidance to use the tools despite their availability:

Right now, there’s been very little guidance on how we should be using climate change models and tools. We’re being told we should incorporate it into our management

decisions, and when we're justifying why we're doing certain things, that should be part of the discussion. But like I said, our upper-level managers aren't really given much more guidance than that.

Several managers further expressed that the lack of clear guidance with models led to reliance on guesswork and reactive decision-making. One federal manager described, "We're just taking our best-educated guess when we're making decisions related to climate change, and I almost feel like nobody wants to take the responsibility for making that decision, because what if it's wrong?" Overall, while many state and federal agency managers recognized the value of climate data for decision-making, a lack of understanding of key climate terms, lack of awareness of available tools, and insufficient extension support hinder effective integration into conservation planning.

DISCUSSION

Despite challenges related to institutional constraints hindering collaboration, stakeholder representation in engagement, and integration of scientific data, this study identified opportunities for improved conservation planning, including through aligning organizational goals, enhancing shared governance, and improving public engagement strategies. Additionally, our findings highlighted the possibility of improving integration of scientific data into decision-making through the use of co-produced climate tools and training with managers. This study highlighted the need for conservation planning processes that are both adaptive to change and responsive to the social contexts in which they occur.

Goal alignment across agencies and scales may strengthen collaboration and reduce duplication in conservation efforts

Managers reported that many organizations and agencies shared the overarching goal of conserving natural resources but struggled to establish complementary and well-aligned objectives that support effective collaboration. Goal alignment across organizational and geographic scale can strengthen collaboration, as coordinated efforts often yield greater conservation impact than individual actions (Mace et al. 2000). The Central Grasslands Roadmap offers an example of this type of cross-scale collaboration by bringing together organizations working across North America's Central Grasslands to identify shared priorities and common principles for conservation. Such coordination offers opportunities for partners to co-develop resources, strengthen institutional collaboration, and guide collective action.

Similarly, joint ventures provide a conservation planning approach that fosters alignment of goals among agencies

and organizations through regular communication, shared data, and coordinated planning efforts. This type of coordination is reflected in South Dakota's participation in two bird-focused joint ventures (Table 2), presenting an opportunity to expand such collaboration to include other species and ecosystem issues. To promote broader participation in joint ventures and strengthen other collaborative opportunities, organizations may need to integrate shared goals into their programs and priorities, allocate funding accordingly, build public awareness, and increase partnerships. This approach reflects Margerum's (2008) observation that changes within organizations in a collaborative occur when programs, budgets, and priorities are deliberately aligned to support and sustain such collaboration. Similarly, Greer (2017) and Savage et al. (2010) found that shared goals enhance inter-organizational collaboration and reduce the effort required to align different interests. Successful collaboration benefits from goal alignment among participating organizations, and initiatives such as the Central Grasslands Roadmap and joint ventures demonstrate how shared goals are operationalized in practice.

Participants also warned that limited collaboration within organizations sometimes led to duplicative efforts. This may limit the potential impact of efforts since duplication of efforts across conservation organizations can increase project costs and reduce the efficacy of interventions (Mace et al. 2000). Strengthening coordination at higher policy levels where shared priorities and goals can be established may help reduce duplication and improve collective impact across organizations (Margerum 2008).

Non-profit organizations may support more nimble decision-making in collaboration

Our findings underscore the invaluable role of non-profits in conservation planning. Unlike federal or state agencies that must follow strict procedures that can delay action, non-profits are able to act swiftly and adapt to emerging conservation needs. When collaborating with federal agencies through grant-funded projects, non-profits are required to meet stringent funding and reporting requirements, which can place a disproportionate burden on smaller organizations with limited administrative capacity. Tilt (2005) similarly found that agency culture, trust, and federal law and policies pose barriers for non-profits looking to collaborate with federal land management agencies given their complex authorities and rigid budgets that limit flexibility in decision-making. Recognizing institutional realities at play allows non-profits to anticipate administrative delays and establish timelines and responsibilities with their federal partners from the outset.

To overcome administrative barriers, Cheng (2006) suggested a gradual, learning-based approach to collaboration that builds trust and shared understanding, helping partners navigate rigid administrative structures and limited flexibility. Following this approach, non-profits can over time establish credibility with federal partners, strengthen communication channels, and develop systems for continuous learning. Through collaborative partnerships, non-profits can support government capacity and keep land management efforts adaptive to changing conditions.

Effective public engagement benefits from a combination of methods

Our findings also showed that there is no one-size-fits-all approach to public engagement. Many managers described public involvement as minimal, typically limited to submitting comments on draft plans rather than contributing at earlier stages of the planning process. This pattern reflects a procedural approach to engagement, one that prioritizes compliance over meaningful engagement with the public. The limited engagement of the public early in planning underscores a broader cultural challenge where public participation is a box to be checked rather than a process that can shape decision-making. Such practices restrict opportunities for co-production of knowledge, where managers and community members could collaboratively identify issues, develop solutions, and build mutual understanding.

Several managers also noted that commonly used engagement tools such as public forums and comment periods did not reach wider audiences, and participation often reflected the views of a vocal minority. Gaining wider participation requires a shift in organizational culture toward valuing early and sustained engagement in conservation planning. In addition to cultural barriers, practical constraints such as tight deadlines, limited budgets, and staff capacity can discourage managers from experimenting with a variety of engagement methods. Moreover, historical distrust of agencies, particularly among communities who feel their input has been overlooked, can further erode participation and make efforts to broaden engagement more difficult (Reed 2008; Klein and Arts 2022).

To address barriers of engagement, agencies could adopt methods that make participation more representative and continuous throughout the planning process. The Public Trust Doctrine reinforces the responsibility of agencies to include all voices in conservation decision-making. Creating supportive spaces for participation can help build trust and encourage involvement from all, especially those whose voices are not always heard. Using scientifically grounded tools, such as representative surveys, alongside participatory forums could support a broader range of perspectives. Partnerships with

community-based organizations and local non-profits could also provide opportunities to reach a broader population. Managers could adopt a combination of different participation formats, such as in-person, online, or print, to ensure a range of perspectives is considered in decision-making and to facilitate greater public trust. In addition, employing human dimensions specialists could improve agencies' ability to design more participatory methods, provide evidence of the public's values, and connect those values to management practices.

Engaging broader audiences provides opportunities for citizens to initiate conservation planning processes, shape management options, and remain engaged throughout the process (Rowe and Frewer 2000). This type of engagement reflects a shift from "consultative" to "empowered" participation (Muigua 2014), where the public not only provides feedback but has decision-making power and helps shape priorities from the outset of conservation plans. Establishing clear objectives, timelines, and evaluation criteria for participation may further ensure that engagement processes are accountable, measurable, and include different perspectives.

Collaboration may bridge knowledge and action in applying climate information

Finally, managers in our study engaged with climate information in varied ways depending on their access, experience, and training. Many recognized the value of climate data and models for informing decisions, however some were uncertain about where to find reliable sources or how to use available models. In some cases, managers used local weather data as a substitute for long-term climate information, reflecting a lack of understanding of key climate concepts. This mirrors the findings of Lemos et al. (2012) who noted this as a "usability gap" stemming from a disconnect between scientists and managers in the way climate data are produced and used, and Kiem and Austin (2013), who observed ambiguity in how "weather" and "climate" are distinguished. The usability gap narrows when scientists and managers interact more frequently to co-produce applied science to support decision-making (Redmore et al. 2025).

Furthermore, several managers described needing clearer guidance on how to use existing tools within their management context, rather than more data. This aligns with another study in the same region, which found that managers sought guidance on how to use and apply existing data, especially for understanding projected climate impacts on key habitats and species (Yocum and Ray 2019). These findings suggest that with adequate support and training, managers can more effectively integrate climate data into conservation planning.

Components of effective conservation planning	Role of relationships in supporting each component	Opportunities to strengthen relationships to improve conservation planning outcomes
Collaboration	Strong relationships built on trust across government agencies, non-profits, and other non-governmental organizations to support goal alignment, open communication, and joint problem-solving	- Promote trust-building through consistent engagement and transparent communication among agencies and partners - Create opportunities for regular collaboration (e.g., through joint planning, information sharing) - Strengthen leadership training opportunities both within and across agencies (Sanderson et al. 2022)
Public participation	Relationships shape if and how public participation occurs and determine whether engagement is meaningful and effective	- Build and maintain relationships with the public through consistent engagement and transparent decision-making processes - Facilitate open dialogue within and across communities to ensure participants feel heard and invested in conservation outcomes (Muigua 2014) - Invest in capacity development through human dimensions and communication training to help managers sustain meaningful engagement with the public (Sanderson et al. 2022)
Use of climate information	Relationships bridge the science–practice gap and increase the co-production and application of climate information through trust and knowledge exchange	- Foster regular interaction among scientists, managers, and partners through collaborative networks or communities of practice (Watkins et al. 2018) - Support intermediary organizations that bridge science and policy gaps such as university extension programs, state extension offices, and conservation partnerships to connect science producers with users (Howarth et al. 2022) - Build capacity among managers and state extension specialists to strengthen relationships between scientists and practitioners, translate climate information into actionable management strategies, and sustain collaborative decision-making

TABLE 3. Strategies to improve conservation planning through relationships.

Processes to connect technical guidance with decision-making may improve the use of climate information. Co-production offers opportunities for scientists and managers to collaborate as they design, test, and refine tools that are scientifically sound, user-friendly, and directly applicable to management needs. However, co-production is often constrained by limited staff capacity, short timelines to complete projects, and competing agency priorities. Enhancing the capacity and engagement of existing climate extension services would better support collaboration between scientists and managers. Climate extension officers can play a critical role by convening joint workshops, offering on-the-job training, and facilitating peer learning to help integrate climate tools into routine planning and adapt them to local contexts.

Relationships may be central to improving collaboration, public participation, and the use of climate information

Bridging findings related to collaboration, public participa-

tion, and the use of climate information, we propose that conservation planning outcomes depend on the quality of relationships among agencies, partners, and the public. Strong relationships promote trust, shared understanding, and coordination across agencies, communities, and scientists, all of which are factors consistently linked to improved planning outcomes (Margerum 2008; Lemos et al. 2012; Muigua 2014). Previous research has shown that collaborations grounded in trust and open communication are more likely to achieve lasting agreements (Knight et al. 2006; Sanderson et al. 2022). As Lauber et al. (2011) noted, the use of scientific information depends on support from decision-making authorities, coordination among partner groups, and the presence of shared conservation goals, all of which require effective relationships. Relationships influence how information is shared and how decisions are made and implemented for improved conservation planning (Table 3).

This study revealed that efforts to strengthen relationships

in conservation planning are already underway. Promising innovations in relationships are emerging at the state level that advance collaboration, public participation, and the use of climate information. Through initiatives such as joint ventures, managers and partners are building trust-based connections that enable data sharing and create new spaces for interaction. Funding for human dimensions specialists and other related positions within existing collaborative efforts could develop capacity to strengthen partner relationships. Likewise, community-based groups such as the Walleye Restoration Coalition are leveraging relationships between local communities and state agencies to facilitate conservation action. Climate extension agents hold considerable potential to bridge relationships between scientists and practitioners, translate climate data into actionable management strategies, and strengthen trust in science and management decisions. Across these examples, relationships emerge as the foundation connecting collaboration, public engagement, and the use of climate information in practice. As relationship-building efforts continue to expand from the ground up, future research could evaluate both what makes relationship-building efforts successful and the influence of relationships on conservation outcomes. Furthermore, research that employs more community-based methods, like ethnographic research approaches, could better capture the role and nuances of how relationships are built and sustained over time. Innovative efforts already underway in South Dakota likely offer lessons learned on how relationships impact conservation planning for the state and beyond.

CONCLUSION

This study revealed that conservation planning is often hindered by challenges in collaboration, public participation, and incorporating climate information, but several opportunities exist to improve planning efforts. The challenges identified included the misalignment of goals among agencies, limited representation and early engagement of the public, and difficulties in applying climate information to guide management decisions. We combined lessons from 35 interviews with conservation professionals and an analysis of 56 planning documents to describe challenges in conservation planning and highlight opportunities for natural resource managers to improve conservation efforts. Addressing the challenges of conservation planning will require prioritizing shared goals and collaborative opportunities, applying several methods to engage the public meaningfully throughout the planning process, and strengthening the interactions and relationships between scientists and managers to better incorporate climate information into their plans. Although this study focused on South Dakota, the lessons may be relevant to other cases and regions that are simi-

lar, where conservation depends on partnerships among public, private, and Tribal actors, particularly in states with extensive private land ownership and changing environmental conditions. Expanding collaboration, increasing public participation, and incorporating climate information can lead to effective conservation planning and help ensure that ecosystems and communities can be managed sustainably.

REFERENCES

- Charmaz, K. 2017. Constructivist grounded theory. *The Journal of Positive Psychology* 12(3): 299–300. <https://doi.org/10.1080/17439760.2016.1262612>
- Cheng, A.S. 2006. Build it and they will come? Mandating collaboration in public lands planning and management. *Natural Resources Journal* 46(4): 841–858. <http://www.jstor.org/stable/24889091>
- Djenontin, I.N.S., and A.M. Meadow. 2018. The art of co-production of knowledge in environmental sciences and management: lessons from international practice. *Environmental Management* 61: 885–903. <https://doi.org/10.1007/s00267-018-1028-3>
- Forman, J., and L. Damschroder. 2007. Qualitative content analysis. In *Empirical Methods for Bioethics: A Primer*. L. Jacoby and L.A. Siminoff, eds. Leeds, UK: Emerald Group Publishing, 39–62. [https://doi.org/10.1016/S1479-3709\(07\)11003-7](https://doi.org/10.1016/S1479-3709(07)11003-7)
- Greer, P.A. 2017. Elements of effective interorganizational collaboration: A mixed methods study. PhD diss., Antioch University. http://rave.ohiolink.edu/etdc/view?acc_num=antioch1502545581350892
- Guerrero, A.M., and K.A. Wilson. 2017. Using a social-ecological framework to inform the implementation of conservation plans. *Conservation Biology* 31(2): 290–301. <https://doi.org/10.1111/cobi.12832>
- Hanson, L.A., and C.H. Vincent. 2020. *Federal Land Ownership: Overview and Data*. CRS Report no. R42346. Washington, DC: Congressional Research Service. <https://www.congress.gov/crs-product/R42346> (accessed November 5, 2025)
- Hennink, M.M., B.N. Kaiser, and V.C. Marconi. 2017. Code saturation versus meaning saturation: How many interviews are enough? *Qualitative Health Research* 27(4): 591–608. <https://doi.org/10.1177/1049732316665344>
- Hewitson, B., K. Waagsaether, J. Wohland, K. Kloppers, and T. Kara. 2017. Climate information websites: An

evolving landscape. *Wiley Interdisciplinary Reviews: Climate Change* 8(5): e470. <https://doi.org/10.1002/wcc.470>

Howarth, C., M. Lane, S. Morse-Jones, K. Brooks, and D. Viner. 2022. The 'co' in co-production of climate action: Challenging boundaries within and between science, policy and practice. *Global Environmental Change* 72: 102445.

Hulugh, V., Zavaleta Cheek, J., and Redmore, L. 2025. Assessing conservation planning in South Dakota: Challenges and opportunities in collaboration, public participation, and climate information. Support dataset. South Dakota State University NRM Departmental Data Sets. 25. https://openprairie.sdstate.edu/nrm_datasets/25

Kiem, A.S., and E.K. Austin. 2013. Disconnect between science and end-users as a barrier to climate change adaptation. *Climate Research* 58(1): 29–41. <https://doi.org/10.3354/cr01181>

Klein, L., and K. Arts. 2022. Public participation in decision-making on conservation translocations: The importance and limitations of a legislative framework. *Restoration Ecology* 30(1): e13505. <https://doi.org/10.1111/rec.13505>

Knight, A.T., R.M. Cowling, and B.M. Campbell. 2006. An operational model for implementing conservation action. *Conservation Biology* 20(2): 408–419. <https://doi.org/10.1111/j.1523-1739.2006.00305.x>

Lauber, T. B., R.C. Stedman, D.J. Decker, and B.A. Knuth. 2011. Linking knowledge to action in collaborative conservation. *Conservation Biology* 25(6): 1186–1194.

Lemos, M.C., C.J. Kirchhoff, and V. Ramprasad. 2012. Narrowing the climate information usability gap. *Nature Climate Change* 2(11): 789–794. <https://doi.org/10.1038/nclimate1614>

Mace, G.M., A. Balmford, L. Boitani, G. Cowlishaw, A.P. Dobson, D.P. Faith, K.J. Gaston, C. J. Humphries, R. I. Vane-Wright, P. H. Williams, J. H. Lawton, C. R. Margules, R. M. May, A. O. Nicholls, H. P. Possingham, C. Rahbek, and A. S. van Jaarsveld. 2000. It's time to work together and stop duplicating conservation efforts. *Nature* 405(6785): 393. <https://doi.org/10.1038/35013247>

Margerum, R.D. 2008. A typology of collaboration efforts in environmental management. *Environmental Management* 41: 487–500. <https://doi.org/10.1007/s00267-008-9067-9>

Mitchell, B.J. 2021. Duck brood use of wetlands in crop-

dominated landscapes within the United States Prairie Pothole Region. Master's thesis, Iowa State University. <https://excelsior.sdstate.edu/login?auth=shibboleth&url=https://www.proquest.com/dissertations-theses/duck-brood-use-wetlands-crop-dominated-landscapes/docview/2579714874/se-2>

Muigua, K. 2014. Towards meaningful public participation in natural resource management in Kenya. Nairobi: Kariuki Muigua & Co.

Parker, C., S. Scott, and A. Geddes. 2019. Snowball sampling. In *SAGE Research Methods Foundations*. P. Atkinson, S. Delamont, A. Cernat, J.W. Sakshaug, and R.A. Williams, eds. <https://doi.org/10.4135/9781526421036831710>

Pressey, R.L., M. Cabeza, M.E. Watts, R.M. Cowling, and K.A. Wilson. 2007. Conservation planning in a changing world. *Trends in Ecology and Evolution* 22(11): 583–592. <https://doi.org/10.1016/j.tree.2007.10.001>

Quirke, D. 2016. The public trust doctrine: A primer. Eugene: University of Oregon School of Law Environmental and Natural Resources Law Center.

Rädiker, S., and U. Kuckartz. 2020. Focused analysis of qualitative interviews with MAXQDA. MaxQDA Press. <https://www.maxqda-press.com/>

Redmore, L., J. Rushing, C. Armatas, V. Wright, and O. Helmy. 2025. Examining and strengthening the role of science in wilderness decision-making. *Parks Stewardship Forum* 41(1): 102–112. <https://doi.org/10.5070/P5.42009>

Reed, M.S. 2008. Stakeholder participation for environmental management: A literature review. *Biological Conservation* 141(10): 2417–2431. <https://doi.org/10.1016/j.biocon.2008.07.014>

Rölfer, L., L. Celliers, M. Fernandes, N. River, B. Snow, and D. Abson. 2024. Assessing collaboration, knowledge exchange, and stakeholder agency in coastal governance to enhance climate resilience. *Regional Environmental Change* 24(6). <https://doi.org/10.1007/s10113-023-02163-7>

Rowe, G., and L.J. Frewer. 2000. Public participation methods: A framework for evaluation. *Science, Technology, and Human Values* 25(1): 3–29. <https://doi.org/10.1177/016224390002500101>

Sanderson, J., R. Alper, J. Barrack, C. Byrd, E. Glenn, K. Jespersen, A. Kimple, H. Knight, P. Konrad, T. Kowalski, D. Nezzie, K. Ortey, C. Robles, T. Ruth, D. Smith, N. Steele, T. Stevens, G. Wagner, and J. Archibald. 2022. Best practices for collaborative conservation philanthropy.

Conservation Science and Practice 4(10):e12811.
<https://doi.org/10.1111/csp2.12811>

Savage, G.T., M.D. Bunn, B. Gray, Q. Xiao, S. Wang, E.J. Wilson, and E.S. Williams. 2010. Stakeholder collaboration: Implications for stakeholder theory and practice. *Journal of Business Ethics* 96: 21–26.
<https://doi.org/10.1007/s10551-011-0939-1>

Sax, J.L. 1970. The public trust doctrine in natural resource law: effective judicial intervention. *Michigan Law Review* 68(3): 471–566.

Southwick Associates. 2022. *Economic Impact of Outdoor Activities Managed by South Dakota Department of Game, Fish and Parks*. Fernandina Beach, FL: Southwick Associates.

Stratton, S.J. 2024. Purposeful sampling: Advantages and pitfalls. *Prehospital and Disaster Medicine* 39(2):121–122.
<https://doi:10.1017/S1049023X24000281>

Thomson, A.M., and J.L. Perry. 2006. Collaboration processes: Inside the black box. *Public Administration Review* 66: 20–32. <https://doi-org.excelior.sdstate.edu/10.1111/j.1540-6210.2006.00663.x>

Tilt, W. 2005. Getting federal land management agencies to the collaborative table: Barriers and remedies. Unpublished paper, distributed at the Fifth National Community Based Collaborative Research Consortium Conference, Sedona, AZ, 17–19.

United States Census Bureau. 2024. State and county QuickFacts. <https://www.census.gov/quickfacts/table/PST045214/00,46> (accessed February 25 2025)

Watkins, C., J. Zavaleta, S. Wilson, and S. Francisco. 2018. Developing an interdisciplinary and cross-sectoral community of practice in the domain of forests and livelihoods. *Conservation Biology* 32(1): 60–71.

Wiréhn, L. 2021. Climate indices for the tailoring of climate information—A systematic literature review of Swedish forestry and agriculture. *Climate Risk Management* 34: 100370. <https://doi.org/10.1016/j.crm.2021.100370>

Yocum, H.M., and A.J. Ray. 2019. Climate information to support wildlife management in the North Central United States. *Regional Environmental Change* 19: 1187–1199.
<https://doi.org/10.1007/s10113-019-01474-y>