

# A Qualitative Assessment to Inform Strategic Improvement of Research and Development within the USDA Forest Service

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## Abstract

Past reviews of the USDA Forest Service (USFS) Research and Development (R&D) branch have identified several persistent challenges, including unclear strategic direction and a need for greater communication with end users. We conducted research focused on the Rocky Mountain Research Station (RMRS) of R&D to understand current perceptions about the station's efficacy and strategic direction as well as its engagement with partners both inside and outside of USFS. We conducted fifty-eight interviews with USFS and RMRS leaders, scientists, and partners. Interviewees said national research priorities are unclear, and there is tension between conducting basic and applied science. Nonscientist partners said they depend on RMRS for scientific expertise. Interviewees recommended clarifying research priorities, improving leadership and communication both inside and outside of the agency, investing more in science communication, and strengthening incentives to conduct applied research. These station-level results provide insight into improvements that could be made to enhance R&D's ability to pursue its mission.

**Study Implications:** The USDA Forest Service provides actionable science to foresters, land managers, and other stakeholders through its Research and Development (R&D) branch. Recent administrative studies of this branch have highlighted some mission-critical challenges that must be overcome for R&D to fulfill its mission. This study provides new information about the effectiveness, collaboration, and communication of the Rocky Mountain Research Station to provide a high-resolution assessment that can be used to inform the strategic improvement of R&D and improve science delivery to stakeholders.

**Keywords:** forest research, collaboration, science-management, science policy, dissemination

Impactful forestry and natural resource research provides scientifically grounded knowledge and tools to inform and improve land-management practices. The USDA Forest Service Research and Development (R&D) program, a prominent forest research organization in the United States and globally, conducts science to support forest and natural resource stewardship and policy (GAO 2010). Declines in forest research capacity and funding are linked to impacts on forest management that jeopardize forest health and productivity, and sustained innovation and investment in forest sector research is essential to secure continued benefits from our nation's forests (Jolley et al. 2017; McGinley et al. 2019).

A growing number of assessments have evaluated the effectiveness of R&D at the national level. Collectively, these studies have identified challenges and opportunities related to R&D's organizational structure, strategic direction, and communication practices (Dominguez et al. 2019; GAO 2010; Jolley et al. 2017). These studies also identified a growing emphasis on "applied research" for land managers (i.e., shorter-term research that focuses on management-oriented needs, also referred to as the "end user" needs). A primary

tension for R&D is sustaining research independence and forward-looking innovation while being responsive to land management needs (Dominguez et al. 2019). Adding to this complexity, R&D research funding and the number of permanent R&D research scientists have declined over the last decade, while the costs of conducting research (i.e., maintaining research facilities, purchasing scientific equipment), have risen (McGinley et al. 2019).

Previous recommendations informed potential improvements in R&D, but there remains a need to understand these high-level challenges and opportunities at a finer resolution to develop more effective R&D operations, which vary within the R&D organization. Few studies have been conducted at the individual research station or program level to evaluate variability across stations, target specific deficits, and help operationalize broad recommendations contained in high-level reports. Glenn et al. (2022) is one of the few efforts conducted at this resolution. The study examined a set of seven Rocky Mountain Research Station (RMRS) fire science projects that involved collaborations between RMRS researchers, land managers, and other partners, and organizational

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influence on “co-production.” The process of co-production involves scientists and managers jointly informing various stages of the research process. Authors noted that although R&D can continue to improve incentives for co-produced fire research with managers, the fact that research scientists sit within a broader system of rewards, funding, and professional evaluation by peer scientists itself is a challenge for co-producing research with managers. Nonetheless, [Glenn et al. \(2022\)](#) found that it would be helpful to have more boundary-spanning positions to communicate science and support the process of designing research together, along with ongoing incentives for such work in performance evaluation.

Past investigations, which we discuss more below, informed our study by illustrating barriers and opportunities related to R&D’s organizational structure, collaboration, and communication efforts. Using previous investigations as a starting point, we sought to explore these issues specifically for RMRS, centering on two primary research questions:

1. With a focus on RMRS, what are current perceptions of the efficacy of R&D and how is R&D’s research agenda and strategic direction established and interpreted?
2. What are the current perceptions of RMRS collaboration and communication with other deputy areas within the USFS and with external partners?

The purpose of this study was to provide new knowledge and actionable information that can guide improvements at RMRS and more broadly within R&D, with an emphasis on enhancing the organization’s ability to develop and deliver knowledge and innovative technology to improve the health and use of the nation’s forests and grasslands across all ownerships. We reflect on this considering the literature on the history of R&D and organizational change.

## History of R&D and Perspectives on Organizational Structure and Change

In the formative years of the Forest Service, leaders were intent on establishing a research program independent of the administrative and managerial needs of federal bureaucracy ([Brock 2015](#); [Steen 1998](#)). Strongly influenced by new ecological approaches to research and management, they were inspired to expand the understanding of forested landscapes beyond the traditional timber-focused goals of forestry ([Brock 2015](#)). As such, an independent research department was established where “scientists could pursue topics of forest research without being beholden to the yardsticks of practical management concerns” ([Brock 2015](#), p. 46). At its foundation, the research program in the agency was intended to give researchers the ability to investigate with the aim of basic understanding, not practical application ([Brock 2015](#)). As federal forestry expanded to focus on understanding forest health and meeting the demands of economics and culture, such tensions created rifts in the research agenda to balance scientific rigor and practical relevance. This history is important in understanding tensions that still exist today.

Forest Service R&D is a Forest Service deputy area, along with State, Private, and Tribal Forestry (SP&TF), the National Forest System (NFS), and Business Operations. Each deputy area is led by a deputy chief who sets policy direction and oversees the budget. The deputy chiefs report to the chief of the Forest Service, who reports to the undersecretary

for natural resources and environment (NRE) of the US Department of Agriculture. R&D was established in 1905 at the inception of USFS in USDA to work at the “forefront of science to improve the health and use of the Nation’s forests and grasslands” ([Forest Service, n.d.](#)) and it remains one of the largest forest research organizations in the world. In pursuit of this mission, R&D partners with and serves other Forest Service deputy areas, Forest Service administrative and international programs units, other federal and state agencies, nongovernmental organizations (NGO), universities, tribes, and the private sector.

R&D’s organizational structure includes five research stations (the Northern, Southern, Pacific Northwest, Pacific Southwest, and Rocky Mountain Research Stations), the Forest Products Laboratory, the International Institute of Tropical Forestry, Experimental Forests and Ranges, and the Washington, DC office (WO) headquarters. R&D also manages the Forest Inventory and Analysis (FIA) Program, which provides a congressionally mandated assessment of the status and trends of forest lands across the United States. Our research was focused on the RMRS, which spans four NFS regions across twelve states ([figure 1](#)). The RMRS is distinct in that it includes the largest number of national forests within its geographical footprint, the Aldo Leopold Wilderness Research Institute, as well as the Missoula Fire Sciences Laboratory and the Wildfire Risk Management Science team, thereby housing much of the Forest Service wildfire-related research capacity. Currently, it has eight science program areas, each led by a science program manager who supervises research scientists working in that program topic area and reports to the station director. Like the other five research stations, RMRS is led by a station director who reports to the associate chief of the Forest Service.

Being embedded within a land management agency is unique for R&D as a government research entity. The US Geological Survey, by contrast, is a separate scientific research agency that serves the Department of the Interior and other partners and customers. Similarly, the Agricultural Research Service (ARS) is an agency of the Research, Education, and Economics mission area of USDA. Even so, from the outset, agency architects intended for R&D to have scientific independence from Forest Service land management functions and other statutory goals ([Brock 2015](#); [Steen 1998](#)). Within this structure, R&D interacts with land managers and other Forest Service staff outside the R&D deputy area and in some cases, conducts research and monitoring activities in close coordination with SP&TF and NFS leadership at the national level, especially in the case of wildfire research, the Resources Planning Act assessment, and other large efforts. Funding for R&D (outside of FIA) is primarily from a single appropriation account, which includes callouts or set-asides for specific programs within R&D, along with more general research funding. Additional funding comes from formal agreements with partners and from external grants according to relevant policies ([GAO 2010](#)).

Over the past decade, there have been several studies investigating the R&D deputy area at the request of various administrative units and key actors, including Congress ([Dominguez et al. 2019](#); [GAO 2010](#); [Jolley et al. 2017](#)). Most recently, the 2019 National Academy of Public Administration Assessment (NAPA) identified areas for improvement, stating that research priorities at the R&D enterprise level were unclear and that there was a lack of transparency in how



**Figure 1** The geographic footprint of the Rocky Mountain Research Station (RMRS) spans twelve states with twelve laboratory locations in the Interior West. Map courtesy of RMRS.

resources are allocated to achieve priorities (Dominguez et al. 2019). This assessment also noted a lack of clarity in the R&D approach to coordinating research across research stations and integrating research with the Forest Service mission, with internal agency partners in NFS and SP&TF, and with external partners and stakeholders outside Forest Service and US Department of Agriculture. The NAPA recommended a focus on improving R&D's communication efforts, particularly with Congress, and addressing more of the needs of Forest Service partners.

The NAPA assessment and an earlier report, the 2017 US Endowment for Forestry and Communities Blue Ribbon Commission Report (the "Endowment report") both noted that, with station directors reporting to the associate chief of the Forest Service rather than the deputy chief of R&D, the deputy chief does not have direct authority over research stations, creating challenges for establishing consistent collaboration approaches across the organization (Jolley et al. 2017).

The Endowment report suggested restructuring R&D to have station directors report directly to the deputy chief of R&D to streamline coordination across the branch (Jolley et al. 2017).

To some degree, the NAPA and Endowment reports echoed some conclusions from the 2010 United States Government Accountability Office (GAO) Report to the US Senate, which was conducted to examine the scope of activities and accomplishments carried out by R&D; trends in resource use and the effects of those trends on its research efforts and priorities, steps R&D had taken to improve its ability to fulfill its mission, and challenges R&D faced in fulfilling its mission (GAO 2010). These past reports all identified contention within R&D about conducting basic versus applied research. "Basic research" generally refers to research that is longer-term, more exploratory, and forward-thinking in nature, whereas "applied research" often encompasses shorter-term research that focuses more on the near-term application of research to contemporary land-management needs. According to the

GAO report (GAO 2010), interviewees said there had been a shift in R&D priorities towards applied research because external funders, who are a critical source of funding for R&D, are more interested in applied research (the short-term research needs of end users), and in science delivery (how research results are communicated). Some interviewees argued this shift toward applied research conflicts with R&D's performance evaluation processes for scientists, which they said rewards basic research, because such work often leads to more prestigious peer-reviewed publications that are more widely cited (GAO 2010). The NAPA report relatedly found that the Research Grade Evaluation Guide<sup>1</sup> (RGEG), which guides performance evaluations for scientists, makes it difficult to identify metrics that reflect outcomes or the impacts of a scientist's contributions relative to the agency's mission (Dominguez et al. 2019). Recent revisions of the RGEG have included more explicit guidance on evaluating and fully crediting such work (OPM 2019). Being embedded within the Forest Service may also create a source of tension between maintaining research autonomy and being responsive to the management needs of the other deputy areas, especially NFS (Dominguez et al. 2019; GAO 2010).

These past studies recommended that more attention in the deputy area should be directed toward science delivery, with a focus on end users. The studies noted that a focus on science delivery can often cost scientists the time needed to conduct innovative or exploratory science. In addition to encouraging attention towards science delivery and applied research, the NAPA report also suggested specifically that R&D scientists work more directly with end users to co-produce science. The NAPA report stressed that a primary challenge facing R&D had been maintaining a balance between scientific independence and being responsive to the agency and its partners (Dominguez et al. 2019).

Although these studies suggest some possible reorientations for R&D, there are a variety of challenges associated with achieving organizational change. An important factor is goal ambiguity, which is characterized by competing mission objectives or problem definitions. Such ambiguity is prevalent in almost all public agencies, often because those agencies have broad mandates and diverse constituencies that look to the agency for a variety of activities and services (Lee et al. 2009; Pandey and Wright 2006). Translating those mandates into measurable objectives can be challenging, as can be prioritizing among multiple and sometimes competing goals (Rainey and Jung 2015). We can expect that when dealing with goal ambiguity, agencies typically will focus on measurable activities that provide a sense of accomplishment to political overseers; as such, activities and deliverables that are measurable will crowd out those that may not yield clear results on measurable timeframes (Biber 2009). Individuals also will typically undertake activities that are easier to accomplish or more familiar based on their experience and professional training (Cairney et al. 2016). Goal ambiguity exists within R&D and has since its early days, and within Forest Service more broadly. Agencies tend to focus on measurable outputs to constituents and political overseers, and this might explain why there might be a reduction in investments in R&D over time in a budget constrained environment, because research does not typically produce measurable outputs on short timeframes (Biber 2009).

In most cases, when change is desired, overarching legislative mandates remain unaltered. A number of factors have

to align to support organizational change, particularly if it is a change in direction away from measurable or familiar outputs. In such cases, leadership must communicate the importance of and rationale for change. They must diligently build in new incentives and processes to support the desired change, support training and learning, and work with internal and external constituencies to support the change culturally and within the broader system (Fernandez and Rainey 2006; Kuipers et al. 2014). Perceived threats, including reduced budgets or threats to individual's jobs can stymie organizational change. To put this in the context of the recommendations we discussed above, the NAPA report recommended scientists work closer with managers to co-produce science, which is an organizational change challenge. As defined earlier, co-production is the collaboration of managers and scientists in knowledge creation, which can improve the relevance of research products, among other benefits (Beier et al. 2017). Appropriate incentive systems to reward engagement with managers and an effective strategy to integrate new co-production practices would need to be developed for successful co-production (Colavito 2021; Dilling and Lemos 2011).

In summary, when we consider recommendations for organizational change, they must be understood in terms of agency mandates and associated ambiguity, whether there is adequate training, internal, and external support for change, and alignment with current systems and leadership direction. Such recommendations must be operationalized at both high levels and at finer organizational scales, which requires high-resolution, context-specific information.

## Methods

We conducted qualitative research using semistructured interviews to understand the contextual factors shaping RMRS strategic directions and partnerships. Our sampling strategy was motivated by an interest in learning the perspectives around integrating R&D science into agency operations, perceived value, and improving relationships of those within and outside of R&D. Thus, we had a tiered approach to sampling, and our interviewee populations of interest included individuals ( $n = 58$  total) that we categorized into three groups: (1) national-level actors who are involved in R&D decision-making and oversight or are key partners, to understand how national-level factors shape RMRS activities and perspectives ( $n = 11$ ); (2) RMRS-level individuals who work at the station in various capacities, including scientists, program managers, and science delivery experts ( $n = 20$ ); and (3) key partners who work with RMRS either cocreating or using research expertise within the station's geographical footprint, both internal and external to the Forest Service ( $n = 27$ ).

We worked with leadership and senior officials within the Forest Service, including people from the R&D, NFS, and SP&TF deputy areas to identify potential individuals for recruitment. We also identified and contacted current and former RMRS program managers and external groups working closely with the RMRS headquarters in Fort Collins, Colorado, for interviews. Throughout the study, additional interviewees were identified through a referral approach based on recommendations from our other interviewees. Contact information was identified through public governmental web pages. We began interviews with a select number of key informant interviews with national-level actors who were involved in R&D decision-making and oversight or were key partners.



These interviewees included current and former WO leadership and Forest Service senior officials across deputy areas. We also spoke to people in positions of political oversight in the legislative and executive branches of the US government and with national-level NGO partners and representatives of state forestry agencies. These eleven interviews provided context for our RMRS study. Our goal for this group was to have a national-level perspective to inform our work.

To gather perspectives at RMRS, we targeted the current and former program managers, research station scientists, and communications staff members. These RMRS-level interviewees ( $n = 20$ ) work at the station in various roles. We interviewed RMRS leadership and program managers to gather a more programmatic view, recruiting all program managers we could identify and interviewing those who agreed to participate. We also interviewed a subset of scientists to understand the nature of their connections and partnerships. Because we were interested in understanding scientist–manager connections, our scientist interviews focused on those working in or with the Intermountain Region (Region 2) and the Northern Region (Region 1) of NFS. We selected these regions because they had experience with Regional Science Advisory Teams (RSATs) and the RMRS-Intermountain West Science Partner program, which were established to support coordination between agency land managers and scientists (Clark et al. 2021).

For RMRS partner interviews, our target population included people who collaborate with or use RMRS science and work within the RMRS geographical footprint, although we recognize that RMRS partners exist across the nation and around the world. Participants included a sample of state foresters, university leaders in units specializing in forestry, individuals from other federal land management agencies, representatives of external forestry-related groups and NGOs, private landowners, industry groups, tribal liaisons or representatives, and NFS and SP&TF Regional Office staff members ( $n = 27$ ). Our goal was to reach multiple individuals from each of these groups to gain perspectives from a range of partners with regard to our second research question. We could not possibly reach all partners, but we included a diversity of perspectives and interviewed until we were not hearing significantly new themes or information.

In total, we conducted fifty-eight semistructured phone interviews with Forest Service and non-Forest Service individuals knowledgeable about R&D and RMRS strategy and operations. Interviews were conducted following a human subjects ethics protocol approved by our university's institutional review board; all interviews were voluntary and confidential. All but one interview<sup>2</sup> was audio recorded. Detailed notes were taken in the one instance where an interviewee did not consent to being recorded. Each interview generally lasted between 45 and 75 minutes. We concluded interviews upon reaching data saturation where no substantially new information was acquired related to our primary research objectives. All recordings were transcribed by a third-party transcription service in preparation for qualitative data analysis and checked for errors by a student research assistant.

We then used Dedoose, a qualitative analysis software program, to assign labels or “codes” to excerpts of interview text to help sort and review findings, in addition to writing memos. Coding is an established social science practice used to purposefully analyze text (Bazeley 2020). The lead author led coding and analysis. At the beginning of this process, the

first two authors refined a codebook based on several interviews, identifying emergent themes, and worked as a team to reach intercoder agreement on major themes (Campbell et al. 2013). The first author then coded all interviews, and through memoing identified subthemes as part of data analysis.

This work was done in partnership with and funded by RMRS. The third author, as an RMRS scientist, secured funding for the study, helped design the study and assisted with our interpretation and presentation of findings. However, to limit any perceived conflict of interest, they were not involved in selecting interviewees, conducting interviews, or analyzing data. Colorado State University retained sole access to the data and research independence to present our findings, and interviewee identities were never disclosed to any Forest Service employee. We present the findings from our interviewees in the next section. Findings are organized by our two primary research questions.

## Results

### With a focus on RMRS, what are current perceptions of the efficacy of R&D and how is R&D's research agenda and strategic direction established and interpreted?

We began by inquiring about how priorities and strategic direction for R&D are broadly established at the national level in the WO and translated to scientists and programs by RMRS. We learned the R&D deputy chief sets the strategy for R&D, working with input from some members of the Executive Leadership Team (ELT) and the National Leadership Council (NLC)<sup>3</sup> based on expectations from the USDA undersecretary for natural resources and environment and the Forest Service office of the chief. WO R&D program staff directors work with the ELT and the NLC to communicate national priorities to the stations. This guidance is used to inform how stations will address science needs within each program area. There was a shared perception among all interviewees however, that the R&D enterprise lacks clear strategic direction (see Table 1). The Forest Service interviewees across deputy areas and within RMRS perceived a lack of consistent priorities among WO leadership and R&D leadership, which they thought could be contributing to the ambiguous direction.

Within RMRS, interviewees were unclear about national priorities and specific research directions associated with general priorities. Most RMRS interviewees said they both valued the autonomy to set localized priorities and wanted more clarity about national priorities for research at the station or project level. One program manager said, for example, “One of our big challenges is differences in station priorities, we get pulled in different directions ... I have been concerned for a long time about the lack of national focus, and it doesn't need to be ‘here are the projects we are going to be working on’, but if they were [to say] here are the five priorities we really want to work on over the next decade, then each of us could rally around those priorities in terms of the focus in whatever program.” The RMRS interviewees emphasized they do not want top-down directives but desired more coordination with R&D staff at the WO to provide clarity about the scope and expectations of R&D, define high-priority research needs, and provide appropriate funding and incentives to meet those needs. Some RMRS interviewees also said they wanted to see more collaboration among R&D scientists in general.

Most interviewees from all groups collectively agreed that the role of R&D is to provide scientific expertise through the development of management tools, scientific support for land management and planning, inventory and analysis, science interpretation, and innovations. Almost all interviewees discussed how R&D conducts various levels of both applied and basic research, but they said disagreements about which is the primary focus for R&D causes misconceptions about expectations and performance. For example, one RMRS interviewee claimed, "It's a constant yin-yang where we're being pulled and tugged from different parts of the organization in terms of what our role is ... not just in the agency but to advance science more generally." An interviewee external to the Forest Service affirmed, "Forest Service [research] has this pretty unique challenge of needing their research to be able to have enough open-endedness and that they're finding opportunities and spotting them ahead of all of us, which we rely on, as they also respond to needs ground and within the agency ... they sit in a really hard space because they're trying to be practitioner-oriented and open science big query oriented." Most RMRS interviewees discussed how nonscientists often do not understand the timeline and resources required to conduct scientific research, which they said

contributes to misunderstandings about expectations and capacity needs.

There were also divergent perspectives across interviewee groups about the scope of R&D. Some interviewees stated that R&D's focus is to address management needs on NFS lands, whereas others mentioned how external US and global partners are equally a part of R&D's purview (see Table 2). Some suggested these different understandings around research scope also contribute to misunderstandings about R&D's expectations. For example, we heard from NFS and congressional staff members that R&D should be more focused on supporting NFS land management. Meanwhile, some partners external to the agency explained that the Forest Service emphasis on NFS lands can constrain the station's ability to meaningfully integrate with jurisdictions outside of the Forest Service. We heard from RMRS interviewees that it is difficult for them to balance NFS-focused projects, collaborate with external partners, and maintain long-term independent studies without operational support and clear incentives to encourage applied research focused on NFS priorities. RMRS interviewees said directing more research toward NFS lands would require clearer leadership direction, adequate resources, appropriate incentives, and rewards for focusing on NFS priorities.

**Table 1.** Interviewee perspectives on USDA Forest Service Research and Development direction.

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<p>"As a deputy area, I don't think we have a real clear vision of where we want to be and how we want to get there. Everybody has their ideas, but there's no consensus." - R&amp;D WO staff member</p>
<p>"[The research deputy area] needs to know from the agency leadership, where are we going? What is it that is expected of us so that we can gear our work towards supporting the mission priorities or the questions that are facing us currently." - USFS Washington DC office (WO) staff member</p>
<p>"There appears to be this inner struggle in R&amp;D between the management of R&amp;D and the scientists themselves about their purpose, function, and mission. That needs to be resolved because all it's doing right now is creating finger-pointing and tension. [R&amp;D] needs to be like, this is who we are as an organization, and this is what we're doing." - National Forest System (NFS) staff member</p>
<p>"[Is there] a way to create a more unified sense of what the mission is, of the Forest Service research program?" - RMRS staff member</p>
<p>"Do they have breakout sessions when [the] Executive Leadership Team gets together to discuss coordination? Or does the Deputy Chief ... have a strategic plan to execute with reduced or eliminated duplication or clear understanding of priorities and administration policy? Not clear." - USFS WO staff member</p>
<p>"What I advocate for is broader, strategic, integrated leaders' intent, advocacy of budget, and integration of execution, whether that's through policy or operationally." - NFS staff member</p>

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**Table 2.** Interviewee perspectives about the scope of USDA Forest Service Research and Development.

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<p>"Maybe this is a mischaracterization on my part. I think there's some scientists that are doing work that's directly relevant to the management of our National Forests. And then sometimes it seems like their work is less relevant ... I want them working for NFS because that's who I work for. And I want all their help focused on my needs ... I don't actually know what their mission says. Is it broader than that?" - National Forest System (NFS) staff member</p>
<p>"R&amp;D has sort of a bifurcated role. One is to meet the obligations of being the largest forest research organization in the world and setting leadership for major forestry research globally. Because the sciences operate in a global community ... But [the other obligation is] meeting the science needs of the agency. And in some cases, the balance between those two veers more toward the internal research needs, versus the external ones. I think the R&amp;D organization needs to be mindful of that." - External R&amp;D partner</p>
<p>"Research is not getting translated to on-the-ground management, on national lands, on National Forests, and that's what we want, right? It's all good, but, in the end, we want it to be focusing on the National Forest System. We don't want research to have to go out and get a lot of grants and projects from outside of the Forest Service because then they're not focused on those issues that the forest managers really need help with." - Congressional staff member</p>
<p>"There's expectations within National Forest Systems that we're their R&amp;D shop. That we're in service of them, when in fact, we're chartered to be more like an institute for studying forest and grassland systems." - RMRS staff member</p>

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We consistently heard there is a need for a more effective interface and communication between the station, the R&D WO, and congressional staff members. RMRS scientists and program managers agreed that staff members in key political positions are not fully aware of the station's accomplishments or the scope of their work. Interviewees in the R&D national office also said that communication from researchers and program leaders about R&D's capabilities was not effectively reaching congressional staff members. Congressional staff members were unclear about how research is being used to inform NFS land management. [Table 3](#) highlights some interviewee quotes regarding these perspectives. A common solution that interviewees offered was to diversify the range of R&D staff members who communicate with Congress to include, for example, station directors, program managers, and senior scientists. Ideally, these individuals would be motivated communicators with strong advocacy and relationship-building skills to help R&D be more visible, interviewees said. Several interviewees also suggested added investments in boundary spanning, liaison, or translator roles who specialize in science communication and can help connect with the WO agency leaders to understand the scope and importance of research occurring in the field. Specifically, many thought that the national program leads could be more involved in congressional visits and boundary-spanning efforts. Several RMRS interviewees suggested that they would like WO R&D leadership to focus on building awareness and visibility with Congress to distinguish R&D's value as a deputy area. RMRS interviewees also recommended additional investments in science delivery specialists at the station and program levels to help translate the success and accomplishments of R&D with effective science communication materials.

Almost all interviewees, both external and internal to the agency, discussed how career incentives affect R&D's capacity, trajectory, and resulting reputation, although perspectives among our interviewees were variable on this topic. A few program managers, some R&D WO staff members, and some scientists explained that the RGEG (see endnote 1) generally incentivizes individual research interests and publishing academic papers more so than integrating with land managers to produce applied science or outreach efforts. There were some discrepancies in this claim, however; for example, some program managers felt there was

ample space within the evaluation system to report on and be rewarded for partnership efforts. Several scientists did not see a need for the RGEG to change expectations for publications, emphasizing the importance of peer-reviewed publications in establishing broader credibility as scientists. Scientists nonetheless suggested that there could be greater recognition and support for pursuing collaboration, science outreach, and for conducting applied science. Many scientists said they continue to partner with managers despite the lack of incentives and rewards for doing so. An RMRS interviewee captured the challenge of balancing scientific independence, application, and incentives, saying "The research station as an independent deputy area has relished its independence... but there's also a new reality around the need for research to be applied, and there's concurrent stressors around making your research relevant and obtaining external funds to get the operating costs to do your work and the institutional incentives and structure of the research organization.... This new reality has not been reflected in the incentive structure... That's the inherent tension I think that has not been well addressed."

Interviewees agreed that a lack of workforce capacity, declines in funding, and competition for budgets across deputy areas within the agency continues to place stress on scientists' ability to be responsive to NFS. R&D staff explained that alongside a decreasing budget, scientists are driven to seek funds from sources outside the Forest Service, such as other land management agencies and research institutes, further causing a division between R&D and the other Forest Service deputy areas. Most RMRS interviewees agreed they lack a discretionary operating budget and must seek external funding to pursue their work, which they said often directs time and attention to problems that are not agency specific. Budget modernization, according to multiple interviewees, which separated funding for salaries and travel from research operating funds, has made it more complicated to form partnerships with external entities and enter into formal agreements and informal collaborations with NFS. As one interviewee explained, "With budget modernization, the only way we can make up those deficits [in operational budgets] is by going outside for funding. So, in effect, what it will do is it will drive us into the arms of the Bureau of Land Management, Department of Interior, and Department of Defense, which

**Table 3.** Interviewee perspectives on communication gaps.

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<p>"Messaging and delivery to the policymakers who influence the budget and the program direction. That really is so critical right now.... [T]here's so many who are authorizing, or appropriating dollars [that] don't know about what research is delivering. I think that's just really critical to get in front of." - External R&amp;D partner</p>
<p>"I hear stories that R&amp;D isn't helping, 'Why are we giving them money, they aren't helping'. I think that's a communication issue. I've been here a lot of years and it's just always been an issue of, 'Isn't there somebody up there telling the leadership why we're so important and why they need to keep thinking about us?'" - RMRS staff member</p>
<p>"It's like two different enterprises that aren't connected. We might be helping at the local level where the need is, but it never gets yarded up and brought to the national level ... There isn't a great way to show how our science is being used in the gray literature, in the NEPA documents, and the biological opinions." - RMRS staff member</p>
<p>"There needs to be a broader spectrum of trusted individuals that are interacting [with policymakers] ... The [USFS] WO should be spending most of their time communicating to policymakers about the value of research. That is almost job one. Station Directors should be able to either speak on behalf of their organization, their researchers, or get the researchers into the room ... Our partners need to be encouraged to talk about what service research has given in value to them." - USFS WO staff member</p>

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**Table 4.** Partner perspectives about Research and Development (R&D) Rocky Mountain Research Station (RMRS) efficacy and value.

“RMRS is engaged in some of the most important questions relevant to the sustainable management of forests [and] some of the best research on climate change impacts, on fire, on forest recovery following fire, on the composition and structure of resilient forests. These topic areas are really important to dig in on right now, and I see that across RMRS.”

“[RMRS] has really done a good job and continues to do a good job of trying to break down the silos and really get the science into the hands of managers and I’m always really impressed with the products on the communications end of the things that they produce, like the Science That You Can Use Bulletins, the webinars, and other opportunities for engagement.”

“I trust the Forest Service R&D. There is not a doubt in my mind that when I need science - good, unbiased, science-based information that I can trust and can feel confident sharing with others - that’s why they’re valuable to me.”

“There’s been a really nice change in the Rocky Mountain Research Station with Science Application and Communication where that team in particular has really upped their game in terms of the types of products they’re producing, the webinars they’re producing, and the companion publications.”

“We see RMRS as, I would say, probably the most important - not the sole - but a very, very well-respected source of that information. And quite honestly, probably the most - because they’re an agency, I think they have a better understanding of how to produce applied information.”

means we’re doing less work for our colleagues in NFS and State and Private, not more.”

A couple of interviewees at the national level and RMRS program managers noted that it is problematic for R&D to operate as an independent research organization embedded within a land management agency, especially if the R&D mission is supposed to be broader than NFS. Interviewees within R&D conjectured that the current structure perpetuates the idea that R&D’s purpose is to serve NFS and the resulting narrative that R&D is not always responsive to NFS management needs. For example, one RMRS interviewee suggested, “There is an ongoing frustration on the part of National Forest Systems in particular, that we aren’t meeting their needs. There’s this tension between, is it our job to meet their needs and only their needs, or do we have a much broader mission? ... I think part of it is because R&D is uniquely embedded as an agency that has regulatory powers and a management authority for public lands and has a huge fire suppression mission, that our role is not well understood by all the parties in the agency that need to understand it.” Some discussed restructuring R&D as an independent research institute or organizing by topical areas instead of by regions. Although they suggested that restructuring might be valuable, they were clear that this would be a major organizational overhaul and recommended first prioritizing clearer strategic planning and strengthening skills in communication. Similarly, some R&D interviewees considered the idea of having station directors report directly to the R&D deputy chief to improve communication, but most said they thought it was most important to have the right people and dedicated liaisons to help build meaningful and bold advocacy for R&D.

### What are the current perceptions of RMRS collaboration and communication with other deputy areas within the USFS and with external partners?

External and internal partner perspectives on the value of R&D and RMRS were generally positive, focusing on R&D’s mission to conduct independent, rigorous science. RMRS partners provided a suite of examples where people collaborate directly with the station and the ways they use RMRS science in their management.

When talking about the ways actors use science, partners commonly noted RMRS Science You Can Use<sup>4</sup>, General Technical Reports, monitoring information, and data syntheses. They consistently said that a primary value of RMRS is

its applied information and tools. Most partner interviewees shared positive outlooks about the station’s science delivery and communication initiatives, saying RMRS has made important strides in the program and continues to evolve in a promising direction (see Table 4). Partners advocated for the deputy area to continue to invest in the science–management interface, although they sensed there is limited support within the agency for RMRS to work on such efforts. Most partners external to the Forest Service and RMRS researchers also noted that focusing more on science delivery diverts staff time needed to develop, conduct, analyze, and publish research.

Partners and RMRS staff agreed that informal interactions are the best practice for promoting communication and collaborative research–manager partnerships. Interviewees consistently said the strongest relationships are formed organically and are often maintained based on an individual’s willingness to connect. Both partners and RMRS staff agreed that field visits, being in proximity to a lab or station headquarters, and attending professional and academic conferences were necessary for establishing and sustaining communication with the station. These opportunities provide space to discuss key management needs, requests, and feedback, they said. Many partners suggested that the agency should encourage and fund RMRS staff for such interactions.

Comparable to perceptions from R&D staff members, partners also sensed a lack of strategic direction from R&D leadership guiding the deputy area’s priorities, which they said can make it difficult to know how to collaborate with RMRS. Partner interviewees revealed that connections with the station were maintained because of the personal drive from individual RMRS researchers to collaborate, but they said RMRS staff are often not directed, incentivized, or supported by the agency to do this. For example, one partner external to the Forest Service recommended, “Making sure they’re [RMRS is] authorized and encouraged to engage. I think all of us want to do our jobs well and if [they] are told that there’s no value in partnership development, network development, in talking with folks outside of your immediate space, then it’s going to be hard to make space for that and make that a priority in your work.” External partners also suggested WO-level staff provide clearer encouragement and recognition of R&D’s strategy and culture to emphasize R&D’s distinct value in providing global scientific expertise.

An exception to how the station typically collaborates with its partners is the RSAT. Interviewees told us this was



a structured collaborative effort across the RMRS footprint with the intent of facilitating regular and strategic interaction between R&D scientists and NFS managers at the regional level. NFS employees at regional offices and RMRS interviewees discussed that although the intention of this program was favorable, the effort has largely disbanded due to leadership turnover and the effects of COVID-19, although these interviewees noted that some connections that were established from these teams persist. RSATs were particularly successful in the NFS Intermountain Region (Region 4) due to the dedicated and consistent leadership facilitating the teams and because NFS provided funding to scientists, interviewees said. Although NFS and RMRS interviewees suggested that engaging in co-produced projects was valuable, both entities were largely unsupportive of reinstating RSATs without dedicated operational and travel funding or committed leadership.

## Discussion

This research contributes to the growing work characterizing the mission, value, and accomplishments of the Forest Service R&D deputy area, with a focus on the RMRS. Unlike previous high-level efforts, this study was designed to capture more granular, high-resolution information for a specific station to help inform strategic improvement. In our first research question, we aimed to understand perceptions of the efficacy of R&D and how the deputy area's research direction was interpreted. To summarize our findings, WO leadership, RMRS program managers, scientists, and partners who work with them perceived that the deputy area is misunderstood and often underrecognized. Most attributed this to unclear national research priorities, misconceptions about the deputy area from nonresearchers, and limited communication among the regional research stations, the WO, and congressional staff members. Most also pointed out ongoing barriers within the R&D evaluation system and a lack of operational resources that affect R&D's capacity, trajectory, and overall reputation.

In our second research question, we sought to understand the perceptions of RMRS collaboration and communication by interviewing a variety of entities RMRS works with, including SP&TE, NFS, and partners external to the agency. To summarize, all partner interviewees, internal and external, spoke favorably about their interface with RMRS and the research RMRS produces. Partners collectively championed RMRS's applied work but understood research scientists often have little support and incentives to conduct applied research and to work on science delivery. Most partners were unclear about R&D's research scope and priorities.

Interviewees at all levels provided several recommendations to facilitate strategic development and to support R&D partnership endeavors. Here we highlight the most consistent recommendations reported in our findings and offer some perspective from the literature on each point:

1. Clarify R&D expectations, scope, and research agenda through a strategic plan at the R&D WO level. Congressional staff members, RMRS program managers, scientists, and partners, said they would benefit from clarity about the strategic priorities of R&D and better incentives to pursue these. Almost all interviewees suggested that the WO should define and broadly communicate a strategic plan with research priority areas and attendant, specific research needs, along with clarity

about the scope and expectations of R&D's research. Strategic plans are a primary factor in operationalizing effective organizational change and therefore could be key in helping to clarify misconceptions about R&D's expectations (Fernandez and Rainey 2006). At the same time, leadership would need to support implementation of such a plan with appropriate incentives, support, and processes, and to engage key populations through targeted outreach (Fernandez and Rainey 2006; Kuipers et al. 2014). Recommendations for successful organizational change include deliberate communication from leadership about expectations and intent internally and externally, by involving trusted constituents and communicating with political overseers.

2. Improve communication among the regional research stations, the Forest Service WO, and Congress. Interviewees at multiple levels said the success, capacities, and accomplishments of R&D can be better distinguished, articulated, and elevated to Congress, among key partners, and within the agency. Leadership skill and expertise is emphasized as one critical driver of change in the literature on organizational change in the public sector (Kuipers et al. 2014). For this reason, the agency should ensure R&D leaders are motivated communicators with strong relationship-building skills to enhance communication among the research stations, the WO, and Congress. To improve interface between congressional staff members and R&D in particular, interviewees suggested diversifying who communicates directly with Congress, for example to include station directors, station-level program managers, or national program leads. Doing so could help clarify the range of activities being undertaken by scientists and thus better demonstrate the value of R&D to Congress and policymakers. Furthermore, interviewees recommended added investments in dedicated regional boundary-spanning or translator roles. Boundary spanners facilitate sustained communication between scientists and nonscientists and thus could enhance communication with political overseers and inter- and intra-agency communication (Colavito et al. 2019; Goodrich et al. 2020).
3. Incentivize and recognize applied work and collaborative projects. RMRS interviewees explained that limited career incentives and support to conduct applied research with the NFS together drive scientists to pursue external funding sources, which often directs their focus to problems that are not agency specific. To encourage more focus on applied work, some possible solutions include sustained funding, incentives, and workforce capacities needed to conduct applied research and building recognition for researchers to address management priorities. Boundary-spanning experts can also facilitate working with end users to produce actionable science (Colavito et al. 2019). Leadership turnover and vacancies pose significant problems for long-term collaboration. Some research staff further suggested designating a portion of scientists' time to focus on applied research with the NFS but emphasized that their role was to conduct research and not to provide nonresearch services or functions. Researchers also said they need support and opportunities to connect with other scientists and managers to build their programs. In practice, this would entail increased and sustained travel and operational funding for scientists

to travel to conferences and to conduct field visits with managers, as well as encouraging informal networking opportunities to discuss research priorities and the value of different products. We also recognize that this pursuit requires joint incentives where managers also have encouragement to engage with scientists (Fernandez and Rainey 2006; Kuipers et al. 2014). Future research on this topic could explore whether managers have incentives to engage with scientists and how to support this.

Several studies have noted that Forest Service research scientists must be more generously credited within the RGEF or emphasized by RGEF reviewers for applied research and working directly with managers, and to some degree, recent changes to the RGEF have improved this aspect of performance appraisal (Dominguez et al. 2019; GAO 2010). However, regardless of the RGEF and the system established for professional evaluation, government research scientists are part of a professional community of science that prizes innovative and original research, as measured most typically through high-impact peer-reviewed publications (i.e., widely cited papers in prestigious journals) and by securing highly competitive external funding. Thus, even if scientists are rewarded internally for their work with managers, their professional colleagues and peers in other organizations, potential employers outside of Forest Service (e.g., in academia), and peer scientists who review papers and grant proposals, are likely to weight traditional metrics of scientific accomplishment higher than manager interaction. This dynamic, also noted by Glenn et al. (2022), must continue to be acknowledged as a tension for research scientists; similarly, to thrive professionally, scientists need to be able to pursue such activities and participate in professional meetings to share their work, build a reputation that amplifies impact, and network with colleagues who are both land managers and scientists. Additional change in this arena may be difficult given this tension and given that goals must align with incentives and capacities within the organization.

Some of the tension around the practical relevance of R&D work has been around since the origins of the research arm of the Forest Service, which has always had to balance being scientifically rigorous and socially relevant (Brock 2015). But it may be exacerbated by an increased need among managers for individuals who can provide scientific expertise to the NFS. The expertise of ecologists, biologists, hydrologists, silviculturists, social scientists, economists, engineers, and scientists in many other disciplines is critical to planning and compliance with both the National Forest Management Act of 1976 and National Environmental Policy Act of 1969. These forest- or regional-level specialists have different responsibilities and often less research training than R&D research scientists, whose job revolves around designing, implementing, and disseminating primary scientific research. As a result of the increased cost of fire, internal agency research has shown that there has been a major decline in all nonfire programs within the NFS. In a 2015 report, the Forest Service notes, “In 1995, fire made up 16 percent of the Forest Service’s annual appropriated budget—this year, for the first time, more than 50 percent of the Forest Service’s annual budget will be dedicated to wildfire. Along with this shift in resources, there has also been a corresponding shift in staff, with a 39 percent reduction in all non-fire personnel” (USDA, 2015, 2). The report goes on to predict accurately that nearly two-thirds of

the budget will go to fire in the coming years. Although this was stabilized by Congress’ “fire funding fix,” (Schultz et al. 2019), the nearly 40% loss in personnel has meant a loss in staff capacity within the NFS, including those who provide scientific expertise and serve as a bridge between the research community and land managers.

We posit that this loss in capacity has put an even-greater pressure on R&D to provide scientific expertise directly to NFS to address near-term management needs rather than through the dissemination of primary research to NFS forest- and regional-level specialists who can implement it. This, however, is at odds with the job requirements and incentives of research scientists. The Infrastructure Investment and Jobs Act of 2021<sup>5</sup> and the Inflation Reduction Act of 2022<sup>6</sup> increased funding to US land management agencies to reduce fire hazard in the wildland–urban interface and important watersheds. It remains to be seen whether these increased funds will be used in part to rebuild the science capacity within NFS. It does appear that significant funding will be used to facilitate R&D engagement with NFS in critical landscapes under the Wildfire Crisis Strategy.

## Conclusion

We set out to build on existing findings from previous reports and research investigating the performance of the Forest Service R&D deputy area with a focus on the RMRS. Many of our findings were consistent with previous findings, adding to a body of evidence that more can be done to clarify research priorities and support connections between scientists and managers while attending to the professional incentives that scientists face. Conducting this study at the station level generated some new insights. A few specific takeaways from our work are that scientists at RMRS do not perceive clear strategic direction and leadership from the national level, think the value of their work is misunderstood by congress and others in leadership positions, and would like to see a broader range of individuals within the agency communicating science and the value of their work in the broader political landscape. RMRS partners spoke favorably of the work being done by RMRS, but they agreed that collaborations are often unknown to broader audiences and are underrecognized. RMRS interviewees said that they would benefit from dedicated funding and incentives to focus more on NFS-specific or applied work but noted that they must conduct research that advances knowledge in their field. Most wanted to see a clearer strategic plan to frame research priorities, clarify the scope and impact of R&D’s work, and identify factors that constrain the ability of R&D to achieve different aspects of its mission. Developing such a plan may be a valuable next step, particularly if it is accompanied by some internal discussions to explore potential barriers and solutions to persistent challenges.

We faced several limitations in conducting this work. The range of actors at the national and station levels, including political overseers, internal agency partners, scientists, program managers, and external partners, is both extensive and diverse. As such, we likely missed some perspectives. As a next step, a survey would be useful to understand more comprehensively scientists’ perceptions about their incentives and the factors that drive their research program. Similarly, a survey of partner perceptions might reveal differences in perceptions among various groups. In addition, focus groups on specific topics might yield additional insights on some topics,

although they would require strong buy-in and participation from within R&D.

We also want to call attention to recent influxes of funding for the agency that occurred after the conclusion of our interviews. As noted above, Congress recently passed the Inflation Reduction Act and the Infrastructure Investment and Jobs Act, both of which direct billions of additional funds to the agency for fuels and forest restoration treatments and other activities on NFS lands. Congress also approved budget modernization, which will realign the agency's budget structure. In light of these developments, it will be important for future studies on this subject to track how the deputy area is responding, but it is possible that these resources will help catalyze collaboration across deputy areas and help align strategy and priorities within R&D and across the Forest Service.

Finally, on a broader note, we recognize that R&D is in a unique position as a research organization within the Forest Service. Although this creates a potential for greater connectivity between science and management, it also presents challenges. For instance, if budgets are in decline, this might present agency leadership with difficult choices about how to prioritize management, particularly given the nation's current focus on reducing fire hazard through land management rather than research. It also is likely adding to some confusion about the intended scope of R&D's work, whether it is to advance knowledge about forest science globally, to address more agency-specific, applied research needs, or even to provide resource-specific scientific expertise for management, but not necessarily conduct primary scientific research. A broader survey of the structure of government-funded land management research organizations globally might yield new insights on the challenges and opportunities faced within the Forest Service.

## Supplementary Materials

Supplementary data are available at Journal of Forestry online.

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## Conflict of Interest

This work was funded and conducted at the request of the USDA Forest Service, Rocky Mountain Research Station. The funder had no influence on our data analysis or conclusions. However, see our Methods for the role of the third author in our study and manuscript writing.

## Endnotes

1 The Office of Personnel Management's Research Grade Evaluation Guide informs the performance evaluation system for federal

government scientific research positions. It provides criteria for evaluating the grade level of a research position and the position description.

- 2 Colorado State University Institutional Review Board Protocol Number 2434.
- 3 The ELT is composed of USFS deputy chiefs, their associates, and the Office of the Chief. The NLC is composed of all research station directors and regional foresters, ELT members, and some additional USFS WO staff members, like legislative affairs and communications.
- 4 Science You Can Use are RMRS products intended to synthesize scientific information for priority management needs.
- 5 The Infrastructure Investment and Jobs Act. Pub. L. 117-58, No. 135 Stat. 1097 (2021).
- 6 The Inflation Reduction Act. Pub. L. 117-169 (2022).

## Literature Cited

- Bazeley, P. 2020. *Qualitative Data Analysis: Practical Strategies*. Thousand Oaks: SAGE Publishing.
- Beier, P., L.J. Hansen, L. Helbrecht, and D. Behar. 2017. "A How-to Guide for Co-production of Actionable Science." *Conservation Letters* 10 (3): 288–296.
- Biber, E. 2009. "Too Many Things to Do: How to Deal with the Dysfunctions of Multiple-Goal Agencies." *Harvard Environmental Law Review* 33: 1–63.
- Brock, E.K.. *Money Trees: The Douglas Fir and American Forestry, 1900-1944*. Corvallis: Oregon State University Press. 2015
- Cairney, P., K. Oliver, and A. Wellstead. 2016. "To Bridge the Divide between Evidence and Policy: Reduce Ambiguity as Much as Uncertainty." *Public Administration Review* 76 (3): 399–402.
- Campbell, J.L., C. Quincy, J. Osserman, and O.K. Pedersen. 2013. "Coding In-Depth Semi-Structured Interviews: Problems of Unitization and Intercoder Reliability and Agreement." *Sociological Methods & Research* 42 (3): 294–320.
- Clark, N.C., Little, N.J., and S. Kantor. 2021. *Intermountain Region-Rocky Mountain Research Station Science Partner Program: A Road Map to Connecting Forest Service Science and Management*. Research Note RMRS-RN-89. Fort Collins: USDA Forest Service, Rocky Mountain Research Station.
- Colavito, M. 2021. "The Human Dimensions of Spatial, Pre-wildfire Planning Decision Support Systems: A Review of Barriers, Facilitators, and Recommendations." *Forests* 12 (4): 483.
- Colavito, M.M., S.F. Trainor, N.P. Kettle, and A. York. 2019. "Making the Transition from Science Delivery to Knowledge Co-production in Boundary Spanning: A Case Study of the Alaska Fire Science Consortium." *Weather, Climate, and Society* 11 (4): 917–934.
- Dilling, L., and M.C. Lemos. 2011. "Creating Usable Science: Opportunities and Constraints for Climate Knowledge Use and Their Implications for Science Policy." *Global Environmental Change* 21 (2): 680–689.
- Dominguez, M., Birdsell, D., Kane, T., Goss, K., and S. Redburn. 2019. *Organizational Assessment for U.S. Research and Development*. Washington: National Academy of Public Administration.
- Fernandez, S., and H.G. Rainey. 2006. "Managing Successful Organizational Change in the Public Sector." *Public Administration Review* 66 (2):168–176.
- Glenn, E., L. Yung, C. Wyborn, and D.R. Williams. 2022. "Organisational Influence on the Co-production of Fire Science: Overcoming Challenges and Realising Opportunities." *International Journal of Wildland Fire* 31 (4): 435–448.
- Goodrich, K.A., K.D. Sjostrom, C. Vaughan, L. Nichols, A. Bednarek, and M.C. Lemos. 2020. "Who Are Boundary Spanners and How Can We Support Them in Making Knowledge More Actionable in Sustainability Fields?" *Current Opinion in Environmental Sustainability* 42: 45–51. <https://doi.org/10.1016/j.cosust.2020.01.001>
- Jolley, R., Punke, T., Ringeisen, R., Selzer, L., and J.D. Williams. 2017. *The Blue Ribbon Commission on Forest and Forest Products Research & Development in the 21st Century*. Greenville: US Endowment for Forestry & Communities, Inc.

- Kuipers, B.S., M. Higgs, W. Kickert, L. Tummers, J. Grandia, and J. Van der Voet. 2014. "The Management of Change in Public Organizations: A Literature Review." *Public Administration* 92 (1): 1–20.
- Lee, J.W., H.G. Rainey, and Y.H. Chun. 2009. "Of Politics and Purpose: Political Salience and Goal Ambiguity of US Federal Agencies." *Public Administration* 87 (3): 457–484.
- McGinley, K.A., R.W. Guldin, and F.W. Cabbage. 2019. "Forest Sector Research and Development Capacity." *Journal of Forestry* 117 (5): 443–461.
- Office of Personnel Management (OPM). 2019. *Forest Service Guide for Preparing Research Scientist Position Descriptions and Conducting Research Grade Evaluation Panels Version 2.4*. Washington: US Office of Personnel Management.
- Pandey, S.K., and B.E. Wright. 2006. "Connecting the Dots in Public Management: Political Environment, Organizational Goal Ambiguity, and the Public Manager's Role Ambiguity." *Journal of Public Administration Research and Theory* 16 (4): 511–532.
- Rainey, H.G., and C.S. Jung. 2015. "A Conceptual Framework for Analysis of Goal Ambiguity in Public Organizations." *Journal of Public Administration Research and Theory* 25 (1): 71–99.
- Schultz, C.A., M.P. Thompson, and S.M. McCaffrey. 2019. "Forest Service Fire Management and the Elusiveness of Change." *Fire Ecology* 15 (13): 1–15.
- Steen, H.K. 1998. *Forest Service Research: Finding Answers to Conservation's Questions*. Durham: Forest History Society.
- US Government Accountability Office (GAO). 2010. *Forest Service Research and Development: Improvements in Delivery of Research Results Can Help Ensure That Benefits of Research Are Realized*. GAO-11-12.
- USDA Forest Service. 2015. *The Rising Cost of Wildfire Operations: Effects on the Forest Service's Non-fire Work*. Washington: USDA Forest Service.
- USDA Forest Service. "About Research and Development," n.d. Accessed February 27, 2023. <https://www.fs.usda.gov/research/about>.