

Science Exchange in an Era of Diminished Capacity: Recreation Management in the U.S. Forest Service

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Abstract

Promotion of effective science exchange between government scientists and managers requires thoughtful arrangement and operation of research and management functions. The U.S. Forest Service was established at the peak of the Progressive Era, when science exchange was designed to occur between researchers and resource managers who worked in distinct arms of the agency, but shared similar goals of effective forest management. In this article, the authors explore the implications of diminished agency capacity for science exchange interactions between researchers and managers in recreation management. Managers and researchers identified their current interactions, their perceptions of ideal interactions, and barriers to achieving those ideals. Reductions in agency capacity for recreation management have resulted in the erosion of interactions between managers and researchers. However, effective science exchange does occur, but requires innovative and adaptive approaches.

Keywords

agency capacity, science exchange, recreation management, interaction, managers, researchers

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Managers and staff do not have research needs, they have problems

—U.S. Forest Service Manager

The key is relationships and being engaged—management reaching out and research doing the same.

—U.S. Forest Service Researcher

The role of science in natural resource decision making, although becoming more critical, has also become more complex (Mills & Clark, 2001). Since its early roots in Progressive-era conservation, the U.S. Forest Service has championed the paradigm of technical rationality and empirical

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science as the basis for sound resource management practices that benefit all Americans (Kaufman, 1960; Wellman, 1987). New processes of governance and public decision making shape the contemporary reality in which the Forest Service must operate and the way scientific information is produced, exchanged, and used (Mills & Clark, 2001). Science exchange includes the framing of issues and problems, identification of information needs, communication with researchers, production and dissemination of relevant scientific information, and the appropriate application of science to management issues. Interaction between managers and researchers is central to the process of science exchange. By interaction, we mean direct encounters between managers and researchers (e.g., in-person exchange, telephone, video-conference or email conversation, training session), as opposed to anonymous, impersonal encounters (e.g., reading a scientific journal article, attending a lecture).

In this article we explore the Forest Service's capacity for science exchange interactions by focusing on three major questions: (a) What types of interactions do resource managers and researchers currently experience?, (b) What types of "ideal" interactions do managers and researchers desire?, and (c) What institutional factors enhance or inhibit the achievement of ideal interactions? To address these questions, we relied on theory and literature related to organizational capacity, communication, and technology transfer. Below, we describe the organizational context of the Forest Service and the structure of recreation research and management within the agency. We then present our methodological approach and study findings. We conclude with a discussion of strategies and approaches for science exchange in an era of diminished agency capacity.

Organizational Capacity in the U.S. Forest Service

Organizational capacity refers to the ability of an institution to perform by defining and realizing its goals in an effective and sustainable manner (Horton et al., 2003). An organization's capacity includes the resources (human, financial, technological), knowledge, and processes used to achieve its mission. Organizational capacity is a dynamic process, requiring agencies to adjust to new conditions and respond to changing factors in the external and internal environment that affect its ability to achieve its goals (Horton et al., 2003). Capacity has also been defined as the limited resources that agencies can devote to a particular policy area (Bowman & Kearney, 1988; Brown, O'Toole, & Brudney, 1998; O'Leary & Yandle, 2000). A rich literature links agency capacity with implementation outputs and outcomes (Berry, 1979; Cline, 2003; Goggin, 1987; Goggin, Bowman, Lester, & O'Toole, 1990; Meier, 1987; Pressman & Wildavsky, 1984), and much of that literature points to the need to increase agency capacity to ensure successful policy implementation (Mazmanian & Sabatier, 1983; Pressman & Wildavsky, 1984). For example, many implementation problems are directly linked with insufficient resources, including trained and educated personnel (Goggin et al., 1990; McDermott, 2006; Miller, 2000). Our study focused on the capacity of the Forest Service to exchange scientific information for recreation management.

The Forest Service was created in 1905 within the Department of Agriculture as the administrative agency to manage National Forest reserves, and consists of three parallel units (Steen, 2004). The National Forest System (NFS) oversees 193 million acres of forests and grasslands, and 9 Regional Offices oversee activities in 155 National Forests and 20 National Grasslands. These units are further divided into more than 600 Ranger Districts. The Forest Service Research and Development (FS R&D) division consists of 5 Research Stations, along with the Forest Products Laboratory and the International Institute for Tropical Forestry. The FS R&D division is responsible for conducting basic and applied science related to forest resources. This division oversees studies at 83 Experimental Forests and Rangelands. The State and Private Forestry (S&PF) division works with nonfederal landowners to transfer technical knowledge in forest health. In 2008, the Forest Service supported a budget of \$4.5 billion and employed 32,818 workers (U.S.D.A. Forest Service, 2007a).

Similar to other federal agencies, the Forest Service has faced budget constraints in the last decade because of several factors: a general policy trend toward downsizing government; a shift in mission that deemphasized commodities production and stressed forest protection, biodiversity, ecosystem services, and recreation; and a marked increase in expenditures to suppress fire in response to public demand. While the overall Forest Service budget increased from \$3.7 billion in 2000 to \$4.5 billion in 2008, the portion of that budget devoted to controlling wildfire increased from 21% in 2000 to 42% in 2006. Other programs, such as recreation, absorbed the costs of fire management. Recreation management is viewed as a critical mission in the agency and is featured as one of seven strategic program directions in 2009. Yet the recreation program has been challenged by significant declines in financial and human capacity. Since 2000, the budget for recreation has been fairly stable, hovering around \$250 million, or about 5% of the total agency budget. Meanwhile, recreation employees in the agency have declined from 3,153 in 2002 to 2,198 in 2008—a loss of 955 recreation management professionals (U.S.D.A. Forest Service, 2007b). Other programs are being downsized as well, and recreation managers have assumed responsibility for other content areas, stretching their capacity to manage recreation programs. An increased reliance on concessionaires to manage campgrounds and partner groups to maintain trails and other recreation facilities has shifted the burden outside the agency, though it is impossible to quantify this effect.

Since 2001, federal budgets in many agencies have been experiencing no or slow growth and in some cases gradual declines because of the wars in Iraq and Afghanistan which require additional appropriations to the Department of Defense, and the need to fund a new federal agency, Homeland Security. Within the Forest Service, recreation funding declined an average 1.8% per year from 1993 to 2008 (in constant 2005 dollars). Recreation budgets have been affected by internal shifts in agency funding to cover the costs of fighting wildfire outbreaks. Since 2002, more than \$2 billion has been shifted from other departments to cover the cost of fire, disrupting the agency's ability to deliver recreation programs and services (U.S.D.A. Forest Service, 2009). In addition, agencies have experienced increased expenditures of budgets and salaries associated with forest planning and National Environmental Policy Act requirements. In 2006, the agency spent \$365 million on 6,000 processes required by National Environmental Policy Act, which involved 8,000 employees (Management Analysis Inc., 2007). Languishing budget capacity (despite an increase in management costs), along with a decline in human capacity (despite increases in visitor use and conflicts), presents significant challenges for recreation management. Our study focused on how the exchange of scientific information takes place in an agency where capacity has been severely diminished.

Challenges of Scientific Information Exchange

The task of communicating research findings to managers that can interpret the information and put it to use is highly complex. A belief in scientific management of forest resources was an important tenet embedded in Forest Service culture (Kaufman, 1960). Foresters and natural resource managers were expected to incorporate state-of-the-art scientific knowledge to manage public lands (Lachapelle, McCool, & Patterson, 2003). To accomplish this, information and knowledge must be exchanged or transferred. The concept of technology transfer is defined by Roessner (2000) as the movement of know-how, technical knowledge, or technology from one organizational setting to another. A key assumption of technology transfer is that the knowledge or tool being transferred will actually be put to use by practitioners. Explorations of technology transfer include the entire cycle from the transfer agent (source), transfer medium (vehicle), transfer object, (scientific knowledge, tools, processes), transfer recipient (end user, firm, agency), and the overall environment creating demand for the technology (Bozeman, 2000). Transfer agents may choose from a variety of media to share their science (e.g., publications, direct interaction, on-site demonstration,

informal) based on the type of transfer object, the needs of the transfer recipient, and the demand environment in which they are operating (Bozeman, 2000). Institutions may employ incentives to promote certain mechanisms for knowledge transfer due to cost or efficiency factors or to meet established accountability standards for effectiveness.

Knowledge transfer is foremost a social process with interaction between researchers and managers (Rogers, 1995). Yet organizational science scholars have observed that researchers and managers inhabit different worlds, with unique sets of goals, values, ideologies, and operating conditions that impede the extent to which knowledge is used (Beyer & Trice, 1982). Academics and practitioners have different frames of reference about what information is required to make decisions and often have different systems of meaning (Shrivastava & Mitroff, 1984). They also work on different time frames, with practitioners needing to address immediate, real-time problems (Thomas & Tymon, 1982). Researchers are divided in their views about whether interaction with practitioners leads to the advancement of science. For example, some believe that practitioners can be excellent sources to identify new problems for analysis, whereas others believe that collaboration results in short-term, narrowly-scoped problems that respond to manager interests (Rynes, Bartunek, & Daft, 2001).

During the 20th century, federal agencies in energy, agriculture, health, defense, and many other areas developed laboratories, experimental stations, and research units for conducting mission-focused science (Reingold, 1994). The rationale for this approach was that the government was in a unique position to generate and organize financial and human resources to foster knowledge creation for the public good. One study on technology transfer in government laboratories found that government units that emphasize basic research as their mission are less likely to engage in technology transfer than organizations with more diverse goals. In addition, government agencies in which scientists focused on the production of scientific articles for publication were less likely to engage in technology transfer (Rahm, Bozeman, & Crow, 1988). This has led some to question whether basic research is something that can effectively be transferred to managers and other practitioners. One study concluded that highly focused, direct interaction between researchers and industry practitioners is necessary for technology transfer from basic research (Hammer, 1996). As policy scholars note, government Research and Development (R&D) units have unique characteristics that distinguish them from private industry. The reward system for government scientists is largely based on scientific publications (as opposed to patents or product development). Promotion is based on something akin to a university tenure process, where science affect is evaluated (Crow & Bozeman, 1998). Unlike universities, government laboratories are managed hierarchically and are organized in discrete departments based on functional areas.

Consistent with this trend, the FS R&D division was developed during a time when it was believed that the role of government was to conduct R&D in service of specified missions of national interest, where private R&D was not available (Bozeman, 2000). Then called the "Branch of Research," FS R&D was established in 1915, just 10 years after the Forest Service was founded as an agency within the Department of Agriculture (Steen, 1998). The purpose of this new branch was to organize and shape research efforts occurring at various experimental forests under one division and develop this division into a highly respected repository of scientific knowledge and technical skill related to forest sciences. The 1924 McSweeney-McNary Act solidified its role as a discrete unit existing alongside and independent of forest management (Steen, 1998). Initially, research focused on wood chemistry and forest products, but later expanded to include timber harvest practices, inventory and monitoring, water and flood management, range management, biological and geophysical processes, ecology, and eventually recreation and human dimensions. In spite of the agency's obvious strengths and capacity in research, the means by which scientific knowledge was communicated between divisions and transferred into the hands of managers was not explicit.

Managers obtain scientific information both indirectly (by reading publications, journals, and reports), and directly through interaction with researchers and technology transfer specialists (Wright, 2007). Barriers in communication between researchers and managers can inhibit the exchange of science used to address resource management problems (Wright, 2007, 2006). Previous studies in natural resource management suggest that barriers to the exchange of scientific research by managers include a lack of awareness of existing information sources; lack of access to information or technology; cultural and communication differences between research and management professionals; and lack of capacity (resources, personnel, time, and funds) to access research (Blahna & Kruger, 2007; U.S.D.A. Forest Service, 1995; Warrington, 2007; Wright, 2007).

Scientific exchange can be highly effective when it involves direct interaction between managers and researchers. Frequent interaction between managers and researchers often results in enhanced trust, which stems from enduring relations. Trust is a key factor that influences whether scientific knowledge actually gets used or applied (Alderman, Nakamoto, & Brinberg, 2007; Wright, 2005). Research also shows that effective communication occurs when individuals share common background, training, institutional setting, and purpose (Rogers, 1995). In other words, a history of communicating together in the same organizational environment can contribute to greater understanding, use, and implementation of science in decision making (Wright, 2007). Other scholars have referred to the need for a "community of practice" or collegial learning communities among professionals as important ways of sharing (Wenger, 1999). However, organizational and cultural barriers between science and management realms can hinder the development of such communities. For example, researchers and managers communicate in different ways, and as discussed earlier, respond to different sets of incentives and responsibilities (U.S.D.A. Forest Service, 1995; Warrington, 2007). These organizational realities may inhibit the development of the trust necessary for science exchange between researchers and managers.

Several scholars have explored the role of technology transfer in federal government agencies (Bozeman, 2000; Bozeman & Coker, 1992; Bozeman & Crow, 1991; Crow & Bozeman, 1998; Rahm et al., 1988). Government agencies that formed in the early 20th century share characteristics of classic bureaucracies, in that they operate with clearly defined parts and a set of ordered relations among those parts (Morgan, 1997; Weber, 1946). They are hierarchical in structure, with differentiation in functions among relatively compartmentalized departments. Optimally, decisions are made based on efficiency, rational decision making, and linear thinking (Weber, 1946). In the scientific management paradigm seen in many bureaucracies, researchers and managers occupy discrete units, and the transfer of scientific knowledge from research to management was primarily conceived as linear and unidirectional, from researcher to manager. We examine science exchange in the Forest Service by focusing on recreation management, a management area that is of increasingly high importance to the agency.

Capacity for Science Exchange in Recreation Management at the U.S. Forest Service

Recreation has been an important aspect of Forest Service management since the agency's inception, although it has often been overshadowed by forest products, range, and fire management programs. Investment in recreation capacity followed enactment of the Multiple Use-Sustained Yield Act in 1960, and growing environmental awareness and interest in outdoor activity filled the forests with hikers, anglers, and boaters. The publication of *Outdoor Recreation for America* (1962) prompted the development of degree programs in recreation at universities and the development recreation research capacity within the Forest Service (Cordell, 2003). Close interactions between recreation managers and researchers in the 1970s and 1980s led to the development of

science-based applications such as the Recreation Opportunity Spectrum that directly responded to management needs to understand dispersed and developed recreation use (Manning, 1999). Recreation researchers joined managers in training agency employees in the use of tools for recreation planning, management, and inventory. A common means of sharing scientific information was through direct interaction (e.g., short courses, field visits, and workshops). During this time, FS R&D was recognized internationally as a leader in outdoor recreation and wilderness research (Burdge, Buchanan, & Christensen, 1981).

To promote exchange in recreation knowledge, the agency sponsored regional and national conferences and workshops emphasizing interaction between researchers, academics, and recreation professionals. In 1978, the Southeastern Forest Experiment Station sponsored a gathering of researchers and managers in Asheville, North Carolina, which eventually evolved into the Southeast Recreation Research Symposium. Ten years later, a similar model was adopted by the Northeastern Forest Experimental Station, and the Northeast Recreation Research Symposium was born. Both regional conferences continue to meet on an annual basis as a cooperative effort between FS R&D and regional universities.

Throughout the 1980s and 1990s, the Forest Service underwent dramatic changes. Many national forests began to invest in forest and regional (multiforest) planning processes, which required employees who could synthesize and integrate ecological and social science information. Recreation managers, who were often the only staff members with human dimensions training, were brought in to foster public involvement and assist in forest planning and environmental impact analysis. At the same time, recreation researchers in FS R&D began to redirect their work to consider broader human dimensions issues and to conduct research on public involvement, collaboration, and regional planning. In response to available funding incentives and research gaps, recreation researchers in FS R&D also began to expand into other functional areas, such as fire. Accordingly, the frequency of national level recreation meetings dwindled after 1990s. In 2005, a national workshop on recreation research and management was held in Portland, Oregon, facilitated by the Pacific Northwest Research Station's Focused Science Delivery program as a special recreation and tourism initiative (Kruger, Mazza, & Lawrence, 2007). This represents the most recent national effort to convene recreation managers and researchers.

Public use of national forests for recreation continues to grow and diversify (Moore & Driver, 2005). Recreation visits to National Forests increased from 560 million in 1980 to 860 million in 1996 (U.S.D.A. Forest Service, 1998) and continues to increase. As a result, managers find themselves in complex situations in which they must balance the need for resource protection with the competing interests of multiple publics. In the 21st century, visitors are more ethnically diverse and increasingly urban, leading to new patterns of recreation preferences (Manning, 1999) as well as increased conflict among visitors. The need for research to understand the values and expectations held by various recreation segments is significant, and new recreational uses result in biophysical effects that require analysis. "Unmanaged recreation," and the growing concerns regarding Off-Highway Vehicles and other dispersed recreation activity has been an important focus for the agency since 2001, under Chief Bosworth, and remains an important strategic area identified by Chief Kimball in 2009. The Forest Service is faced with increasing recreation demands and management costs, although human and budget capacity is declining. This article explores the effects of these capacity constraints on the agency's ability to engage in scientific exchange for recreation management.

Study Methods

Our study employed multiple methods, including 86 semistructured interviews and analysis of quantitative budget and personnel data sets. The primary phase of data collection occurred in the

spring and summer of 2005, when in-depth telephone and personal interviews were conducted with 49 managers in the NFS and 20 researchers employed in FS R&D. Additional interviews were conducted with 9 human dimensions and science delivery specialists working in the NFS and affiliated units and 8 university researchers who had conducted studies on forest recreation. A combination of purposive and snowball sampling was used to determine the study samples. The sample of managers was designed to maximize regional diversity and ensure that recreation managers at all levels in the NFS were included. All of the researchers in the sample had a history of involvement with outdoor recreation research and represented each of the six major research stations in FS R&D (all but one or two recreation researchers in FS R&D were included in the study). Although our sample was robust, there are potential limitations to the generalizations that can be drawn from data that asks participants to recall their perceptions over time. The results presented in this article concentrate on the sample of NFS participants (recreation managers and human dimensions specialists) and FS R&D scientists.

Sample groups each responded to a slightly modified version of an interview guide (see the appendix; Kvale, 1996; Rubin & Rubin, 1995) and were asked about their background and training, the recreation issues and challenges they face, and how they translate their information needs to researchers (or exchanged science with managers). The guide then prompted respondents to characterize the current nature of their interactions with managers or researchers and to describe their perceptions of ideal interactions. Finally, they were asked to reflect on the institutional factors that facilitate or hinder those interactions. Interviews generally took 1 hour to complete and were recorded and transcribed. Qualitative data analysis software (Atlas.ti) was used to assign codes to the interview data and assisted in the sorting and organizing of coding and content analysis (Rubin & Rubin, 1995). Using the sorting functions of Atlas.ti, similarities and differences between participants in the study were discerned and analyzed.

Findings: Science Exchange at the U.S. Forest Service

There are a variety of ways researchers and managers interact that result in production, exchange, and use of relevant science. In this section, we present our findings about the types of interactions researchers and managers currently experience, the ideal types of interactions desired, and barriers to achieving these ideals. We also present innovative approaches to facilitate science exchange interactions.

Science exchange interactions. Study participants were asked to characterize the types of science exchange interactions they currently experience. Managers and researchers in the Forest Service recognize the broad array of opportunities for working together; however, many differences were observed in the frequency of responses in various categories (Figure 1). Managers highlighted formal processes for interaction, whereas researchers recognized the role of informal ties and personal relations. Overall, the most common form of interaction was the collaborative engagement of researchers on studies related to forest management. Both managers and researchers extolled the value of collaborative research, which was linked to the development of applications and tools managers used. However, according to respondents, opportunities for long-term collaboration had diminished in recent years. As one researcher explained,

Early on it was both research and management driving the need for research . . . A bunch of us had base funding and worked closely with managers. We understood their concerns and were able to translate. We performed a joint function; managers would come to us with money to give and help with the work. It was a collaborative approach. We were certainly independent from managers, but there was constant dialogue. [I] dealt with Chiefs, supervisors, rangers . . . Now, that cooperation is completely gone. The agencies have lost their way. Timber harvest is gone, resources gone, money, expertise—gone.

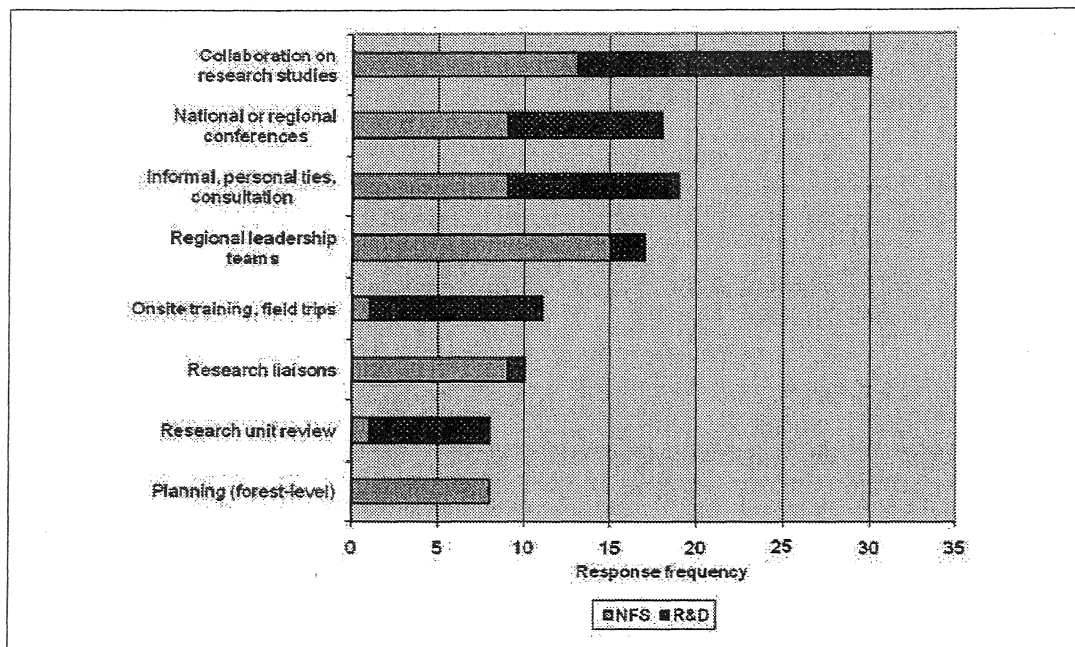


Figure 1. Current science exchange interactions

Note: There were 58 National Forest System (NFS) respondents and 20 R&D scientists in the sample.

Whereas some described the gradual decline in collaboration between managers and researchers over time, others had seen a recent surge in interaction.

Over the last three years, there has been increasing interaction with Forest Service social scientists. They are showing more willingness to meet the decision demands of the day. I can't speculate on why this has changed. We all learn together on what needs to be done. But, management does not always know what to ask and how to ask it.

Several managers mentioned that the new performance and accountability standards (evaluating the quality and relevance of research) issued by the Office of Management and Budget may be encouraging researchers to reach out to managers to ensure that their research products are relevant for management needs.

Conferences and workshops were mentioned by both managers and researchers as primary venues for interaction. The regional recreation conferences discussed earlier as well as the national workshop in Portland in 2005, were mentioned by many respondents. One researcher explained that in the 1970s and 1980s, there was a "flurry" of recreation workshops related to specific themes (e.g., wild rivers; wilderness). These smaller meetings were subsumed by the International Association for Society and Natural Resources, but that association expanded their focus beyond recreation and these topics are not dealt with in such a focused way.

Some types of interactions were mentioned more often by researchers than managers. For example, researchers were far more apt to note on-site technology transfer activities, such as issue-based workshops, joint field trips, short courses, and other means of direct, face-to-face interaction. In addition, researchers were more likely to mention the importance of personal ties and informal relations with managers, though a few managers indicated that they had a circle of researchers they called on to discuss problems or brainstorm with for information sources. Researchers also pointed out their interaction with managers in conjunction with research

program or unit reviews, as well as manager involvement in the development of station or unit strategic planning processes and technical assessments.

Managers were more likely to note formal settings where interactions took place with FS R&D. Several mentioned that researchers were involved with station leadership teams at higher levels of administration (regional office level). Others noted that FS R&D representatives participated in regional planning efforts, and a few respondents were aware of formal research station liaisons colocated at the regional offices that were responsible for linking research and management priorities. Interestingly, very few researchers in the sample mentioned these higher-level, more formal means of interaction. Managers readily noted researcher participation in forest or local planning processes, although this was seldom acknowledged as a form of interaction by researchers, who perhaps did not perceive this as constituting "research." This preference for "formal" interactions between research and management may be a response to a trend toward greater accountability between research and management. As one NFS social scientist explained,

Interactions should be more formal. This would probably cause a mutiny among scientists, but funding is not going up and the NFS is under the gun to produce documents and come up with plans. They need to be able to go to research and get what they need.

Ideal science exchange interactions. Managers and researchers in the Forest Service were asked to characterize their "ideal" interactions. Although many similarities between managers and researchers are evident, again important differences emerged from the analysis (Figure 2). Both heralded the need for collaboration on recreation research, developing channels for communication of information needs on a regional and national level, and creating forums for sharing research results and new applications.

The benefits of collaborative research were noted by many respondents, and these involve working together to identify pressing issues in recreation management, establish information needs, frame research questions, and cooperate in data collection, analysis and interpretation as well as monitoring. As one manager explained, "Ideally, you would present problems, issues, or thoughts about the data you thought you were lacking, or that you needed, to researchers. Researchers would help you design a study to get information that you were lacking." An NFS social scientist also emphasized, "For nuts and bolts issues, you need the actual 'working-together time' more than just reading the paper, but working together with researchers on a team." The collaborative approach was preferred by managers because of the blending of expertise, including on-the-ground the knowledge of managers with conceptual frameworks of researchers. Collaborative interactions were often contrasted with more top-down approaches, where researchers arrived with predeveloped questions and prepared research agendas that met their needs for scholarship, but did not address a pressing resource issue. This finding is consistent with studies indicating that collaboration and direct contact between researchers and managers are often more effective and preferred means of sharing information (Graham & Kruger, 2002; White, 2004; Youngblood et al., 2007).

In addition to collaborative research, both managers and researchers sought venues for the open and direct transmission of information needs. Managers sought ways to communicate these needs both within the Forest Service and to the research community. As one manager clarified,

We should be asking managers at the lower level what their needs are. There should be direct communication to identify priority research needs. I don't know where this is occurring and am not sure if the information is getting down to our level.

An NFS social scientist added, "It would be nice to be in the same room and realize that you have a pot of money." Researchers also sought ways to gain direct insight about science that could

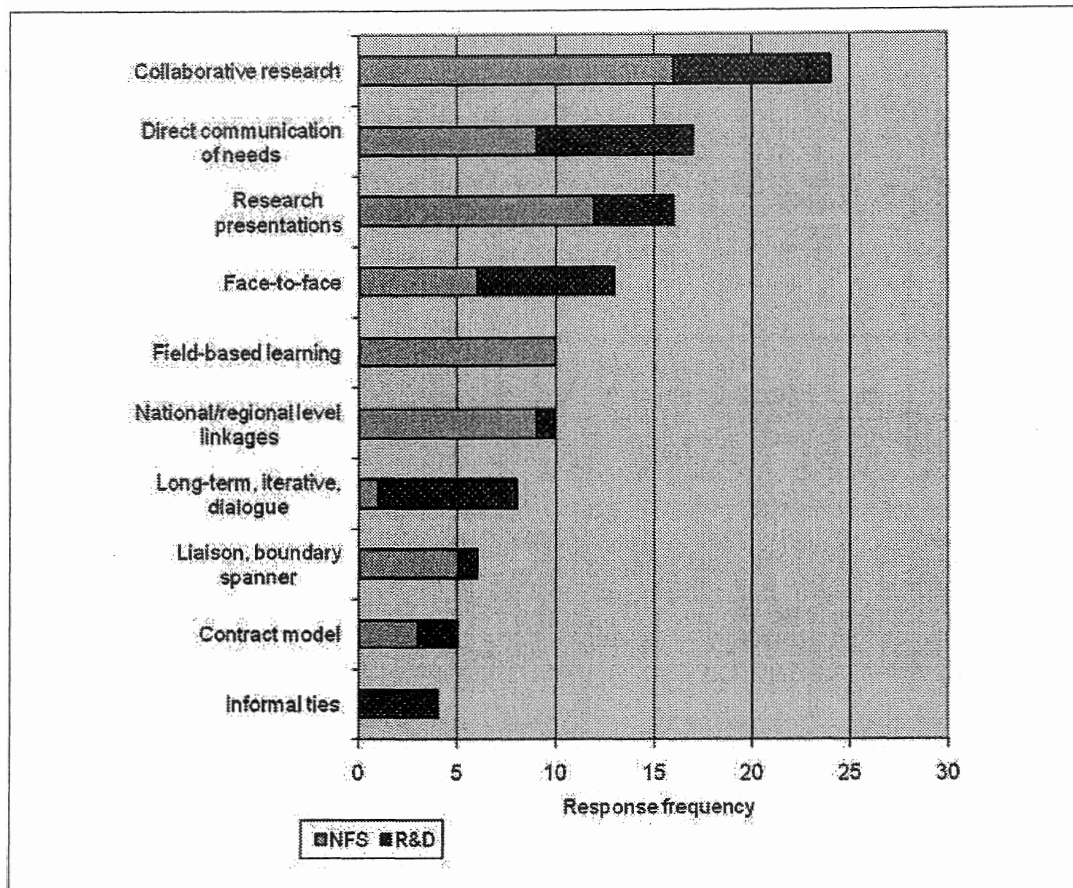


Figure 2. Ideal science exchange interactions

Note: There were 58 National Forest System (NFS) respondents and 20 R&D scientists in the sample

benefit managers. In developing mechanisms for the sharing of information needs, researchers may need to be clear and realistic about the nature of their role and approach. One recreation manager described this problem.

The problem managers have is that they go to researchers and say, "I have this problem, solve it." What is preferred is that the manager says, "I have this problem," and the researcher says, "Have you thought of a, b, and c."

Researchers may not always be able to address discrete problems immediately through empirical research, but may be able to help managers to frame the problem in a way that appropriate information can be sought. The California Recreation Roundtable, initiated by state officials and made up of recreation professionals, academics, agency researchers, and others, was mentioned as an example of effective interaction resulting in direct science exchange. According to managers, an ideal world would include more opportunities for local and regional problem framing and information exchange.

Managers stressed the value of embedding researchers into ranger districts and field sites to help them gain understanding of the daily realities and on-the-ground problems faced by resource specialists and rangers. Some noted the value of extended field trips where managers from various levels in the agency and researchers visit field sites together and identify problems that could be

addressed by recreation researchers. Managers felt strongly that researchers could benefit from a deeper understanding of the recreation setting and the complex operating environment managers face. These remarks reflect a shared perception among managers that researchers may have lost touch with the real-world of recreation management. Interestingly, few researchers identified the need for field experience as a component of an ideal interaction with managers.

Meanwhile, researchers were more likely to identify the need for long-term, iterative contacts that were based on professional interests and personal ties. They mentioned the need for informal ties, rather than a role in a formal planning process or review team, whereas managers presented ideals that included formal ties between divisions at the national and regional level. Researchers were eager to develop close bonds with a few managers as a way to develop a long-term dialogue about issues of shared importance. As one researcher explained,

It is a continuous dialogue where people in each group know the other group and where they are headed and what their concerns are and might be. When a crisis or urgent information need comes up, then it is not so difficult to communicate and share information as it might be if there was less communication . . . Given the rapidly changing context of recreation resource management, it is critical that we maintain a dialogue and look for trends and prospects.

Researchers in the sample preferred to have more autonomy about the nature of their research direction and reiterated their role in addressing both long-term (fundamental) research questions in addition to short-term (applied) studies that addressed specific manager needs. For many researchers, the need for independence in setting their own agenda was paramount. This suggests that the autonomy of FS R&D may reflect an important theme in the agency's organizational culture, but that tension exists between autonomy and responsiveness. Innovative approaches are needed to build opportunities for more "ideal" science exchange interactions between managers and researchers that include both formal and informal processes and balance research independence with responsiveness.

Identifying barriers to science exchange. There was general agreement about the most persistent barriers to achieving ideal interactions, but our analysis revealed several distinct differences in the perceptions of managers and researchers regarding other key constraints (Figure 3). Some barriers were associated with the autonomous and independent nature of FS R&D or the lack of responsiveness of researchers to real-world concerns. The emphasis of FS R&D on the production of basic scientific knowledge that advances theory and methodology does not always mesh with the managers' needs for concrete information for use in planning models or for experiential cases that provide lessons and insights for making recreation management decisions. In addition, the publication schedule that is necessary for many researchers does not always match the manager's immediate need for information that addresses a real-time, pressing issue.

Managers and researchers recognize that although they inhabit the same agency, they operate in different professional worlds, with different goals, incentives, priorities, and measures of success. Some attribute the differences to the deliberate housing of research and management in separate divisions and the emphasis in FS R&D on more academic standards related to publications versus the need to respond to managers' issues. Consistent with the literature discussed earlier in this article, respondents observed that the structure of autonomous divisions results in a "wedge" or "chasm" between research and management. As one manager expressed, "There is an invisible wall between research and management that needs to be torn down. We need to get the researchers amongst us. They are too independent. You don't have the infusion unless you work amongst each other." Some recognize the importance of an independent research division, but urged the agency to bridge the gap so that research is more responsive to management concerns. As one manager explained,

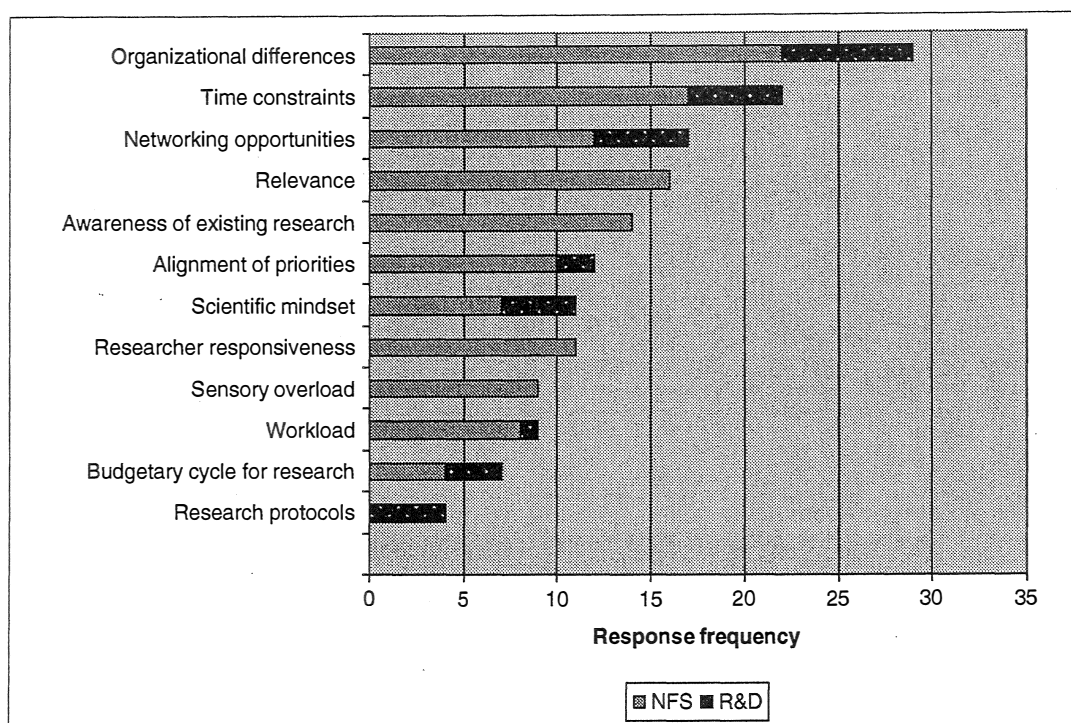


Figure 3. Barriers to achieving ideal science exchange interactions

Note: There were 58 National Forest System (NFS) respondents and 20 R&D scientists in the sample.

Researchers feel a need to maintain their professional independence. But, we are not asking them to alter their findings to fit our needs. I find that hollow. It's more that researchers feel that rubbing shoulders with the real world will tarnish their lofty distance.

One aspect of this barrier is the focus of FS R&D on basic science and long-term studies. As one manager put it, "There is a cultural barrier. There is separation between valuing research which is longer term, versus acquiring immediate answers." Differences between managers and researchers have been described as a barrier to information and technology exchange in the context of other studies as well (Sydoriak, 2007; Wright, 2007). As a manager succinctly stated, "It is inarguable that an agency that has a research branch should focus on agency issues."

Another aspect of this operating reality lies in the incentives and reward systems that motivate researchers and managers. Researchers in FS R&D are rewarded most highly for publication in peer-reviewed journals. Direct technology and information transfer is sometimes perceived by fellow researchers to be of secondary importance for a researcher's promotion. The emphasis on publication of scientific articles often means that the researcher does not make time for disseminating results in a format that managers may readily access. Meanwhile, managers are charged with addressing problems faced on-the-ground. One manager commented,

Research doesn't always focus on immediate management needs. They are focused on publications, while managers are focused on immediate problems. The reward system is different for researchers versus managers. It would be heaven on earth to have a social scientist working with us on these issues.

Time constraints also present a barrier. Managers and researchers alike acknowledged that the needs of managers for immediate answers contrasted with the emphasis in FS R&D on long-term

studies, basic research, and the development of theoretical models and methodological approaches. Researchers acknowledged that their results took time to produce and often did not meet the timing needs of managers. This researcher respondent captured the sentiments of many:

Sometimes the timeliness of getting information [is a concern.] They [managers] come up with questions that they need immediate answers for, but have to wait a few years for the study. You have to predict what questions you want answered.

These responses reflect a need for applied research that is responsive to manager needs. Recreation managers often rely on private consultants and universities for this type of research, though funds for conducting these types of “administrative studies” are growing scarce (Cervený & Ryan, 2008).

The absence of professional networking opportunities to gather for science exchange was identified by managers and researchers as another barrier to science exchange. One researcher reflected on science exchange in his early career,

There has been a diminishment of formal structures. In any given year in the first decade [1970s] one could guarantee 4 to 10 major recreation management meetings across the country on a regular basis. I would be invited to come . . . Managers were creating the venues in which interaction was taking place; we were debating and discussing policy issues. There were ready-made opportunities to say: Here is what we are doing, and listen to what we may be doing. That is virtually non-existent now.

Both researchers and managers explained that leadership was needed in FS R&D.

The networks don't exist for researchers. The social scientist linkages have been broken. The Washington Office does not provide leadership or a home for social scientists.

The need for national direction along with a recreation management strategy to develop, fund, and sustain opportunities for interaction was frequently mentioned.

A prominent concern for recreation managers was the relevance of existing recreation research and the need for studies grounded in real-world experiences. Although managers often acknowledged the value of long-term basic studies, many were frustrated by the dearth of applied research, experiential case studies, and applications useful for managing in a complex environment. As one manager explained succinctly, “Managers are more focused on users and recreationists rather than looking at an issue in a scholarly fashion.” Managers discussed ideas for exposing researchers to the realities of the field, through field trips, details, and sabbaticals. Although many examples were noted of R&D researchers whose work had been responsive to manager needs or who provided information of immediate use, one-third of the managers in this study expressed a concern about relevance.

Lack of awareness of the body of work produced by R&D units was another barrier mentioned by managers. In some cases, recreation managers were simply unaware that any researcher teams in FS R&D focused on social sciences or recreation. Approximately 30% of the managers in the study indicated that they were unaware of what recreation research was available, who in R&D was engaged in recreation studies, or how to contact them for assistance.

Managers also stated that a significant barrier to improved interactions is the lack of formal alignment between resource management goals and priorities and those of FS R&D. Several managers and NFS social scientists described the need for mutual strategic leadership meetings for FS R&D to more closely match their research programs with the problems managers face on the ground. These meetings should take place both at the Washington Office of the Forest Service as well as in Regional Offices.

The absence of a scientific mindset among recreation professionals was frequently noted not only by researchers but also some managers. Downsizing and a decline in funding for professional training of recreation personnel was deemed partly responsible for this waning human capacity. Many respondents noted that a large number of current recreation specialists do not have formal training in recreation and are less comfortable with social sciences. As a result, they may lack knowledge of the core principles of recreation management, awareness of the history of recreation research, or understanding of the ways that research and science-based applications might assist them in addressing everyday management problems.

Responsiveness and availability of researchers in FS R&D was mentioned as a concern by managers. A few noted that they had contacted Forest Service researchers for assistance with questions, problems, or information needs, but researchers were unable or unavailable to help. In other cases they were told that there were no researchers in the FS R&D network available to address a particular problem or need in the short-term.

Other managers talked about sensory overload and heavy workloads. Several managers described the challenge of being overwhelmed with information, e-mails, and electronic "chatter." Increasingly, researchers are using Internet and Web-based communications to disseminate research findings, rather than through training and other in-person interactions. For some, overreliance on electronic dissemination impedes the adoption of science. Several managers felt that FS R&D relied too heavily on electronic communication, eclipsing the need for direct interaction for science exchange. Heavy workloads were noted by many managers, as reductions in personnel have resulted in increased responsibility in areas other than recreation. Managers noted that they were doing the jobs of two or three people, allowing them little time to concentrate on recreation science or read journals with recreation findings. Under these conditions, achieving an ideal interaction with researchers is very difficult. Managers referred to being in "crisis management mode" or "stuck in the trenches" and unable to take time to consider big-picture issues. As one NFS social scientist explained, "The folks on the ground are struggling to get the work done—the work they have now. They are doing work with fewer people. And, they are paying attention to more projects."

The ability to fund research was another barrier, and managers explained that they had little discretionary money to fund recreation research. Long-term basic studies were viewed by some recreation managers as a luxury in this era of budget reductions and although many considered science important, it was often trumped by other priorities. Several managers said that they lacked funds to travel to recreation conferences or to sponsor recreation workshops in their area. Meanwhile, they noted that researchers also were challenged by budget constraints and were moving away from recreation in favor of topics with more substantial funding, such as fire. Some researchers had seen declines in their base funding and were relying more on clients to pay for research. According to researchers in the study, support for recreation research varies widely among research station directors. Researchers in FS R&D seek foundation support and other "soft-money" sources for recreation research, but funding options are slim, compared with other higher profile topics, such as wildland fire and climate change.

Finally, researchers in the study explained that one of the biggest barriers they face in conducting research is related to research protocols, specifically the Office of Management and Budget (OMB) requirements for paperwork reduction and protection of human subjects (OMB, 2007). The requirements stipulate that any social science research involving more than 9 human subjects must be approved by OMB officers, who evaluate the study based on methodological approach, reliability and validity, content, and burden on subjects. The amount of time required to navigate OMB review can slow down a project by months or years, making it difficult for researchers to be immediately responsive to management needs and in some cases nearly impossible to conduct the social science research that is relevant for recreation managers.

Responding to Diminished Capacity: Addressing the Challenges of Science Exchange

Federal agencies such as the Forest Service rely on scientific information for management planning and decision making, and like many agencies developed in the 20th century, a distinct research division was established to generate and disseminate science for use in management. Interaction is a critical element in successful exchange of technology and information (Wright, 2006) and emerging structures to promote interaction may be used in combination to create an environment where researchers and managers can build trust as well as shared experiences, common language, and collegiality that are important elements for effective knowledge exchange (Rogers, 1995).

Our study findings suggest that in an environment of diminished agency capacity, an approach to science exchange that relies on informal ties and spontaneous interactions between managers and researchers appears to break down. The breakdown may result from lack of goal consensus or structural mismatches. In terms of goal consensus, it is apparent that the long-standing consensus within the Forest Service around mission has broken down and there are now competing demands from both inside and outside the agency (recreation provides an excellent example of these competing demands). The lack of goal consensus, or at least the emergence of more complex goals, is potentially a key variable that may help explain the discontinuity between the science and management units of the Forest Service.

In terms of organizational structure, the era of greater organizational specialization and increased outsourcing has led many organizations to develop practices for ensuring maximum utility and efficiency. It may be that outsourcing of some research functions is a possible solution, with joint research management by agency scientists and managers. Others have pointed out that by connecting research funding to the utilization of research, collaboration could be encouraged by financial resource motivations. Enterprise teams are one example where the agency has responded by encouraging internal competition for the provision of data and information.

Nevertheless, the opinions of the researchers and managers who participated in our study coalesce around the idea that interaction is optimal for science exchange, and they offered a number of suggestions for enhancing interactions between researchers and managers. The desire for a functioning "community of practice" was often mentioned. A community of practice is a group engaged in mutual learning through shared terms, concepts, history, and experiences (Wenger, 1999). It requires a strong cohort group, a sense of common identity, and professional networks that foster rapport, understanding, and a shared vocabulary. Furthermore, trust is a key factor that influences whether scientific knowledge actually gets used or applied (Alderman et al., 2007; Wright, 2005), and effective communication occurs when individuals share common background, training, institutional setting, and purpose (Rogers, 1995). Developing a community of practice for forest recreation may lead to more frequent and fruitful interactions between managers and researchers. Our findings indicate that the recreation management community of practice has eroded as a result of budget constraints, personnel shifts, increasing workloads, more complex agency mission, and staff being pulled from recreation into other areas of research and forest management.

Managers and researchers in our study suggested conferences at the regional or national level geared toward identifying current information and research needs, sharing recreation research, databases, and applications, creating issue-oriented sessions, and promoting networking opportunities. This could be accompanied by publication of proceedings, a newsletter, or journal. Some researchers suggested taking advantage of an existing meeting, such as the International Symposium for Society and Natural Resource Management, as a venue for recreation managers and researchers to interact.

In addition, researchers suggested that greater emphasis be placed on targeted workshops that focus on particular management issues. A variation on the workshop idea is the notion of a field-trip or “workshop in the woods” that includes a combination of researchers and managers who visit sites together and collectively engage in the process of problem identification, brainstorming, and developing researchable questions. On-site training sessions, where researchers come to Ranger Districts and National Forests to share their research findings, applications, and models were also mentioned as desirable. Managers offered that researchers periodically embed themselves “in the field” through sabbaticals or temporary detail assignments to national forests. These field experiences would not only promote greater understanding of the complexity and breadth of issues faced by recreation and other staff at the forest level, but also generate opportunities for expanding professional networks. Assigning managers to research units in temporary positions may also foster this type of interaction.

Managers mentioned that they would appreciate working with intermediaries between research and management, who not only were keenly aware of on-the-ground management problems but also had access to state-of-the-art research. Based on the original conceptualization of NFS more than 100 years ago, the tasks of translation, extrapolation, synthesis, and application of study findings to management settings is assumed by regional-level managers who distill and disseminate to forests and districts. However, other critical tasks draw them away from these functions, and managers at the ground level are expected to find their own ways to access and apply relevant scientific information. Several suggestions were made to place technology transfer specialists, extension agents, or “boundary spanners” into the middle ground between research and management and to develop units geared specifically to science exchange. Finally, several respondents (especially those in the NFS), suggested that interaction between researchers and managers should take place more formally at the regional level, with shared agendas and priority setting between Regions and Research Stations.

Conclusion: Building and Maintaining Capacity for Science Exchange

Organizational capacity is a dynamic notion, requiring agencies to adjust to new conditions and respond to changing factors in the external and internal environment that affect their ability to achieve their goals (Horton et al., 2003). As pointed out earlier, policy implementation problems are directly linked with insufficient resources, including trained and educated personnel (Goggin et al., 1990; McDermott, 2006; Miller, 2000). Our study illustrates a decline in trained personnel and a lack of sufficient funds, requiring that steps be taken to enhance opportunities for science exchange interactions. However, researchers and managers inhabit different worlds, with unique sets of goals, values, ideologies, and operating conditions that impede the extent to which knowledge is used (Beyer & Trice, 1982). In addition, agencies in which scientists focus on the production of scientific articles for publication are less likely to engage in technology transfer (Rahm et al., 1988). Our study identified several barriers that must be overcome to enhance science exchange.

The Forest Service has traditionally focused on maintaining its scientific approach, yet the separation of science and management, along with the expectation that technology transfer and science exchange will occur spontaneously (without dedicated funding or support) has resulted in a chasm between research and management. The research arm of the agency appears to be somewhat “stuck” in its scientific management paradigm, whereas the management arm appears to desire a more adaptive use of knowledge. This is compounded by the fact that all facets of the agency are embodied within a scientific management structure, leading to stark contrasts in perceptions and expectations of what science can and should do for managers and the institutional constraints associated with realizing those expectations.

Our findings suggest that managers and researchers have different expectations and ideas about how to promote science exchange interactions. Managers rely on more formal structures

to promote exchange and are not averse to working with intermediaries, such as technology transfer specialists. Researchers gravitate toward more informal, long-term, personal interactions with particular managers as a way to foster science exchange. Our findings also indicate that both formal and informal interactions between researchers and managers are needed for effective transfer of scientific information. When faced with declines in human and budget capacity for recreation, relationships between management and research break down. Commitment from all levels of the agency to bridging this divide is necessary. In spite of this rather bleak outlook, there are several examples of the agency taking steps to shift its efforts and capacity toward technology transfer and science delivery, allowing researchers and managers to find ways to interact for science exchange.

One example of an innovative program in FS R&D is the Focused Science Delivery (FSD) Program at the Pacific Northwest Research Station. The goal of the FSD Program is to develop and disseminate science products that integrate information across many disciplines and at various spatial scales. FSD is organized around short-term strategic natural resource initiatives, including a recreation and tourism initiative, which brought researchers and managers together for a national workshop in 2005. FSD emphasizes long-term collaboration between clients and researchers to frame problems, contemplate solutions, and disseminate results. Another FS R&D project is "RECopedia," an online synthesis of recreation research organized around topics relevant to managers and clients. The goal of the project is to enhance visibility and increase dissemination of recreation research among resource managers and is planned to be launched by 2010.

The NFS has also recognized the gap in knowledge exchange between research and management. The Forest Service established a human dimensions network which includes social scientists operating in National Forest regions as well as enterprise teams and units devoted to research and science delivery. Our interviews with these social scientists showed that many function as liaisons between research and management within the agency as well as universities and other agencies. Social scientists in NFS perceive part of their role to be research liaisons, but spend the bulk of their time assisting NFS staff in forest planning and revisions, National Environmental Policy Act assessments, and other types of planning and monitoring.

Boundary spanners and enterprise teams are additional examples of NFS initiatives to promote science exchange. A boundary spanner is an organizational member who serves as a link between departments, divisions, or agencies for the purposes of exchanging information (Daft, 1989). The boundary spanner concept has been around since the 1970s in business management and was introduced in the mid-1990s to the Forest Service. Individual boundary spanners were identified throughout the agency with the goal of connecting relevant science with management, though the effort was not funded and eventually fizzled with a change in administration. A boundary spanner approach was applied in the Bitterroot Ecosystem Management Research Project, where challenges were faced in organizing and communicating data collection efforts as a result of a massive fire in 2000. The role of the boundary spanner was to foster dialogue and science exchange among researchers and managers and to promote technology transfer and outreach (Ritter, 2006). Enterprise teams were introduced in 1997 as part of the National Partnership for Reinventing Government to encourage innovation and efficiency through competition. Enterprise teams operate as discrete units internal to the Forest Service that take on specific roles and compete with the private sector for projects. One enterprise team, Recreation Solutions, deals specifically with data collection and monitoring for recreation projects. These examples demonstrate that the Forest Service is indeed finding new ways to link research and management, while working within the existing structure of separate but mutually modifying divisions.

The State and Private Forestry (SPF) Division represents an important and untapped opportunity for science exchange in recreation. SPF emphasizes agency cooperation with state natural resource agencies, tribes, communities, and private landowners to share information relevant to forest management. SPF provides both technical and financial assistance to state and private landowners through special programs, with particular emphasis on protecting forests and communities

from fires, disease, invasive species, and insects. Recreation is not currently a focus area for SPF, but the division has built significant capacity and expertise in education and knowledge transfer, and has potential to play a greater role in science exchange for recreation management.

Illuminating and learning from these examples provides a foundation for new organizational structures and processes that promote a reinvigorated community of practice and more effective interactions for science exchange and application. Consistent with our findings, the innovative approaches discussed above illustrate that although managers and researchers have different expectations and ideas about how to promote interaction, the agency is embracing approaches that assist in reducing the gap. As the operating environment changes, agency capacity to produce and use science can be enhanced and monitored to facilitate science exchange.

Appendix

Interview Guide

A. Background (for All Respondents)

A1. Tell me a little bit about your background and professional history

- Where are you from?
- What did you study in school?
- What other training have you had (relevant to your current position)?
- How many years have you worked for the Forest Service?
- How many years have you worked in this [ranger district/forest/station]?
- What other forests/districts/stations have you worked in? Other positions held?

A2. Tell me about your job

- How long have you held this position?
- What are (were) your responsibilities? What is your job description?
- Has your job changed over time? How?
- Does your (current) job title accurately reflect your position description?
- Why or why not?
- [If not] What title would you give yourself that better reflects what you do?

A3. (for Researchers). Now let's talk about your research

- What (or who) originally inspired you to work in recreation? What shaped your interests? [How did you get interested in recreation?]
- Can you describe some of your early research with the Forest Service? What were some of the early problems/issues in recreation that you worked on?
- What were some of the issues and problems that followed? Can you bring me up to the present?

B. Recreation Management Issues and Approaches (for Managers)

B1. What have emerged as the most significant recreation management issues that you have faced over the course of your career?

(continued)

Appendix (continued)

- What were the issues? Could you give me some examples?
- How did these issues become issues? (Who/how decided it was an issue?)
- Have you notice changes over time in how issues are identified (become issues)?

B2. How did you initially respond to the issue/problem? (What was/is your approach for dealing with the issue?)

- Did you seek out information to help you? (If so, where did you look?)
- Did you turn to other individuals or institutions (agencies) for help? [internal/external]
- [If so,]What assistance did they provide? How did they help you?
- What other resources did you employ to help you address the problem?
- Was this a typical approach for you to deal with an issue?
- Did you feel you had appropriate and adequate skills and resources to address this issue? Why/why not/examples

B3. Now I want to ask you about the role of research in resolving these recreation problems and issues

- What were your greatest information needs with regard to recreation management or planning?
- Have you had opportunities to communicate your needs? In what ways?
- Does the Forest Service have structures or processes to encourage interaction between managers and researchers? (Does this take place on a formal or informal basis?)
- Have you worked with recreation researchers to address these issues? Give examples of how . . . [e.g., *workshops, conferences, one-on-one, indirectly*] Also who, context, setting
- What types of interactions have been most effective for you?
- Have there been studies, tools, or models that you have found to be useful? (in recreation management, planning, or decision-making) Why?
- What is the best way for you to access research/scientific information? What format of presentation has been most helpful to you? [e.g., *technical reports, computer models, manuals, presentations, websites, workshops, videos, demonstration projects*]
- How important (or relevant?) is research information to recreation management decisions? (What other factors influence recreation actions and decisions?)

C. Research–Management Interactions Over Time (for All Respondents)

C1. Have you had the opportunity to interact with researchers/managers to address recreation issues during your career?

- In what ways have you worked with researchers/managers?
- How would you characterize or evaluate your interactions with researchers/managers?
- Were researchers/managers accessible? Did they respond if contacted?

(continued)

Appendix (continued)

- What aspects of these interactions did you find successful or productive? Examples Why?
- Have you observed any particular challenges in working with researchers/managers?
- Have you observed any trends/changes over time in the interactions?

C2. How might you describe an “ideal interaction” between managers and researchers in addressing resource management problems?

C3. What factors prevent or enable this “ideal interaction” to occur?

C4. Do you have a regular group of researchers/managers with whom you interact to address resource management issues? Who?

D. Institutional Capacity for Recreation Management (for All Respondents)

Now let's talk about your observations/thoughts on recreation management in the FS over time.

D1. How has *recreation* (broadly) been viewed within the Forest Service over time? Have you noticed any changes in support for recreation?

D2. Have you noticed trends or changes in support for *recreation research* over time?

D3. Have you observed any changes in training for recreation staff over time?

D4. Have you noticed any changes in responsibilities of recreation staff over time?

D5. Have you observed any changes in the capacity (ability) of researchers to convey or communicate relevant research findings to Forest Service resource managers? (e.g., workshops, conferences, trainings, reports)

D6. Have you observed any changes in the capacity (ability) of the Forest Service to communicate the needs of resource managers to researchers?

D7. In your view, what should be the role of Forest Service research?

E. Wrap-up

E1. Is there anything else related to the interaction between recreation research and management that you would like to discuss?

E2. Do you know of specific district or forest level researchers/managers with knowledge on this topic that you would recommend I interview?

E3. Would you be willing to be contacted in the future about this research or participate in a workshop on this topic?

Authors' Note

The views expressed here are those of the authors alone, and do not represent any official position or policy of the U.S. Forest Service.

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