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Research in Adaptive Management: Working Relations and the Research Process

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Abstract

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This report analyzes how a small group of Forest Service scientists participating in efforts to implement adaptive management approach working relations, and how they understand and apply the research process. Nine scientists completed a questionnaire to assess their preferred mode of thinking (the Herrmann Brain Dominance Instrument), engaged in a facilitated conversation to "map" their ideas about research (Conceptual Content Cognitive Mapping, or "3CM"), and participated in several open-ended interviews. Recommendations are made for future adaptive management efforts, and propositions for further study are suggested.

Keywords: Adaptive management, social learning, collaboration, research, natural resources.

Summary

This report analyzes how a small group of Forest Service scientists participating in efforts to implement adaptive management approach working relations, and how they understand and apply the research process. Nine scientists completed a questionnaire to assess their preferred mode of thinking (the Herrmann Brain Dominance Instrument), engaged in a facilitated conversation to "map" their ideas about research (Conceptual Content Cognitive Mapping, or "3CM"), and participated in several open-ended interviews. Scientists' orientations toward working with others, particularly nonscientists, ranged from highly collaborative to relatively independent. Scientists also displayed wide variation in their perceptions of science, from science as an open-ended, value-laden process to more traditional views of science as objective and oriented toward ascertaining conclusive truth. A holistic and collaborative orientation among leading science participants seems to be a necessary but insufficient condition for social learning and the fulfillment of adaptive management objectives. Recommendations are made for future adaptive management efforts, and propositions for further study are suggested.

Contents

Introduction

The Adaptive Management Context

Managing natural resources at the national level is a complex undertaking. Agencies at this level frequently face the dual challenges of ensuring that the scientific bases of their work are rigorous and credible and that their management practices are responsive to a diverse and dynamic set of stakeholders, legislative overseers, and environmental conditions. These challenges often seem to be in competition with one another.

This paper examines how scientists approach adaptive management, a merger of science and management intended to enable scientists and managers to work hand in hand. Adaptive management, a concept first articulated by Holling (1978), has been used in natural resource contexts such as fisheries management (Halbert 1993) and balancing salmon restoration with energy conservation (Lee 1993). The essence of adaptive management is that management should be designed as an opportunity for learning (fig. 1). Like Lee (1993), we follow Dewey's notion that learning is the "reconstruction or reorganization of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience" (quoted in Lee 1993: 136). In adaptive management, lessons learned through scientific study and management activities should be deliberately planned, gathered, and incorporated into future management and research activities. **Adaptive management calls for the integration of science and management** and for researchers and managers to work collaboratively with each other and with the public: adaptive management thus requires major changes in how scientists and managers approach their work (Stankey and Shindler 1997: 13). This innovative approach to natural resource management has received increasing attention during the past decade, creating both the opportunity and the need for exploring the challenges associated with shifting from more traditional management approaches to adaptive management. The primary research question addressed by this study is, To what degree do the practices and perspectives of key adaptive management participants reflect an orientation conducive to adaptive management?

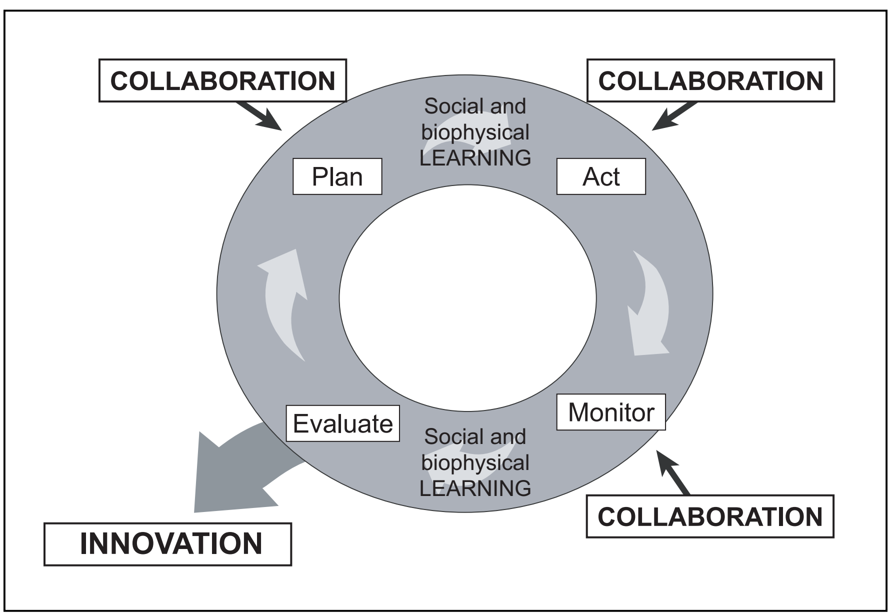

Figure 1—The process of adaptive management.

We first describe a theoretical framework for examining adaptive management efforts based on social learning theory and the concepts of the learning community and learning organization. We then examine the experience of agency scientists in one of the most ambitious experiments in adaptive management to date: the USDA Forest Service and USDI Bureau of Land Management adaptive management area (AMA) program. The AMA program, begun in 1993, designated 10 areas in the Pacific Northwest for experimentation with adaptive ways of managing land and natural resources. The intent of the AMA program was to develop a deeper understanding of how to implement adaptive management so that it could be expanded and extended (FEMAT 1993: III-27). In the context of the AMAs, adaptive management was described as "a continuing process of action based on planning, monitoring, evaluation, and adjustment" (FEMAT 1993: VIII-17). Although the AMA program provides context for the current study, our focus remains oriented toward the principles of adaptive management rather than on the success of the AMA program.

Scientists were appointed to spearhead science projects on each AMA. In most cases, natural resource scientists were recruited and then appointed to these positions. Regulatory guidance only specified that these research scientists would lead the design of research on their respective AMAs (USDA FS and USDI BLM 1994: D-5). Although science on the AMAs was not necessarily limited to the activities of these scientists, the "lead" scientists were intended to play a central role in implementing the agency vision of scientific participation. This vision entailed reconfiguring relations among social groups (scientists, managers, and citizens) and between society and the natural environment.

In the words of Lee (1993: 6), "science linked to human purpose is a compass: a way to gauge directions when sailing beyond the maps." Science contributes the engine for learning to adaptive management; without science, adaptive management becomes unreflective operations uninformed by rigorous examination and pursuit of possibilities. Without key scientists, this vital learning component of adaptive management may run adrift.

Science in adaptive management differs radically from classical or traditional notions of science: adaptive management scientists must respond to social contexts (which include often-conflicting groups of citizens, industry, environmentalists, and other natural resource users); be able to operate under conditions of complexity, unpredictability, and risk; and work over large landscapes, to name a few of their most significant challenges. In addition, Stankey and Shindler (1997: 9) note that "a more cooperative and collaborative approach (to knowledge) that sees personal or experiential knowledge as rich, relevant, complementary, and the source of insight that verifies or challenges scientific understanding will likely prove beneficial" to implementing adaptive management.

Thus, the scientists in our AMA study were subject to the competing demands of the traditional approach to science in which most of them were trained, as well as the adaptive approach to science required by their new position. The role of scientists within the adaptive management area program—how they were to carve out their responsibilities to citizens, managers, program objectives, etc.—was not clearly defined at the outset of the AMA experiment. This ambiguity created both limitations and opportunities for scientists.

To get a better idea of the practices and perspectives of study participants, we supplemented open-ended interviews with two cognitive methods oriented toward cognitive thinking: the Herrmann Brain Dominance Instrument (HBDI) and Conceptual Content Cognitive Mapping (or 3CM). We conclude the report with many considerations for adaptive management practitioners, as well as research questions for future study.

This study does not assess the capacity of scientists to succeed in adaptive management; such a study would require data on adaptive management performance, a goal beyond the scope of this study. Rather, this study focuses on an assessment of scientists' **orientations**, in order to develop a baseline understanding of the experience of participating in adaptive management and social learning. A study of capacity and success in adaptive management would be a logical followup to the current effort. This study offers a theoretical framework for understanding adaptive management work, a set of questions to help guide future research, and the identification of several areas of potential concern for managers and administrators currently engaged in designing or implementing adaptive management programs.

Synthesis of the Literature and Conceptual Framework

The concept of adaptive management involves the merger of science and management. Management practices should be deliberately and explicitly designed as experiments so that learning is maximized and reincorporated into management practices. Science should be open to and informed by the questions and concerns of managers and citizens who are intimately involved with the land and natural resources that will be affected by results of scientific studies.

Yet the concept of adaptive management itself offers only limited guidance for the social structures and processes necessary to achieve such goals. The guiding principle of adaptive management is summarized in the phrase, "learn to manage and manage to learn." For a framework to understand and assess the **doing** of adaptive management, we turned to theories of **social learning** (fig. 2), the **learning community**, and the **learning organization**, which are all discussed below. These perspectives describe

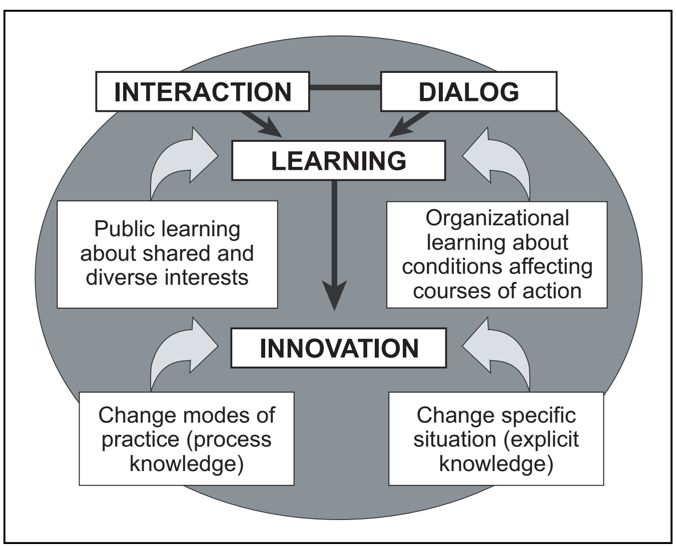

Figure 2—The social learning concept, including elements from the learning community and learning organization concepts.

	Social learning	Learning community	Learning organization
Working relations	1. Do working relations exist among scientists and other important adaptive management participants? (p. 14–20) 2. What is the nature of those relations: do they exhibit qualities of shared deliberation, open participation, and creativity? (p. 14–20) 3. What sort of forums or processes exist for the cultivation and maintenance of these relations? (p. 20) 4. To what degree have scientists' views of their work, their collaborators, their own roles changed as a consequence of their involvement in adaptive management? (p. 20–21)	5. Are dialog and engaged communication fostered? (p. 21–22) 6. Are scientists facilitative leaders? (p. 22–24) 7. Are public participants and managers involved in every step of the research process? (p. 24–25)	
Integration of working relations and science			1. To what degree are scientists' views of the world reflective of a system's view? (p. 27–28) 2. To what degree does their work reflect such a view? (p. 28–29) 3. What sort of "mental models"—of science, of adaptive management, of integration—do they hold? To what degree are these models characterized by complexity, interdependence, broad participation, or flexibility? (p. 29–33)
Science	1. What happens to the "process" knowledge produced in these contexts—is it recognized? Is it documented? Is it shared? (p. 25–26)	2. Is knowledge understood as contextual and provisional? (p. 26) 3. Is learning prioritized? (p. 26–27) 4. Who counts as a knower? (p. 27)	

Figure 3—Research questions from the theoretical framework.

social characteristics of an environment where learning is prioritized and integrated into the workplace; i.e., an adaptive management environment. Research questions for the current study are generated within the discussion of each of these perspectives (fig. 3).

Social learning—There are at least two distinct conceptualizations of "social learning" in the social science literature. In the fields of psychology and human behavior, social learning theory is the idea that internal, cognitive sources are primarily responsible for human behavior. Bandura (1977: 11–12) states that "in the social learning view, people are neither driven by inner forces nor buffeted by environmental stimuli. Rather, psychological functioning is explained in terms of a continuous reciprocal interaction of personal and environmental determinants." One successor to Bandura further circumscribes the concept by defining it as "learning by observation" (Blute 1981: 1401). Social learning theory from this perspective emphasizes that people learn and consequently modify their behavior in response to a combination of individual and social processes.

A different version of social learning theory is found in the public administration literature (Friedmann 1976, 1987; Korten 1981; Reich 1985). According to Friedmann (1987: 181–182), the central component of social learning theory is action: "social learning . . . begins and ends with action, that is, with purposeful activity. . . . It is the essential wisdom of the social learning tradition that practice and learning are construed as correlative processes, so that one process necessarily implies the other." Because the world is characterized by complexity, changeability, and stochasticity, Friedmann (1976: 7) asserts that the capacity of a society to act has its origins "not in our capacity to foretell the future, nor to design it, but to deal with it in the very process of happening." Learning takes place as people interact during this "process of happening." Friedmann identifies social learning as a mode of engaging in the development of tacit knowledge[1] (Polanyi 1966, Saint-Onge 1996). Friedmann (1987: 185) also notes that social learning fosters both single- and double-loop learning, where learners implement changes to specific situations, in the first case, and to modes of practice, in the second. Double-loop learning requires "a change in the actor's theory of reality, values, and beliefs," where an actor may be understood as an individual, a small group, an organization, or a community.

Two additional features of Friedmann's (1987) version of social learning are of particular interest. First, Friedmann (1976: 7) associates social learning with a capacity for innovation, noting "innovations cannot be planned in advance. They are truly emergents, unexpected events that seemingly appear from nowhere." He further asserts, "social learning systems should be structured so as to enhance the probability of innovation." Second, Friedmann's (1976: 8) social learning theory relies on dialogue and interpersonal interaction: he sees "face-to-face relations," particularly within small groups, as the primary site where change-oriented practice and learning take place. In sum, Friedmann (1976: 8) defines "social learning [as] a dialectical process, a process of reflexive action, that takes place in environments from which we learn in the very process of transforming them." By definition then, social learning happens in a context of engaged interaction, thoughtfulness, and a willingness to change—all of which mean that processes in which social learning take place are likely to be messy and uncomfortable, yet rewarding and exhilarating.

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[1] "Tacit" knowledge is often not recognized as knowledge, per se. Nonaka et al. (1996: 205) note that "Westerners . . . tend to view knowledge as 'explicit,' i.e., formal, objective," whereas the Japanese recognize and value knowledge that is "personal, context-specific, and not so easy to communicate to others"—i.e., "tacit" knowledge. Saint-Onge (1996: 10) defines "tacit" knowledge as "the intuition, perspectives, beliefs, and values that people form as a result of their experiences. Out of the beliefs and assumptions in our individual mindsets, we make decisions and develop patterns of behavior for everything we do" (Saint-Onge 1996: 10). In the case of adaptive management, tacit knowledge includes knowledge about process: how to do things, what works and what does not work in particular settings, etc.

Korten (1981: 613) observes “the key to social learning is not analytical method, but organizational process; and the central methodological concern is . . . with effectively engaging the necessary participation of system members in contributing to the collective knowledge of the system.” He asserts that social learning is what makes deliberative, participatory planning and decisionmaking processes different from hierarchical, centrally controlled structures. Learning about issues of common concern takes place in the creative interaction among people. Stifling this social process sacrifices the capacity of a group or organization to engage in “innovative learning which is directed to creating new values, structures, and problem formulations.” Korten further contends that organizations must be restructured to facilitate social learning if society is to “negotiate successfully the transformation to a post-industrial form.”

Reich (1985: 1625) offers social learning as an alternative to “net-benefit” and “interest group” approaches to public administration, approaches in which “people’s preferences are assumed to exist apart from any process designed to discover and respond to them.” Reich argues that public views and values of public issues are affected and shaped by the manner in which they are addressed. Public administration that is informed by social learning allows people to discover latent public values that they have in common with others and, in the process, to create new public values. Together, citizens begin to define targets of voluntary action, to identify what they value most about the community, and to uncover goals and commitments that transcend their narrower self-interests. Not incidentally, along the way they achieve a deeper understanding of one another and refine their political identity (Reich 1985: 1637).

Krannich and others (1994), Shannon (1991), and Stankey and others (1999) extend the social learning concept to public participation and natural resource management. Shannon[2] (1991: 53) (emphasis in original) places social learning in a central role in planning and decisionmaking in natural resource management. She states that “the critical quality of a planning and public decision process should be the facilitation of learning: **public learning whereby citizens learn about their own and others interests and organizational learning whereby professionals learn about the conditions affecting and affected by alternative courses of action**.” Specifically regarding the public, Shannon (1991: 29) cites “civic conversation” as the experience of citizens coming together to discuss issues of concern. This opportunity for dialogue is also an opportunity for social learning: “It is through civic conversation that citizens invoke and create a vision of a shared future, which can serve to guide difficult decisions. Acting as citizens, people learn about their own interests and contribute to shaping the collective interest.”

Krannich and others (1994: 85) focus on the public participation activities that link federal agencies and the public, and suggest that the processes of “problem definition and solution generation comprise meaningful social learning” opportunities. They critique the inherently hierarchical nature of the traditional relations between the agency and the public, suggesting that social learning offers a way to make public participation more deliberative (Krannich and others 1994: 85–89).

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[2] Shannon, M.A. 1991. Building public decisions—learning through planning: an evaluation of the NFMA planning process. Unpublished report. On file with: L.E. Kruger, Pacific Northwest Research Station, Forestry Sciences Laboratory, 4043 Roosevelt Way NE, Seattle, WA 98105.

Stankey and others (1999: 443) note that "the core feature of social learning is a focus on action" and identify seven characteristics of social learning approaches. Their list provides a concise review of many of the points raised by authors discussed above. According to Stankey and others (1999), social learning approaches include opportunities for deliberation, recognition of the political nature of planning, involving all stakeholders who could potentially undermine a project, bringing together diverse perspectives, including nonscientific knowledge, and ensuring that actions taken are treated as instances of learning. Michael (1997) and Yankelovich (1991) also discuss social learning in planning and social decision processes.

Summary and application to study:

- Social learning is social and interactive, meaning it takes place in the creative interplay among people. Friedmann highlights this idea by emphasizing the crucial role of interpersonal interaction in social learning; Reich focuses on the creative aspect of social interaction, and how shared issues and values are shaped and defined through deliberation; Korten contributes to this theme by discussing social learning as fundamentally participatory.
- Social learning theory is inherently action and process oriented. Thus, learning is not a passive, exclusively psychological or cognitive process in this perspective; rather, it develops as people are engaged in some practical activity. Because outcomes cannot be predicted in the complex social and natural worlds, theorizing without acting will not produce the same results as emergent social learning. Yet, as Friedmann (1976: 8) notes, social learning is not just a case of glorified "learning by doing"; therefore, theory and making sense of unfolding situations are integral parts of social learning.
- Social learning produces process learning, also known as tacit knowledge or double-loop learning. Korten refers to social learning as a transformative process through which groups of people both reflect on and instigate change to social organizations and structures. Reich and Shannon extend the transformative effects of social learning to participants, stating that they develop new understandings of both themselves and each other when they are involved in thoughtful, practical deliberation processes.

To understand how science is incorporated into adaptive management, social learning theory directs attention to the nature and quality of the interaction of scientists with other participants. This study posed the following questions (fig. 3) to assess the social learning orientation of scientists:

- At the most basic level, do working relations exist among scientists and other important adaptive management participants?
- What is the nature of those relations?
- Do they exhibit qualities of shared deliberation, open participation, and creativity?
- What sorts of forums or processes exist for the cultivation and maintenance of these relations?
- What happens to the "process" knowledge produced in these contexts? Is it recognized? Is it documented? Is it shared?

- To what degree have scientists' views of their work and that of their collaborators changed as a consequence of their involvement in adaptive management?

The learning community and learning organization concepts are related, but each offers distinct insights into how social learning theory may be enacted. Aspects of both concepts are presented; the aspects pertinent to this study are summarized, and research questions are developed.

Learning Community and Learning Organization

Learning community—The notion of the learning community is a well-documented concept in literature on education and education reform (i.e., Gabelnick and others 1990). The power of this concept lies in its radical redefinition of the respective roles of teachers and students. Instead of the traditional hierarchical relations where students are the recipients of knowledge from teachers, students participate in the direction of their own learning, and faculty take on a more facilitative, less directive role. White (1992: 60) concludes, "these communities encourage students and faculty to work together and recognize a social and interdisciplinary context for learning. Most importantly, learning communities . . . [transform] the structures of institutions and thereby [facilitate] the long-term development of cooperative and collaborative pedagogies."

For Marshall and Peters (1985: 277), a key prerequisite for applying the term "learning community" is that the goal of learning takes precedence over other "vested interests" within the group. Their purpose is to incorporate evaluation into an ongoing, interactive process of learning. To them, the dialogic nature of the learning community is its most important feature, because it facilitates critical examination of the shared activities that make up daily life and that usually remain in the background. Thus "learning is construed not only in terms of questioning and changing particular rules and practices but also, and more crucially, it is concerned with how, in general, to question and change rules and practices" (Marshall and Peters 1985: 278). In this latter sense, it could be said to be "learning how to learn." Learning community collaboration requires that all participants be involved "in all aspects of the learning process, from the initial perception of a problem . . . through stages of implementation and monitoring . . . to its refinement and reconceptualization." Marshall and Peters' (1985) concept of learning community rests on an understanding of knowledge as pluralistic, historical, and provisional.

According to Prawat (1996: 92–94), learning in learning communities "is defined as a social act, more akin to socialization than instruction." Rather than acting as passive receivers of an instructor's knowledge, students are transformed into active participants in the process of understanding and creating knowledge. This transformation takes place as "interpretive stances are negotiated with rather than transmitted to students." To support these kinds of relations within a group, discourse must be founded on ground rules for behavior that value diverse perspectives, promote collective exploration of new and unexpected ideas, encourage participants to voice their questions, and foster a safe environment for making mistakes (Prawat 1996: 94). In this environment, Prawat (1996: 100) posits, "if our intent is to build social and intellectual connections between people, commitment may be a more relevant construct than control." Control, he (Prawat 1996: 98–99) claims, "inhibits the development of interpersonal connections [and] tends to distance people from one another," and interferes with the capacity for openness because it "is aimed at gaining mastery over self or environment, [and] it is not well suited to developing connections." Prawat (1996: 105) stresses that those who make the commitment to learning and to the learning community must be prepared for the "messiness," changeability, and unpredictability of the social systems in which they operate.

Ryan (1995) discusses learning communities in the context of the workplace. According to Ryan (1995: 91–93), a key aspect of creating a learning community is developing the individual and collective capacity to not know: "learning with others requires going public with 'I don't know' and acknowledging 'we don't know' sometimes," in order to be open to new ways of thinking and doing. Through the open dialogue that can take place in this environment of openness, meanings are shared and created, and community can take shape. Leadership is facilitative and shared—"in a learning community each person feels equally responsible for the 'success' of the community's learning"—and participation is characterized by reflection and curiosity: "learning communities . . . are a place where curiosity reigns over knowing and a place where experimentation is welcome."

Summary and application to study:

- The concept of a learning community responds to the complexity of the social world by creating an open, creative, participatory environment in which learning is collaboratively developed, rather than distributed from a central source.
- Two major features of learning communities are the facilitative leadership style and the participatory nature of group process.
    - Leaders are responsible for helping create and maintain an environment that involves learners and shares responsibility for learning among the entire community.
    - To maintain this level of participation, learning communities rely on commitment rather than control, cultivate dialogue, and foster a reflective, curious, experimental atmosphere for learning.
- Marshall and Peters (1985), Prawat (1996), and Ryan (1995) agree that the learning community process is a transformational one. Prawat's (1996) "ground rules" for discourse establish qualities of learning community collaboration: interaction should be characterized by openness, an exploratory spirit, receptivity to all questions, and acceptance of "mistakes."

The learning community model adds detail to the general concepts suggested by social learning theory. Research questions posed in this study to assess the degree to which an adaptive management situation resembles a learning community (fig. 3) include the following:

- Are dialogue and engaged communication fostered?
- Is knowledge understood as contextual and provisional?
- Is learning given priority?
- Are scientists facilitative when acting in a leadership role?
- Are public participants and managers involved in every step of the process?

Learning organization—Senge's (1994) articulation of the learning organization model is popular in the business world. Senge's learning organization is comprised of five "disciplines": mental models, personal mastery, shared vision, team learning, and systems thinking.

Systems thinking (Senge's "fifth discipline") is the most critical of the five. According to Senge (1994: 12), "it is the discipline that integrates the disciplines . . . without a systemic orientation, there is no motivation to look at how the disciplines interrelate." Senge (1994: 6–7, 68–69, 70–73) advocates a systems perspective where human society, and nature, are characterized by complexity, open-endedness, and interconnectedness. Systems thinking is a way to see interrelations within a whole, displacing the search for linear causality and a fragmented approach to analyzing situations.

Senge (1994: 175) uses the term mental models to refer to the images, assumptions, and stories that we "carry in our heads." They affect what we do, he reasons, because they affect what we see. Senge (1994: 8) holds mental models responsible for low levels of open-mindedness and entrenched ways of seeing situations that can lead to stagnant ways of doing business. He believes (1994: 174) that building awareness of these "deeply held internal images of how the world works" and their limiting effects, coupled with deliberate management of them, can contribute significantly to the capacity of an individual to help create a learning organization.

Senge (1994: 211–232) bridges from the importance of individual views to joint activity by noting that shared experience, ongoing conversation, a sense of interpersonal connectedness, and an awareness of individual and collective roles in creating current realities and future possibilities contribute to moving beyond personal and toward shared vision. Alignment toward a shared vision must be joined with a creative, generative capacity to produce team learning, and this capacity is found most clearly in dialogue (Senge 1994: 237–238). Senge (1994: 241) stresses the collective, creative, exploratory nature of dialogue, and asserts that "in dialogue, individuals gain insights that simply could not be achieved individually."

Summary and application to study:

- Senge introduces the notion of systems thinking, encouraging members of organizations to be aware of the irreducible complexity and interrelatedness of social and natural elements.
- Senge identifies cognitive starting points—"mental models"—as potential blocks to creativity, new ideas, and collaboration. The first step to being able to work better within these mental models is to recognize them.

Our study considers the following research questions in light of these learning organization concepts (fig. 3):

- To what degree are adaptive management scientists' and other adaptive management participants' views of the world reflective of a systems view?
- To what degree does their work reflect such a view?
- What sort of "mental models"—of science, of collaboration, of integration, of adaptive management—do they hold?
- To what degree are these models characterized by complexity, interdependence, broad participation, and flexibility?

Synthesis and Framework for Analysis

By definition, adaptive management is a reflective process. Participants in adaptive management monitor and evaluate their activities at both a process and a substantive level, identify lessons learned, and apply those lessons in planning and implementing future activities. In theory, this cycle of events—this cycle of learning—is repeated indefinitely so that management activities are continuously adapted.

Adaptive management as natural resource policy places this focus on learning within a thoroughly social context. Adaptive management specifically calls for managers, citizens, and scientists to work together. People working together to "learn how to learn" is both the defining characteristic of this policy and the central premise of a social learning approach to management and organization. Under this general orientation, the current study seeks to assess the degree to which AMA lead scientists see themselves as operating within a social learning framework, as well as the degree to which they facilitate an environment of social learning with each other and on their individual AMAs.

The learning community and learning organization are both models of how to put these concepts into practice. These models offer similar criteria for assessing the degree to which interaction and views of doing science reflect the principles of social learning. Both models are oriented toward creating an organizational environment where learning—both tacit and explicit—can thrive. Both models value dialogue that is characterized by openness, respect, and the courage and support to raise and address difficult questions. The learning community model emphasizes that leadership within the group is more facilitative than directive, and that membership is characterized by participation, shared responsibility, and mutual commitment. The learning organization model emphasizes a systems perspective as crucial to developing both individual and collective knowledge, skills, and vision.

The features of social learning, learning community, and learning organization emphasized in this synthesis of selected literature amplify aspects of researcher practice and perspective that might be expected in the context of science in adaptive management. Figures 1 and 2 illustrate the interconnectedness of adaptive management and social learning. It is important to note that these social learning characteristics were not explicitly outlined for adaptive management participants: indeed, AMA scientists received little theoretical guidance on how to reorient their work approaches to respond to the social learning assumptions embedded in FEMAT's notion of adaptive management.

Methods

Study Objectives and Research Questions

In 1993, President Clinton convened the Northwest Forest Conference in an attempt to break the gridlock that permeated the natural resource management environment, particularly regarding forest and wildlife management. The conference resulted in the assessments of the Forest Ecosystem Management Assessment Team (FEMAT 1993) and the Northwest Forest Plan, which substantially revised existing guidelines for the management of public lands in Washington, Oregon, and northern California. One component of the Northwest Forest Plan was the AMA program, which established 10 experimental sites, ranging in size from 44,000 to 350,000 acres, where the overriding objective was to experiment with adaptive management. The AMAs varied in tenure arrangements from fully public lands within one federal agency, to a mix of agency jurisdictions, to a combination of federal, state, local, and private lands. The AMA program created a new atmosphere for agency managers, scientists, and citizens where it was "hoped that localized, idiosyncratic approaches that . . . rely on the experience and ingenuity of resource managers and communities" would be developed (FEMAT 1993: III-24).

Nine agency scientists were appointed to lead scientific work on the 10 AMAs (one scientist worked on two AMAs). The scientists were employed by the Pacific Northwest (PNW) and Pacific Southwest (PSW) Research Stations; included both men and women (seven men, two women); included both traditional scientific training and socially oriented educations (including silviculture, organizational management, and forest economics); included a wide range of international work experience, and represented a diversity of agency experience levels. Because of the small sample size, demographic differences among study participants were not used in data analysis.

This study examines the experience of these nine agency scientists, particularly focusing on their views of working relations and science to assess the degree to which their perspectives on their work are aligned with the principles of social learning, the learning community, and the learning organization. We then propose hypotheses about the degree to which adaptive management is being encouraged or held back by the approaches of scientists to their work. We emphasize that this is a pilot study, designed to develop, rather than test, hypotheses. Because the sample size is small, generalizing our findings to larger populations of scientists or other leaders in adaptive management would be inappropriate. The study is intended only to improve understanding of this particular set of practitioners of adaptive management and generate insights that may prove helpful to other participants in and researchers of adaptive management, and test a unique combination of research methods.

Data-Collection Methods

Three distinct data-collection methods were used. The open-ended interview technique served as the primary interactive-social data-gathering method, and generated the bulk of the data. Interviewing creates an interactive opportunity that is inherently social and co-constructed. In contrast, 3CM technique has its roots in psychology, whereas the HBDI is intended to measure cognitive preferences.

Open-Ended Interviews

Interviewing is a crucial component of much qualitative research. Of the many types of sociological interviews (Denzin 1989, Lofland and Lofland 1995, Rubin and Rubin 1995), open-ended or semistructured interviews were most compatible with the interests of this study. In open-ended interviewing, the “major task is to build upon and explore . . . participants’ responses to [open-ended] questions. The goal is to have the participant reconstruct his or her experience within the topic under study” (Seidman 1991: 9).

Herrmann Brain Dominance Instrument

The HBDI method is well suited for developing a sense for how individuals tend to orient toward their work. This instrument was chosen to help understand the degree to which scientists’ modes of thinking are sympathetic to the principles of social learning. The HBDI is a method for gathering and interpreting “information about . . . preferred mode[s] of thinking and decision making” (Brain Connection 1998a: 3). The HBDI is administered via a written self-report survey, which is then analyzed professionally by the organization that created the survey, the Brain Connection.[3] Analysis of the surveys produces a “profile” of each individual, showing both numerically and graphically how

[3] The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

he or she scores on four key patterns of thinking: analytical, organizational, personal, and integrative.[4] The HBDI results purport to indicate preferences for these domains, not levels of competence or fixed characteristics.

Interpretation of HBDI data is limited by the self-report nature of the survey responses. As noted by Carey (1997) in his larger study of Forest Service employees using the HBDI, "people may respond to such questionnaires by giving answers that (1) they think are socially desirable, (2) are indicative of how they would like to be rather than how they are, or (3) are deliberately inaccurate. All such instruments suffer from problems in interpretation" (Carey 1997: 15). Thus our data should be treated as suggesting possible patterns and inclinations rather than as definitive or conclusive labels of personality traits.

Cognitive Mapping

Conceptual Content Cognitive Mapping, or "3CM," is described by its creators as "an open-ended card sorting technique that allows individuals to explore their own knowledge structure related to a particular issue or topic" (Kearney 1997: 140). Cognitive maps refer to mental models that "represent important objects and concepts and code the relationships . . . among these objects and concepts" (Kearney and Kaplan 1997: 8).

In a departure from previous work using the 3CM technique, this study viewed the 3CM method as an interactive process whereby individuals participate in a reflective conversation to articulate their understanding of critical issues associated with being an AMA scientist. According to the social orientation of this study then, the structured 3CM conversation provided an opportunity to focus on key concepts in AMA scientists' independent and joint work efforts and the interrelations among these concepts.

In cognitive mapping, individuals engage in a structured, reflective process of making sense of an area of concern. In the current study, the 3CM technique was sandwiched between two mini-interviews, with the entire session taking about 1 to 1½ hours. Participants first responded to several background questions and then were asked to describe to the interviewer what they believed were the critical aspects or components of "good research." The researcher wrote key words and phrases on Post-It notes, and then asked the respondent to organize the Post-It notes on a large sheet of paper, make any necessary additions, and clarify categories, relations, and priorities. When the 3CM task was completed, the researcher conducted a followup interview to clarify several key points.[5] This component of the project provided an opportunity to create indepth understanding of the views of the AMA lead scientists about the research process and how people interact in research and in adaptive management.

Data-Collection Sequence

The HBDI was administered to AMA and other PNW scientists in fall and winter 1997–98. Analysis from the developers of the HBDI was distributed to and discussed with the participating scientists at an informal session during the PNW all-scientists' meeting in spring 1998. Analysis results were mailed directly to PSW scientists.

A team of two researchers conducted 3CM and interview data collection. One researcher administered the cognitive mapping instrument to each scientist during January and February 1998. Mini-interviews concerning scientist background and perspectives on adaptive management were conducted with each scientist during

[4] See appendix 1 for an illustration of the four "selves" indicated by the brain dominance survey analysis.

[5] See appendix 2 for protocol for the 3CM task and mini-interviews.

these sessions, one before and one after the actual 3CM activity. The second researcher conducted two open-ended followup interviews with each scientist via telephone. The first followup interview, which focused on working relations, was conducted with a protocol common to all scientists; the second interview was tailored in each case to the individual scientist, and further probed issues raised in the 3CM exercise-interview and the first telephone followup interview.[6] These interviews occurred in April and May 1998. Conducting the interviews over the telephone, although necessary owing to scheduling and budgeting constraints, limited the capacity of the researcher to observe contextual and nonverbal aspects of communicating with each scientist.

Interpretive Findings and Interview Findings

The questions framed at the end of the discussions of social learning, learning community, and learning organization concepts as applied to adaptive management (outlined in the literature synthesis and compiled in fig. 3) were used to analyze the interview data. This section proceeds from findings illustrating perspectives of scientists on working relations, to findings on their views of science, to findings that examine the intersection between working relations and science. In presenting the findings, we have disregarded the gender of the scientist and have alternated use of masculine and feminine pronouns.

Working Relations

Questions 1 and 2:

- *Do working relations exist among scientists and other important adaptive management participants?*
- *What is the nature of those working relations: do they exhibit qualities of shared deliberation, open participation, and creativity?*

All scientists participating in this study described functioning relations with a range of adaptive management participants, including AMA coordinators, other AMA scientists, and other managers. Working relations with the public are not as universal. Relations with non-AMA scientists seem to depend on where the office of an individual scientist is located: those whose offices are in locations other than PNW and PSW research laboratories report minimal relations with non-AMA scientists.

The nature of the working relations of AMA scientists depends both on the individual scientist and on whom the relation is with. Relations with AMA coordinators tend to be cooperative in nature. Relations with other AMA scientists tend to be intermittent but collaborative and collegial. Relations with the public sometimes encourage confidence and participation, sometimes are vital components of the work to be done, and sometimes are disconnected from primary scientist activity.

For example, one scientist described her working relations with the AMA coordinator as "workable," saying that they "get along fairly well." In her working relations with adversarial groups (environmentalists), she believes that ultimately they can come to consensus on a program via "proper negotiations" and "without fighting," and expends considerable effort to fulfill these standards. This scientist rejects the "judgmental, openly hostile" manner in which she sees other agency scientists treating each other. In her words, "you can attack people or you can work with people. You can't really do both."

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[6] See appendix 3 for protocol for the first followup interview.

Adaptive management area scientists differ in their general orientation to relations. For some scientists, relations are seen as necessary to actually accomplishing their work goals; without strong relations with various people, these scientists believe that they could not get their jobs done. These scientists tend to devote considerable time and energy to developing and cultivating working relations.

For example, one scientist noted that his role is to “utilize the enthusiasm, the energy, and the expertise of local people.” Another emphasized the importance of making friends with and gaining the trust of the people with whom she works. She also asserted that the success of her AMA is related to the development of capacity in those who care about AMA lands so they are able to work together:

> I really want my AMA to be successful, and success in my mind is not answering the big ecological questions that are associated with . . . management of the forest. It is developing some way these disparate groups can find a place where they can work together to answer the questions that are important to them.

Still another scientist emphasized the importance of devoting sufficient time to working relations, particularly within the context of attempting to do the integration required in the adaptive management context. The timelines he described to develop shared understandings with managers and local citizens are on the order of years, not weeks or months.

For other scientists, relations are less of a focus. These scientists also have working relations, and see them as important, but their ideas of success in their jobs and in their AMAs do not seem to be as strongly associated with the way they work with other people. One perspective is that working relations do not necessarily require much effort to create:

> [The Northwest Forest Plan infrastructure] makes a difference in that I don’t have to go out and build these relations myself. . . . Somebody from the top down has . . . mandated that these relations will occur and . . . we don’t have to expend a lot of time developing these things brand new.”

This scientist seems to understand relations as tasks that can be accomplished simply by being mandated, rather than as time- and energy-intensive, creative, necessary components of adaptive management work.

Within this context, the scientists also differentiate between the types of people they interact with and approach each set of relations somewhat differently. Relations between the scientists and several key groups of AMA participants are discussed more specifically below.

Relations with AMA coordinators—Most of the scientists who specifically discuss relations with their AMA coordinator counterparts describe them as a key component in their own AMA work. Contact with coordinators commonly takes place via one-on-one and group meetings, frequent telephone and e-mail communications, workshops, and field trips. Whereas some scientists noted that discussions about “big picture ecosystem management type ideas” and “writing some papers together” are included in their interactions with coordinators, most described more mundane activities, such as meeting planning, regular decisionmaking sessions, or cyclical project coordination.

Scientists also comment that a great deal of give-and-take and joint effort are another important aspect of AMA coordinator-scientist relations. In one such case, the scientist frequently used "we" (referring to the scientist and the coordinator) in discussing most other working relations, noting that because they often work so closely together, "it's hard to differentiate" from the coordinator. Another scientist observed, "For certain projects . . . [I] tend to split tasks with [the coordinator] . . . sort of a collaborative role there."

Personal, informal contact is another aspect of scientist-coordinator relations. This is a notable feature within this set of relations: a greater percentage of the scientists described their interactions with AMA coordinators in personal, individualized terms than any other set of interactions. The importance of this feature is suggested by a scientist who observed that "get[ting] to know each other . . . personally . . . [and] getting used to each other's strengths and weaknesses" contributes to the development of effective, productive working relations.

Relations with other managers—Relations with forest and natural resource managers form a significant component of AMA-related working relations for most AMA scientists, and are reported to compose most of the interpersonal AMA interactions of at least one scientist. Contact with managers frequently concerns "active projects" including issue identification, design, planning, implementation, and monitoring. Interactions with managers are frequently "heavy on the logistics" and center largely on specific practical and technical issues or objectives. They also are characterized as "the most detailed or . . . intensive" relations, entailing more interaction than other sets of relations.

One important way in which scientist-manager relations differ is in the degree to which they accomplish tasks together, as opposed to one (usually the scientist) providing the other (usually the manager) with expertise.[7] One theme within these relations is a "give-and-take" or an "iterative working back and forth" aspect. One scientist identified partnership as a goal for scientist-manager relations. Another scientist emphasized that it is important "to develop a common purpose, a common understanding" specifically with managers. Yet another scientist noted "When we first started we were all sort of strangers to each other. People tended to be a little more guarded about what they expected and how things were going to go." Over time, trust and respect developed, and they became "more comfortable" with each other and better able to work effectively together.

Scientists who say they are called on to provide "expert opinion" to managers highlight a contrasting theme. In one case, a scientist specifically noted that these interactions are not particularly collaborative because the scientist-manager relation is "kind of a one-way street where I have a set of expertise. They need some of that information." Another scientist reported, "It has been difficult to engage [the managers]," indicating that the degree to which the scientist-manager relations are collaborative depends not just on the intent of the scientist but on the motivations of the managers as well.

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[7] These modalities were not necessarily reported as mutually exclusive within a particular scientist's relations with managers. In other words, an individual scientist may refer to relations with managers both in terms of an expert-learner exchange, and in terms of a give-and-take, partnered or team-oriented approach.

One scientist raised an important subtheme in manager-scientist relations: funding. With funds increasingly limited for both research and management, funding opportunities that require their collaboration can exert significant influence on the shape of the relations: ". . . often there's a monetary investment on their [managers] part so . . . along with that comes more involved and interested relations."

A strongly collaborative work environment with managers is one clear theme in these data.

> I . . . see the AMA as being a very valuable place to have continuing working relations with some important shared interests with people at the District Ranger and Forest Supervisor levels, just meeting in a regular meeting and sharing . . . what we're doing. Knowing each other as people is very important because then when something comes up where we need to help each other, we need to be on the same team. Although we're coming from very different points of view and we have different slants on it, . . . that personal trust . . . I feel like a family . . . eating dinner together fairly regularly, most of the time nothing's happening . . . but then when something goes wrong, or something challenging comes up, you have that base.

Yet this pattern is not universal. Scientists identified several constraints on their relations with managers.

> I think it's changing a lot but . . . there's still that feeling there that . . . 'we can't do research' and part of that is regulatory. That's a law. . . .There may be some kind of bias against researchers.

> It's a big shift for both managers and researchers because the manager is supposed to come up with answers to questions and yet is not expected to have the amount of rigor and control that traditional research does. So managers are immediately suspicious and uncomfortable and the researchers are also suspicious and uncomfortable. So it's interesting trying to figure out where that middle ground really is. [Establishing] better working relations between science, the researchers, and the managers. . . . That's easier said than done because the two cultures are very, very different.

Relations with the public—In general, scientists do not experience substantial interaction with the general public. For example, one scientist commented that "no specific mechanism is built in for" research collaboration with the public, because "there is no place in the budgeting process . . . to allow that to happen." Direct contact with the public is low for most scientists and almost nonexistent for a few (budget constraint was one reason cited for no direct contact). Those who do directly encounter citizens reported discussions with members of environmental groups, timber industry representatives, and public interest groups. Discussion topics at such meetings included general ideas about adaptive management and related aspects of management and science, the general question of the public's involvement in AMAs, as well as opportunities for joint research or monitoring projects. Those scientists who mentioned working with the public often included managers as a part of these contacts as well, thereby suggesting that the relation of scientists with the public may rely on the involvement of all three of these crucial participants in adaptive management.

Those scientists who do come in contact with the public tend to see these relations as well integrated into the work they are doing. One scientist takes a participatory research approach[8] to her work, as exemplified by this description of two primary goals of one of her research projects: "The link back to the community was to (1) try to spread the money for research back into the community, and (2) spread the understandings and the participation in the research process back to the community." This scientist provided an example of an orientation toward adaptive management that thoroughly integrates social concerns with biophysical concerns: "I want to do whatever I can to ensure that seven generations from now we still have this biological diversity here and that they're healthy, happy people. . . . In order to do that, you have to involve the people, the local people in the area."

Open participation and creativity—Trust and credibility are important themes in study participants' thinking about relations with the public. Scientists referred to trust at both an organizational and an individual level. In the words of one scientist, "I think it's important for [environmental non-government organizations] . . . to be able to trust us, particularly to be able to trust me because I'm the scientist representative there . . . otherwise . . . it'll be more difficult to move forward with much of a research program." Another scientist asserts, "A lot of what is going on here is trying to regain the public's trust both by doing things that deserve trust and conducting ourselves that way."

Relations with fellow AMA scientists—In comparison to the significance of relations with AMA coordinators, other managers, and other scientists, the scientists reported a limited level of interaction with their fellow AMA scientists. For some, contact with others in this group is limited to the occasional AMA scientist meetings and supplemented by gatherings such as the PNW all scientists' meeting (held in 1998) and the AMA coordinator/scientist meetings (held about twice a year). These respondents reported that the other AMA scientists do not figure into the weekly or monthly picture of getting their work done on their individual AMAs. Other AMA scientists do work together outside of these meetings, reporting "some," "regular," or "quite a bit" of contact with each other. Discussions among AMA scientists range from "philosophical" to "organizational" issues, and include AMA program issues and how to work together as a team.

Many of the scientists commented on various aspects of the nature of the AMA scientist group. The potential of the group to work together to develop new knowledge about working adaptively is frequently emphasized, such as by one scientist who stated, "I think we can be an example of working . . . across age classes and across disciplines and across areas and across programs." Another scientist also mentioned that the "variety of different expertise" across the group of scientists could be a benefit to them all.

Evidence of a team sensibility among the AMA scientists is also present in scientist comments. Study participants noted the development of "pretty good chemistry" and a sense of "camaraderie," "brotherhood,"[9] "family," and a "team way of seeing things"

[8] Participatory research is an approach to knowledge creation that explicitly links the research agenda to social action and empowerment of local people (Maguire 1987, Park and others 1993).

[9] The two female scientists (PSW AMA scientists, located in California) rarely attended AMA scientist-coordinator meetings held in Washington and Oregon, and consequently may not have been considered fully part of the group by their male PNW counterparts.

among the group of AMA scientists. One scientist summed up this view with the comment that AMA scientists "are people who are more desirous of working together and less competitive."

A contrasting theme is also present, as other scientists remarked on the fragmented or "disaggregated" nature of the group. Although they share adaptive management goals and the scientist role, there is a strong sentiment that the full potential of the AMA scientists as a group remains unrealized, and it is unclear where responsibility lies for making this happen. The following comments summarize these concerns:

> When we do get together as a group, we talk about . . . collaboration but ... everybody's so busy with their own AMAs . . . as individuals . . . picking up the ball on a specific issue and pushing it forward . . . that hasn't really happened yet.
>
> . . . there's a lot of interest . . . among the AMA group of scientists to come up with . . . a more . . . cohesive program for the AMAs. Right now we're just a collection of different AMAs. We share ideas but really have no structured way of deciding what kinds of research we're going to do and how we can do it across the different AMAs in terms of a network. That's being developed.
>
> . . . there's a big difference between the collection and the functioning network.

Overall, working relations among the AMA scientists seem to be works in progress. At the time of the study, scientists could see progress and development in those relations but tended to describe them in restrained terms. One scientist commented,

> I think our ability to discuss certain issues and be a little more open with each other has developed over time. . . [as we have been] getting to know . . . what each other's . . . particular interests are . . . developing a little greater level of . . . respect and trust that you can sound out ideas and discuss them in a fairly open environment.

Relations with other scientists—Degree of contact with non-AMA scientists range from "very limited" to "a lot," with several reporting moderate levels with university or PNW and PSW scientists. In most cases, contact with Station scientists is facilitated when the office locations of scientists are within a research laboratory or near other research scientists, and hindered when offices are located elsewhere.[10] Some scientists reported working regularly, in face-to-face meetings, with a core group of scientists who are involved with projects in the AMA, whereas others—frequently those who are more isolated geographically from the scientific community—have no such resource, although they did report experiencing some contact with other scientists at a distance, via electronic or written documents. One respondent spoke for several in the group when he said "As a scientist, you're cut off being out over here."

Adaptive management area scientists participate in a variety of activities with other scientists, incorporating several different roles in these interactions. One version of AMA scientist–other scientist interaction is AMA scientist as gatherer and synthesizer of information and advice from other scientists; another version is as collaborator at any or all points in research efforts; and a third version is overseer, facilitator, or

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[10] When scientists were located outside of research labs, interaction with other groups, such as managers, was high.

“broker” of the time and energy of other scientists. Accordingly, activities with other scientists run the gamut, from information exchange, to brainstorming and developing study ideas and implementing projects, to working together on reviewing and publishing papers, to discussing “big picture ideas,” and spreading awareness about research opportunities on the AMAs.

Adaptive management area scientists used the term “collaboration” most frequently when discussing their work with fellow scientists. Reasons suggested for this include sharing “a reasonably similar mission” (within a research institution such as PNW) and “shared interests in adaptive management in general.”

> Working with other scientists often comes in bouncing ideas or refining the questions . . . working on a common problem and then piecing it out with other scientists in terms of who does what. And then that kind of collaboration would carry through the whole process.
>
> I feel most comfortable and I think most scientists in general feel most comfortable . . . criticizing each other and coming up with different ideas . . . and . . . a lot more back and forth.

Question 3:

- *What sorts of forums or processes exist for the cultivation and maintenance of these relations?*

In general, AMA scientists reported few forums or processes for cultivating or nurturing working relations. Contacts between scientists and most other AMA participants are typically project-oriented, and time and funding limitations restrict the degree to which development of relations are fostered. One scientist put this plainly when he stated, “I don’t think that there are very strong mechanisms for having scientists and managers interact or very strong mechanisms for having scientists and the public interact.”

Although several scientists mentioned attending occasional AMA coordinator-scientist meetings, these meetings were not reported to contribute to individual scientist-coordinator relations. Because scientist-coordinator relations are a vital link in the successful implementation of AMAs, the apparent absence of support for the smooth development of these relations suggests a significant limitation on social learning.

Several scientists interact with fellow AMA scientists only when agency managers convene the group. According to one respondent, “interaction that is expected to happen on a regular basis among AMA scientists . . . is orchestrated by someone else.” The limited contact among this group suggests a parallel limitation in the degree to which learning is shared across the network.

Question 4:

- *To what degree have scientists’ views of their work, their collaborators, or their own roles changed as a consequence of their involvement in adaptive management?*

Most scientists reported that working with adaptive management has not made a significant impact on how they view or perform their work responsibilities. In one notable exception, a scientist said that working with adaptive management changed her view of the local community and its residents:

> I think I've grown to appreciate the knowledge of the community and their ability to work independently more than I did before. I've run into a lot of talented people who kind of just came out of the woodwork. You would never know they were there.

One of the important aspects of social learning is the transformation that takes place among participants. This finding seems to indicate that by and large, AMA scientists are not experiencing that aspect of social learning.

Question 5:

- *Are dialogue and engaged communication fostered?*

More than half of the scientists included in the study identified communication as important in accomplishing their jobs. Others are clearly aware of having to deal with communication issues at certain points or stages in their work, but in general, communication plays at most a background role. Those who emphasize communication identified and commented on specific components they see as important, such as listening and nonverbal communication cues,[11] as well as how they see communication contributing to the development of trust and mutual understanding.

One scientist offered an inventory of important communication skills, such as being able to say "I don't know" or "I learned something, tell me more"; being able to agree to disagree; paying attention to body language, phrasing, and tone of voice; monitoring one's own behavior and degree of aggressiveness and temperament; being patient; and active listening. One scientist emphasized that part of being a good listener is reserving judgment in order to encourage everyone to come forward.

According to another scientist, communication is essential for effective problem solving: communication is not just a way to share information, it also serves as a process to help identify opportunities for integration. He believes that there are "a zillion different forums for getting information across . . . there doesn't need to be a forum for it to happen . . . you just sow a lot of seeds."

One scientist's rhetorical question, "Why are we doing this [science] if we don't communicate?", emphasizes the belief that science is most worthwhile when its results are shared. A scientist must help "people to understand the consequences" of certain actions. The process of communication enables a scientist to perceive whether or not people trust him and whether or not they are comfortable with him, and work to develop those conditions if they are deficient.

International experience can contribute to the development of necessary communication skills. One scientist commented,

> Speaking another language and being exposed to different cultures and people . . . gives me a better appreciation, maybe a little more patience for different points of view and how when two people are talking they might not actually be communicating; they might be using some of the same words but

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[11] Nonverbal cues include vocal tone, body language, and silence, which in addition to the actual words spoken, contribute significantly to the meaning constructed in communicative interaction (Knapp and Hall 1992, Leeds-Hurwitz 1989: 105).

> they're not actually reaching each other. There's little real communication going on. . . . I think that gives me the ability to . . . try to get a deeper understanding of where someone's coming from.

Within the subset of scientists who place a high priority on communication, some are personally and closely involved in communication with nonagency participants in the AMA (primarily the public). Some recognize a need to make research more understandable and available, such as the scientist who said that one responsibility of the researcher is to avoid publishing only in journals and to "[find] the format for communicating broadly so they'll understand what you did and why you did it." These scientists tend to view their own communication with managers and the public as an integral factor in successfully accomplishing their goals as AMA scientists. One scientist commented, ". . . part of [the research process] is to communicate effectively, not just broadly but effectively . . . [and] understanding your audiences." Another commented, "You have to get the information into the decisionmaking process."

Others are less directly involved, relying more on media contacts and agency public outreach staff to facilitate intergroup communication.

> I have wondered if our huge research emphasis and living in a research culture leaves us with language, lifestyle and all that, but . . . creates some impediments to talking with some . . . segments of the public. On the other hand, we try to . . . communicate through media people quite a bit. . . . One facet of it is to try to have professional communicators be our intermediaries.

In addition to communicating with AMA participants, several scientists also identified another form of communication they see as crucial: communicating with the broader scientific community via meetings, conferences, and publications. Although they recognize that these modes of communication may have little direct impact on success of their AMAs, scientists still feel that these traditional criteria for assessing credibility and competence apply to them. The implication is that if a scientist does not live up to the standards of the scientific community, he or she will not be taken seriously outside of the AMA context.

> Our credibility comes from communication in fairly technical media. And my understanding is that you don't have much credibility as a scientist if you don't have those publications. . . . Communication at professional meetings is also important. . . . Those are not very useful or satisfactory in an adaptive management setting, however.

Question 6:

- *Are scientists facilitative leaders?*

The scientists in this study seem to cluster into three categories as to the degree to which they see themselves in a facilitative role. Several described their AMA scientist role as ***essentially facilitative***. They believe that successful AMA science requires them to help cultivate connections and work to support and encourage collaborative work, rather than taking sole responsibility for conceiving, designing, coordinating, and overseeing the implementation and monitoring of their AMA science.

One scientist sees herself as a “moderator” and stated that “what’s important to me is to be able to play the game, not to be the one that is the best or the leader.” She places priority on the evenhanded quality of interaction she is involved with: “One thing that I pride myself on is making sure that there’s good interaction with the people who are asking the questions. . . . I want to understand their issues, what’s important to them.” She sees the facilitation aspect of her work as more important than specific scientific questions: “The primary issue is, in order for these AMAs to work, you need to establish a set of people who are willing to cooperate with one another, who see the world very differently . . . trying to help people get into the position where they can cooperate with one another.” And again: “I’ve put most of my effort not into developing really discrete high-quality science but into facilitating the interactions between these people.”

A second scientist commented that “I see my role as trying to facilitate learning and . . . it’s not my job to decide what . . . the specific . . . focus of the AMA or specific activity [would] be but to just throw out suggestions. As far as advocating specific policies . . . I still try to steer away from that.” He continued, “I see my role primarily as working with managers and the public to figure out what this thing called adaptive management means for this place. . . . There’s no guidebook on how to do this stuff.”

Still another scientist used a vivid metaphor to describe the role she finds herself playing as an AMA scientist: “The setter in the volleyball game is an appropriate [image]. . . . I’ve been working with people here and I’m really trying to help build bridges and forge that . . . communications link that is really supposed to be happening in the AMA process, where you’re trying to work with agency management people, research people, and the community.” She also feels that “the scientists need to be responsive to agency stuff, management needs, and then also responsive to the community.”

And finally, a fourth scientist sees his role as trying “to utilize the enthusiasm and the energy and the expertise of the local people, and then try to bring other help in whenever we can’t fill it with local people.”

The second group shares a distinctly different interpretation of the AMA scientist role—as an **advisor** or consultant. This perspective acknowledges the specific content-oriented expertise that scientists bring to their positions. It conceives of using that information to help groups of AMA participants learn and make decisions as an important part of the scientist’s role. The key word here is “help”: these scientists are not intending to drive the AMA process. Rather, they see themselves bringing experience or knowledge into adaptive management as needed and as requested. How much these scientists see themselves, versus others, as the ones to decide when to help, is unclear. This ambiguity is an important distinction between scientists describing themselves as “advisors” and scientists describing themselves as facilitators, as discussed above.

> The hat I wear is the scientist hat, the . . . technical expert . . . and not only technical expert in terms of . . . any particular scientific discipline but in the integration of those disciplines and integration of research results and translation of those results into . . . management prescriptions.
>
> . . . as . . . research coordinator for the AMA, [my role] would be helping to determine which projects are important or needed, viable for the AMA, what ones are proposed, if they’re technically sound and . . . can . . . address our priority issues and are actually feasible . . . technically and logistically and financially.

> . . . ensuring that the program is implemented in a sound way; ensuring the scientific credibility of the program in the AMAs is kind of the bottom line, and then actually doing some work myself or supervising people who do work in the AMAs as part of a research team.

A third group of scientists seems to understand their role as being **ultimately responsible for the quality of the science** performed on their AMA. As one might expect in an agency environment, all the scientists hold this perspective to at least some degree.[12] At least one scientist, however, interprets this to mean that she should closely manage all the stages of research, and as a result, the locus of control of the scientific process on these AMAs is with the individual scientist associated with each AMA. These scientists work with other people in the course of doing their jobs, but they are relatively nonfacilitative in the manner in which they do so. Even when they describe working "together" with others, these scientists discuss it in terms that signal that the way they work with others, is significantly less open to negotiation and active co-construction than the scientists who see their role as more facilitative.

> My main responsibility is to see that we move together, hand in hand on the projects that we anticipate to do some learning on, that the science . . . is designed in such a way that we are going to get maximum learning from it, relative to the objectives.
>
> I may have an agenda that I want to follow, that I think is a more intriguing research question. I will probably push that agenda for awhile, and if it doesn't go over well, I'm willing to adapt and listen to what they have to say.

Question 7:

- *Are public participants and managers involved in every step of the research process?*

Most of the scientists endorse a participatory approach to at least some part of research. Some indicate the importance of involving citizens and managers early on in the design phase; a few facilitate the maintenance of that involvement throughout the course of the research process. These scientists in particular, view the knowledge and perspectives of citizens and managers as not only worthwhile but frequently critically important in their own capacity to do the best science possible.

Early involvement is necessary. Previous attempts to involve the public placed public comment near the end of projects, when most decisions had already been made. Adaptive management requires getting the perspective of multiple participants early on.

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[12] For example, one of the scientists with a facilitative view of her role also noted that in the case of a specific project, "we worked out through this community participation process what the question was going to be and then I came in as the scientist . . . and said okay if that's the question that we have, this is the research approach that will be statistically significant and will meet the criteria that we need as science." This comment suggests that this scientist still retains a significant component of control over research design, despite her interest in working collaboratively with the community on research projects.

> [Scoping out research] begins with engaging in a dialogue with those people who would be willing to fund research on those particular issues.
>
> . . . I like to get ownership up front early because I think it helps to build the client base for the future.
>
> . . . what I see as a real opportunity is to work with them [managers] at the beginning of the process, identifying questions and determining the gaps, in ways to go through this whole process working together because they can do the experiments. They can implement the experiments and we can't. We can think them up and we can help design them, but we can't implement them. And then we have the ability to do the analysis.
>
> [You need to listen] throughout the whole process. You've got to make sure people are comfortable to be able to talk freely. . . . Don't judge early on.

At least one scientist specifically noted the shift from a traditional agency stance toward public involvement to increased levels of participation in adaptive management: "Traditionally we tend to go public very late in the game, if at all. In the AMA [context], we have you go public at many points in the process, including asking for input on the study itself."

Several barriers to the involvement of nonscientists throughout the research process emerged from the interviews. They ranged from limited funding, to limited time, to the lack of institutional models.

> I guess the role there has mainly been presenting a variety of ideas and getting feedback. . . . I haven't really thought too hard . . . about incorporating them into my field work . . . but we have given a fair amount of thought about how to include them in the AMA planning process.
>
> Obviously it's better to plan [public involvement] at the beginning, but . . . it's just so hard to do that. . . . There are all kinds of time . . . considerations. There are always the funding considerations. There's not a lot of incentive to do it because it takes so long.

The Research Process

Question 1:

- *What happens to the "process" knowledge produced in these contexts? Is it recognized? Is it documented? Is it shared?*

Several scientists note the importance of process knowledge. For example, one scientist reports that learning to be patient with the bureaucratic process has been helpful! Another equally strong supporter of process knowledge asserts that "the real wisdom is how your information fits with the other guy's piece of the pie, so if you can't communicate that, then that's a lost opportunity. . . . The real opportunity is to be able to integrate." From most of these data, however, it seems that this knowledge is rarely documented or shared. Most of the scientists seem too preoccupied with day-to-day activities to think about ways to track tacit knowledge. One scientist's comment reveals process knowledge is not often shared, even among AMA scientists: "In my future work, I hope to include public and managers more directly in what I'm doing, and maybe what I'm doing more into what they're doing, but I sort of have to work that out as I go. There are not . . . many precedents or models to follow."

One potential function of the AMA network itself would be to develop protocols, "precedents or models" to help scientists accomplish collaborative goals. We found no evidence that would suggest that process knowledge is documented or shared to any significant extent, or that there are any other mechanisms to facilitate the documentation and sharing of tacit knowledge among the AMA scientists.

Question 2:

- *Is knowledge understood as contextual and provisional?*

Understanding knowledge as contextual and provisional follows from a rejection of the notion that useful information has been globalized and standardized. Local, situated meanings are important when knowledge is understood as contextual. Although there is always some context for knowledge, this is not always recognized. Whether information about community demographics is helpful for decisionmaking depends on how it was gathered, at what scale, and at what level the deliberations are taking place.

One issue that foregrounds assumptions about knowledge among the scientists in this study is the concern over bias in science. Recognition that some degree of bias is inherent in any human perception or behavior is entailed in understanding knowledge as contextual. A contrasting view holds that it is possible to eliminate all bias from science.

Both perspectives on knowledge are represented among the AMA scientists.

> I guess I don't . . . believe . . . in objectivity, and so I think that . . . where your funding is coming from, who your employer is, will influence the kinds of work that you do, the kinds of questions that you ask, for example.
>
> Science should be conducted in an unbiased manner. Questions to be answered should be approached as if the answer is not known. Something that I think would improve the value of research would be getting past individual or disciplinary paradigms.
>
> The bias comes in identifying which question to address. But once you've chosen the question, you should set up an experiment that . . . definitively addresses it without biasing it in terms of the kinds of . . . sites you choose or the way you do your sampling or the way you analyze the data or the way you ignore certain data sets, which is sort of more the standard . . . conception of . . . unethical science.

Question 3:

- *Is learning prioritized?*

The scientists in this study are acutely aware of the learning objective of adaptive management and take it seriously as a central part of their role. Learning is a strong priority for them.

> I see . . . my main role as helping lay out a path for future work and how we're going to learn from it in the AMA, how we're going to learn from management, then conducting specific research projects that help fill in some of the . . . holes in our knowledge within the AMA itself.
>
> In the way I interact with [managers], I . . . consciously focus on developing learning designs and making the ideas they're talking about as effective as possible in terms of an adaptive management approach.

It is unclear, however, to what degree conviction about the importance of learning translates into strategies and activities that actually promote and enhance learning. One study participant recognized this when he asserted that the "system of reward does not facilitate . . . gleaning" information that is crucial for managers out of all the information they gather.

Question 4:

- *Who counts as a knower?*

More than half the study participants acknowledged the importance of knowledge coming from other perspectives, most specifically citizens and managers. There is some variation in the value both scientists and administrators place on these other forms of knowledge, however.

> The managers have a lot of experience and so they're experts in their own right. I look to them to provide . . . expertise on . . . local issues, things that they know intimately.
>
> Citizens that I work with in the course of the research, are usually living off the land, very close to the land. Their knowledge and their expertise has to do with . . . the context that they're living in very closely, and they have a lot of . . . background and . . . experience there in . . . ways in which things are done locally.
>
> I want to try and get away from the idea that only scientists or researchers can use the scientific method to gain reliable knowledge. . . . Anybody can be a scientist . . . if they use the scientific method to gain reliable knowledge, and you don't have to have a Ph.D. to do that.
>
> It would be really important at those AMA meetings to give the AMA coordinators more time to interact with each other and less . . . Washington office or REO [Regional Ecosystem Office] leading. . . . They need to focus less time on the bureaucracy of AMAs and people who are thinking about what AMAs are dominating the discussion and more on people who are out there trying to make AMAs happen. . . . They really just need to listen to their coordinators a little bit to get a better sense about what's going on.

Working Relations and the Research Process

Question 1:

- *To what degree are adaptive management scientists' views of the world reflective of a systems view?*

Adaptive management area scientists in this study identify strongly with a systems view of the world. In their discussions about the research process, they identify that the research process relies on input from multiple sources to yield strong results. Disciplinary borders, however, present real communication challenges that must be addressed if integrative, interdisciplinary work is to proceed. Information cannot remain in one party's domain for this kind of work to happen: it must somehow move across disciplines.

> One of the things that really interests me is getting people with different backgrounds to work together so that I can use the information that they have. . . . I just try to get people to be involved.

> The reason that I work with . . . any number of other people is because they have skills that I don't have and . . . sometimes if you do things together you can get a much more interesting product.
>
> . . . the important research is the stuff that bridges disciplines, and the only way you can bridge a discipline is if you make it understandable to different disciplines.
>
> . . . for me science is more than just talking in your narrow little focus field. For science to really be science, you've got to look at how it connects to everything else and how you communicate with a broader group of people. So you not only communicate broadly to get the information out, but also perhaps even more importantly . . . the real wisdom is how it fits with the other guy's piece of the pie.

A slightly different, yet still systems-oriented, focus is revealed in one scientist's "problem-centered" approach to research:

> The main thing is a problem-oriented focus so that . . . if there's an issue at hand that needs to be dealt with . . . you use a series of different kinds of approaches and methods that might come from one or more disciplines to address a problem and see how one might best understand a problem.

Another theme related to the systems perspective, is an interest in the interrelations between social and ecological perspectives. Here, adaptive management is understood to require that social aspects be integrated with biophysical aspects in science and management.

> I don't think anybody would willingly take on being an AMA scientist if they weren't very interested in social relevance of . . . science, and it seems to me that the people who are doing it, give that real priority in their work, although they were trained to do something more narrowly and technically.
>
> If ecology is literally the study of . . . the pattern that connects things, it means you have to understand the things that are being connected. If you're looking at connections among plants, animals, environmental functions . . . if you're also including people . . . then you're immediately opening the door to a whole spectrum of science and so forth that involves people.

Question 2:

- *To what degree does their work reflect such a view?*

The scientists report some frustration with not being able to implement the kind of systems approach they want. A high-pressure work schedule is one specific barrier to working in an integrated fashion. Adaptive management takes time. Scientists may recognize aspects of social learning as priorities but may not be able to find the time to follow them. Reluctance by managers is a second barrier. In a more general sense, scientists note that the Northwest Forest Plan, adaptive management, and their own network of AMA scientists create appropriate frameworks in which to conduct work from a systems perspective, but that for various reasons, this type of work simply is not yet occurring.

> I've been trying to reduce [my job] by about half, but my . . . work metabolism is such that I don't have sustained conversations with practically anybody. It's just going so fast.
>
> There's a bigger emphasis on integration, bigger emphasis on ecosystem management, involvement with communities, [all out] of the Northwest Forest Plan. . . . The door is open for anybody who wants to do this. . . . The structural framework is to do this and actually even promotes it. . . . Not a lot of people are doing it and I don't know why.
>
> The AMA scientists have an opportunity to lead the way in demonstrating integration.
>
> We've talked about it among the [AMA] scientists . . . really trying to work through this . . . much stronger integration among the AMAs but . . . we're not quite there yet.
>
> I think that the AMA scientists could be an integrated group. We have a lot of different expertise, and we could . . . do integrated projects. We just haven't learned to do that yet.

Question 3:

- *What sort of "mental models"—of science, of adaptive management, of integration—do the scientists hold? To what degree are these models characterized by complexity, interdependence, broad participation, and flexibility?*

Views of science—Two basic models of science emerge in the interview data. Although individual scientists may not fit either profile exactly, they tend to share many qualities with one or the other. Although both models are oriented toward generating new information and creating knowledge, the process and evaluation of what has been learned differ considerably.

Model A: research emphasizing the scientific method—This model of science emphasizes the step-wise nature of the scientific method. Nonscientists may be involved in one or two phases of particular projects, but typically experiments are designed, implemented, and overseen by scientists. Efficiency takes precedence over "muddling through." Bias can be avoided, and the boundary between science and policy is kept firm and clear. One goal is to solve problems by predicting and controlling phenomena. An objective of this model of science is accurate knowledge.

> Research is a systematic approach to answering questions. It applies techniques that answer questions in the most efficient manner. . . . It usually involves . . . replication . . . and in order to ensure lack of bias, we usually try to randomize.
>
> The scientific method is tremendously important in that it enables [us] to gather accurate information. . . . What research means to me is . . . a powerful tool to gather accurate information . . . beyond people's belief systems.
>
> The process of Forest Service research is laid out pretty clearly in the manual. You develop a study plan. It's reviewed. You implement the study plan. . . . You have the results reviewed. You publish the results.

Model B: research emphasizing social context—The second model is sensitive to multiple forms of knowledge, prioritizes broad participation in the scientific process to ensure as much learning as possible, and recognizes that these factors mean that research can be a slow process of "muddling through." The phenomena that are studied and the people who do the studying, are components in an interconnected web of components and processes. The standard notion of the scientific method is recognized within this model and used to improve social and ecological conditions and policies. Listening and involvement with community and citizens receive priority. Managers are particularly important participants in the scientific process. Knowledge is socially constructed and contextual. This approach to research emphasizes questioning and exploring. An objective of this model of science is contextualized knowledge. The following statements from interviews help to illustrate these aspects of model B.

> That's our target . . . public understanding and informed decisionmaking on natural resources. . . . If we don't have effective discourse, and if we limit the way we do, we might come to only one view of what's going on and . . . if we don't balance that with good public discourse to reveal the limitations, we're not going to achieve that goal of having an informed public.

> [Adaptive management] makes . . . the research method more effective . . . better and more productive. In terms of implementing it, you have more support for the project, political, social support. You have a better feel for . . . all the other things that may affect the kinds of variation you see in your experiment.

> Here's how you do research, . . . the [scientific] method, but . . . if you just do that you really haven't done everything.... [There's] just so much more to it than that.

> Sometimes . . . you wind up with . . . data that looks like this and we draw a curve through it, and then we don't show the data anymore. We just have the curve and we say this is reality, when maybe it is not reality. This is a great deal of concern to me that we don't really express the variation in what we see . . . the uncertainty that's associated with it. . . . And I'm uncomfortable with that. I'm not necessarily uncomfortable with the process, but I'm uncomfortable with the preset notion that this is what truth is.

> Every one of us is a product of our culture and our family, our education, our personal experience. . . . And you can't separate the person from the research. You can't separate the research from the culture. We do our research in a cultural context.

Views of adaptive management—Adaptive management area scientists' understanding of adaptive management is clearly informed by the basic working principles of learning and the integration of science and management found in the adaptive management literature (i.e., Holling 1978, Lee 1993). One scientist claimed "Adaptive management . . . in its definition is integrative." The creation and treatment of knowledge in the context of adaptive management emerge as important concerns for these scientists as they discuss their views of adaptive management. Another scientist observed that one priority shared among the group is the wide scope of their research interests, relative to other scientists. "Probably the biggest issue [in adaptive management] is the need to address things at larger scales than most scientists have been doing in the past."

Some scientists also are concerned about what happens to the knowledge that is created, emphasizing the importance of finding a way to make sure it can be used by the people who need it (i.e., managers and citizens).

> [With] adaptive management . . . you have to get the information back into the decisionmaking process.

> I think the AMA scientists have more responsibility to . . . transfer ideas and . . . work more one on one with managers and with the public . . . discussing . . . what appropriate management is and how it should develop over time and how we test some of these ideas in the forest plans.

A particular strength of adaptive management noted by one scientist is the way it ties management and science to a particular place, and thereby develops a richer base of knowledge about resource and societal dynamics in that place.

> When you assign somebody to a place . . . their research or knowledge base begins to become very specific about a particular area and . . . we begin to develop . . . building blocks of information about different systems. . . that each one of the . . . AMAs can then provide from a long-term basis. . . . The AMA scientists . . . have kind of a license to get their hands dirty with a number of applied issues or issues that are . . . troubling either society or a land management branch. . . . The adaptive management scientists have an opportunity to take a look at some of those sideboards that . . . are used for managing these different resources and testing them.

Views of integration—Although integration has been a crucial feature of current efforts to improve Forest Service research and management, it is often a vaguely defined concept. Despite this uncertainty, scientists in this study had little trouble discussing integration and were not surprised or puzzled when the topic came up in interviews. In the words of one scientist, "Integration is a natural; it should be a natural for most scientists." Still, they did not typically respond to the question "What is integration?" with a definition. Rather, they tended to describe aspects of what is involved in integrative work as a way of understanding what it means.

A basic feature of integration as discussed by scientists here is interaction with other people. One cannot "do" integration alone: it requires multiple perspectives, multiple actors, and the crossing of boundaries.

> The genesis of the process [of doing integrative work] involves talking with other people . . . to find out what their questions and problems are, and then consulting with other people to determine what they've already done.

> To me, an integrated project is one that you plan, conduct, and report as a team of people . . . not as a group of separate entities.

> If somebody wants to do some integration with another discipline, they have to step across an organizational boundary. . . . That's not necessarily a problem, but that boundary might also be a physical or geographic boundary.

> Integration usually involves getting an interdisciplinary group working . . . ideally on the same project, on the same objectives and studies.

The degree to which integration must actually be collaborative—characterized by joint decisionmaking where team members share control of the process and where all voices are respected and included throughout—is not consistent among the scientists' perspectives. Some specifically assert that integration is collaborative, but the notion that separate groups working side by side (rather than jointly) can also "do" integration is also present in scientist comments.

> The integration I see is between [university and agency] scientists, [and] I see collaboration going on all over the place.

> Integration . . . could be something that's as simple as just including different disciplines in the project and have them address different aspects of the . . . particular project . . . so you could have a kind of interdisciplinary group that does their own thing and they don't really integrate in terms of creating links between the different . . . disciplines.

Few scientists discussed integration in terms of processes of knowledge creation. One scientist claimed that "one aspect of integration . . . is . . . synthesizing existing information and trying to come up with some 'bigger picture' conclusions or some ideas about what it all means and where we go from here.

Several factors that could aid integration are identified; these include funding for collaborative projects, some sort of shared or commonly developed conceptual framework to guide interdisciplinary work, effective cross-boundary communication, and fluid work groups.

> Often what happens if a smaller group of people is able to get a good study off the ground is you generate a lot of interest from other people. It's like "oh, maybe we can piggyback on that, put our heads together." So . . . as far as mandating integration, there's only so far you can go. It's sort of got to build up from the bottom. If you want to promote integration . . . one way to make it work is just to provide or earmark funds specifically for those kinds of projects.

> I think there has to be a conceptual framework for integration. . . . If you have players in your process to match the boxes on your conceptual framework, you're working from an integrated standpoint. They agreed on the framework. They agree . . . that these boxes exist and that the arrows are . . . where they are. Then I think you have a basis for integration.

> My belief is if you had teams that formed and dissolved as needs arose and disappeared . . . that would be a good system because people wouldn't always have to be followers and they wouldn't always necessarily have the responsibility of being the leaders. . . . There would be a whole lot more mixing of ideas if you had teams that came and disappeared.

Several institutional challenges and barriers to integration also are noted. The momentum of the status quo, traditional scientific training, funding challenges, and simply the increased challenges of working across boundaries are identified as limiting factors in achieving integration.

> Usually one discipline comes up with something and then calls around to see if anyone else is interested in participating. . . . There is not really a way to integrate. They get to the end and say 'Well how can we integrate this." They don't design the integration up front. So . . . it's multidisciplinary in that it ends up being more than one discipline involved, but it is not designed and developed to be integrated up front.

> They're reductionist . . . and they want to know a lot about something and they're not comfortable not knowing a lot about . . . a particular thing. . . . I'd say the majority of scientists are that way.... They're very comfortable being reductionists and why not? . . . You're the expert. . . . It's like a powerful thing. . . . That's the biggest barrier [to integrative work].

> I don't believe that [the AMA scientists] can be a group of separate entities. We have to be some sort of integrated something, and that's going to require mixing our money. I'm not sure how everybody's going to feel about that.

> . . . all you need then is . . . the resources to actually do the integration and that is often really the most difficult part because instead of doing a project that involves one discipline, you have a project that involves several disciplines and additional costs.

> [Integration] takes a lot of energy. . . . It's a lot more to keep track of . . . You have to be concerned about people's feelings. There's a lot of people involved . . . more human dynamics things that can wear you down.

> . . . there's a whole set of technical skills . . . that go with the synthesis and integration of diverse sources of material into . . . a holistic overview, and then breaking that overview down into concrete actions to achieve certain goals and objectives.

Herrmann Brain Dominance Instrument Findings

In addition to the interviews, each scientist completed a questionnaire. The questionnaire used, the Herrmann Brain Dominance Instrument (HBDI), measures the preference of an individual for each of four "modes" of thinking:

Quadrant	Dominant way of thinking
A	Problem-solving, mathematical, technical, analytical, logical
B	Planning, controlling, conservative, administrative, organizing
C	Talking, musical, spiritual, emotional, interpersonal
D	Conceptual, imaginative, synthesizing, holistic, artistic

Herrmann (1990: 76) emphasizes that a "preference" indicates what an individual prefers to do, rather than what he or she is competent to do. In each quadrant, individuals display one of three degrees of preference: a primary preference, or a "featured thinking" mode that is "usually visible in one's behavior"; a secondary preference, or an "accessible or usable" mode of thinking that "is available with a shift in thinking"; or a "usually apparent" tendency to avoid a particular mode of thinking (Brain Connection 1998a: 2). Within the primary preference zone, a further distinction is made between simply "one's featured thinking" and particularly high degrees of preference, which "indicate a strong preference, an unbridled enthusiasm, or a passion for that mode of thought." In the HBDI system, a scientist can show a "primary preference" in more than one quadrant. Each individual's scores combine to create a unique "profile" of styles of thinking and behaving. Several themes are evident across the group of AMA scientists.[13]

All study participants show a primary preference for quadrant D, indicating that they tend to think integratively, holistically, and intuitively. Quadrant D also indicates conceptual, exploratory, imaginative, and nonconformist tendencies. Curiosity and a preference to experiment, take risks, and appreciate surprises are also qualities associated with this preference, according to HBDI analysis (Brain Connection 1998a: 17). All these qualities should contribute to a social learning orientation in scientists' approaches to their work. Preference for this mode ranges widely from a low of 69 (barely a primary preference) to a high of 147 (almost off the chart). Five of the nine scientists show a strong preference or a passion for this mode of thinking. The other four show a much higher primary preference for either A or C mode.

Most of the scientists (seven out of nine) have a secondary preference for quadrant B. This means that organizing, planning, and procedural tendencies tend to require a shift in thinking for these individuals, rather than occurring automatically and visibly. Scores in this quadrant have the narrowest range for the group of scientists, varying from a low of 38 to a high of 80.

The AMA scientists differ widely in preferences in quadrant A, from a low of 32 to a high of 108. Four scientists show a primary preference (one very strong preference), four show a secondary preference, and one scientist avoids this pattern of thinking. Those who have a primary preference for quadrant A tend to emphasize logical, analytical, theoretical approaches and tend to have lower D quadrant scores. Thus the AMA scientists range from preferring to think and act in visibly and strongly logical and analytical ways, to actually avoiding this mode of thought and behavior.

The scientists also vary significantly on quadrant C, where five scientists show a primary preference and four show a secondary preference. The range on quadrant C, however, is not as broad as on quadrants A or D (C scores range from a low of 39 to a high of 92), and there is no preference for or avoidance of quadrant C. Individuals with a primary preference for C are often seen as participative, interpersonal, humanistic, expressive, and sensitive to others. All the scientists are able to access the participative, interpersonal mode of thinking and behavior, either easily and automatically or with some degree of effort, which suggests a significant degree of social learning orientation.

Scientists in this study with low preferences for A tend to have relatively high preferences for C, and vice versa. Thus in this sample, those who may typically tend to think in highly logical and analytical ways tend not to prefer participative and interpersonal approaches, whereas those who tend to be highly participative and interpersonal tend to have a lower emphasis on logic. The degree to which the scientists are collaborative

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[13] In comparison, Carey's (1997: 11) study of 230 USDA Forest Service managers and research scientists found that "overall, the sample showed tendencies toward A-quadrant, analytical thinking and D-quadrant, integrative thinking." See "Discussion and Conclusion" of this report for further discussion of Carey's study.

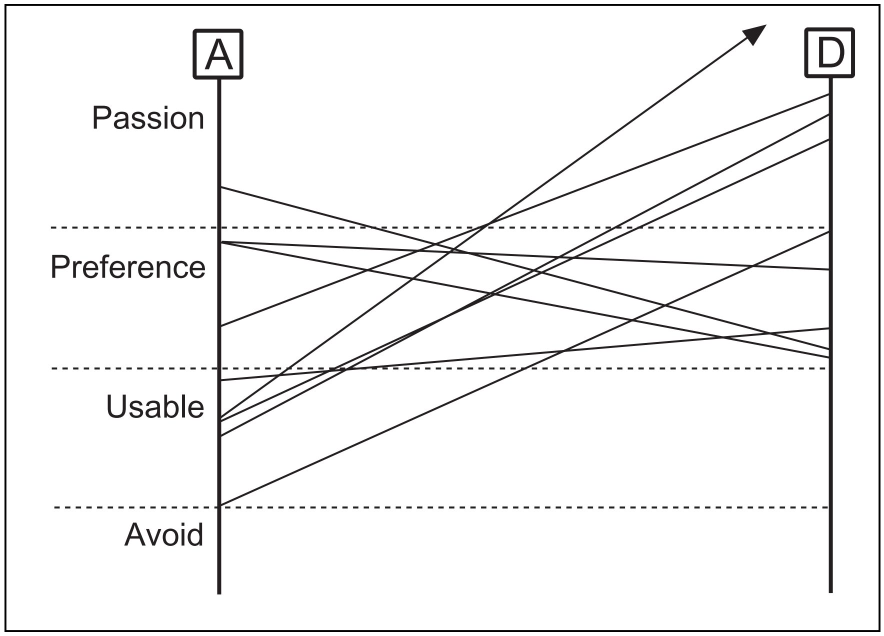

Figure 4—Comparison of A and D quadrant scores for each study participant.

in their relations with managers, the public, and other scientists is most likely associated with the degree to which quadrant C is a primary mode for them. This mode seems to be most closely associated with relational aspects of being and thus seems to have the most influence over how individuals value interpersonal relations.

Views of science, on the other hand, could be associated with all four quadrants, although probably most closely with quadrants A and D. Many of the scientists in this study with the lowest preferences for quadrant A (the logical, analytical mode) had the highest preferences, frequently in the strong preference or "unbridled enthusiasm or passion" zones for quadrant D (integrative, intuitive, holistic; see fig. 4). This comparison seems to indicate that some AMA scientists tend to approach science as a logical, analytical endeavor (balanced preference for quadrants A and D), whereas others tend to view science more strongly as a holistic, exploratory, intuitive, unpredictable venture (stronger preference for D than A). Again, it is important to remember that all the scientists showed a primary preference for Quadrant D.

A theme to remember is the number of primary preferences exhibited by the scientists. Within the group, only one scientist showed a single primary preference, four showed two, and four showed three. The number of primary preferences reveals the ability of an individual to easily access multiple modes of thinking. This group thus seems to have a fairly well developed capacity to shift among two to three of HBDI's four identified ways of thinking about and approaching the world.

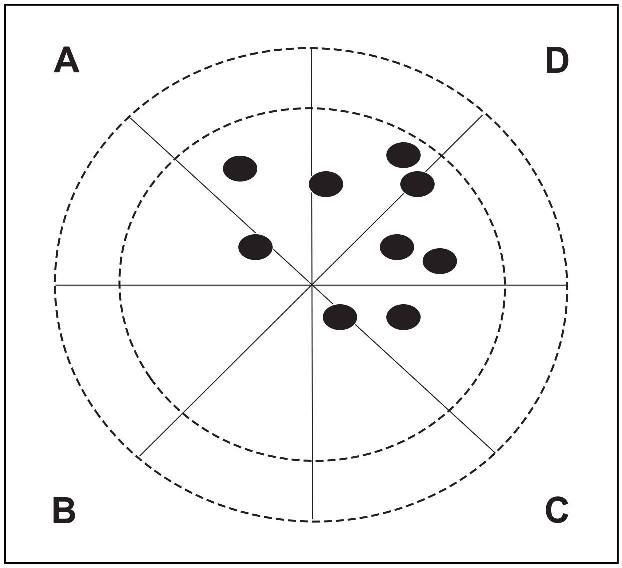

Figure 5—Herrmann Brain Dominance Instrument profile centers for all study participants.

A final calculation of HBDI scores arrives at an overall profile center for each scientist (fig. 5). The closer a person's profile center is to the overall center of the scale, the more "whole" his or her thinking is. The farther away a person's profile center is from the overall center, the more "declared" his or her preference is for one or more of the quadrants (Brain Connection 1998b). The profile centers in this sample are strongly oriented toward the D quadrant, with a significant influence from the C and D modes of thinking. No profiles are completely below the A through C axis.

Cognitive Mapping Findings

Because of the small size of the sample, neither quantitative nor statistical methods were used to analyze the 3CM maps created by study participants.[14] For the purposes of this study, these data were examined qualitatively for broad themes and differences in how the participating scientists conceptualize the research process and working relations.

Five of the maps created by study participants present fairly traditional views of science. These maps define the purpose of science as the provision of knowledge. Involvement with the public was rarely mentioned in these maps (when the public was mentioned on one map, it was referred to only within the context of the "identification of concerns").

Four of the maps present an expanded view of science and the research process. These maps include many of the standard scientific process components, or at least a reference to the scientific method, but they go on to venture into many different arenas. Two maps mention bringing people together face-to-face on the ground to discuss issues and concerns. One identifies science as a public process and describes the scientist's role as "custodian of science as a public process." Other

[14] Kearney (1997) utilized primarily quantitative approaches to analyzing data in a study with 23 participants. Yet she recognized the value of using qualitative methods to assess 3CM data, using it to augment her statistical findings (Kearney 1997: 142).

notations include science as a cooperative, interactive process of bringing people together; science as a holistic, expanded view that looks at a whole range of values; science as a process that requires knowing local culture and relating research to it; and science as requiring the bridging of disciplines.

In a fashion similar to the HBDI results, the 3CM results sort the scientists into two groupings. One group emphasizes a more traditional, logical, analytical, technical orientation focused on obtaining facts, and the other group emphasizes a more integrative, interpersonal, holistic, humanistic orientation that recognizes multiple forms of knowledge.

One basic way in which the maps differ is in the proportion devoted to the scientific method. One map is almost completely allocated to aspects of the scientific method. At the other end of the spectrum, a different map categorizes about a third of the items displayed as included in the scientific method. This variation highlights the degree to which notions associated with the scientific method are interwoven with other important features of the world. Where the scientific method as the way of doing research takes up virtually the entire map, science is a self-contained process. Where it is just one of five or six components, science is enmeshed within a complex web of actors, relations, and institutions. Also, those maps that focus closely on the scientific method include a high degree of specificity and detail about aspects of that process relative to the other maps. The maps in which research is contextualized tend to describe research in somewhat more general terms. A comparison of figures 6A and 6B shows the wide range in the proportion of 3CM maps of "the research process" devoted to describing the scientific method.

A second striking area of variation among the 3CM maps of scientists is the degree to which their views of science are clearly and neatly organized. The group is fairly evenly distributed from very clear and neat maps, to somewhat less organized, to loosely organized maps. Whereas Kearney's methods of 3CM analysis do not consider the actual layout of the maps, for this study, the relations between components of the maps are as important as the individual items they organize. The learning organization literature suggests that scientists' awareness of their mental maps is important to overcoming potential internal barriers to pursuing innovative management techniques such as adaptive management. The variation in how the AMA scientists mapped the research process suggests differences in how they approach adaptive management. Those whose views of the research process are found to be complex, characterized by multiple interrelations, and often loosely organized, may initially be better equipped to meet the expectations of an adaptive management environment. It would be reasonable to hypothesize that awareness of their way of understanding science could spur reflection and modification among all the scientists. Figures 7A and 7B show the range in the degree to which scientists' maps were tightly or loosely organized.

The maps made by the scientists also varied as to when and how the public is included in the research process. At one extreme is a map that shows the public at the fringes of the research process; at the other, is a map that literally places the public at the "heart" of how science is conceived. The rest of the maps fall along the continuum, between these two. These data suggest that scientists have widely different views about public participation in the research process (see figs. 8A and 8B).

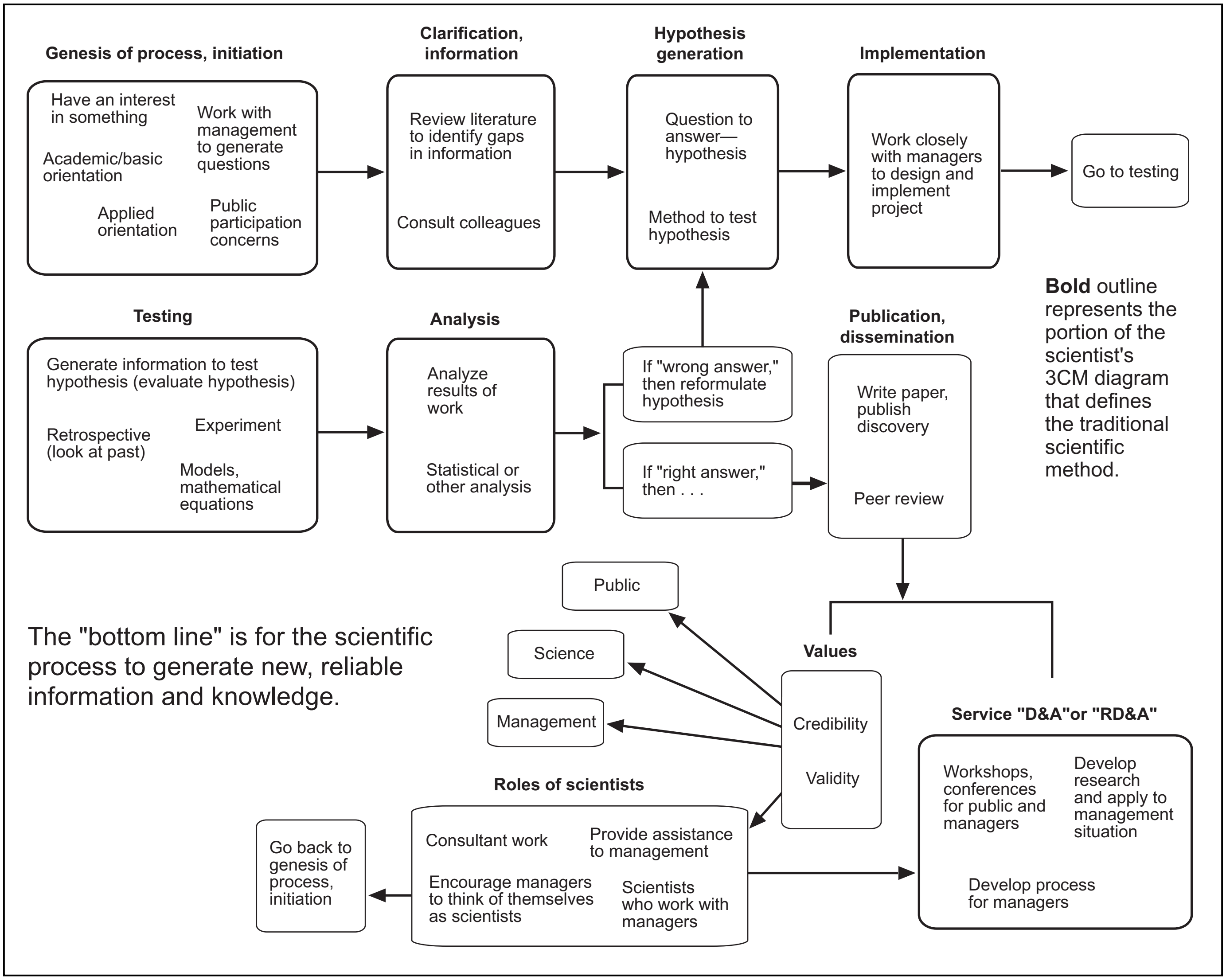

Figure 6A—Higher portion of the Conceptual Content Cognitive Mapping (3CM) diagram devoted to scientific method.

Synthesis of Herrmann Brain Dominance Instrument and Cognitive Mapping Findings

The HBDI and 3CM results—the two sociocognitively oriented data sets—point to two divergent orientations held by AMA scientists. To help illustrate these different perspectives, we develop hypothetical composite profiles. Although no one scientist is depicted in either of the composite profiles, each profile presents a fair representation of the features that differentiated scientists within the two groups.

A "profile A" scientist has a profile center in HBDI quadrant A, with a higher primary preference score for A than for D, and secondary preferences for B and C. This scientist approaches learning and working in a highly logical, analytical, and primarily quantitative manner. She approaches problem solving in a factual, rigorous, and analytical manner. In working with others, this scientist tends to be formal, somewhat reserved, and frequently decisive; she focuses on providing information to those she works with and rarely engages in extensive discussion with citizens. A "profile A" scientist primarily works independently and is careful to conform to established rules and guidelines. She

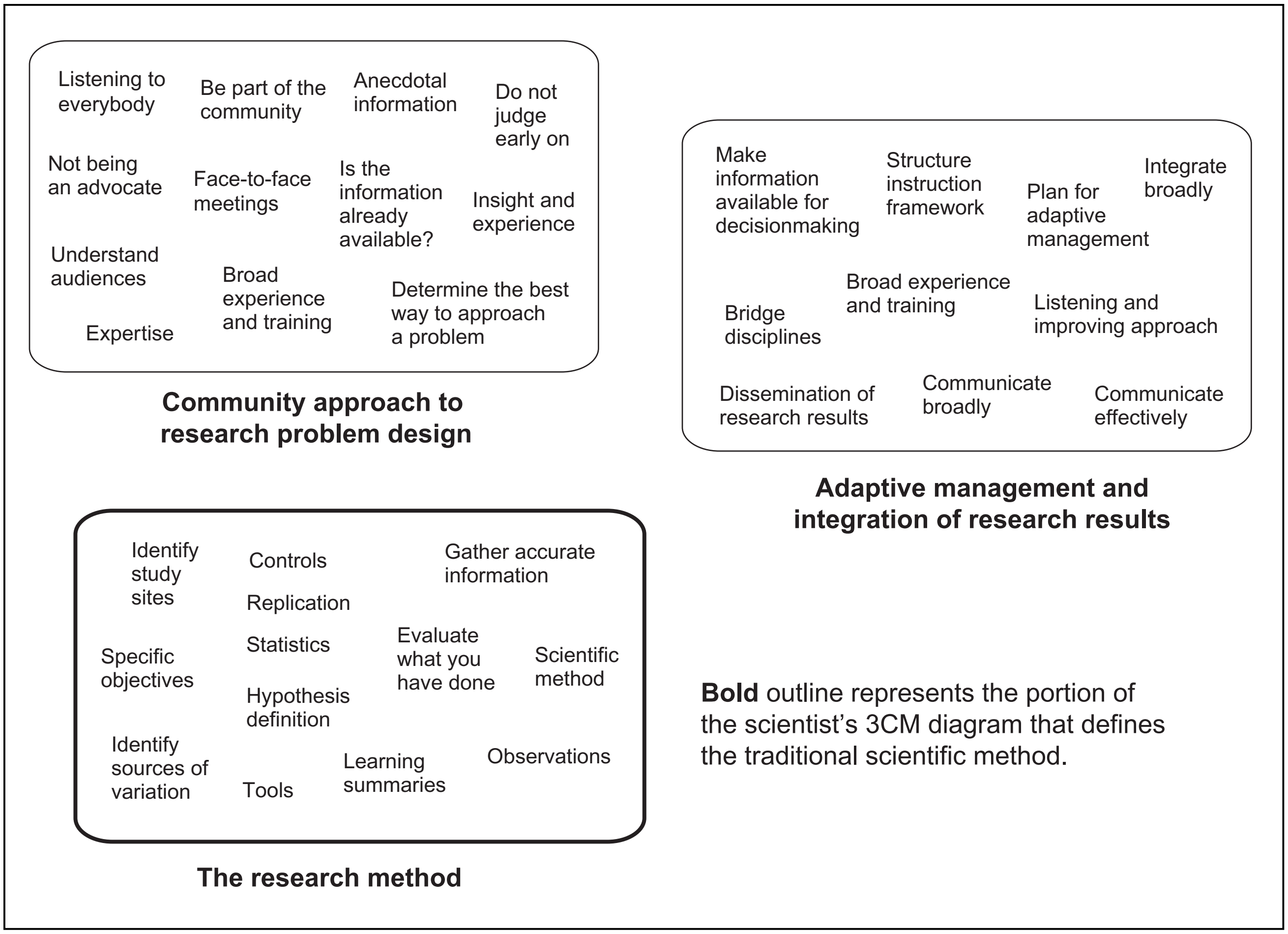

Figure 6B—Lower portion of the Conceptual Content Cognitive Mapping (3CM) diagram devoted to scientific method.

is more concerned with objectivity of data collection and analysis than she is with the incorporation of multiple perspectives into the research process. A scientist of this orientation considers values and personal perspectives to be outside the realm of good science. She believes that the discovery of "raw," unbiased facts is possible through empirical study, and that the role of science is to find those facts and arrive at scientific truths. We would expect to find "profile A" scientists involved in fairly traditional hypothesis testing, analytical experiments.

A "profile B" scientist has a profile center solidly situated in D quadrant. His strong D quadrant preference is accompanied by a lesser but still very strong preference for C quadrant. This scientist approaches learning and working as synthesizing, integrative activities. He is a conceptual, imaginative, and innovative thinker. "Profile B" scientists believe that there are multiple ways of knowing and that the scientific method is one of them. He embraces intuition in his work. In contrast to "profile A" scientists, "profile B" scientists are nonconformists and are willing to take risks and break rules in order to extend learning. A scientist with this orientation is playful and open-minded in his work, and is often empathetic, supportive, and expressive in relations with others. He is comfortable with uncertainty and ambiguity, believes that value-free science is a myth and that there are not any purely objective, value-free truths. This scientist sees attitudes,

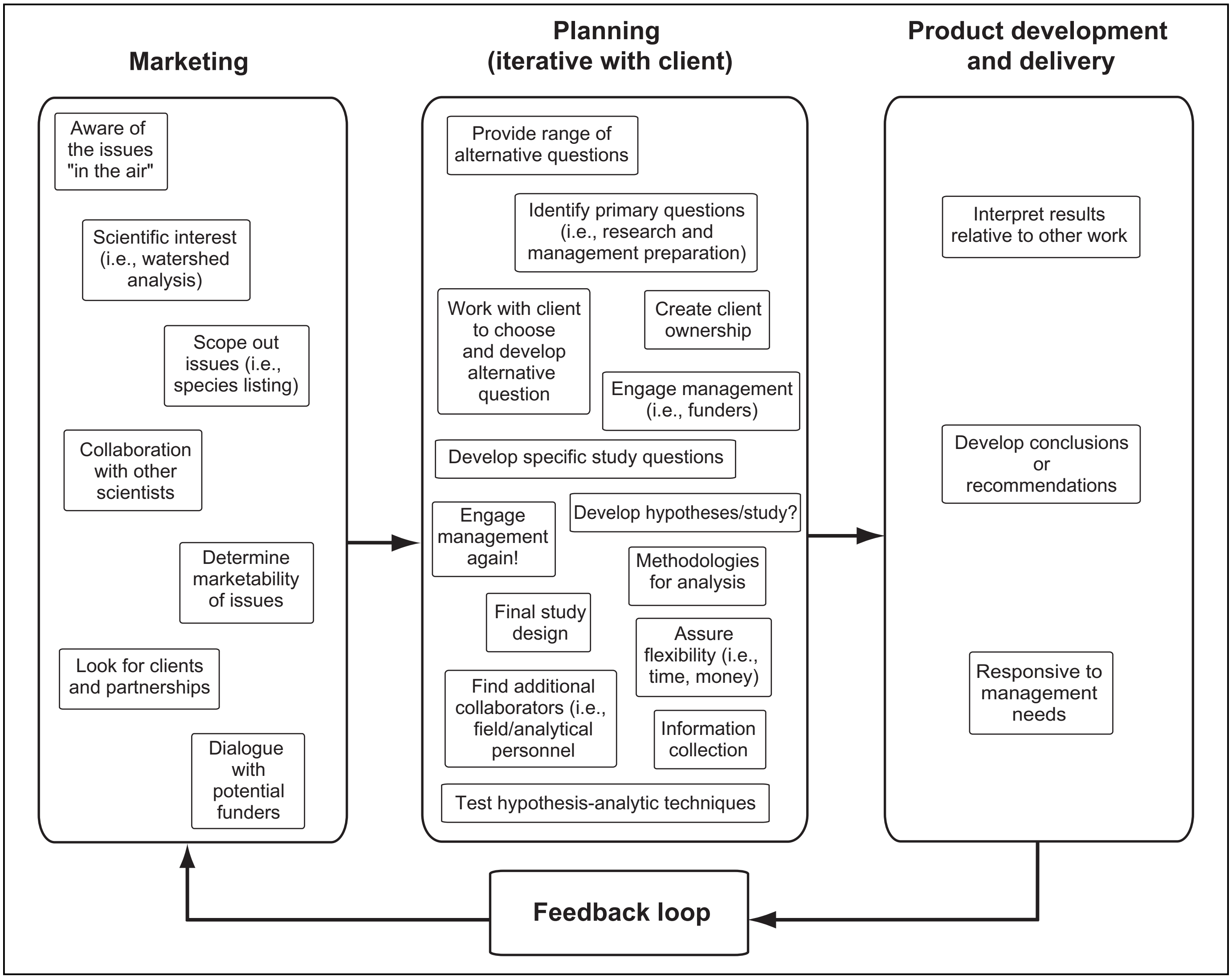

Figure 7A—Example of tightly organized Conceptual Content Cognitive Mapping diagram.

values, emotions, and beliefs as important and active in the scientific endeavor. He has faith in group processes, values working with others, and in general tends to be a people-oriented person. "Profile B" scientists believe the role of science is to help society. We might expect to find this scientist involved in participatory, collaborative, multidisciplinary projects that bring scientists, managers, and citizens together in new and innovative working relations.

This study did not assess which composite profile is more successful in engaging in adaptive management science. One might posit, however, that a "profile A" scientist would have a more difficult time with the experimental, dynamic nature of the adaptive management approach, particularly with the uncertain, ambiguous, and collaborative aspects of this orientation toward science and management. In the adaptive management context, the technical solutions a "profile A" scientist is likely to favor are often

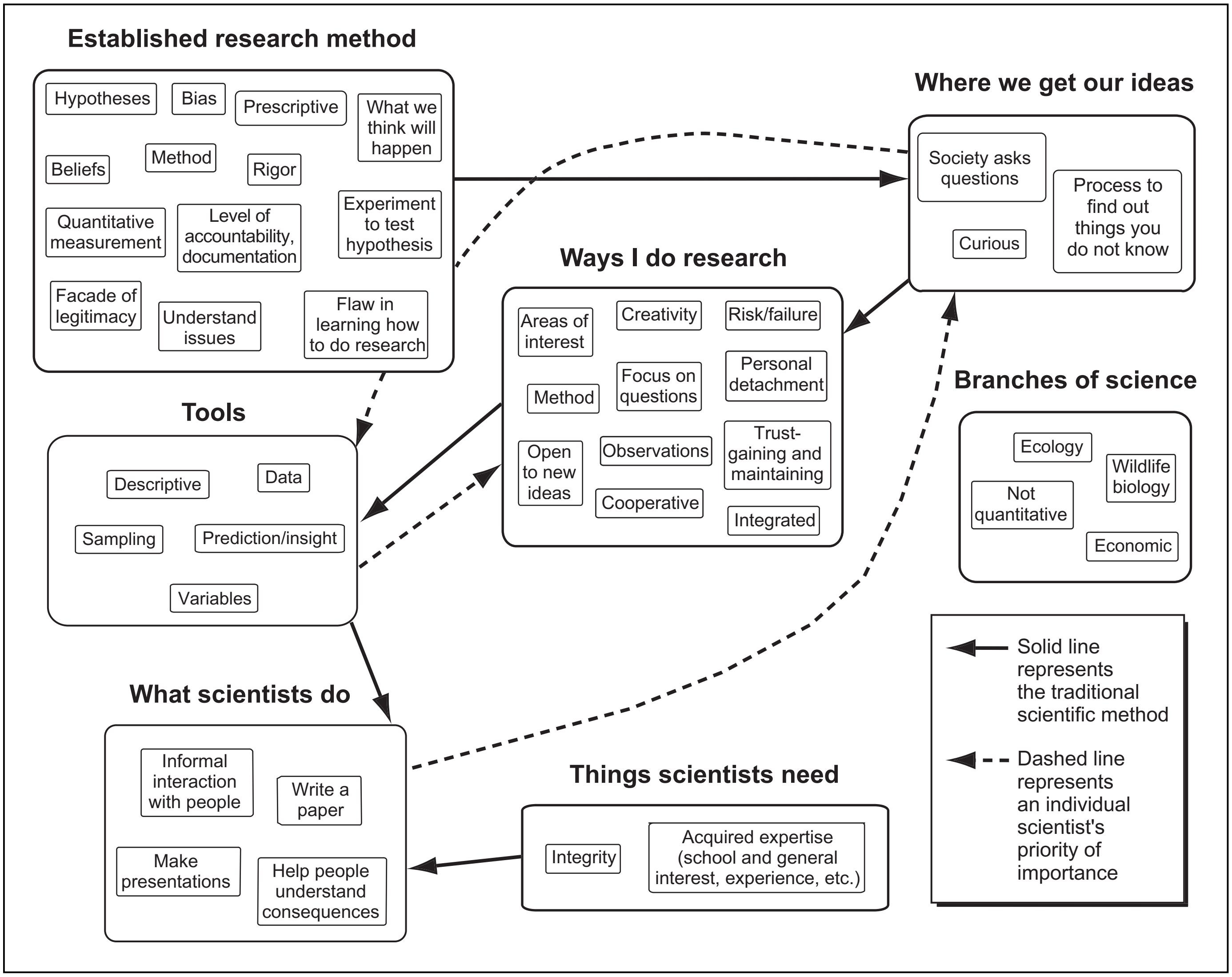

Figure 7B—Example of loosely organized Conceptual Content Cognitive Mapping diagram.

impractical because in their failure to consider attitudes, values, and perspectives as part of the process, they fail to involve a wide enough range of stakeholders to have long-term, broad support. Although both "profile A" and "profile B" scientists are integrative thinkers, adaptive management also depends on the ability of scientists to be collaborative and flexible in their relations with other scientists as well as with managers and the public. A "profile A" scientist's views of science allow nonscientists a limited role. A "profile B" scientist's orientation to science, on the other hand, requires the involvement of citizens and managers in the research effort from start to finish, including face-to-face meetings and field trips to discuss issues of concern, research design, and tentative "discoveries" along the way.

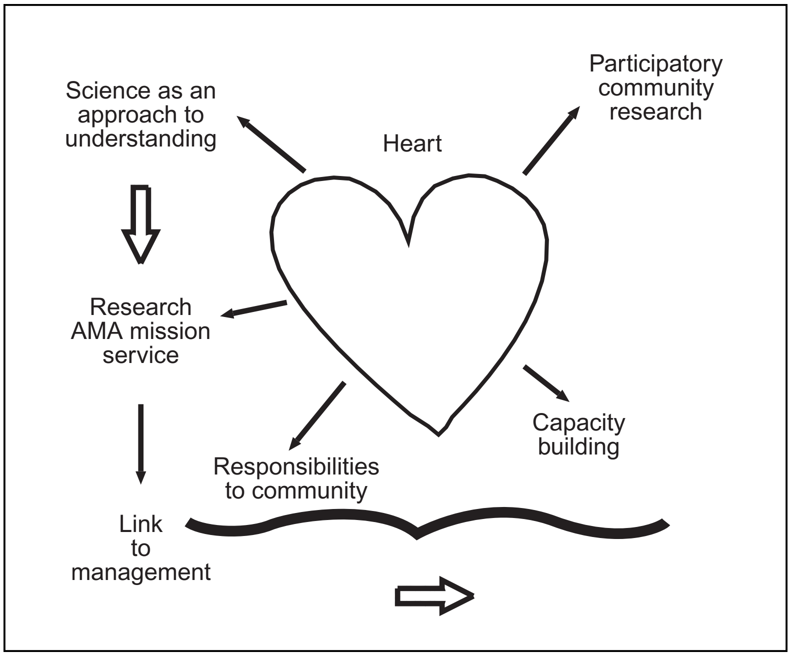

Figure 8A—Example of public at the heart of the process in a Conceptual Content Cognitive Mapping diagram.

Discussion and Conclusion

Research Questions

The small sample size and nonevaluative nature of this study make it premature to offer final conclusions about the effect of a scientist's view of the research process on his or her ability to participate in adaptive management. The data gathered, however, deepen understanding about different ways scientists approach working relations and the research process. When these data are viewed from the perspective of social learning theory, several significant implications for the implementation of adaptive research and management become clear. In the following discussion, these implications are highlighted as research questions to suggest directions for study and reflection by future practitioners and researchers. These questions are suggestive, not conclusive.

Does the degree to which adaptive management scientists are oriented toward social learning constrain or facilitate social learning for the entire adaptive management process?

Some scientists take a collaborative, dialogic approach to both their working relations and to science, whereas others are reluctant to involve managers and citizens in their work. As a group, they are generally not working collaboratively so as to benefit from one another's efforts. The adaptive management concept and the AMA mandate both call for social learning, yet we found little evidence of conditions conducive to social learning across the network of AMAs. Scientists are at the crux of the learning processes that define adaptive management, as they are largely responsible for research projects to generate new knowledge about ecological conditions as well as human dynamics. The choices made by scientific participants often prove to be particularly consequential. If social learning orientations are limited among scientists, new knowledge and its applications may be jeopardized for the entire network of participants in adaptive management.

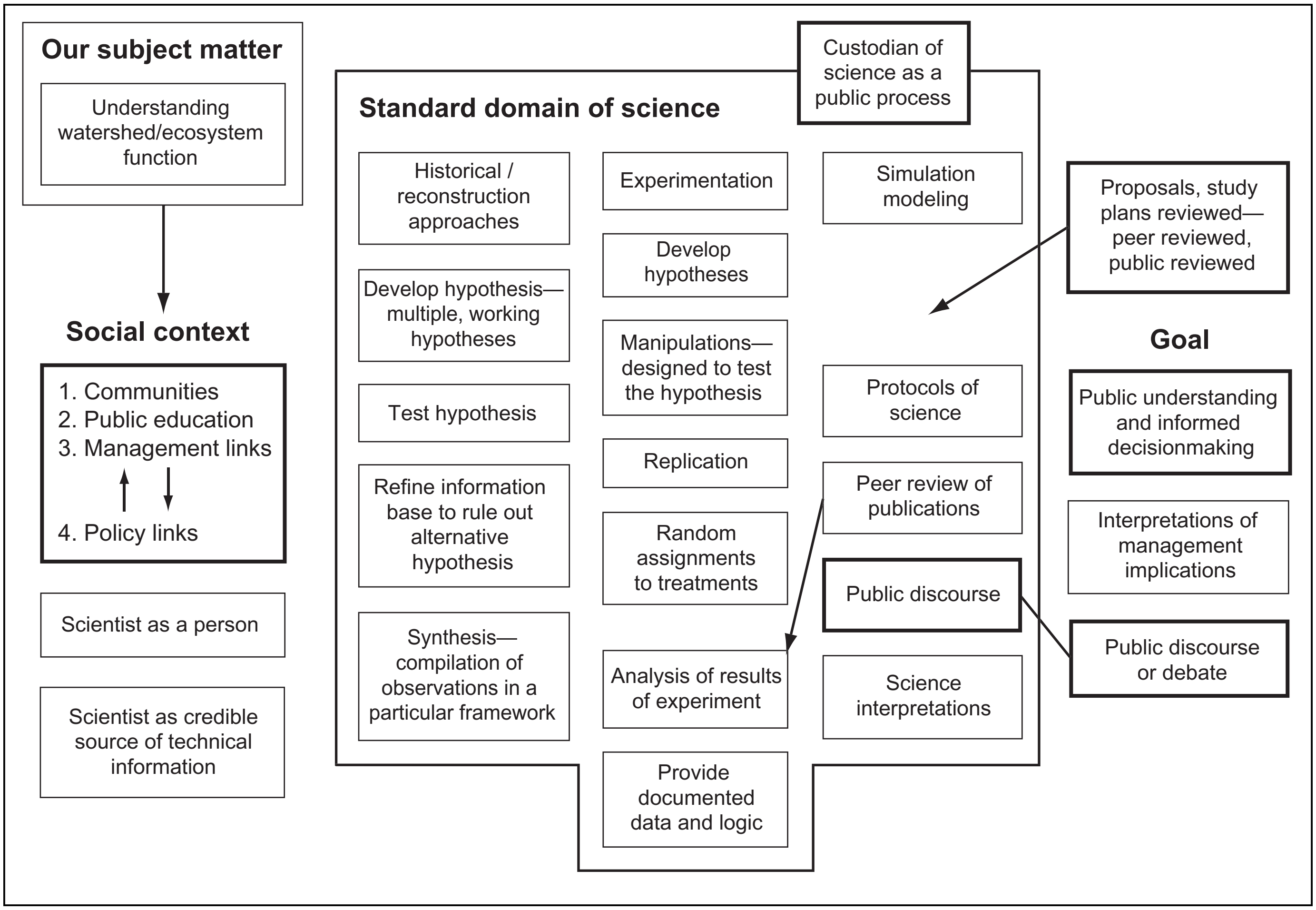

Figure 8B—Example of public at fringes of the process in a Conceptual Content Cognitive Mapping diagram.

Are holistic thinkers best prepared for adaptive management work? Does successful, effective adaptive management require holistic thinkers, a clear mandate, and careful institutional reform? Without these three conditions, will adaptive management efforts be significantly hampered?

A holistic mindset appears to be a necessary but insufficient condition for social learning and adaptive management. Every scientist who participated in this study showed a preference for holistic thinking. We suggest that the capacity to comprehend and appreciate the complexity, unpredictability, and interconnectedness of society and ecology—the capacity to think holistically—facilitates an individual's ability to be an effective participant in social learning and adaptive management. Not all scientists in the study, however, demonstrate a social learning orientation to their work. It is not enough to gather holistic thinkers and give them a mandate for social learning and adaptive management. Institutional constraints such as funding opportunities, standard operating procedures within an agency, traditional incentives and sanctions in the scientific community, and existing agency reward-disciplinary action guidelines impede holistic thinkers given a mandate for adaptive management. Reward structures that favor independent work and academic publications over collective work and more accessible formats such as organizational newsletters and other gray literature perpetuate an institutional framework that appears to be out of step with adaptive management. Clark and others (1998: 15) similarly report, “there is a serious question about how well current planning processes fit with adaptive management.” Organizations attempting institutional reform to create an environment more conducive to adaptive management would do well to consider Clark and others’ “prerequisite to successfully integrating science and policy: clarity of objectives, processes, and desired outcomes; clarity of roles and responsibilities of scientists, policymakers, and the public; quality control through open peer and public review; and effective communication and involvement of stakeholders throughout the process” (1998: 6).

Will scientists who do not see roles for nonscientists in the research process limit the scope of learning and the effectiveness of adaptive management?

Although some scientists articulate specific ways in which local citizens, land and resource managers, and interest groups should be involved in the research process, others simply do not include nonscientists in any other way than as recipients of scientific knowledge. One of the most important innovations of adaptive management is its emphasis on collaboration among scientists, citizens, and agency managers. This blending of perspectives and experiences promotes more robust knowledge and facilitates smooth implementation and long-term effectiveness of policies and projects based in research results. Stankey and Shindler (1997: 9) warn, “to the extent that relevant knowledge is seen as held only by ‘experts,’ conflicts with those who claim knowledge by virtue of a history of connection with a place [such as local citizens] are likely.”

When the cultivation of working relations and the recognition, documentation, and sharing of learning are limited, are social learning and adaptive management significantly constrained?

Whatever the cause, these limitations have significant consequences for adaptive management. Documentation seems to many to be a time-consuming, mundane, often onerous task. But with high personnel turnover and the dual challenges of complexity and sheer quantity of information and insights to process, documentation becomes vital to ensuring the incorporation of new knowledge that makes adaptive management **adaptive**. Without specific, articulated structures for capturing lessons learned, as well as loosely structured time set aside for incubating relations, these aspects of adaptive management can easily be lost in the shuffle of daily deadlines.

Does the degree to which working relations are collaborative depend in part on the interest and motivation of all involved parties? Can organizational status and disciplinary boundaries pose serious obstacles for the establishment of collaborative working relations?

The units of analysis for determining the degree to which working relations are collaborative are the relations themselves. No one individual can make relations collaborative. Collaboration requires the sustained engagement of both parties. In some cases, despite a scientist’s orientation toward working collaboratively with a manager or other AMA participant, the relations did not develop. Mandates may sow the seed, but whether or not the seed germinates depends on the particular individuals involved and on how they interact.

The power differential between individuals influences their interaction. Scientist-to-scientist relations, in which parties shared similar training backgrounds and similar positions in the organizational hierarchy, were the ones most frequently described as collaborative. For adaptive management to be successful, special attention must be given to the cultivation and support of relations that cross boundaries of background, discipline, education level, and organizational status.

Clark and others (1998: 17) encourage the development of "boundary spanners": "individuals who can link the worlds of science and management and translate the concerns of one to members of another." They acknowledge that boundary spanners are rare, and recommend "altering incentive structures in both management and science branches and . . . increas[ing] opportunities for staff crossover experience."

Additional research questions suggested by several reviews of the study include the following:

- Do scientists trained in traditional approaches to research have the capacity and skills required to successfully conduct research within the context of adaptive management?
- Do scientists have the capacity for double-loop learning?
- How do the supervisors of adaptive management scientists see the scientists' jobs?
- How do demographic characteristics—gender, agency experience, education, field of science, international experience—affect the scientist's social learning orientation and effectiveness in implementing adaptive management?
- Could the cognitive mapping technique be used to teach social learning as well as assess it? Could it be used to encourage more open systems thinking among scientists?
- How are the relations created by AMA efforts leading scientists to develop the capacity to work effectively in a learning community with a public component? In what ways are these relations helping scientists to develop the capacity to contribute to a learning organization that takes the public nature of scientific work seriously?
- How does the culture of traditional science affect the ability of scientists to work with individuals from other cultures where traditional scientific values do not prevail and might be viewed as undesirable?

Considerations for Practitioners

In many ways, the AMAs seem to offer an ideal environment for social learning. The mantra of the AMA program is "learn to manage, manage to learn;" social as well as ecological issues are mandated priorities; and collaborative approaches to research and decisionmaking are required.

Agency scientists display many characteristics that seem likely to foster social learning. As a group, they are strongly disposed toward holistic thinking (as illustrated by the quadrant D preferences they all shared in the HBDI analysis), and all value working relations as part of getting their work done. Some show high levels of commitment to strong communication, collaboration, and broad involvement in research and management.

The scientists in this study, however, are also hampered in their capacity to engage in social learning. Forums and support for collaborative relations are rare. Traditional scientific standards and agency incentive systems may be out of step with the goals of social learning and adaptive management. Limitations on time and funding minimize the capacity to effectively engage in integrative, innovative projects.

What insights can this study offer to an institution or organization considering a shift toward adaptive management? What characteristics enable scientists to implement social learning-oriented adaptive management? What would an adaptive institution look for in an individual scientist? How would adaptive organizations foster an interactive network of adaptive management scientists? This study can offer several responses to managers, agency decisionmakers, and administrators implementing adaptive management. These considerations are posed as questions the adaptive management administrator may wish to consider.

To what degree do scientists hold a participatory orientation?

At the level of the individual scientist, one would look for the belief that community members are vital participants in natural resource research and decisionmaking. Scientists who support and practice what Shannon and Antypas (1996: 68) term "civic science" (where "one essential role of citizens is as lay scientists who seek to clearly, objectively, and honestly assess themselves, their communities, and society . . . [and] an essential role of scientists is to be engaged as citizens") understand their own role as facilitating a multiparty learning process that is enriched by a wide range of perspectives and experiences and thus is more useful and more durable.

To what degree do scientists demonstrate flexibility in their views of science and diversity of the knowledge sources?

One would also look for individuals whose view of science could accommodate and respond to a world characterized by complexity, interconnectedness, dynamism, unpredictability, and the interaction of social and environmental processes. Approaches to science in which outcomes are virtually predetermined and are seen as fixed markers of a finite truth, lack the flexibility and adaptability that define adaptive management.

In addition, scientists whose understanding of legitimate and valuable knowledge includes nonscientific perspectives are in a better position to embrace and integrate the multiple perspectives that are at play in adaptive management situations.

To what degree do scientists exhibit tolerance for ambiguity and uncertainty?

Scientists who are able to work effectively in situations with unclear boundaries, expectations, and forms of knowledge are better suited for the uncertain context of developing adaptive management. Difficulty in adjusting to such conditions seems likely to constrain job satisfaction and performance in adaptive management contexts.

To what degree can the institution share lessons learned?

To maximize social learning, an institution would foster sharing of lessons learned among scientists and with other adaptive management participants. Scientists would recognize both social and environmental lessons that might increase understanding and improve research and management practice. It also would entail documenting those lessons so they are not lost with personnel changes or buried by other responsibilities.

Is the institution prepared to address time limitations and conflicting work priorities?

When time is in short supply—due to competing demands and priorities—interactive and documentary activities are typically sacrificed in favor of meeting deadlines and responding to urgent requests. It takes more time to work collaboratively and integratively, especially at the beginning of the process. In addition, adaptive management practitioners can never be guaranteed that their work will have clear "payoffs" when assessed by existing measures of success. Efficiencies should be sought in other areas, such as administrative reporting, to make time for such activities as on-the-ground negotiations and project monitoring, tasks crucial to effective adaptive management that are shortchanged when time is precious.

Is the institution prepared to expect long incubation times?

It is critical to recognize that it will take time to implement adaptive management. Lee (1993: 51) notes that "a durable lesson of [adaptive management in] the Columbia basin is the inherent inefficiency of large systems." Working across many ecological and organizational boundaries increases the complexity of work tasks and the lead-time required for accomplishing adaptive management objectives. Thus the success of adaptive management efforts should be measured over the course of years, not months.

Can the institution structure interscientist interaction?

Another practice that could help develop interactive capacity is loose structure (Meidinger 1996). Cross-disciplinary relations do not just appear fully formed and functioning. To develop networks and working relations among adaptive management practitioners, regularly scheduled seasonal gatherings could be held, by using a field trip or retreat to both bring people together around some common ground and to build in time for exploration of further connections.

Can the institution develop incentives for collaboration?

Institutional structures may need to be revised to align organizational expectations and resources with the realities of adaptive management practices. Specific incentive structures designed to encourage collaboration between scientists, citizens, and agency managers would help focus energy on the development of these crucial working relations.

Can the institution facilitate partnerships among scientists?

Teaming scientists with a tendency toward collaboration and holistic views of science with scientists whose perspective on science is more traditional could open fruitful avenues for discussion, learning, and innovation. In particular, such partnerships could increase the degree to which "traditional" scientists (those whose profile lines up most closely with that of "Profile A" scientists, described earlier) are able to understand, appreciate, and explore adaptive management.

Concluding Comments

Do the views of a scientist toward science and working relations affect his ability to implement adaptive management? We found that those scientists who hold a fairly traditional view of science place a lower value—and thus focus less time, money, and energy—on work-related relations and collaboration. Those who have more nontraditional or alternative views of science (nonlinear, intuitive, integrative, holistic, flexible, synthesizing), place a higher value on interpersonal relations and collaboration. Because interpersonal relations and collaboration are important aspects of social learning, and "learning to learn" is an underlying premise of adaptive management, we suggest that a scientist's view of science does affect her ability to implement adaptive management.

Research in adaptive management continues to evolve. Scientists involved with the adaptive management areas clearly approach their working relations and science from different perspectives. Social learning theory suggests that these differences are likely to have significant implications for the ability of individual scientists to effectively facilitate adaptive management. Traditional, individualistic, analytical approaches to science tend to limit interaction with nonscientists, and as a result, tend to alienate lay citizens and resource managers.

The findings presented here emphasize the complexity of efforts to implement adaptive management: the perspectives of the scientists and their experiences with science and working relations do matter. Institutional structures and resources can present both formidable barriers and inspiring opportunities. Adaptive management operates at multiple scales, both on the ground and within the structure of an organization. From the microlevel of an individual's sociocognitive make-up, to the midlevel of a working group of potential collaborators, to the macrolevel of an entire federal agency, effective implementation of adaptive management requires rethinking how science is done. An individual scientist is just one participant in that process, albeit a vitally important participant. Enabling that scientist to rise to the challenge of adaptive management requires that he hold an integrative, participatory orientation to his work, and that his institution be characterized by an integrative, participatory orientation toward policies and regulations. Even the most holistic, integrative, participatory scientist will struggle to implement adaptive management if the organizational structure that surrounds him or her maintains contradictory policies even while adopting the goals of innovation and adaptive management.

A collaborative orientation is just as much a requirement for success in adaptive management as a holistic, systems-based, social-learning-oriented perspective on science. With this integration of science and collaboration, adaptive management may occur.

Afterword

In 1999, the AMA program budget was eliminated, effectively terminating research efforts that depended on agency funding specifically supporting adaptive management work. Despite this turn of events, the principle of adaptive management remains alive. Several of the AMA scientists terminated adaptive management work in response to the budget cuts; others, primarily those who had been involved in innovative and collaborative efforts before the AMA program was initiated, continue to incorporate the adaptive management philosophy into their research programs.

Traditional preferences for reports on finished work constrain the ability of scientists involved in adaptive management to document their usually "in-progress" work in scientific publications. Continued conversation, innovative means of publishing and distributing results, and other modes of sharing lessons learned are necessary for the adaptive management approach to fulfill its promise.

Acknowledgments

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Literature Cited

Bandura, A. 1977. Social learning theory. Englewood Cliffs, NJ: Prentice-Hall. 247 p.

Blute, M. 1981. Learning, social learning, and sociocultural evolution: a comment on Langton. American Journal of Sociology. 86(6): 1401–1406.

Brain Connection. 1998a. Interpretation booklet of the Herrmann survey of thinking preferences. Hendersonville, NC: The Brain Connection. 20 p.

Brain Connection. 1998b. Plot of profile centers for PNW scientists. Hendersonville, NC: The Brain Connection. 1 p.

Bunderson, C.V. 1990. The validity of the Herrmann Brain Dominance Instrument. In: Herrmann, N., ed. The creative brain. Lake Lure, NC: Ned Herrmann/Brain Books: 337–379. [Appendix A].

Carey, A.B. 1997. Cognitive styles of Forest Service scientists and managers in the Pacific Northwest. Gen. Tech. Rep. PNW-GTR-414. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p.

Clark, R.N.; Meidinger, E.E.; Miller, G. [and others]. 1998. Integrating science and policy in natural resource management: lessons and opportunities from North America. Gen. Tech. Rep. PNW-GTR-441. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 22 p.

Denzin, N.K. 1989. The research act: a theoretical introduction to sociological methods. Englewood Cliffs, NJ: Prentice Hall. 306 p.

Forest Ecosystem Management Assessment Team [FEMAT]. 1993. Forest ecosystem management: an ecological, economic, and social assessment. Portland, OR: U.S. Department of Agriculture; U.S. Department of the Interior [and others]. [Irregular pagination].

Friedmann, J. 1976. Innovation, flexible response and social learning: a problem in the theory of meta-planning. Reading, England: University of Reading, Department of Geography, Reading Geographical Papers. 21 p.

Friedmann, J. 1987. Planning in the public domain: from knowledge to action. Princeton, NJ: Princeton University Press. 501 p.

Gabelnick, F.; MacGregor, J.; Matthews, R.S.; Smith, B.L. 1990. Learning communities: creating connections among students, faculty, and disciplines. New Directions for Teaching and Learning. 41: 1–107.

Halbert, C. 1993. How adaptive is adaptive management? implementing adaptive management in Washington State and British Columbia. Reviews in Fisheries Science. 1(3): 261-283.

Herrmann, N. 1990. The creative brain. Lake Lure, NC: Ned Herrmann/Brain Books. 456 p.

Holling, C.S. 1978. Adaptive environmental assessment and management. London: John Wiley. 377 p.

Kearney, A.R. 1997. Some implications of cognitive map theory for environmental problem-solving and decision-making. Ann Arbor: University of Michigan. 151 p. Ph.D. dissertation.

Kearney, A.R.; Kaplan, S. 1997. Toward a methodology for the measurement of the knowledge structures of ordinary people: the conceptual content cognitive map (3CM). Environment and Behavior. 29(5): 579–617.

Knapp, M.L.; Hall, J.A. 1992. Nonverbal communication in human interaction. New York: Holt Rinehart and Winston. 507 p.

Korten, D.C. 1981. The management of social transformation. Public Administration Review. 41: 609–618.

Krannich, R.S.; Carroll, M.S.; Daniels, S.E.; Walker, G.B. 1994. Incorporating social assessment and public involvement processes into ecosystem-based resource management: applications to the East Side Ecosystem Management Project. Report for the USDA Eastside Ecosystem Management Project. http://www.icbemp.gov/science/scanned.html. (31 May 2001).

Lee, K.N. 1993. Compass and gyroscope: integrating science and politics for the environment. Washington, DC: Island Press. 243 p.

Leeds-Hurwitz, W. 1989. Communication in everyday life: a social interpretation. Norwood, NJ: Ablex Publishing Corporation. 203 p.

Lofland, J.; Lofland, L.H. 1995. Analyzing social settings: a guide to qualitative observation and analysis. Belmont, CA: Wadsworth. 267 p.

Maguire, P. 1987. Doing participatory research: a feminist approach. Amherst, MA: Center for International Education. 305 p.

Marshall, J.; Peters, M. 1985. Evaluation and education: the ideal learning community. Policy Sciences. 18(3): 263–288.

Meidinger, E.E. 1996. Organizational and legal challenges for ecosystem management. In: Kohm, K.A.; Franklin, J.F., eds. Creating a forestry for the 21st century: the science of ecosystem management. Washington, DC: Island Press: 347–365.

Michael, D. 1997. Learning to plan and planning to learn. [Place of publication unknown]: Miles River Press. 403 p.

Nonaka, I.; Umemoto, K.; Senoo, D. 1996. From information processing to knowledge creation: a paradigm shift in business management. Technology in Society. 18(2): 203–218.

Park, P.; Brydon-Miller, M.; Hall, B.; Jackson, T. 1993. Voices of change: participatory research in the United States and Canada. Westport, CT: Bergin and Garvey. 203 p.

Polanyi, M. 1966. The tacit dimension. Garden City, NY: Doubleday and Co. 108 p.

Prawat, R.S. 1996. Learning community, commitment and school reform. Journal of Curriculum Studies. 28(1): 91–110.

Reich, R.B. 1985. Public administration and public deliberation: an interpretive essay. Yale Law Journal. 94: 1617–1641.

Rubin, H.J.; Rubin, I.S. 1995. Qualitative interviewing: the art of hearing data. Thousand Oaks, CA: Sage. 302 p.

Ryan, S. 1995. Emergence of learning communities. In: Gozdz, K., ed. Community building: renewing spirit and learning in business. San Francisco: New Leaders Press: 85–93.

Saint-Onge, H. 1996. Tacit knowledge: the key to the strategic alignment of intellectual capital. Strategy and Leadership. 24(2): 10–14.

Seidman, I.E. 1991. Interviewing as qualitative research: a guide for researchers in education and the social sciences. New York: Teachers College. 119 p.

Senge, P.M. 1994. The fifth discipline: the art and practice of the learning organization. New York: Doubleday/Currency. 423 p.

Shannon, M.A. 1991. Resource managers as policy entrepreneurs. Journal of Forestry. 89(6): 27–30.

Shannon, M.A.; Antypas, A.R. 1996. Civic science is democracy in action. Northwest Science. 70(1): 66–69.

Stankey, G.H.; McCool, S.F.; Clark, R.N.; Brown, P.J. 1999. Institutional and organizational challenges to managing natural resources for recreation: a social learning model. In: Jackson, E.L.; Burton, T.L., eds. Leisure studies: prospects for the twenty-first century. State College, PA: Venture Publishing: 435–450.

Stankey, G.H.; Shindler, B. 1997. Adaptive management areas: achieving the promise, avoiding the peril. Gen. Tech. Rep. PNW-GTR-394. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p.

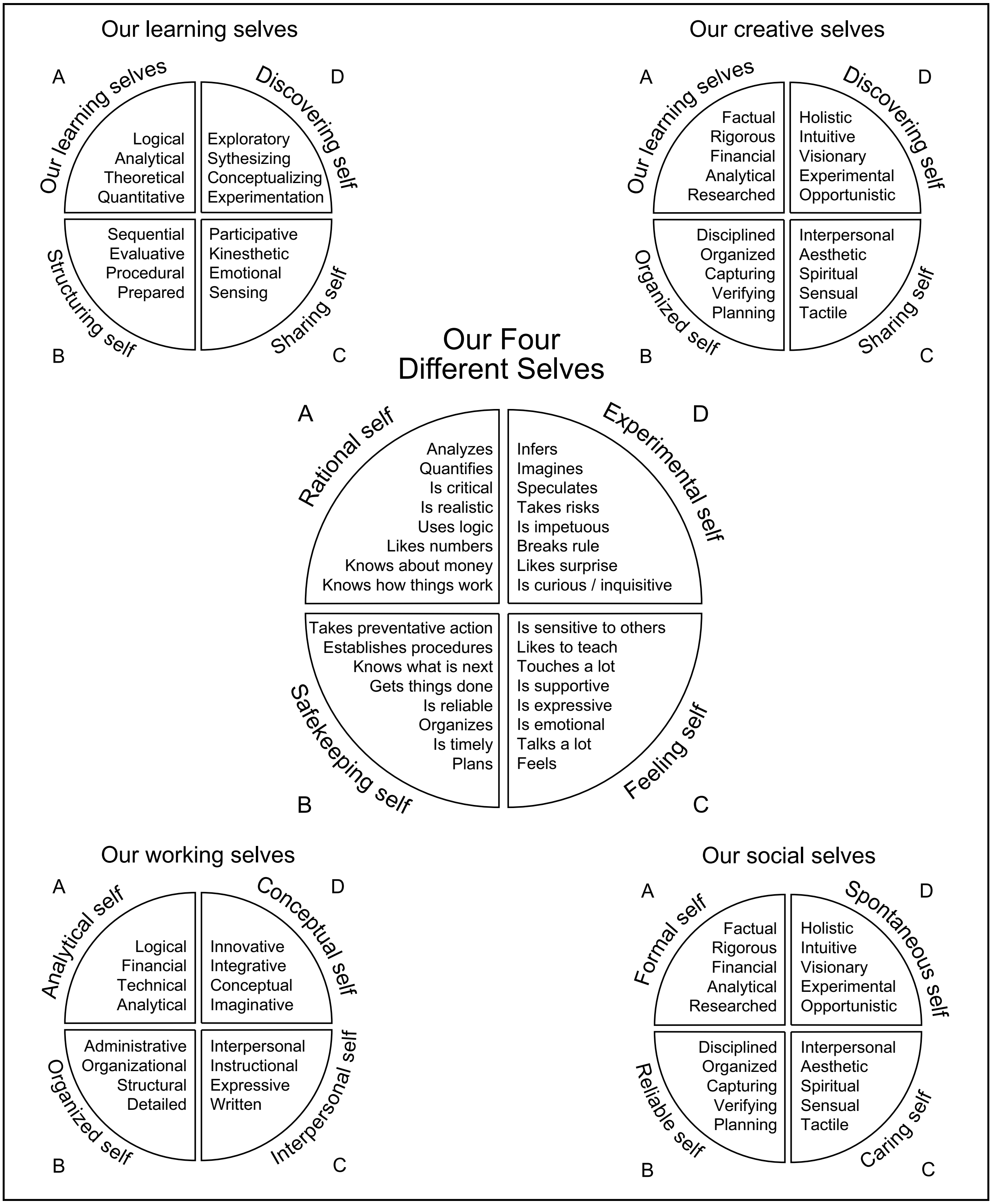
U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. [Place of publication unknown]. 74 p. [Attachment A: standards and guidelines].

Walters, C. 1986. Adaptive management of renewable resources. New York: Macmillan Publishing Company. 374 p.

White, K.W. 1992. An application of Gadamer's hermeneutics through an empirical description of communication in a collaborative learning community. Seattle, WA: University of Washington. 224 p. Ph.D. dissertation.

Yankelovich, D. 1991. Coming to public judgment: making democracy work in a complex world. Syracuse: Syracuse University Press. 290 p.

Appendix 1: Our Four Different Selves Illustration



Appendix 2: 3CM Mini-Interview and Mapping Exercise Questionnaire

A tape-recorded session was held to gain a better understanding of how scientists actually do research. To get at a number of different dimensions, a short interview and a 3CM process were used. 3CM is a cognitive mapping process. The following scenario was used for the 3CM process:

3CM Task

> Imagine that I am someone with no experience in science or research and I ask you what the research process is all about. How would you answer me? I'd like you to think about what you believe are the critical aspects, components, processes, or ways of doing good research. In other words, what are you sure to do when doing research? What are all the pieces that you include as part of the research process? What I'm interested in are phrases and words—more or less a list rather than a lengthy discourse. While you list the components I'll be writing them on these little sticky notes and arranging them in front of you so you can see what you've already covered. Are you ready?

While they list components, the interviewer will write each one on a separate sticky note and place each note on the table for the participant to refer to while continuing the exercise. When the participant is finished, ask the participant to organize the components.

> Now I would like you to organize or categorize the notes into groups that make sense to you. (Duplicate notes may be made if a note fits in more than one category.)

Interviewer may ask for further explanation/description of categories and/or why components were organized as they were. For example, one question might be:

> How do you see the components you've grouped here fitting together?
>
> The next step is to label each group. Think of a word or short phrase that describes the category.

Interviewer may ask about interrelationships between/among the categories. Participant may continue to add new components at this time.

> Can you describe any interrelationships between any of the categories or the components with the categories?
>
> Is there any ordering among the categories, for example is one category a prerequisite to another?
>
> Does one category (or any of the individual components) have more significance or importance than others? Could you prioritize the categories as to importance, or would you say they are equal in importance?

Interviewer may ask about aspects that seem to be missing and that may lie outside the participant's conceptualization of research. If participants want to do so, they can add new concepts now and talk about how they see them fitting with their existing arrangement. Interviewer will make a note of any new components added in this fashion as this may reflect a different level of salience than those notes initially volunteered. Examples of questions might be:

Some other people in doing this exercise have included the concepts of communication and collaboration with other scientists and stakeholders. Is this something you would include in your note arrangement, or do you see it as a separate issue?

I notice that you haven't included any type of technology transfer. Do you see that as coming after the research process is completed?

If participants have been very inclusive/broad in what they consider to be part of the research process, the interviewer may ask for clarification as to why they have included such things as collaboration with clients or other scientists, tech transfer and other aspects as part of doing research. For example,

I see that you have included collaboration with other scientists as part of your most important category. Could you tell me why you think this is an important part of doing research?

If participants have mentioned collaboration, integration, communication, or shared learning in the 3CM process, they will be asked about these components.

You've listed integration as a component of doing research. Could you talk a little bit about integration and how it relates to the other components?

Open-Ended Questions

How do you see your arrangement as unique in comparison to what other AMA scientists might say?

How do you see your arrangement as unique in comparison to what other PNW (PSW) Station, non-AMA scientists might say?

What have you seen or experienced that has been a barrier to doing good research?

What have you seen or experienced that has facilitated being able to do good research?

Do you think your ideas about science and research have changed since you have been an AMA scientist? How so?

And finally, is there anything you would like to add to our discussion that I may not have touched on or that may have come to mind as we've gone through these last questions?

Thank you so much for your time and assistance with this project. (I may mention the Hermann Brain Dominance Instrument depending on whether they still need to take it, whether I already have their profile, etc.)

Appendix 3: Collective Followup Interview Questionnaire

As we've been conducting the preliminary analysis of the cognitive mapping exercise each of the scientists participated in with Linda, it has become clear that there are really two levels of followup that are important to this project. We've developed a set of followup questions that we'd like to ask everyone, as well as a set of questions that are specific to each scientist, in order to clarify points raised in the original exercise. To really do justice to what you've given us so far, as well as to be sensitive to your own time constraints, what we'd like to do is conduct two interviews with you, each no more than an hour long. What I'm proposing here is that we go through the questions I have for all the scientists today, and then schedule a time for me to call you again in the next week or two to ask the questions specific to your interview. Would that be all right?

1. The first question I have is a broad one. I'm trying to get a sense of the kinds of people you typically work with in the course of fulfilling your research and other AMA responsibilities. Reflecting back over the course of the last month or so, think of the kinds of people you talk with in person, on the telephone, who you correspond with via e-mail or regular mail. I'm not looking for specific names here, just categories of people.
2. What are your respective roles and functions/expectations within these relationships?
3. Keeping these thoughts in mind, who would you say you have sustained conversations with, on the job?
4. Think for a minute about who you are most comfortable working with, who you have good working relationships with. What factors do you think contribute to this, and why?
5. Now shift your thoughts to your interaction specifically with other scientists. Where do AMA/PNW/other scientists fit into your daily/weekly/monthly work?
6. Can you tell me a bit about how these interactions are different from interactions with other people?
7. In light of the recent all-scientists meeting, how do you see the role of the AMA scientists in relation to the role of PNW scientists generally?
8. What contributes most to your own learning? (Regarding research findings, how to do research, how to work with different groups of people, etc.)
9. If you define the word "resource" broadly, to include both social and economic factors as well as financial ones, what would you say are the important resources for accomplishing the work of your AMA? Where do you get those resources? (Who do you work with, what do they bring to the table, how do you work with them, on what?)
10. Many scientists use the terms managers, public, and decisionmakers. We'd like to have a clearer sense of what these categories include for different people. Keeping in mind that they may be used differently depending on the context, could you clarify for me what comes to mind when you hear the term "managers"? How about the term "public"? "Decisionmakers"?
11. Finally, we would like to hear your impressions about the 3CM method. What did you get out of participating in the cognitive mapping exercise with Linda, if anything?

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