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THE ROLE OF SCIENTISTS AND SCIENTIFIC INFORMATION IN PUBLIC POLICY DECISIONS: THE CASE OF DROUGHT PLANNING

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THE ROLE OF SCIENTISTS AND SCIENTIFIC INFORMATION IN PUBLIC POLICY DECISIONS: THE CASE OF DROUGHT PLANNING

A Dissertation APPROVED FOR THE
DEPARTMENT OF POLITICAL SCIENCE

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LIST OF ACRONYMS

AAAS	American Association for the Advancement of Science
ADAPT	Alabama Drought Assessment and Planning Team
AGU	American Geophysical Union
AMS	American Meteorological Society
CALFED	California Bay-Delta Authority (CALifornia-FEDeral)
CARC	Climate Assessment Response Committee (Nebraska)
cfs	Cubic Feet per Second
CLIMAS	Climate Assessment for the Southwest
CWRM	Commission on Water Resource Management (Hawaii)
FEMA	Federal Emergency Management Agency
GIS	Geographical Information System
GPP	Government Performance Project
IARC	Impact Assessment and Response Committee (Oklahoma)
ICC	Interagency Coordinating Committee (Oklahoma)
IDWR	Idaho Department of Water Resources
INDC	Interim National Drought Council
IPCC	Intergovernmental Panel on Climate Change
NAS	National Academies of Science
NCDC	National Climatic Data Center
NDMC	National Drought Mitigation Center
NDPC	National Drought Policy Commission

NIDIS	National Integrated Drought Information System
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
NSF	National Science Foundation
NWS	National Weather Service
ODEM	Oklahoma Department of Emergency Management
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
OWRB	Oklahoma Water Resources Board
PSAC	President’s Science Advisory Committee
RISA	Regional Integrated Sciences and Assessments
RQ	Research Question
UCS	Union of Concerned Scientists
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WAOC	Water Availability and Outlook Committee (Oklahoma)
WDCC	Western Drought Coordination Council
WGA	Western Governors’ Association
WMO	World Meteorological Organization

ABSTRACT

Does a cultural divide separate scientists from the broader community in which they live? This concept, proposed by C.P. Snow in 1964, has driven studies and reform movements within the scientific community for more than two decades. Calls to make science more relevant and to bridge barriers have been made. This study explores the concept of a cultural divide in the context of drought policy. Its goal is to examine whether such a cultural divide exists and if so, what mechanisms facilitate interaction across this divide.

The study was conducted between the summer of 2004 and spring of 2005. More than fifty individuals, representing both the scientific and state-level policy communities, were interviewed. Questions focused upon how scientists conducted and communicated their research, and information sources upon which policy-makers draw advice on creating state drought plans. The study uses a communications model, consisting of a sender (scientists), a message, and a receiver (policy-makers). An additional component, intermediary organizations and technical staff that help to integrate and reformat information, is included. This communication process takes place in an environment filled with competing messages, often detached from their sources, and noise.

Findings suggest that these intermediary organizations are a key component in facilitating interaction between the two communities. Scientists, intermediary organizations, and technical staff from state agencies operate together in knowledge communities, in which information is shared for development of state policy. Scientific and technical information is integrated and formatted for easy access and inclusion into

the state drought policy-making process. Scientists were willing to fashion information into useable contexts and policy-makers had little difficulty accessing or using information.

This process has been effective at getting scientific information into plans, but has yet to yield many instances of successful implementation. Much of the scientists' involvement focuses on aspects of monitoring drought conditions. This is largely a technical question and avoids many of the difficult normative issues involved in mitigating exposure to drought. Because of this, state drought plans have improved in their abilities to serve as early-warning indicators, but have not yielded substantive changes in community behavior. In order to bridge the implementation barrier, scientists must become more involved in addressing the normative aspects of drought management.

In addition to general interaction between the two communities, differences within elements of the communities also are highlighted. Scientists interact with policy-makers and the public at-large through several different roles, driven by their perceptions of how information is used in the policy process and their style of engagement. Policy-makers were found to have different roles, determined principally by their location in the state organizational hierarchy.

CHAPTER 1: INTRODUCTION

Public decision-makers and administrators face an array of complex problems, many of which are multi-disciplinary in nature. Environmental issues, such as global climate change, dealing with the effects of severe storms, and seasonal climate anomalies like droughts and floods, require both an understanding of climate and recognition of the impact human choices make on their vulnerability to hazards. These problems cannot be solved without input from the scientific community, but the social aspects of these problems require participation outside of the scientific community. This study examines the extent to which scientists participate in policy decisions in the area of drought management. Their involvement, barriers to participation, and issues pertaining to communication of scientific and technical information are examined in five key areas:

1. Informing policy decisions with the best information available;
2. Difficulties arising because of the two cultures phenomenon;
3. Linkages between the scientists and policy-makers;
4. Processes of scientific communication; and
5. The role of knowledge communities

The first two of these relate to the need for involvement, while the latter three relate to organizational structures and communication channels that facilitate this involvement.

Statements by senior policy-making officials in Washington D.C. suggest that scientific information is a critical element for making informed policy decisions. President George H.W. Bush in 1990 stated that "government relies on the impartial perspective of science for guidance" (Union of Concerned Scientists 2004). While scientific perspectives are not the sole factor in decision-making, scientific information must be readily available as one of the inputs into the process. Former Presidential Science Advisor Neal Lane distinguishes between policy for science and science for policy. He notes that the two are linked; research funded by the federal government (Policy for Science) must produce applications to public needs (Science for Policy) in order for government to continue to fund scientific research.

When communicating with policy-makers, scientists have two strikes against them. One is the nature of academic research and the other is the nature of scientific research. Academic research tends to be theory-driven while policy is often application-driven, a phenomenon dubbed “the two communities” (Sabatier and Jenkins-Smith 1988). These different worldviews create a communication barrier at the outset. What policy-makers need may not be what academics are studying. The two cultures phenomenon (Snow 1964) relates more specifically to scientists. Physical scientists work within dominant paradigms that structure their research and guide their expectations, a pattern Kuhn (1962) characterized as puzzle-solving. Scientists do not like to work outside of that paradigm, and tend to shun problems that do not fit so neatly. Over time, scientists have developed their own distinct culture, including their own language, habits and assumptions. The language barrier adds another level of complexity to communication outside the culture.

Linkages between the two communities may be established at individual or organizational levels. In the former, individuals who develop expertise in a scientific or technical subject area directly participate in policy-making bodies. In the instance of this study, such participation would include directly serving on a state drought task force, as an example. In so doing, scientists are readily available to educate policy-makers on issues and potential technical solutions, as well as to assure that information under consideration is being properly understood and applied. In the latter instance, organizational structures act as libraries, where information and expertise may be stored and accessed on-demand. In these cases, the source of information is further removed from the policy-makers, but the breadth of knowledge may be increased.

In addition to the physical channels of participation, the way in which information is conveyed affects how it is used. Ronald Havlock (1969) developed some building blocks of a knowledge generation, exchange and utilization process. Basic components include a sender, a message, and a receiver. Characteristics of each enhance or diminish communication between the two. This concept is used to establish a framework in which communication within and between scientists and policy-makers may be examined.

The fifth key area, the role of knowledge communities, represents an alternative to the direct participation model. Diane Stone (1996) noted that information, problem definitions, and alternatives are sometimes shared among 'knowledge communities'. These communities involve individuals who understand both the scientific input and policy needs. Individuals within these communities understand the characteristics of scientific information and reports and are able to summarize scientific and technical information into a format more easily accessible to policy-makers, thus increasing the utilization of scientific research in decision making. National centers and state and national-level policy-making bodies work out issues on a routine basis, becoming a conduit to more senior policy-makers.

The scientific community recognizes barriers to communication and utilization. Rosina Bierbaum, formerly acting director of the Office of Science and Technology Policy, noted that "scientists have to do a better job of communicating" and that "scientists are not known for simple declarative sentences or putting their information in a single graphic" (public lecture, University of Oklahoma, March 23, 2005) This represents awareness among leading scientists who routinely interact with policy-makers that scientists must do a better job at communicating their findings in an understandable and useable format.

In addition to communication barriers, many scientists have voiced concerns over the way in which scientific information is used in the policy process. More than 7,000 individuals have signed a statement by the Union of Concerned Scientists (UCS) regarding misuse of scientific information and political manipulation of scientific advisory boards. The UCS charges that "when scientific knowledge has been found to be in conflict with its political goals, the [Bush] administration has often manipulated the process through which science enters into its decisions." (UCS http://www.ucsusa.org /scientific_integrity/interference/scientists-signon-statement.html). Among methods cited in a detailed report (UCS 2004) are appointments of unqualified individuals or individuals with conflicts of interest to scientific advisory committees, disbanding existing advisory committees, censoring reports, and excluding unsolicited input. The report also charges that "objective scientific knowledge is being distorted for political ends by the Bush administration, and misrepresented or even withheld from Congress and the public at large" (UCS 2004, 31).

Given this climate, some scientists are reluctant to become involved in policy-related issues. Some fear termination of employment, others loss of funding for their research. Even though drought itself is relatively non-controversial, some related management and mitigation actions are certainly not. Water rights, protection of endangered species and forest management practices are affected by drought and must be discussed as mitigation options. These hot-button issues will certainly draw attention, something that some scientists may be reluctant to address.

This study focuses upon information provided in the context of drought mitigation planning. Drought is a naturally occurring phenomenon that has tremendous social and economic effects. Within the last five years, nearly every region of the country has experienced moderate to severe drought. Eighteen states have revised their drought plans since 2000. National efforts to encourage drought planning and information management systems are being led by the Western Governors' Association (WGA), with legislation pending in Congress (National Drought Preparedness Act of 2005; H.R. 1386; S. 802). Thus, drought has become an active policy issue with an engaged scientific community.

Yet despite communication barriers and concerns about involvement at the federal level, evidence suggests that scientists actively are involved in drought planning among state governments. Scientists have organized themselves in such a way as to overcome barriers to translation of scientific or technical information into policy actions. Furthermore, scientists are active participants on state drought task forces, as well as some federal initiatives such as that led by the WGA. It will be demonstrated that concepts originating within the scientific community are routinely adopted as parts of state drought response and mitigation plans. While implementation barriers remain, it does not appear that scientific views are excluded or misunderstood by the policy-makers interviewed in this study.

At the outset of this study, expectations were that most of the communication between scientists and policy-makers would occur through intermediary institutions, such as the National Drought Mitigation Center (NDMC) and the National Oceanic and Atmospheric Administration (NOAA). These organizations would seek opportunities to apply their knowledge to the policy arena. Research scientists, by contrast, would favor more traditional academic forms of communication, such as journal articles and scientific meetings, most of which occurs internally within the scientific community. It also was expected that state policy-makers would have limited capacity to access and interpret scientific information, causing difficulties in communication and correct application of scientific and technical information to drought management and mitigation strategies.

Specific research questions addressed in this study include the following:

- Does a gap really exist between policy-makers and sources of scientific and technical information?
- Do policy-makers seek scientific and technical information in circumstances where such information could be an important component in decision-making? Do they know where to find such information? Is information available in an understandable format and context?
- Does the scientific community make an effort to contribute its knowledge to policy users? If not, why not?
- What factors either facilitate or act as barriers to the communication of scientific and technical information between senders and receivers?

- How do policy-makers integrate scientific and technical information with other sources of information? How do they deal with information from multiple sources, especially when it may conflict?
- What is the role of intermediary organizations as conduits between knowledge producers and knowledge users?
- What mechanisms would facilitate integration of scientific and technical information with the policy-making process?

Drought management policies vary from state-to-state; therefore states are the unit of analysis in this study. Between the summer of 2004 and spring of 2005, individuals representing the scientific community, intermediary organizations, and those involved with state drought planning processes were interviewed. Information provided by the interviews was compared against written documents, including scientific publications and reports and state drought plans. The findings were used to construct a model showing conduits between the scientific and policy-making communities.

Chapter 2 provides a more in-depth look at differences between scientific and policy-making processes. The two cultures phenomenon is introduced and its effects on the organization and involvement of the scientific community in the policy process is discussed. The chapter concludes with an examination of knowledge communities and how they may help to bridge the culture gap. Chapter 3 turns to drought management. Past initiatives, policy options for mitigating the effects of drought, and its is physical recurrence are examined. Chapter 4 describes the constructs of the study. Theories used to examine communication between the scientific and policy communities are introduced. A description of the respondents who participated in the study and characteristics of the states included as case studies are presented. Chapter 5 presents an analysis of the interview results relating to the scientific community. Interactions between scientists and policy-makers and their preferred means of communication are examined. Chapter 6 focuses on the policy community. Conclusions are drawn from the state case studies, including interviews with policy-makers. Political barriers to drought mitigation efforts are discussed. The document concludes in Chapter 7 with a summary of key findings, barriers to effective communication, and how those barriers are surmounted. Recommendations for improvements that would facilitate communication also are offered.

CHAPTER 2: THE SCIENCE-POLICY DIVIDE

"Science has the power to illuminate, but not to solve, the deeper problems of mankind. For always after knowledge come choice and action. Both of them intensely personal."

- Paul B. Sears, *Deserts on the March*, 1935

Seventy years after Paul Sears wrote these words, policy-makers are still grappling with an array of complex problems, many of which deal with scientific or technical knowledge. Human vulnerability to natural hazards is increasing. Billion-dollar disasters are becoming more frequent as more people live in harm's way (Mileti 1999). Global climate change threatens to disrupt global economies and inundate low-lying areas as sea levels rise. Policy-makers are searching for solutions to these and similar problems, and they need scientists to contribute to solutions.

The public, and those who represent them in Washington, D.C. and in state legislatures, recognize the increased vulnerability. Evidence of this can be found in the 28 members of the U.S. Senate's Natural Hazards Caucus. Leaders are looking toward the scientific community to contribute. Representative Sherwood Boehlert (R-NY) stated that:

> "…academia, as a leading generator, analyzer, repository, and purveyor of human knowledge and insight, will necessarily have an impact on whether and how the world actually changes. I hope and expect that academia…is up to that task, which may require some new undertakings, but mostly will simply require more intensive and better focused attention on existing efforts and greater engagement with the rest of society." (Anthes 2001)

Leaders such as Representative Boehlert highlight the need for improved communication between not only scientists and policy-makers, but scientists and the general public.

Scientific input into policy decisions is not only necessary in the halls of Congress; Federal and state agencies, grappling with these issues also must have access to understandable information as they devise implementation strategies. Dealing with natural hazards is a tremendous challenge to decision-makers. "Today hazard managers are being called upon to tackle problems they have never before confronted, such as understanding complex physical and social systems, conducting sophisticated cost-benefit analyses, and offering long-term solutions" (Mileti 1999, 13). Public administrators need to understand the state of scientific knowledge and technical solutions, as well as their limitations. In the past, adoption of technical solutions represented a paradigm for hazards management. Building dams and levees to reduce flooding, draining swamplands, and clearing hillsides reduced immediate threats, but actually increased susceptibility to more severe impacts from extreme events. Annual flooding of low-lying areas do create losses, but a dam or levee failure, like in the 1993 Mississippi River floods, can produce much more catastrophic damage. Proper understanding and application of scientific and technical solutions is essential to reducing long-term vulnerability to such hazards.

As policy-makers focus attention upon issues such as these, it is critical to have a means to communicate scientific understanding into operational knowledge. This includes telling policy-makers the state of the scientific knowledge regarding an issue, uncertainties related to that knowledge, and possible impacts of various scenarios. Policy-makers recognize the limitations of science, but still look to scientists for input. John Marburger III, presidential advisor for science and technology, speaking on the issue of global climate change research, noted: "Science rarely gives enough information to narrow policy choices to a single option, but it can clear away some of the underbrush" (Revkin 2002, F1). At the core of the research problem is building linkages between knowledge producers and consumers.

The central premise of this dissertation is that various knowledge areas use conduits between the producers of knowledge and their intended targets. Policy-makers want scientists' input into formulating alternatives, but the nature of scientific research introduces barriers that must be overcome (Snow 1964). Poor communication between the two is a legacy of the specialized nature of scientific research, path-dependent development of disciplinary fields, and poor communication of needs to the producers. Some instances, such as health care, have succeeded in applying knowledge to social issues. Genetic breakthroughs lead to new medicines to solve problems, and much of the focus of the research is driven by the pursuit of those new medicines, making a two-way linkage between knowledge producer and consumer. Can similar kinds of relationships be developed for other areas, such as mitigating against losses from natural hazards, including floods, droughts, forest fires, and winter storms? Do some elements of these relationships already exist?

People engaged in scientific research are, in general, distinctly different than those involved in other endeavors (Snow 1964; Kuhn 1962). Thomas Kuhn describes the mode of scientific research as 'puzzle-solving'. Scientific research is designed largely to prove what already is known. Many of the big problems on which scientists work involve designing methods or tools for the purpose of testing theories. They operate within a paradigm – a set of theories that represent a shared belief among the community and an associated set of methods for testing those theories. Paradigms may operate on different scales, ranging from the grand theories of Newton or Einstein to paradigms that define what is known among sub-disciplines like biogenetics.

Kuhn (1962, 10) defined ‘normal science’ as “research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice.” Research proceeds along a deductive, objective model, in which certain accepted principles are applied to individual cases, or as Kuhn states, the past scientific achievements that form the body of accepted principles. Consensus emerges when deviations from expectations disappear. To Kuhn, this is the formation of a paradigm.

Paradigms exist pertaining to the laws of nature, but there are few candidates that may be considered paradigms for human behavior. While scientists are very efficient at defining problems and devising solutions, they are reticent to step outside of the boundaries of ‘natural science.’ As Kuhn (1962, 37) states:

> “A paradigm can, for that matter, even insulate the community from those socially important problems that are not reducible to the puzzle form, because they cannot be stated in terms of the conceptual and instrumental tools the paradigm supplies.”

Without paradigms, problems cannot be broken down into puzzles to be solved, causing those problems to be largely shunned by the scientific community.

2.1 Two Cultures

This paradigm-inspired mode of research manifests itself in what C.P. Snow called “the two cultures” syndrome. Snow, a physicist by education, noted a distinct difference between scientists and what he termed ‘the traditional culture”. Snow focused upon writers as representative of thought patterns of the traditional culture. Literature of the time tended to focus on the individual condition, in which human suffering is prevalent, while scientists, according to snow, tended to focus upon the social condition – the aggregate of individuals which could be addressed through science and policy. Traditionalists blamed the industrial revolution for the plight of the working poor, implicitly rejecting science as being able to solve the problems of mankind. Thus, those drawn from the traditional culture, which included most administrators and policy-makers of the time, saw science as irrelevant, if not a problem in itself.

Snow documented differences in perceptions, approaches to problems, outlooks on life, and even language between the two dominant cultures. The differences were so vast that it resulted in "two groups, comparable in intelligence, identical in race, not grossly different in social origin, earning about the same incomes, who had almost ceased to communicate at all" (Snow 1964, 2). While the difference may not be so vast as Snow identified, others have noted a predisposition among scientists to stay away from political involvement (e.g., Morin 1993, Shapely and Roy 1985).

By culture, Snow meant not only intellectual development, but also an anthropological definition: "a group of persons living in the same environment, linked by common habits, common assumptions, a common way of life" (Snow 1964, 64). In the first instance, intellectual development refers to the process of education and training. Our educational background and social context act to shape our perceptions of the world around us.

The anthropological definition attests to the commonalities within each group. Culture is the basis of unquestioned assumptions within thought. Each group will take certain assumptions for granted based on their *cultural* perspective, while the other group may question such assumptions. Schein (1985) notes three levels of culture: basic assumptions, values, and artifacts. While one can observe artifacts and even to some extent measure values, it is very difficult to discern basic assumptions, which are buried deep within a person's subconscious. Because these basic assumptions differ between the two groups, through training and experience, communication is impeded. Thus, there is very little attraction for a member of one group to delve too deeply into the other's arena.

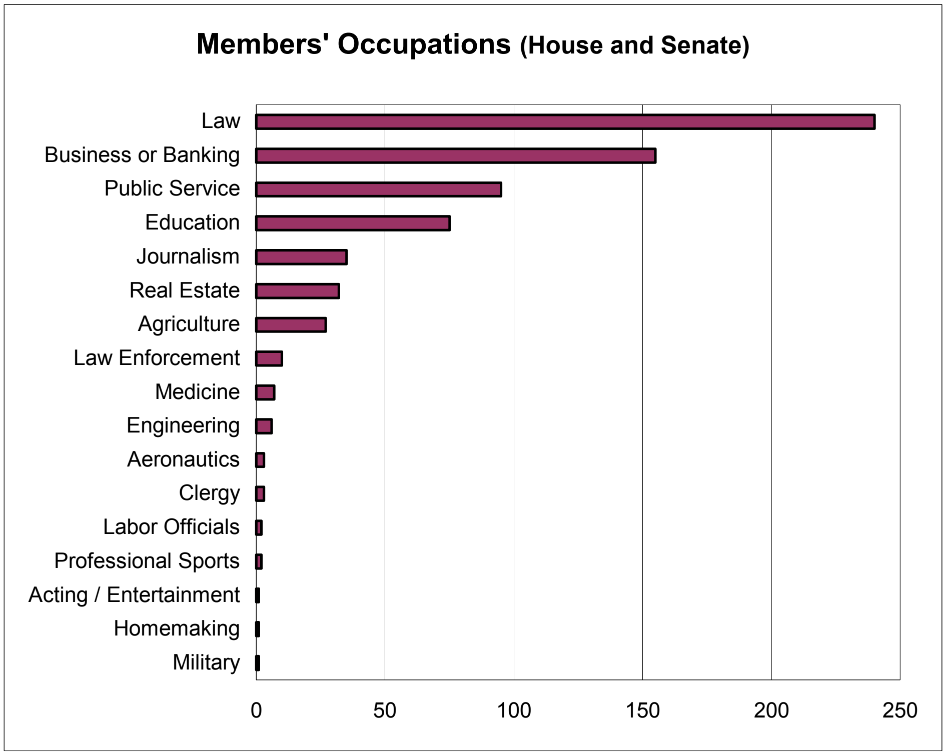
Because patterns of thought between these two groups are so vastly different, each group is incapable of understanding the other. He admits there are many subcultures within these, but the overall way of thinking is what unites the sub-cultures to a common level. The distinction is that although there may not be clear understanding between fields of specialization within a culture, there exists at least a hazy understanding of what other members of a common culture are discussing. Such understanding is totally lacking in discussions between cultures.

The lack of understanding leads to mutual incomprehension. Snow argues that without a common culture, the result is misinterpretation of the past, misjudgment of the present, and a denial of hope for the future. The middle ground is a meeting point where "creative chances" occur, but because the two cultures do not speak to each other, opportunity is squandered.

2.2 Scientists and the Policy Process

One need only look at the backgrounds of Congressmen to discern the impacts of this dichotomy. There are only a handful of members who list their occupations as technical fields (Figure 2.1). Of the listed categories, only Medicine, Engineering and

Figure 2.1. Occupations of elected members of the U.S. House and Senate in June 2001. Because some members have more than one occupation, totals are higher than total membership. *Source: Robert E. Palmer, Minority Staff Director, U.S. House Committee on Science and Technology.*



Aeronautics are likely to be immersed in the scientific research paradigm, and even these tend toward the applied side of science.

So why do scientists tend to distance themselves from the political process? Much of it has to do with the training, education, and culture in which they are immersed. The scientific process approximately resembles a linear, rational model. A hypothesis is formulated, a controlled experiment is designed to test that hypothesis, and the resulting data are then compared to the hypothesis. The comparison leads to new problems to further test the theory. The process is driven by sequential collection and analysis of data. In contrast, the policy process does not have the luxury of time or attention to make such exhaustive data collection and analysis. Decisions often must be made with whatever information is at hand, sometimes with only a cursory analysis of any supporting data. It is difficult for someone trained in linear thought to adapt to the chaotic environment of policy-making. Policy-makers are comfortable operating in this realm, while scientists, by their training, tend to hedge decisions and information with caveats.

The policy process involves key decision points and timetables that are set by human needs. At those times when decision points arise, decisions must be made upon the available information, even if that information is incomplete. Many of the top professions represented in Congress involve dealing with unscheduled events and quick decision-making styles. Scientists, in contrast, are trained to do an exhaustive review of resources to collect as much information as possible before making a decision or conclusion. In the world of politics, as is the case in law, business, or public service, decisions must often be made on-the-spot, with only the information at-hand. Many scientists, especially among basic researchers, may feel uncomfortable in such an environment, and thereby limit their participation to indirect means.

Policy-making, to a great extent, is dependent upon perceptions and values. Problem solving tends to be more normative than the trademark deductive process used in science. Conclusions are drawn from personal observations and interpretation of events rather than from objective data. Problems arise from circumstances, such as perceived needs, rather than sequentially following from a broad theory. Perceptions affect how a problem is defined, which in turn affects alternatives that may be under consideration (Rochefort and Cobb 1994). Even problems that appear to be based upon objective measures are dependent upon the choice of index used. Ruggles (1990) shows that for poverty, different indices may make a problem look more or less severe. Poverty may be defined by an absolute income threshold or a relative threshold. In the former case, unless the threshold is updated, people will naturally rise out of poverty based upon increasing incomes, thus decreasing the severity of the problem. Choosing a relative measure means the target is constantly changing, which may never see 'improvement' in the problem.

Because problems in the political arena are not amenable to scientific paradigms and require value judgments, scientists have preferred to stop at the water's edge, leaving application of their findings to others, whether that be in policy or in commercial enterprises. This is what Freudenburg (1996, 44) means when he states: "scientists have made remarkable progress in dealing with technical challenges, but not in dealing with society." Expert solutions grasp only parts of the scientific enterprise.

2.3 The Structure of Science

In addition to the pre-disposition against involvement in politics, utilization of scientific knowledge faces the further barrier of structural relationships. Over the past fifty years, the 'post-war consensus' has created a tacit division of labor in scientific research (Morin 1993). Basic research consists of a small group of researchers whose communication is primarily internal to the group. Their focus of research is on fundamental aspects of the phenomena. Applied research is pursued on behalf of definable needs; however, the techniques used in applied research are similar to those employed by basic research. In many cases, the distinction between the two can become fuzzy, especially when considering interdisciplinary research. Development is the application of knowledge toward the production of materials. Development is also essential to the research process, because through it, new tools, such as computer technology, are created which aids researchers. This division of labor in itself creates barriers to communication. As basic researchers work on a problem, they converse in their own language, with the result that published findings are often incomprehensible to those outside the group.

This research and development process is supported substantially through federal funding. Over the past century, science has grown from a relatively small cadre of researchers largely supported by industry and philanthropy to a large endeavor dependent upon federal funding (Smith 1990). Prior to World War II, there was no central direction or active government role in the support of scientific research. All of this changed with Vannevar Bush's report *Science – The Endless Frontier* (1945). The report advocated government funding for basic research on the premise that long timelines for basic research were not amenable to industrial support and the need for basic research exceeded available philanthropic funding. The report laid the foundation for a system of government-supported research through a peer-review system, in which basic research was largely supported by the National Science Foundation and mission-oriented research was supported by various government agencies.

This division of labor has with it some problems. Shapely and Roy assert that the system focuses on basic research "without thought of practical ends" (1985, 15). The freedom to pursue research regardless of practical applications conflicts with the government's need for accountability and with its needs to meet other priorities. The funding mechanism developed in the post-war framework envisioned basic research directed toward a definable goal, first on the success of the atomic bomb development and subsequently in the space race (Morin 1993). The unified system never materialized.

Instead, mission agencies separately fund research to address their own needs. The result is that decisions are made at the agency level, rather than at the level of a presidential advisory committee. Few overarching goals drive research priorities, and what priorities are set by the executive branch are usually determined by the Office of Management and Budget (Smith 1990). Furthermore, the growth of large projects consumes more of the available research dollars, creating competition among government, science, and industry as decisions about which projects to fund often become the subjects of internal politics.

Partitioning of problems according to mission agencies is reflected within the disciplinary structures of academia. However, societal problems are by nature holistic or interdisciplinary. A report by the National Research Council (2001, 55) found that “it is rare to encounter integration of physical, biological, social, and health sciences in any phase of climate studies and services, from basic research to observations to interaction with users.” Putting these pieces together often proves more difficult from an organizational standpoint than from a research question standpoint.

For most of the past five decades, separation between science and policy suited scientific research well. During the immediate post-World War II years, many of the problems to which scientists were asked to contribute were of a technical nature, such as building more effective military capabilities or putting a man on the moon. Scientific input was more a question of ‘how’, rather than ‘what’. The ‘postwar consensus’ was based upon a fundamental assumption that research was separate from, but a necessary precondition, for development (Shapely and Roy 1985).

That line has become increasingly blurred over the last several decades as the nature of problems have begun to change. There are fewer technical issues, which previously science could address in some degree of isolation. More problems are multi-disciplinary, reflecting a combination of natural sciences, economics, demographics, and human behavior. “Science and technology can certainly help solve national problems, but deciding which parts of which problems are reasonably amenable to scientific and technical solutions is complex” (Smith 1990, 15).

For example, Mileti (1999) cites a host of individual factors affecting preparedness and response to natural hazards that are beyond the scope of scientific knowledge. At the individual level, preparedness and response decisions are affected by socioeconomic status and economic resources (economics); age, race, gender, and social relationships (demographics); and recent experiences with disasters that may affect an individual’s awareness of the risk (human behavior). Organizations similarly assess risk in the context of non-scientific measures, including financial needs of the organization, whether they believe a threat is imminent, or whether government regulations or incentives exist that mandate preparedness.

Policy choices also drive scientific research. Climate change policy based on mitigation will have a markedly different set of research initiatives than one based on adaptation. Pollution prevention entails different mechanisms than after-the-fact pollution cleanup. Because of this, science cannot remain separated from policy needs or demands.

In this context, science is no longer ‘on retainer’ to government; it is an active participant. The nature of the policy process, the necessity of value judgments, the way in which scientific research is organized, and partitioning of problems into disciplinary areas all create difficulties in communicating state-of-the-art knowledge between scientists and policy-makers. Many elements of the academic research process have defined roles and structural boundaries, but there is no defined role for communicating scientific and technical information to the policy community and for integrating information with other perspectives, such as economics, social values, or political context. Policy-makers have a vast reserve of scientific and technical knowledge upon which they can draw, but determining what is appropriate for a given issue is not necessarily straightforward. Furthermore, some policy-makers may not want the answers given to them by scientists; preferring value judgments over objective consensus. This dissertation seeks to examine how policy-makers cope with these barriers when selecting appropriate information for their needs.

2.4 The Politicization of Science

Science policy does not exist in isolation; it is a part of the American democratic process in which a variety of individuals and groups have input into the emphasis and level of support for scientific research. The result is that priorities set through a pluralistic setting may not mesh with those set by scientists alone (Smith 1990). Scientists have more autonomy in basic research, but as one moves toward applied research, commercialization, regulatory behavior, and international issues, the autonomy of the scientists diminishes. Science and politics are no more inseparable than politics and administration. As science and government funding have become more entwined, both the expectations for science and the opportunities for its application have grown.

Over the course of the last 40 years, science policy has ranged from a relatively unregulated endeavor to a process which competes with other issues on the political agenda. The civil rights, environmental, and anti-nuclear movements of the 1960s and

1970s challenged the relationship between science and government policy. It was viewed as a conspirator and a contributor by some, including many in the scientific community who sought to distance themselves from government policies in order to preserve the perceived objectivity of basic scientific research.

Battles in the 1980s over leadership of the Environmental Protection Agency (e.g., Davies 1984) and prominent scientists' open criticism of the Strategic Defense Initiative highlighted how political control of agencies reliant upon scientific expertise can clash with the culture of science. In his 1983 State of the Union Address, President Reagan highlighted an optimism of science and technology as being able to advance the causes of national defense, health, and welfare. Because of the negativity with which his proposals were met from the scientific community, he subsequently became more tempered in his views. Scientists based their objections to the Strategic Defense Initiative not so much on the inability to develop a technical solution, but upon the normative merits of the project. Scientists openly expressed concern that developing an anti-weapons system would upset the delicate balance of power between the United States and the Soviet Union, ultimately increasing the likelihood of nuclear warfare.

The politicization of science is nowhere more apparent than in the role of advice to the President. The role has always been ambiguous (Morin 1993). Science advisors principal role is to serve the President and offer advice, but the scientific community tends to see advisors as advocates for science policy and funding issues within government. The President's Science Advisory Committee (PSAC), which was central to execution of science policy during the late 1950s, lost their cohesiveness during the 1960s. Once viewed as providing valuable advice to the President, they now became seen as an advocacy group who countered presidential initiatives. This led to elimination of the committee by President Nixon in 1973. The advisory committee was recreated as the Office of Science and Technology Policy (OSTP) in 1976, but it remains of marginal value. OSTP acts as a resource for the President, but is only useful if the President seeks its advice. Furthermore, OSTP is only one of several sources of information on science policy upon which the President may draw.

In more recent years, controversy between science and politics has re-emerged. Charges that scientific conclusions are being altered by political leadership, supervisors are ignoring internal scientific staff members, and that the Bush administration has a near-obsession on control of information has led to declining morale among government scientists. Yet, as Smith notes, all administrations "seek to some extent to mold scientific evidence to fit their political agendas" (2005,38). Is the Bush administration really different? In a revealing interview with John H. Marburger III, the president's science advisory, Smith shows that science as an enterprise is faring well. Despite high-visibility contests over global climate change and stem cell research, overall research and development spending rose 44% during President Bush's first term. Initiatives in nanotechnology, maintaining the peer review process in an age of Internet publications, assuring the free flow of information in an era of heightened security concerns – all of these are areas in which Marburger has successfully steered administration policy.

Marburger accepts that controversy is reflective of political compromises necessary in formulating science policy. Although individual scientists may vocally oppose administration policies, Marburger sees his role as maintaining a solid base for the continuing conduct of science. The controversial items he sees as part of a larger contest between scientific advances and the willingness of the culture to alter itself accordingly. These choices are affected by perceptions, lifestyles, and moral views. Because scientists challenge these cultural values, Marburger fears that "if we're not careful, the scientific community can become estranged from the rest of society and what it cares about" (Smith 2005, 41). Under such circumstances, the ability for presidential advisors like Marburger to succeed in maintaining a strong funding base and formulating policies endemic to scientific research processes may be undermined.

"Research today is a large-scale enterprise that is conducted in a highly competitive environment" (Morin 1993, 126). Science is not entitled to some share of government funding; rather it competes in a political process with other programs and policies. The National Science Foundation, while not being able to provide an overarching direction for science policy, is important that is a representation by the federal government of the role of research as an instrument of national policy. This relationship rests upon the continuing confidence of the public and policy-makers, and not upon some constitutional right.

2.5 Knowledge Communities

Even though there is no science-policy dichotomy, all research is to some degree separated from policy. Research tends to be theory-driven while policy is often application-driven – a specific solution to an identified problem. Because the two approach problems from different "worldviews", barriers are created in transmitting knowledge from one arena to another.

Complex problems rely upon different mechanisms than the ‘traditional’ methods of scientists. According to Rycroft and Kash (1999), complex problems rely upon synthesis of information rather than examination of cause-and-effect relationships, the typical hallmark of the physical sciences. Problems and solutions are influenced as much by the way information is shared as they are by objective criteria. Shared knowledge is the medium of communications networks, and trust and reciprocity are essential to the flow of information through the networks.

Rycroft and Kash further argue that information itself is context-dependent and often transmitted in the form of metaphors rather than precise statements. For example, Breedlove (2002) cites his success in reframing scientific information by stating that checking automobile emissions once every two years was similar to combating drunken driving by administering a breathalyzer test only when drivers renew their licenses. The scientific reasons why emissions testing would not be effective did not resound with his audience, but when he put it in the context of an issue with which they could better relate, he was able to successfully make his point.

Despite the differing goals of research and policy, information is exchanged between the two. The exchange process may be enhanced through intermediary groups that help translate scientific and technical information into formats more readily accessible to policy-makers, not unlike the way information is discussed in ‘knowledge communities’ (Stone 1996). These communities share information, problem definitions, and alternatives among themselves and try to influence the adoption of favored policy prescriptions and program implementation. They may take different forms, according to the degree of a common, shared, belief system. Knowledge communities collect information from various sources and process it into a range of alternatives, from which policy-makers may draw.

Knowledge communities may facilitate the transmittal of scientific and technical knowledge. Knowledge communities are a means by which individuals or groups can share information regarding a particular topic. These may range from individual reports to broader discussions of the policy environment. For example, social experimentation creates ‘inventories of information’ that may be used at some later date (Feldman 1989). Knowledge communities aggregate information from multiple disciplines in a shared analytic framework (deLeon 1988). In other words, knowledge communities put the pieces together so that decision-makers do not have to invest as much time in deciphering contradictory results from multiple studies.

Because what the scientific community produces may not be what is needed for policy-making, there needs to be an additional component to the communication. Knowledge communities provide such a link. In the case of science-based issues, knowledge communities could be expected to be composed of individuals or groups who understand both the scientific and policy process, and can sift through findings laden with qualifications and confusing terminology to structure information into contextual evidence to be consumed by policy-makers. These communities will amalgamate information coming from the scientific community and provide a single point of contact for policy-makers.

Knowledge communities are at the heart of conveying information for policy-makers. According to James Metcalfe (1994): “The scope for policy is not to optimize with respect to some objective function (e.g., social surplus) but rather to stimulate the introduction and spread of improvements in technology. At the core of this approach are complexity, cognitive limitations, and the role of organizations as operators translating individual subjective knowledge into collective outcomes" (quoted in Rycroft and Kash 1999, 6).

An analogy is the production of a product. A factory manufactures the product, and it needs some way to get to the consumer. Linkages exist that provide outlets for the product and at the same time provide some means of feedback to the producer for improvements on the product or development of new products to address unmet needs. In most cases, intermediary organizations provide the function of a conduit between the producer and consumer.

The same is true in terms of knowledge as a commodity. Because of its means of production, scientific and technical information may not be directly comprehensible to its users, even though it is an essential element in the advancement of society. In order to improve the transmission of such information, linkages between individuals or organizations, even spanning disciplinary boundaries that produce the information, need to be established. Credibility, trust, reliability, and timeliness are some of the essential elements of those relationships.

Involvement in knowledge communities also allows producers a chance to help shape how that information is initially presented. Science historically has relied upon findings that "speak for themselves." More and more, however, researchers are realizing that effort is needed to assure analyses and evaluations are used in a substantive fashion within the policy process (Patton 1986). Although producers cannot control the information once it is presented, relating findings to issues within the policy communities increases the utility of those findings to that community.

2.6 Summary

Differences in the way in which scientists view the world and address problems create barriers to translation of scientific information into the policy arena. Scientists cannot afford to be bystanders to the policy-making process; scientific information is an important factor in many decisions. On an individual basis, the nature of scientific education, experience and professions make it difficult for scientists to communicate or participate directly as policy-makers. Structural boundaries in academia further inhibit integration, as problems are sub-divided into disciplinary boundaries. The nature of policy-making requires non-rational, normative decision-making styles which are driven by timelines and do not always allow sufficient time for collection and analysis of information. The differences between the two arenas create somewhat of a science-politics dichotomy. Although individual scientists and advocacy organizations may express strong political sentiments on any given issue, the overall processes of scientific research and policy development typically have few direct connections.

Barriers to communication may be overcome through the development of knowledge communities, consisting of individuals who are able and willing to define problems, bridge disciplinary boundaries, and distill and synthesize information for external audiences. A hypothetical knowledge community for drought may consist of members from academia, university-based research centers, federal agencies, state agencies and professional societies, with prominent participation from organizations specifically designed for the transfer of knowledge.

The next chapter addresses a description of such a drought knowledge community and key intermediary organizations. The chapter examines why drought is a policy issue, and the interaction of policy organizations, such as the Western Governors' Association, with the drought knowledge community.

CHAPTER 3: DROUGHT AND DROUGHT MANAGEMENT EFFORTS

"An essential aspect of the planning process is integrating the science and policy of drought management. The policy-maker's understanding of the scientific issues and technical constraints involved in addressing problems associated with drought is often limited. Likewise, scientists generally have a poor understanding of existing policy constraints for responding to the impacts of drought. In many cases, communication and understanding between the science and policy communities must be enhanced if the planning process is to be successful. Integration of science and policy during the planning process will also be useful in setting research priorities and synthesizing current understanding."

- Wilhite et al. (2005, 11)

Drought brings together science and policy issues within a framework suitable to examination of the two cultures phenomenon. Over the past several decades, the scientific community has developed a better understanding of the processes that contribute to drought, an ability to use computer models to estimate groundwater movement, and a variety of indices that give early indications of potential drought conditions. Thus, there is a great deal of information available to policy-makers engaged in drought planning activities. This study uses the subject of drought to examine how that information gets from the scientific community to those policy-makers.

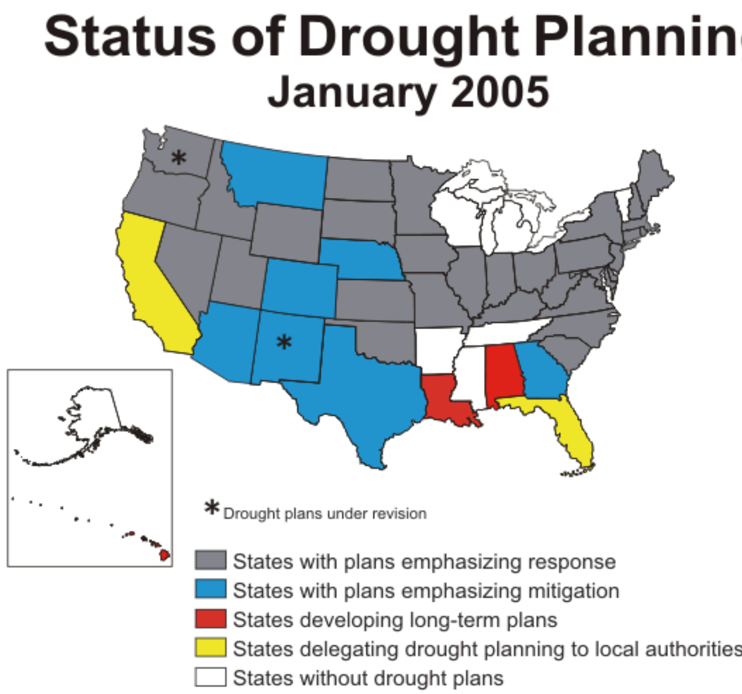
Resources exist today that may aid decision-makers in developing policies for identifying and responding to drought conditions and for mitigating drought impacts. Organizations such as the National Drought Mitigation Center act as clearinghouses for drought planning information. The development of the Drought Monitor, a weekly web-based publication that assesses drought conditions across the country, provides a tool by which operational decision-makers can closely monitor drought conditions. From the scientific and technical standpoint, an extensive infrastructure has been built to enable policy-makers to access information with regards to drought. Whether and how that infrastructure is being utilized is the subject of this study, using drought management practices in the states as case studies.

Drought planning is performed largely on a state-by-state basis, although several national efforts have sought to improve integration of state plans with national resources. Because of the state-based nature of drought planning, the subject provides variability in the sources of information, processes of communication, and structures used to manage drought. Resources are available to drought planners in state governments, including local sources in universities and research centers as well as national organizations. The study examines which sources drought planners select and the reasons behind those selections. In addition, the study examines the extent to which the scientific community organizes itself to make information readily available and useable to those planners.

One reason that makes state drought management policies a fruitful area of study is that despite decades of research and improvements in detection and monitoring drought, few states have effective mitigation policies (NDMC 2005 http://www.drought.unl.edu/mitigate/status.htm). Drought response is often reactive rather than proactive. As of early 2005, the NDMC identifies only seven states that emphasize mitigation measures (Figure 3.1). Most others either emphasize response or have no formal drought mitigation plans.

During the 1980s and early 1990s, states used a variety of measures to combat drought (Table 3.1). These range from developing early detection systems to better water management practices to instituting organizational changes to better manage response to drought. Many different remedies have been tried, but from where did these ideas originate? Did they originate independently within the states, or were they borrowed from

Figure 3.1. State Drought Plans. *Source: National Drought Mitigation Center* (http://www.drought.unl.edu/mitigate/status.htm).



others? Did drought policy planners consult with academic centers or scientific communities that are engaged in relevant research? Answering these questions in the context of current drought management practices will provide clues for assessing the effectiveness of bridges between the science and policy communities.

3.1 Defining Drought

One of the first difficulties faced by drought planners is defining when a drought is occurring. It is not difficult to identify a number of climatological factors associated with the occurrence of drought. McNab and Karl (1991) define drought as persistent or recurrent atmospheric circulation patterns which produce little or no precipitation. But absolute rainfall is not the sole criterion for drought. Smith (1996) defines drought as a relative shortage of useful water. Humans adapt to their environment, such that a

Table 3.1. State responses taken to drought. *From Wilhite (1997).*

<table>
<tr><td><u>Assessment Programs</u>
• Developed criteria or triggers for drought-related actions
• Developed early warning system, monitoring program
• Conducted inventories of data availability
• Established new data collection networks
• Monitored vulnerable public water suppliers</td><td><u>Water Conservation Programs</u>
• Established stronger economic incentives for private investment in water conservation
• Encouraged voluntary water conservation
• Improved water use and conveyance efficiencies
• Implemented water metering and leak detection programs</td></tr>
<tr><td><u>Legislation / Public Policy</u>
• Prepared position papers for legislature on public policy issues
• Examined statutes governing water rights for possible modification during water shortages
• Passed legislation to protect instream flows
• Passed legislation providing guaranteed low-interest loans to farmers
• Imposed limits on urban development</td><td rowspan="2"><u>Emergency Response Programs</u>
• Established alert procedures for water quality problems
• Stockpiled pumps, pipes, water filters, and other equipment
• Established water hauling programs for livestock
• Listed livestock watering locations
• Established hay hotline
• Funded water system improvements, new systems, and new wells
• Funded drought recovery programs
• Lowered well intakes on reservoirs for rural water supplies
• Extended boat ramps and docks in recreational areas
• Issued emergency irrigation permits for using state waters for irrigation
• Created low-interest loan and aid programs for agricultural sector
• Created property tax credit program for farmers
• Established a tuition assistance program for farmers to enroll in farm management classes</td></tr>
<tr><td><u>Water Supply Augmentation</u>
• Issued emergency permits for water use
• Provided pumps and pipes for distribution
• Proposed and implemented program to rehabilitate reservoirs to operate at design capacity
• Undertook water supply vulnerability assessments
• Inventoried self-supplied industrial water users for possible use of their supplies for emergency public water supplies
• Inventoried and reviewed reservoir operation plans</td></tr>
<tr><td><u>Public Awareness / Education Programs</u>
• Organized drought information meetings for the public and the media
• Implemented water conservation awareness programs
• Published and distributed pamphlets on water conservation techniques and agricultural drought management strategies
• Organized workshops on drought-related topics
• Prepared sample ordinances on water conservation
• Established a drought information center</td><td><u>Water Use Conflict Resolution</u>
• Resolved emerging water use conflicts
• Negotiated with irrigators to gain voluntary restrictions on irrigation in areas where domestic wells were likely to be affected
• Clarified state law regarding sale of water
• Clarified state law on changes in water rights
• Suspended water use permits in watersheds with low water levels
• Investigated complaints of irrigation wells interfering with domestic wells</td></tr>
<tr><td><u>Technical Assistance</u>
• Provided advice on potential new sources of water
• Evaluated water quantity and quality from new sources
• Advised water suppliers on assessing vulnerability of existing supply systems
• Recommended that suppliers adopt water conservation measures</td><td><u>Drought Contingency Plans</u>
• Established statewide contingency plan
• Recommended that water suppliers develop drought plans
• Evaluated worst-case drought scenarios for possible further actions
• Established natural hazard mitigation council</td></tr>
</table>

relatively dry year in an area which receives abundant rainfall may have a severe drought, even though it receives more actual rainfall than another area in a normal year. Even using relative measures, these definitions do not capture an important variable: demand. Redmond (2002) defines drought as insufficient water to meet needs. That water shortage may be due to a lack of precipitation, declining groundwater reserves, insufficient storage capacity, or over-development of water use. Thus, drought is as much a social creation as it is a physical creation.

Despite the multiple ways of defining drought, it is nonetheless a naturally occurring phenomenon that has periodic significant impacts on large sections of the United States. According to the National Climatic Data Center (2002 http://www.noaanews.noaa.gov/stories/s965.htm), during the summer of 2002 moderate to extreme drought affected half of the area of the United States. Yet despite its widespread occurrence, drought response is often reactive rather than proactive. One explanation may be that drought is different than most natural hazards. Tornadoes, hurricanes, earthquakes, floods and volcanoes often pose direct threats to life and property, whereas drought in the United States is mostly an economic issue. Furthermore, these other threats are immediate and visual, while drought is characterized as a ‘creeping hazard’ (Smith 1996). Droughts develop slowly, have a prolonged existence, and affect widespread areas. Drought effects vary for different economic and social sectors as well, such that the agricultural sector may be feeling effects while industrial or municipal sectors do not. Likewise, after a period of rain, the agricultural sector may recover quickly, while depleted water supplies may take years to recover.

This bias toward other natural hazards is evident in the United States’ planning for the United Nations International Decade for Natural Disaster Reduction (National

Research Council 1989). The report specifically mentions the need for mitigating the effects of earthquakes, landslides, tsunamis, volcanoes, floods, typhoons, tornadoes and wildfires, but it does not make mention of drought. A contributing factor to the absence of drought may be that mitigating the effects of drought is not a straightforward technical assessment of cause-effect relationships. Intervening factors, such as land use practices and affected sector(s) make definition of drought conditions problematic. Smith (1996) identifies four different types of drought: meteorological, hydrological, agricultural, and famine. Each of these types affects stakeholders differently. The existence of a drought in one of these categories does not necessarily mean drought in the others, or that there will be severe impacts. Thus, unlike other hazards, only segments of a community may be affected by drought, with a commensurate difficulty in identifying those in need of assistance or policy measures that may redress those needs.

Drought is not only an issue of water availability. The impacts of drought are also affected by land management practices. There are also a number of infrastructure factors which can exacerbate or minimize the effects of a dry season. Land use characteristics, especially relating to overproduction from the land, may allow it to more quickly lose its nutrients or capacity to hold water, accelerating the effects of the dry season. On the other hand, careful land management practices, irrigation, application of chemicals and fertilizers, and mechanistic farming can all increase yields beyond what would be expected from the climate scenario alone, thus reducing potential impacts from a dry season.

The scientific community has worked well with the policy community in identifying mitigation measures for other natural hazards. The National Weather Service

(NWS) focuses upon immediate threats of severe weather. The resources put into mission-relevant research by the National Oceanic and Atmospheric Administration and by other federal agencies have led to production of new tools, new techniques, and new understanding that have enabled operational forecasters to improve warning lead times. Consequently, tornado fatalities have declined precipitously since the 1950s (Brooks and Doswell 2001). The NWS $4 billion modernization plan, enacted throughout the 1990s, focused on short-term, predictable events. In fact, long-lead forecasts, which are essential for drought management, were “not directly affected by the NWS field reorganization” (NOAA 1989).

Geologic hazards and severe weather risks benefit from a direct cause and effect relationship. Damage resulting directly from the hazard is highly photogenic and provides good stories of human drama for the media. Hardly anybody in Oklahoma has not experienced a television program interrupted by television meteorologists reacting to an immediate threat from approaching severe weather. Focusing on warning processes and the research that supports them and upon technical solutions such as strengthening structures is largely a scientific exercise. Mitigating the impacts of drought requires social changes on a large scale, one that goes beyond the boundaries of the disciplines and requires interaction between the two communities.

3.2 Legal doctrines of water management

Water law is governed by one of two doctrines: riparian rights or prior appropriation (Carr and Crammond, 1995). Riparian doctrine constructs water as a public good. Under this doctrine, each landowner along a river or stream (riparian land) is allowed to use water for natural purposes, including domestic bathing, drinking, gardening, and household stock-watering. Irrigation, manufacturing, power generation, mining, and stock watering are considered artificial uses, which act to diminish the flow available to those downstream. Diversion of water for such uses follows the reasonable use rule, under which each riparian owner may use water for any beneficial purpose provided it is reasonable with respect to other riparians. This doctrine is vague, allowing for different determinations of what constitutes reasonable use and beneficial purposes, based on conditions at the time of application for a permit. In times of shortage, all water users may be required to curtail consumption. Riparian rights doctrine is found generally in states east of the Mississippi River.

Prior appropriation, dominant in the western United States, is based on the principle that those who allocate water first can determine how much they need, and that nobody coming later can take that water away from them, constituting water under this doctrine as a private good. This doctrine is sometimes referred to as first in time, first in right. The only limitation is that the water must be put to beneficial use, which is usually prescribed in state laws. States may also have minimum flow restrictions. During times of shortage, junior appropriators lose all rights before any senior appropriator's rights are curtailed, regardless of type of use. For example, two land owners, A and B, each allocate 20 cubic feet per second (cfs) of water, with person A's application preceding person B's. Land owner C later allocates an additional 10 cfs. During a drought, flow in the stream decreases to 30 cfs. Person C loses all rights to appropriate any water and person B must curtail use to 10 cfs, while person A may continue to use the full allocation of 20 cfs.

If state law permits, preferred uses may be established which take precedence over temporal priority. An example would be preference given to first domestic use, second to agriculture, third to industry and power generation, and fourth to fish, wildlife, and recreational use. In this case, an industry with a high priority of use may actually lose rights to a more recent agricultural claim. In such events, however, the person losing the rights to the preferred use must be compensated.

Groundwater is generally considered as a property right, similar to minerals that lie underneath a parcel of land. As such, a land owner has the right to pump as much water as needed, provided that it meets the legal condition of reasonable use. The main prohibition is that water drawn from an aquifer cannot be transported away from the land. Because water is not stationary underneath the land, the state maintains the power to determine maximum yields for an aquifer and to issue permits to individuals specifying the amount of water which may be withdrawn. A permit, once issued, cannot be rescinded. Should yields from the aquifer decline, the doctrine of prior appropriation then applies, with the junior right holder forced to relinquish water rights.

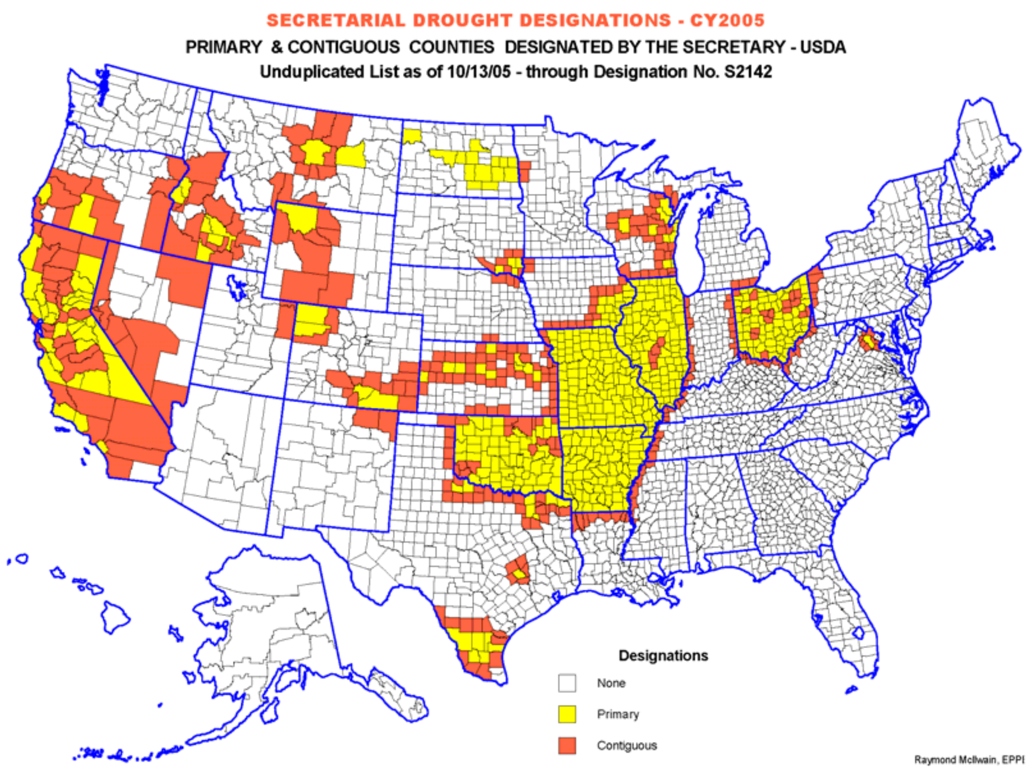
In addition to state laws governing water use within states, interstate compacts govern flow of water between the states. Large river systems, which may span several states, are usually subjected to interstate compacts. Minimum flows at state boundaries must be obtained, such that an upstream state cannot deprive a downstream state of water. Construction of reservoirs are a means of maintaining minimum flows during dry times, but may also divert water from natural flows during wet times. Therefore, mechanisms exist within interstate compacts that require approval before new reservoirs may be constructed or water diverted from river channels.

3.3 The Politics of Drought

Because of the complex legal system governing water use, the timescales upon which drought operates, and the segmented impacts of drought on different stakeholder groups, solutions can become contentious. Short-term droughts disproportionately affect *in situ* water use, but water distribution systems are usually able to withstand short periods of water deficits. Non-irrigated agriculture and some municipal water systems are the primary stakeholders impacted. On longer time scales, water distribution systems may become compromised and well levels decline, affecting a much larger group of stakeholders. Thus, when one speaks of managing drought, there are multiple policies which must be enacted to deal with the diverse impacts on stakeholder groups.

In the governmental arena, those concerned with drought management include the Governor, executive agency leaders, agency staff, and legislators. The Governor needs to be seen as in control of a situation. Therefore, it is essential to have a response plan that can be executed promptly. It also is important for some governors to maintain flexibility. Because impacts vary, even with similar objective measures of precipitation deficiencies, it may not be necessary to declare a drought, even though indicators suggest otherwise. This is an especially important consideration in states where automatic responses, such as water conservation measures, are enacted with the governor's declaration. Figure 3.2 shows drought declarations during 2005. Notice the large extent of drought extending from Oklahoma northeastward to Ohio and the prominent absence of declared drought in Indiana. Given the spatial pattern of drought, it is likely that some areas of Indiana have experienced drought conditions, but it may not have been widespread enough or severe enough for the Governor to feel compelled to request federal drought assistance.

Figure 3.2. USDA drought declarations for Calendar Year 2005 (through October 18). Source: presented at U.S. Drought Monitor Forum, October 20-21, Washington, D.C.



Executive agency leaders must coordinate actions to assure prompt and effective response and recovery while pleasing the Governor and controlling the bureaucracy. This requires an effective assessment and communication system. Agency leaders need to be able to advise the Governor on drought status and recommended actions and execute the Governor's decisions. Often, this entails coordinated action among several agencies, usually including at least the state's emergency management, natural resources, and agriculture departments. Agency staff must be able to implement standard procedures and adapt to situations that do not conform to policy prescriptions. This includes gathering information on impacts to inform agency leaders. Public safety agencies may need to have resources pre-positioned to respond quickly to wildfire areas as dangers increase with drought.

The legislative role is usually more circumscribed. They often do not have direct involvement in management of drought, but they are essential for allocating resources for recovery and mitigation efforts and for necessary changes in state laws governing water regulations. In some cases, legislatures may hold hearings on water plans, drought management, and agency oversight aimed at "fixing" problems identified during an event.

At more local levels, water managers and municipalities must make decisions on if or when to implement conservation measures, and whether to make those measures voluntary or mandatory. The typical negative reaction toward watering restrictions makes some managers and municipalities hesitant to implement those measures, in many cases until drought conditions have developed to such an extent that basic needs are threatened. For example, if stored water levels decline too much, the water system loses pressure, impacting households, fire suppression systems, and enabling inflow of untreated water into distribution systems. Earlier notice may enable some to take precautions, but those decisions must be balanced against local communities' reactions on a case-by-case basis.

The agricultural sector is usually the first to be impacted by drought. On an individual level, farmers must make decisions about crop management and cattle. Those with an ability to irrigate have to decide when and how much to irrigate. Pumping water is expensive, but may be necessary to save the crop. Crop management decisions include the application of fertilizers and pesticides, which cost money. If crops are likely to whither, these costs may be saved; however if rainfall returns the crop may be vulnerable to disease, pests, and have limited growth potential. In the former case, the farmer may save money and get crop insurance payments, but if rainfall returns and crops recover, the farmer may be ineligible for insurance payments plus have no crop to sell. Similarly, deciding on whether to keep cattle on a pasture depends not only on the condition of the field, but on expectations of market impacts. If drought forces cattle sales, the price will fall. Even if the farmer’s own pasture remains viable, it may be a better decision to sell some of the herd early at higher prices.

Farmers and agricultural producers belong to trade organizations or cooperatives. These organizations act in the interest of their membership, and are often politically powerful at state and local levels. These groups may be involved in lobbying the Governor for a drought declaration that enables release of federal assistance. They may be a primary conduit of information on impacts to state agency officials, who then advise their leaders on impacts of drought.

Utilities use vast quantities of water for steam generation and cooling needs in power plants. Insufficient stream flow can require curtailing operations. Another impact of low stream flows is that sun’s energy more easily heats water within the stream. When a power plant’s warm effluent is added to the already-warm stream temperatures, the temperature increase may threaten local fish populations, because warm water holds less oxygen than cooler water. Power plants may come under complaints from environmental organizations as being responsible for fish kills and threatening endangered species.

Recreation and environmental organizations, usually at odds, may actually be allies in drought. Both groups require sufficient stream flows and lake levels. Recreation, such as fishing, hunting, camping, and boating, is a big business and vital to many communities. If there is no water in the rivers, tourism dollars dry up. Environmental groups share an interest in maintaining stream flows, but out of concern for water temperature and water quality for protection of wildlife.

Some of the measures cited by Wilhite (Table 3.1) can be implemented within agencies with minimal resources. For example, improved monitoring using existing information sources for early detection of potential drought development and communication structures that improve the flow of information between agencies, political leadership, the media, and the public can be implemented fairly easily and are in fact common to all drought plans. Other measures require public acceptance, financial resources, changes in law, or changes in behavior, all of which require building sufficient political support to survive the legislative process. Water conservation measures, supply augmentation, streamflow management, and groundwater regulations are examples of the more politically-charged measures.

In order to devise politically-acceptable solutions, four factors must be considered: (1) solutions are complex, and often unknown, (2) generating the public perception of need for action, (3) legal barriers, and (4) socio-economic upheaval. Drought, as discussed in the previous section, is more complex than other natural hazards. Most natural hazards have localized effects and likely outcomes, for which mitigation measures may then be developed. Drought affects different sectors on different timescales, such that identifying likely impacts is difficult. Furthermore, drought covers wide geographical regions, whereas most hazards affect relatively localized areas. The long list of responses presented in Table 3.1 indicates the diverse range of solutions used to address drought impacts.

For many of the same reasons, building consensus on the need for action is difficult. Some stakeholder groups are only impacted in relatively rare multi-year droughts, while other stakeholders are affected by short, seasonal droughts. Because multi-year droughts are relatively rare, stakeholders may not see the need for costly solutions or regulation, figuring that they can 'wait it out' when such droughts do occur. Those affected by frequent short-term droughts may have difficulty building a large enough coalition to generate political action. Sometimes these can be overcome by focusing events (e.g., Birkland 1997).

Solutions that would more effectively manage water resources may fail in court. Even if a solution acceptable to a majority can be devised, senior water right holders or users of groundwater resources may challenge policies in court. Courts have consistently upheld the government's right to regulate water, but any changes in allocation are considered takings for which the land owner must be compensated (Thompson 1995). Thus, water regulation policies may quickly turn into very expensive propositions, with a commensurate erosion of political support. In cases where transfer between river basins is an acceptable solution, interstate compacts may need to be re-negotiated to allow such transfers to occur. Providing state government with more flexibility to manage water resources as a public good would face substantial opposition, especially in western states operating under the prior appropriation doctrine. Even in cases where the government, whether federal or state, has clear authority to manage resources, such as water stored in reservoirs, allocation decisions may be controversial. Klamath Falls, Oregon in 2001 is an example of such a situation (Hathaway and Welch 2005).

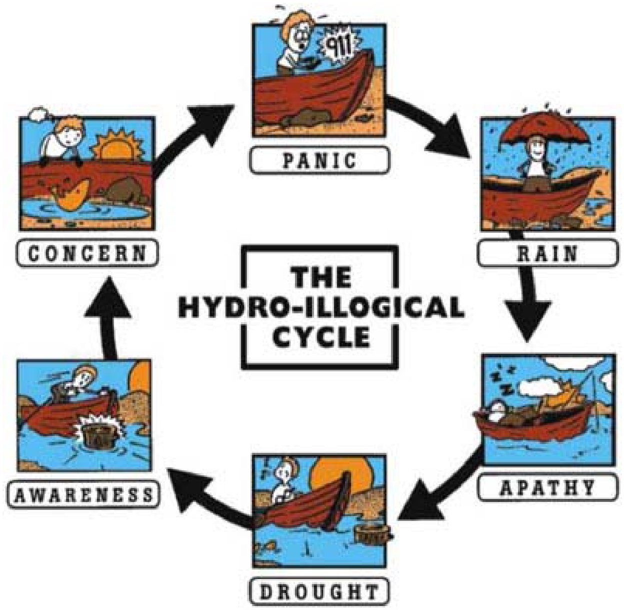
Some potential solutions to water resource management require changes in behavior. Las Vegas, Nevada, receives on average less than five inches of precipitation annually, yet its water use far exceeds local availability. If Las Vegas is to be more resistant to the impacts of drought, less water use is required for such a dry climate. Yet doing so would change the entire culture, and economy, of the region. Irrigation methodology and water use in utilities, the greatest consumers of water nationally, can be reduced, but not without a substantial investment. New capacity can be developed, whether that entails developing reservoirs, drilling new wells, or other ways of storing water for later use, but any of those require financial resources from already-tight state budgets.

Even though what will be described in subsequent chapters appears to be a relatively apolitical process, there are underlying factors that pose great challenges to dealing with water problems. Some of the plans examined in this study propose mitigation activities, but to date there has been little success in implementing those policies. To do so requires political will and financial investment. Most of the measures discussed by those who participated in the study focus upon low-cost, internal processes that improve monitoring and information flow within the agencies, allowing for a more effective and prompt response to developing situations, while leaving the underlying consensus-building for mitigation actions as little more than policy statements.

3.4 Mitigating Drought: The States

The slowly-developing nature of drought leads to the hydro-illogical cycle (NDMC http://www.drought.unl.edu/plan/cycle.htm; see Figure 3.3). A period of apathy

Figure 3.3. The Hydro-Illogical Cycle. *Source: National Drought Mitigation Center* (http://www.drought.unl.edu/plan/cycle.htm).



is the norm, until drought starts to develop. Even after climate conditions begin to reflect drought, decision-makers are unaware of an impending drought. Eventually concern mounts, leading to panic if the drought worsens. Then, when the rain returns, decision-makers return to a mode of apathy.

Getting states to understand what mitigation opportunities are available is itself a major hurdle to overcome. Michael Hayes (2004, personal communication) summed up the difficulties in getting people to understand about drought mitigation:

> "I'd say [the attitude of that's just nature] is even more prevalent with drought than it is with other natural hazards. A lot of times people will talk to us and say 'I understand with hurricanes how you need to mitigate future impacts, build better houses, building codes, have evacuation routes, but I don't understand that with drought'. I think even with drought it's harder than a lot of other natural disasters. But if you point out things and maybe use some of the other natural hazards as examples, then people begin to get ideas about what mitigation means. I think too there is this big confusion about what is exactly mitigation."

Despite the difficulties with understanding mitigation options, many state officials are already engaged in such actions. Drought planning was among the responses identified by Wilhite (1997) that states used to lessen impacts of drought (Table 3.1). Planning, in fact, is a key step of mitigation. Planning involves developing a monitoring system for early detection of drought, performing risk-impact assessments to identify vulnerabilities, and developing a response plan and programs to prepare for when drought occurs. This puts the state on a proactive rather than reactive process, but it is not the entire mitigation process itself. Water conservation measures, conflict resolution techniques, and improved communication between agencies, levels of government, and with the public are also essential mitigation elements.

Because actions taken by states have thus far tended to be on an ad-hoc, response-oriented basis, Wilhite (1991) developed a ten-step process for creating a state drought plan (Table 3.2). The goals of the process are to highlight areas most at risk, examine social, economic, legal and physical hurdles, involve representatives from groups impacted by drought, engage scientific and technical organizations for their expertise, and improve communication among agencies and groups. The end result is a plan in which affected groups have some measure of buy-in, so that implementation barriers are lowered. The recommendations also include periodic review and update of the state plan and development of education programs to raise awareness of issues among a broader community.

3.5 Mitigating Drought: National Efforts

Much of the development of drought planning on a national level has come from two organizations: the Western Governors' Association and the National Drought Mitigation Center. The NDMC is an academic institution, located on the campus of the

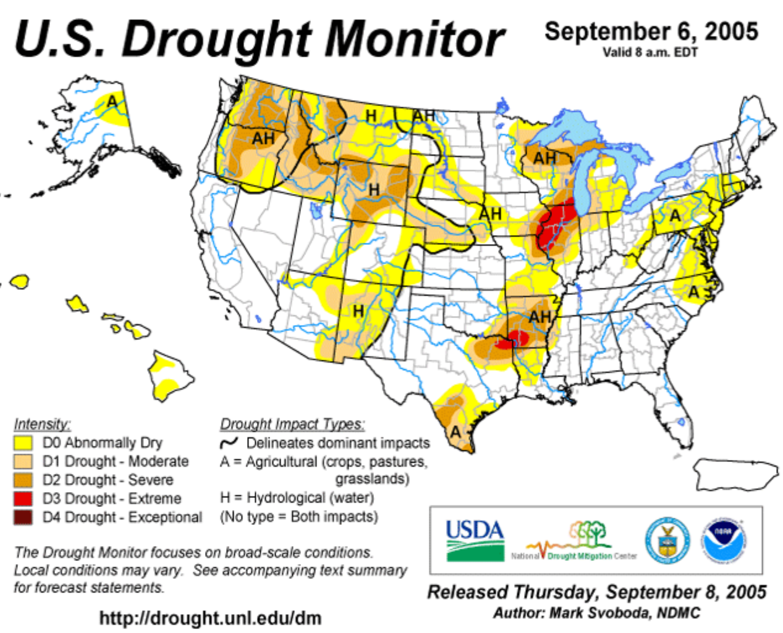
Table 3.2. Ten-step process for drought planning (Wilhite 1991)

	Appoint a drought task force: appointed by the governor; supervises and coordinates the development of the plan and implements mitigation and response programs when active; makes recommendations to the governor, oversee website including current climate information and the planning process; should be multidisciplinary, diverse and include a representative from the governor's task force; makeup varies by state; should have or have access to a public information officer to convey information to the media and public.
2	**State the purpose and objectives of the drought plan**: consider how drought affects different regions of the state, including historical impacts and response; determine resources the state is willing to commit; consider population trends and legal issues; should include assessment, mitigation actions and programs in advance of drought, and response options during drought; may not include financial assistance but may include technical assistance, support for education, or research; plan should include mechanism to collect information in a timely manner, establish criteria for response, and organizational structure and delivery system, define agency duties, identify vulnerabilities and mitigation actions, keep the public informed, and periodically evaluate and revise the plan
3	**Seek stakeholder participation and resolve conflict:** social, economic and environmental values often clash; involve groups early and assure fair representation; develop collaborative solutions; include public interest groups; make sure interests of disenfranchised groups are represented; may create a citizen's advisory council or involve stakeholders in working groups; may want regional groups.
4	**Inventory resources and identify groups at risk**: determine vulnerability of resources to water shortages; natural, biological and human resources; identify constraints to planning process and activation of plan; cost-benefit analysis; address areas of highest risks and possible mitigation actions.
5	**Develop organizational structure and prepare drought plan**: establish relevant committees to develop and write drought plan, including monitoring, risk assessment, and mitigation and response; committees for first two with task force assuming third role; task force composed of senior policy-makers from state and federal agencies in a position to recommend and/or implement mitigation actions, request assistance, or make policy recommendations; monitoring committee should include representatives from agencies with responsibilities for monitoring water and climate; should meet regularly and reports disseminated to drought task force, relevant agencies and the media; should advise policy-makers on workable definition of drought, define drought management areas, develop a drought monitoring system, solicit input on needs of users for different types of data, develop or modify data delivery systems; risk assessment committee should look at objective risk (probability of occurrence) and societal vulnerability (economic, environmental, social factors), have diverse representation, use working groups to focus on sectors, including technical specialists and stakeholders.
6	**Integrate science and policy, close institutional gaps**: bring scientific groups into the policy-making process to provide policy-makers access to understanding what solutions are feasible; synthesize current understanding and set research priorities; compile a list of deficiencies in research and institutional responsibility, make recommendations on remedies to governor, relevant state agencies and the legislature.
7	**Publicize the proposed plan, solicit reaction**: emphasize how drought plan is expected to relieve impacts of drought (focusing on human dimensions), costs of implementing the plan, changes people might be asked to make; in subsequent years do a 'drought plan refresher'; work with media and public information professionals to inform public when nearing trigger points and available assistance; keep information up to date on website.
8	**Implement the plan**: task force should oversee both short-term operational aspects and long-term mitigation measures; periodic evaluation and updating; address changes in technology, research, laws, or political leadership; drought exercise recommended; long-term mitigation measures require a sustained effort, often requiring new legislation.
9	**Develop education programs**: raise awareness of water supply issues to ensure people know how to respond when drought occurs; tailor information to specific groups; task force should develop presentations and educational materials.
10	**Post-drought evaluation**: analyze assessment and response actions of government, nongovernmental organizations; include analysis of climatic and environmental aspects of drought, economic and social consequences, and utility of pre-drought planning; consider contracting with an external evaluator to assure objectivity.

University of Nebraska – Lincoln. It was established in 1995 by Don Wilhite, who had published extensively on the subject of drought policy prior to its establishment. The NDMC is designed as an information clearinghouse and is actively involved in drought planning and drought monitoring activities on both the state and national levels. The nine staff members at the NDMC assist state organizations with drought planning and mitigation, drought policy, advise policy-makers, collaborate on research projects, and conduct educational outreach activities and workshops.

The NDMC is also home to the Drought Monitor, a weekly web-based publication that identifies drought stages in various parts of the country (Figure 3.4). Authors include individuals from the U.S. Department of Agriculture (USDA), NOAA, the NDMC, and the National Climatic Data Center (NCDC). Each author typically serves two weeks on a rotating schedule. Information used to produce the Drought Monitor

Figure 3.4. The U.S. Drought Monitor map for the week ending September 6, 2005. *Source: National Drought Mitigation Center* (http://www.drought.unl.edu/dm/monitor.html).



maps comes from data collected from observing networks, computer-generated models and indices, and direct feedback from individuals through a 'Drought Exploder' e-mail list.

The Drought Monitor was created in 1999 and has been produced weekly ever since. Authors rate drought severity, using the indices, data and direct guidance, as one of 5 categories: abnormally dry (D0), moderate drought (D1), severe drought (D2), extreme drought (D3) and exceptional drought (D4). The drought category designated by the Drought Monitor author requires assessment of a variety of objective indices blended with subjective assessments based on information of impacts (Table 3.3). Because indices will frequently show different designations, the author's judgment is the final determination. The designation may be given based on impacts on either agricultural or

Table 3.3. Drought Severity Classification. *Source: National Drought Mitigation Center* http://www.drought.unl.edu/dm/classify.htm.

		Ranges (Primary Objective Indices)				
Category	Description	Palmer Drought Index	CPC Soil Moisture Index (Percentiles)	USGS Weekly Streamflow (Percentiles)	Standardized Precipitation Index (SPI)	Satellite Vegetation Health Index
D0	Abnormally Dry	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	36-45
D1	Moderate Drought	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	26-35
D2	Severe Drought	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	16-25
D3	Extreme Drought	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	6-15
D4	Exceptional Drought	-5.0 or less	0-2	0-2	-2.0 or less	1-5

	Possible Impacts
D0	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.
D1	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested.
D2	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.
D3	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions.
D4	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.

hydrological concerns. The D4 category is reserved for severity in accordance with a one in fifty year event. USDA assistance is in some cases tied to the designation assigned by the Drought Monitor authors.

Involvement by the WGA dates back to the mid-1970s. Following a devastating Western drought, the WGA formed a Western Regional Drought Action Task Force, which included representatives from 21 states, federal agencies, and White House Staff. Task Force recommendations included development of proactive drought management plans in the states. Unfortunately, little sustained effort was directed at the endeavor following the end of the drought.

National-level drought planning initiatives took a hiatus until the mid-1990s, when Governor Gary Johnson of New Mexico sponsored a new WGA initiative, leading to adoption of the *WGA Drought Response Action Plan* (1996). Much like the earlier effort, the report called for better integration of drought programs and improvements in state plans to focus more on long-range planning and mitigation. The report noted "confusion and a lack of understanding of roles and responsibilities" that hindered reaction time and effectiveness. It also noted that "drought – of all natural hazards – continues to receive the least effective and timely response from the federal government," with action usually on an *ad hoc* basis rather than a systematic, permanent process like with other natural disasters. The report called for evaluation of Federal Emergency Management Agency (FEMA) and USDA policies.

Unlike its predecessor, the new initiative laid a lasting national foundation by calling for a national drought policy council. Through continued efforts by the WGA and collaborators, the Western Drought Coordination Council (WDCC) was established in

1997 to foster collaboration and coordination among partner states, federal agencies, tribes and other groups. Four federal agencies (USDA, U.S. Department of Interior, FEMA and the Small Business Association), three states (Colorado, New Mexico and Texas), one tribal representative and one representative from the National Association of Counties made up the nine-member Council. Working groups, consisting of individuals from federal and state operational entities, were established in four areas: monitoring, assessment and prediction; preparedness and mitigation; response; and communications.

The National Drought Policy Act of 1998 continued efforts on a national scale. The legislation established a National Drought Policy Commission (NDPC), which was charged by Congress to provide advice and recommendations on the creation of an integrated, coordinated Federal policy for drought response. The Commission membership included fifteen individuals, representing federal, state and local organizations. The NDPC subsequently presented a report to the U.S. Congress, *Preparing for Drought in the 21st Century* (2000), which advocated enactment of a national drought policy and funding for an integrated drought monitoring network. The Commission outlined general principles of a federal role in drought management:

- Favor preparedness over insurance, insurance over relief, and incentives over regulation;
- Set research priorities based on the potential of the research results to reduce drought impacts;
- Coordinate the delivery of federal services through cooperation and collaboration with non-federal entities.

These goals highlight a role of federal support for state, tribal, regional, local and individual efforts to reduce drought impacts.

The Commission's report included a suite of recommendations grouped into the following categories:

1. Incorporate planning, implementation of plans and proactive mitigation measures, risk management, resource stewardship, environmental considerations, and public education as the key elements of effective national drought policy.
2. Improve collaboration among scientists and managers to enhance the effectiveness of observation networks, monitoring, prediction, information delivery, and applied research and to foster public understanding of and preparedness for drought.
3. Develop and incorporate comprehensive insurance and financial strategies into drought preparedness plans.
4. Maintain a safety net of emergency relief that emphasizes sound stewardship of natural resources and self-help.
5. Coordinate drought programs and response effectively, efficiently, and in a customer-oriented manner.

"Goal 2" energized scientists within the drought community to independently examine the resources that were available for monitoring drought and develop improved mechanisms for conveying timely drought information to decision-makers. One of the primary outcomes of this collaboration was the creation of the U.S. Drought Monitor.

Acting on the recommendations of the NDPC, the USDA formed the Interim National Drought Council (INDC). Council members included federal and state agencies, the NDMC, The National, Southern and Western Governors' Associations, and several national associations. This created a forum for dialogue, which led to an analysis of existing information systems, technologies, and policies. Continued efforts led to introduction of legislation in Congress in 2001, the National Drought Preparedness Act, and a plan for a National Integrated Drought Information System (NIDIS).

The National Drought Preparedness Act would formally establish a National Drought Council within the Department of Agriculture that would be responsible for overseeing development of a comprehensive National Drought Policy Action Plan, evaluate Federal drought-related programs and make recommendations to the President, Congress and appropriate Federal Agencies on establishment of triggers for authorizing Federal drought mitigation programs. The Council would also assist state and tribal governments with development of drought preparedness plans. The Act would authorize $2 million per year for seven years for a drought assistance fund which would provide: technical and financial assistance for development and implementation of drought preparedness plans; funds for mitigation measures to address various issues related to drought; expanded technology transfer of drought and water conservation strategies and innovative water supply techniques; and post-drought evaluations and recommendations. Although the Act did not pass the 107th or 108th Congress, it has been re-introduced and has strong support by the Western Governors' Association.

Another offspring of the NDPC was an effort, led by the WGA, to develop a National Integrated Drought Information System. The WGA recognized the role the scientific community could play in combating drought: "better science will lead to better and more timely decisions, thus reducing or mitigating a drought's impacts" (2004, 1).

The WGA established a partnership with NOAA to develop a plan for constructing such a system. Through a series of workshops involving members of the scientific community and representatives of state and national agencies, a series of recommendations were developed and accepted by the WGA in 2004. The report calls for national legislation to authorize funding for NIDIS (included as part of the National Drought Preparedness Act), but calls for NOAA to take the lead on implementing recommendations that can be done under existing authorities and funding.

The end goal of the process is a "fuller integration of relevant and available data to improve monitoring, provide a better understanding of how and why droughts occur, enhance dissemination of information at the relevant spatial and temporal scales, and, ultimately, improve the forecasting of droughts" (WGA 2004, 2). Specific goals include:

- Develop the leadership and partnerships to ensure successful implementation of an integrated national drought monitoring and forecasting system;
- Foster, and support, a research environment that focuses on impact mitigation and improved predictive capabilities;
- Create a drought "early warning system" capable of providing accurate, timely and integrated information on drought conditions at the relevant spatial scale to facilitate proactive decisions aimed at minimizing economic, social and ecosystem losses associated with drought;
- Provide interactive delivery systems, including an Internet portal, of easily comprehensible and standardized products (databases, forecasts, GIS-based products, maps, etc.); and

- Provide a framework for interacting with and educating those affected by drought on how and why droughts occur, and how they impact human and natural systems.

This document helps to close the link between the disparate efforts of the science community and *ad hoc* state-level responses to drought, and in effect makes drought policy a national endeavor.

3.6 Recent Drought Episodes

To determine the physical recurrence of potential drought episodes, a climate analysis was performed for each state. The climate analysis is based upon monthly climate division precipitation records available from NCDC. NCDC divides states up into climatologically homogenous regions, called climate divisions, usually comprising an area of several counties (NCDC http://lwf.ncdc.noaa.gov/oa/climate/onlineprod/drought/statelist.html). The data were analyzed for two types of droughts: severe short-term precipitation deficits, sometimes termed 'flash droughts', and sustained deficits extending over the course of a year. Monthly precipitation was normalized by the 1971-2000 mean to create a percentage of normal by month. Short-term droughts are defined as any three-month period during the warm growing season (March through October) in which: (a) the total precipitation was no more than 50% of the normal, and (b) all three months recorded less than 50% of normal or one month recorded less than 25% of normal precipitation with one other month less than 50% of normal. These are typical of seasonal droughts, which develop quickly and have a substantial impact upon agriculture, but may be short-lived. Long-term droughts are defined as at least two consecutive quarters with less than

50% of normal precipitation, similar to the way in which economists define a recession. Results of the analysis are shown in Table 3.4

For the period 1971-2004, western states showed the highest occurrence of long-term droughts. California had 22 drought episodes during the 34-year period. Arizona, Nevada, Texas and Utah each had more than 10 episodes. Florida was the only state east of the Mississippi River to have more than 3 episodes during the period.

Western states again led the way in seasonal droughts. Some portion of California met the criteria for a seasonal drought in each of the 34 years included in the analysis. Arizona, Idaho, Nevada, New Mexico, Oregon, Texas, and Utah, each had 20 or more years in which a seasonal drought affected at least some portion of their respective states. However, some of the states that did not experience many prolonged droughts did experience short-term, seasonal droughts. Alabama, Arkansas, Georgia, Illinois, Louisiana, Maryland, Minnesota, Mississippi, Missouri, Montana, North Carolina, Pennsylvania, and South Carolina, each of which had 3 or fewer long-term droughts, experienced seasonal droughts in at least five of the 34 years studied.

Drought is defined by its impacts, so an assessment of precipitation deficiency may not capture the perceived occurrence of drought. In order to capture the impacts side of drought definition, U.S. Drought Monitor maps were examined for the period 2000-2004. Results are shown in Table 3.5. The D2 category, severe drought, is used by the USDA as a trigger for some of its relief programs. One map from each month for the period was examined for the occurrence of D2 – D4 drought designations within each state. The Drought Monitor is developed based on objective indices as well as subjective input from state officials and local media. Therefore, the Drought Monitor may be able to

Table 3.4. Number of occurrences of substantive precipitation deficits, 1971-2004, and recent occurrences. Deficits are defined as: (a) seasonal 3-month periods in which precipitation is less than 50% of normal with at least one month less than 25% of normal; and (b) at least two consecutive quarters in which precipitation is less than 50% of normal. Seasonal deficits are for the period March – October. The ending year for recent long-term events is listed, with the number of consecutive quarters indicated. States included in the study are highlighted. Alaska and Hawaii were not available from NCDC; NA indicates Not Available.

	Number of Years (1971-2004)		Years Since 2000	
STATE	**SEASONAL**	**LONG-TERM**	**SEASONAL**	**LONG-TERM**
AL	9	1	2000, 2004	-
AK	NA	NA	NA	NA
AZ	28	17	2000 – 2004 (all)	2000 (4), 2002 (5), 2004 (2)
AR	8	3	2000	-
CA	34	22	2000 – 2004 (all)	2000 (2), 2002 (3), 2004 (2)
CO	8	6	2002	2002 (3), 2003 (2)
CT	4	0	-	-
DE	2	0	-	-
FL	10	6	2000, 2004	2001 (2)
GA	10	3	2000, 2004	-
HI	NA	NA	NA	NA
ID	20	9	2000, 2001, 2002, 2003	2000 (2), 2001(3), 2002 (3)
IL	6	3	-	-
IN	3	1	-	-
IA	11	5	2000, 2003	-
KS	16	9	2000, 2002, 2003	2000 (2), 2002 (4), 2003 (2)
KY	2	0	-	-
LA	13	2	2000, 2003	2000 (4)
ME	1	0	-	-
MD	5	1	-	-
MA	1	0	-	-
MI	4	2	-	-
MN	5	3	2003	2003 (2)
MS	9	1	2000	2000 (3)
MO	5	2	-	-
MT	13	3	2000, 2001, 2003, 2004	-
NE	11	6	2002, 2003	2002 (2), 2003 (2)
NV	28	15	2000 – 2004 (all)	2000 (2), 2001 (2), 2002 (4), 2004 (2)
NH	0	0	-	-
NJ	2	1	-	-
NM	23	9	2000 – 2004 (all)	2000 (4), 2002 (4), 2003 (2)
NY	1	0	-	-
NC	5	1	-	-
ND	12	7	2001	2002 (2), 2003 (2)
OH	2	0	-	-
OK	15	9	2000, 2001, 2002	2002 (2)
OR	20	4	2000, 2002, 2003	-
PA	5	0	-	-
RI	1	0	-	-
SC	9	1	2001, 2004	-
SD	17	8	2000, 2002	2002 (3), 2003 (2)
TN	3	0	-	-
TX	25	12	2000, 2001, 2002, 2003	2000 (3), 2003 (4)
UT	25	11	2000 – 2004 (all)	2000 (2), 2002 (2), 2003 (2)
VT	0	0	-	-
VA	4	2	2001	-
WA	17	6	2001, 2002, 2003	2001 (3), 2002 (2)
WV	0	0	-	-
WI	2	2	-	-
WY	13	6	2002, 2003, 2004	2002 (3), 2004 (2)

Table 3.5. Drought occurrences determined by the Drought Monitor maps, 2000-2004. Categories used by the Drought Monitor are: D0 = Abnormally Dry; D1 = Moderate Drought; D2 = Severe Drought; D3 = Extreme Drought; and D4 = Exceptional Drought. Maximum Category is the highest designation during the period. Number of months is the total number of months in which D2 or greater designation occurred in the state (out of 60 possible). Longest run is the longest consecutive period (months) of D2 designation or greater. States included in the study are highlighted.

STATE	Maximum Category	Total Number of Months	Longest Run (months)
AL	D4	14	9
AK	D0	0	0
AZ	D4	34	33
AR	D3	7	3
CA	D3	39	32
CO	D4	32	32
CT	D2	5	5
DE	D3	7	5
FL	D4	16	9
GA	D4	30	15
HI	D3	24	12
ID	D4	43	30
IL	D2	7	4
IN	D2	7	5
IA	D3	17	7
KS	D4	34	17
KY	D2	1	1
LA	D4	14	11
ME	D3	12	9
MD	D3	9	9
MA	D2	4	4
MI	D2	4	4
MN	D3	9	6
MS	D4	10	7
MO	D3	18	8
MT	D4	53	53
NE	D4	44	17
NV	D3	42	42
NH	D2	9	9
NJ	D3	9	6
NM	D4	41	33
NY	D2	5	4
NC	D4	13	9
ND	D2	11	6
OH	D2	1	1
OK	D3	15	7
OR	D3	41	29
PA	D3	4	3
RI	D2	2	2
SC	D4	28	14
SD	D4	31	27
TN	D3	7	7
TX	D4	32	13
UT	D4	39	33
VT	D2	2	2
VA	D4	12	12
WA	D2	13	10
WV	D3	1	1
WI	D3	6	6
WY	D4	42	42

capture events that may not meet precipitation-based criteria, but nonetheless had significant impacts.

Drought Monitor maps indicated three exceptional droughts during the period, each of which afflicted several states. The Deep South, stretching from Louisiana to Georgia, was affected from June through November 2000 (Figure 3.5). Drought conditions subsided across the western portions of the affected region during the winter of 2000-2001, but drought conditions remained across Georgia and the Carolinas, and intensified in Florida, through August 2001. Drought conditions subsided somewhat during the winter of 2001-2002, but began to re-intensify along the entire Eastern Seaboard beginning in February 2002. Between July and October of that year, exceptional drought conditions established themselves across the Mid-Atlantic States from Virginia to Georgia (Figure 3.6). Conditions rapidly improved in the fall and winter

Figure 3.5. The U.S. Drought Monitor map for the week ending August 1, 2000. *Source: National Drought Mitigation Center* (http://www.drought.unl.edu/dm/monitor.html).

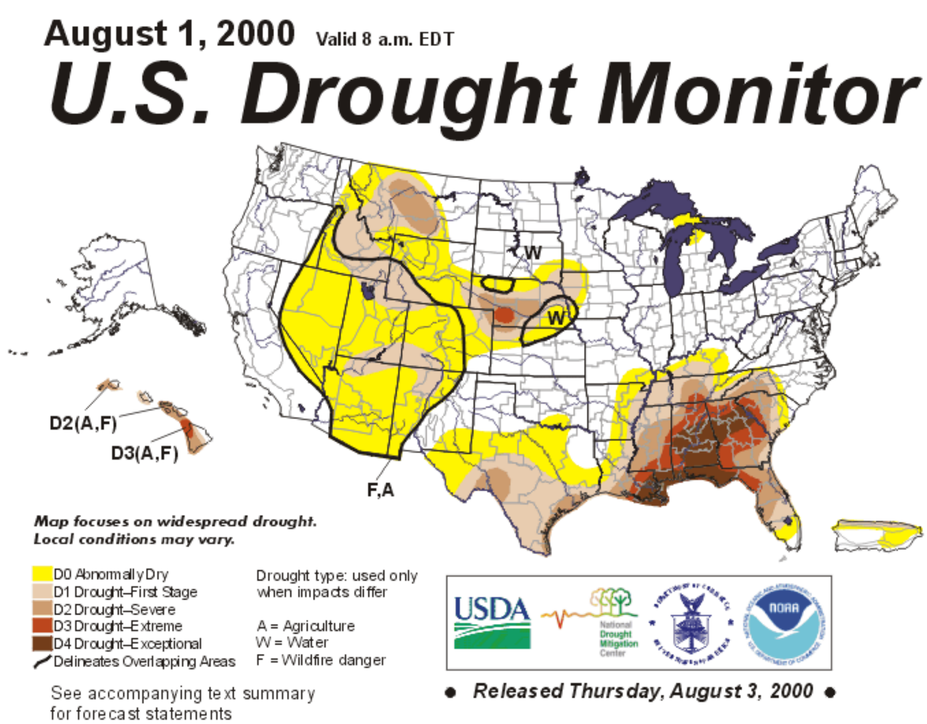
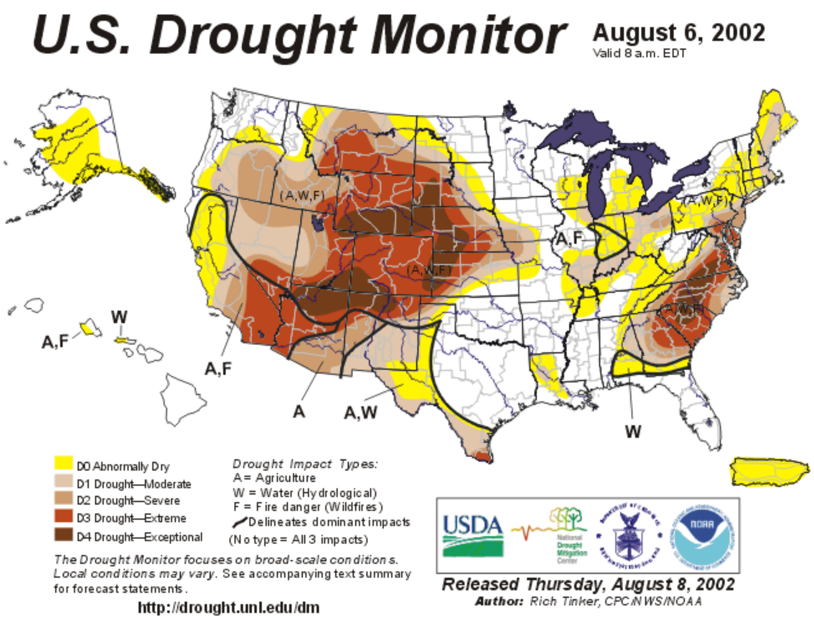


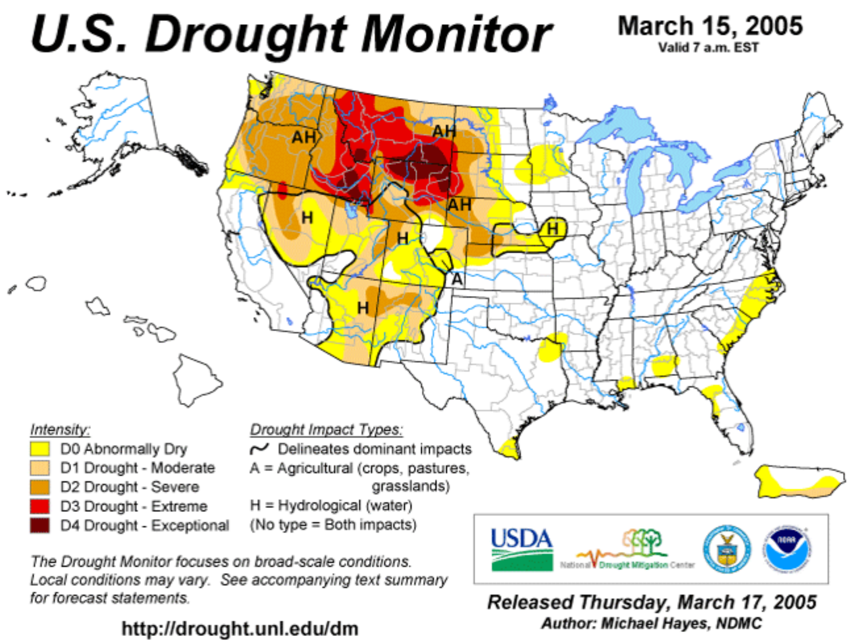
Figure 3.6. The U.S. Drought Monitor map for the week ending August 6, 2002. *Source: National Drought Mitigation Center* (http://www.drought.unl.edu/dm/ monitor.html).



of 2002, such that by January 2003 there were almost no remaining effects noted on the Drought Monitor maps.

Also beginning in 2002, a widespread, persistent drought pattern became established across the Western U.S. From May 2002 through April 2005, some portion of the Western U.S. continuously received a D4 designation on the Drought Monitor maps. The greatest area extent of the most extreme drought category occurred during the summer of 2002, but D3 (extreme) drought conditions persisted in large areas from Montana and Idaho down to Mexico and eastward to the western edge of the Great Plains States. By March 2005, the most severe portion had shrunk to the northern Rockies, but areas of D4 designation persisted (Figure 3.7). Table 3.5 shows that Montana has had D2-D4 designation for 53 consecutive months, at the end of 2004. Nearly all of the states with 24 months (two years) or more of drought conditions are located in this region (the exceptions being Georgia, South Carolina and Hawaii).

Figure 3.7. The U.S. Drought Monitor map for the week ending March 15, 2005. *Source: National Drought Mitigation Center* (http://www.drought.unl.edu/dm/monitor.html).



One note of caution must be expressed here. The precipitation deficiencies analysis may be related to short-term water shortages affecting agriculture and perhaps small water supplies; however it is not a good indicator of water shortages where water supplies are highly managed, such as in the western United States, where water can be stored in reservoirs and imported across state boundaries. Under such conditions, managed areas may be more resilient to short-term or even single-year drought episodes, but the effects of multi-year droughts may persist for years after precipitation has returned to normal.

3.6 Summary

This study focuses on drought because of an active scientific community concerned with drought coupled with an increase in the visibility of drought on national and state agendas in recent years. The existing knowledge community is centered around the Drought Monitor, a weekly publication of drought conditions across the country. The Drought Monitor includes an e-mail based discussion forum, which allows both scientists and decision-makers to exchange views on the status of drought as well as problem definitions and possible solutions.

Since 2000, more than half of the states have recorded at least short-term severe drought. The west, south, and Atlantic coast have been particularly affected. These provide potential focusing events for the development or enhancement of state drought plans. Coupled with the policy need, scientific and technical advances in recent years in measuring, monitoring, and understanding the causes of drought provide new sources of information that may be included in some of these plans. Drought planning is largely conducted on a state-by-state basis, allowing for comparisons of utilization of scientific and technical information.

Active national efforts have been led by the Western Governors' Association since 1996. The WGA's efforts are aimed at developing a comprehensive monitoring system and improving state drought policies. Current initiatives include the National Integrated Drought Information System and the National Drought Preparedness Act.

One of the challenges of studying drought is that drought is difficulty to define. Unlike other natural hazards, drought develops slowly, has diffuse impacts, and has disparate impacts upon different stakeholder groups within a community. Decision-makers' responses often do not happen until drought is well-established, due to a lack of awareness. Attention to drought is typically short-lived. Once a drought ends, decision-makers return their attention to other issues.

Should senior officials perceive the need for action, it is not always clear on what action is appropriate. Officials are constrained by legal frameworks, legislative oversight, and public pressure. The legal framework for water management falls under the doctrine of either riparian rights, which treats water as essentially a public good which can be regulated, or prior appropriation, which treats water as a private good. Interstate compacts further complicate management of water resources because of prohibitions on inter-basin transfers.

Governmental stakeholders include the Governor, executive agency leaders, agency staff, and public safety agencies. Federal drought relief is predicated upon gubernatorial requests. Therefore, all state agency officials must make sure Governor receives accurate advice so that drought declarations, if necessary, are issued in a timely fashion. Furthermore, agency officials are responsible for efficient and effective implementation of contingency plans. State legislatures, while not usually involved in drought management, may become involved in the policy development process and their involvement is essential for appropriating funds for mitigation actions.

Other stakeholders include water managers and municipalities, which must make decisions on if or when to implement voluntary or mandatory conservation measures, farmers and ranches, agricultural producer or trade organizations or cooperatives, utilities, recreation, and environmental organizations. All of these have significant, and often competing, stakes in water use and allocation decisions.

The next chapter discusses the study design and general characteristics of the groups and case studies that constitute this study. The chapter details the communications model used as a template and how the drought knowledge community fits within the model. Data sources and instruments are described along with a brief summary of each of the state case studies.

CHAPTER 4: STUDY DESIGN

In order to ascertain the level of collaboration between the scientific and policy communities within the drought arena, a *post hoc* case study approach was employed. The study design builds on a communications model developed by Havlock (1969). Communication linkages are examined between three groups of individuals: producers (research scientists), receivers (policy-makers) and an intermediary, operationally-oriented group of scientists affiliated with national centers and federal agencies. Using the case study approach, interviews were conducted with individuals representative of each of these groups to examine how they provided and accessed information from within their group and from other groups.

4.1 Communications Model

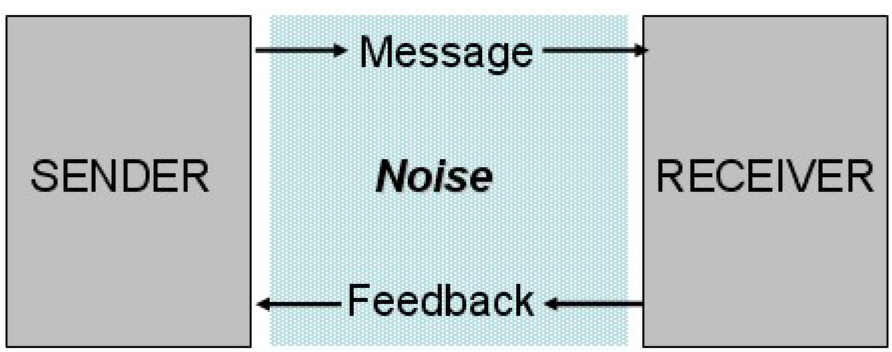
Communication may be addressed on an individual level or an aggregate level. The individual level focuses upon the characteristics of interaction between two individuals, including the medium in which messages are transmitted. The aggregate level focuses upon networks, in which multiple actors and multiple messages compete for attention. This section examines individual communications and then communication networks as it applies to the context of developing state drought policy.

Communication at its most basic level involves three principal parts: a sender, a message, and a receiver. The underlying premise is that in order for information to be transferred from the sender to the receiver, it must be fashioned into a message that can be understood by the receiver. On an individual basis, communication of scientific messages is probably not substantially different than when dealing with less technical concepts. Communication is dependent upon the characteristics of the sender, the message, and the receiver (Havlock 1969). Whether the subject is high-energy physics or ideas about juvenile justice, each part of the communication system must conform to certain characteristics that enhance utilization. However, because of the added difficulties arising from the two cultures phenomenon, the clarity of the message and communication may be muddled.

Figure 4.1 shows the basic elements of a communications model (Gortner et al. 1997). The basic message consists of a sender, a message, and a receiver. The sender assesses the effectiveness of the communication by means of feedback from the receiver. All of this takes place in an environment with competing stimuli for both the sender and receiver's attention, which causes noise in the system and can distort the message.

Considering the characteristics of the *sender*, information is more likely to be utilized if the source is considered competent and credible. These characteristics form an underlying basis of trust. When a user knows that the findings are motivated by the search for "truth" and the source has a track record of credible research, findings are

Figure 4.1 Communications model. Adapted from Harold F. Gortner, Julianne Mahler and Jeanne Bell Nicholson, *Organization Theory: A Public Perspective*, 2nd ed. Fort Worth: Harcourt Brace College Publishers, 1994, 138.



more likely to be accepted as input for decision-making. In addition to these characteristics, those senders who present information for the purpose of external dissemination, as opposed to internal group communication such as scientific journals or technical papers, are more likely to be successful in reaching users. Those who can work with users and are sensitive to the users' concerns fare better. However, even meeting all these criteria does not assure that the information will catch the user's interest. There still exists a bias toward internal sources of information, such that even the best external sources may not be consulted.

The *message*, or transmittal of research findings or knowledge, is composed of two parts: the content of the message and the medium through which it is transmitted. Content issues include credibility of the methodology and outcomes, plausible outcomes, relevance to users, and the relationship between information and existing practices. Information that is intuitive and meshes with the user's personal experience is more likely to be used. Earlier studies pointed toward policy-makers' preference for anecdotal information (Havlock 1969), but subsequent research shows that policy-makers are comfortable with statistical data (e.g., Bardach 2002). Whether information is anecdotal or statistical, policy-makers do respond better to metaphors, which places information in a context familiar to the client. Incidentally, a preference toward anecdotal evidence over statistical data may have been an important factor in the communications barrier between the two cultures. Also, the message should have clear, actionable information.

Medium issues involve the format, timeliness, accessibility, flexibility, reliability, and attractiveness of the information "package." Information that is synthesized into short summaries with clear implications is easier for policy-makers to understand and use.

Policy-makers also tend to favor sources with whom they have direct contact. This makes it possible to clarify results and implications.

A *receiver* is more likely to consider information that has personal relevance to her needs, if the information is appropriate for the level of decision-making, and if information is contextual. Users who appreciate both scientific and political aspects of policy decisions are more likely to use scientific information. Those who understand only one or the other aspect will have difficulty making the link between the information and the policy actions and are less likely to make use of the information. Furthermore, users who are willing to accept information, even if it runs contrary to expectations or necessitates changing practices, will be more likely to include research results in their decision-making process. Trust is important to the user, who will select from sources they deem credible and competent and who can deliver information that fits their needs. A receiver may choose not to accept a message entirely. Such denial may be due to a lack of comprehension of the message, information that is not suitable for use in decision-making, information that is not congruent with the receiver's perspective, or a lack of trust regarding the sender.

Credibility and trust appear in several dimensions of the dissemination framework. Credibility is determined not only by the methodological rigor and the validity of findings; rather it depends upon ambiguity, corroboration with other sources or expectations, congruence with user goals, and users' opinions toward research (Sabatier 1978). Put simply, it is not sufficient to produce a good report with the usual caveats; it must be integrated into the ongoing issues discussions to which it pertains.

Transmittal of the messages themselves is dependent upon perceptions and interpretations that the individuals attach to the messages. Language does not capture the full extent of an intended message. Words themselves may have different meanings to different individuals, such that what the sender says does not create the desired affect because the receiver assigns different interpretation of the words (Gortner et al. 1997). The receiver may have difficulties comprehending the message because her interpretation of words may differ from what the sender intended. This may cause *distortion* of the message, resulting in a different reaction from what is intended by the sender.

One factor that increases the likelihood of distortion is the use of jargon (Gortner et al. 1997). Specialists often develop their own vocabulary around a topic, such that communication may become unintelligible to those outside the community. This is the root of the two cultures problem, in which scientists have specialized to such a degree that both knowledge and language become fragmented. Those in need of information from such specialists must either rely upon the specialists to be presenting an accurate portrayal of the information or have their own trusted sources of information that can evaluate and advise on the nature of the communication.

This model pertains to discrete communication events. In reality, communication is a process, usually a dialogue between two or more individuals, and occurs in a setting of multiple messages that compete for attention. For every message, there is an element of *feedback* which provides the sender with information regarding how the message was accepted. If the sender discerns that the message was not received as intended, attempts to clarify may follow as a result of the feedback.

Another confounding factor to the communication process is *noise*. Noise exists within the environment in which the direct communication takes place. Other individuals, other simultaneous communication, and environmental events may distract the receiver, resulting in a lack of clarity of the message. For example, other conversations in the room may elicit some of the receiver's attention, such that the intended message is not fully received. Noise may also affect feedback because the sender may be similarly distracted and not notice the subtle, often nonverbal, cues of the receiver.

With regards specifically to research communication, Havlock (1969) identified four groups: researchers, applied research, practitioners, and consumers (Table 4.1). Within this spectrum, researchers and applied researchers have regular contact, as do practitioners and consumers. The primary relevance, for Havlock, was communication between the applied researchers and practitioners. This corresponds to Snow's two cultures model, where similarities existed between basic and applied research but a great gap existed in communicating outside of the research community.

As applied to this research project, the scientific community is the sender and policy-makers are receivers. This creates a sort of 'science push' model, in which research drives policy. However, as previously noted, policy-makers have their own needs, distinct from those pursued by the science community. There are also complementary 'policy pull' and 'policy push' models. Policy pull models are ones in

Table 4.1. Groups involved in research communication. *From Havlock (1969).*

Researchers	Applied Researchers	Practitioners	Consumers
• Basic researchers • Scientists • Scholars • Academics	• Development • Engineering	• Producers • Manufacturers • Teachers • Therapists • Retailers	• Clients • Community • Citizens

which policy-makers initiate a message to scientists in search of information, which is subsequently provided as a follow-up message by the scientist to the policy-maker. Policy push models are ones in which policy-makers define the needs for research in order to answer specific questions on their agendas. This is manifested through funding decisions to mission agencies and research programs, and may not result in direct communication between the policy-makers and scientists.

4.2 Communications Networks

Although some policy-makers may be well-versed enough to understand the messages coming directly from scientists, many may look toward external organizations that provide integrating and translation functions. Organizational structure "introduces considerable predictability and stability into interaction" (Gortner et al 1997, 135). These organizations become the primary conduit of information to the policy community and respond to the needs of the policy community. Thus, these organizations must be aware of the 'state of the science' as well as external needs for information. These organizations, in turn, become consumers of scientific information produced by others who work in more specialized aspects of the discipline. These organizations' needs help influence the research agenda, thus linking individual research to policy relevance, sometimes without the individual scientist being aware of that linkage.

Little is known about how policy-makers identify these organizations or individuals who can serve this "science integrators" function. The American Meteorological Society (AMS) noted that "there are a limited number of professionals with skills in synthesizing and integrating climate sciences and information in a societal context" (Greenfield 2003, 10). In its report, the AMS attributed the shortage to a lack of incentives and rewards at academic institutions for those who focus on both climate sciences and socio-economic impacts. Thus, if there is a shortage of individuals with these skills, it may be difficult for policy-makers to obtain the information that they need in a useable format.

In a post-modernist environment, "the key communication elements of source, message, and receiver are all much more complicated and less easily distinguished than in prior periods" (Cheney and Christensen 2001, 241). A feature of post-modernism is rapid, global communication in which the medium becomes saturated with messages. Competing messages create noise in the system, creating difficulties for individuals to select from among the multitude of messages. Indirect connections become as commonplace, if not more so, than direct connections upon which Havlock's model was based. The separation of messages from source opens the door to distortion and misunderstanding.

Meaning is constituted and re-constituted through dynamic, reciprocal, and iterative processing of environmental information (Sutcliffe 2001). Decision-making is performed in the context of ongoing communication. It is not often done on the basis of a single message; rather it is an environment of multiple messages and two-way communication. The initial message, however, may frame subsequent deliberations. Internal perceptions strongly affect what problems are seen, what potential solutions are envisioned, and how the problems are ultimately addressed (Cheney and Christensen 2001). These frames of knowledge help to reduce complexity to conform to predetermined codes (Thompson and Wildavsky 1986). Individuals, through sharing information and interpretation, socially construct information filters through which information is subsequently selected and enacted (Heath 1994). Because different information filters are employed, individual members and organizations may respond differently to the same information (Ford and Baucus 1987).

Policy is the result of repeated and aggregated communication. On an aggregated level, communication networks, composed of multiple individual messages, act to shape information. Communication networks play an important role in the transmission and exchange of messages. Networks allow simultaneous contact between multiple communicators within a shared environment. The structure of networks is defined by relationships between the individuals and organizations, the number of entities involved, the strength and symmetry of the communication 'nodes', and norms of reciprocity (Monge and Contractor 2001). An individual's or an organization's relative position within the network affects how its messages are received by others. These organizational structures define and manage a universe of discourse within which issues are discussed (Heath 1980).

Grunig (1992) views organization-environment relationships through terms of organizations, stakeholders, publics, and issues in dynamic competition. If communication responsibilities are distributed among multiple organizational members at varying hierarchical levels, two-way symmetric communication with stakeholders is more likely. If communication is more closely controlled, either two-way asymmetric communication (goal-oriented to obtain favorable outcomes) or one-way communication is more likely.

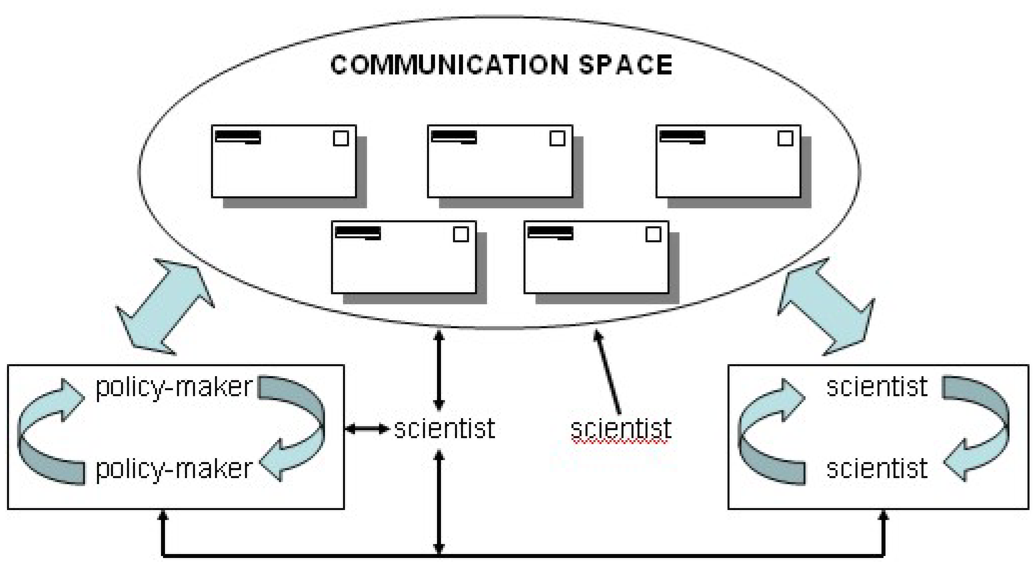
The medium also defines how easily knowledge can be transmitted. Badaracco (1991) cites two forms of knowledge: migratory and embedded. Migratory knowledge can be easily moved. It exists in products like books, designs, or individual minds. Embedded knowledge is the result of specialized relationships among individuals and groups. It is dependent upon particular norms, attitudes, information flows and decision-making processes. Embedded knowledge cannot be transported in whole because each communication network is unique.

In the context of a drought communication network, migratory knowledge resides in products while embedded knowledge resides within the network itself. Products, such as the Drought Monitor maps and publications such as the NDMC's ten steps planning document, can be accessed and extracted in while from the network. Both products are utilized extensively in multiple contexts. The sum of drought knowledge, however, is dependent upon the relationships in the communication network, between individuals participating in the Drought Monitor discussion group, participants in the NIDIS and WGA planning processes, and staff at organizations such as the NDMC. While each participant may have specialized knowledge and can be moved, the sum of the knowledge resides within a community. Products can be considered as an intermediate step, encapsulating knowledge but not fully. To achieve transfer of the full knowledge, the whole communication network must be accessed.

In this model, knowledge communities consist of intermediary science-based organizations and agency "focal points" for a subject area. Policy-makers, who are the receivers in the model, get most of their information and alternatives from agency people who act as in-house policy analysts, even if their official functions may differ. They may have some grounding in research and evaluation of technical information, which decreases communication barriers between the scientific community and policy-makers. Scientific centers, such as the National Drought Mitigation Center, act as repositories of scientific information, but also actively reach out to agency focal points. These intermediary organizations provide both a synthesis of the scientific and technical knowledge as well as an objective review of the science behind it, similar to the importance of outside experts as mentioned by Orr (2002) with regards to dissemination of social science research.

The post-modernist environment consists of a communication space, in which messages become detached from sources and may be accessed by multiple stakeholders (Figure 4.2). At any given interest, multiple messages are floating within this communication space, competing for attention. Messages, which are universally accessible, are selectively accessed and interpreted according to each individuals

Figure 4.2. Communication in a post-modernist environment. Messages exist independently within a communication space (oval) that may be accessed by agencies or research centers (boxes) or by individual scientists.



experience and perceptions. These messages may be subject to interpretation by someone other than the originator, such as another scientist, an agency staff member, or even a policy-directly. As direct communication channels between the sender and receiver are curtailed, messages become more subject to misinterpretation or misapplication due to the lack of immediate feedback to the sender.

Not all messages are pulled directly from this communication space. Policy-makers may draw directly from sources such as scientists serving on a task force. In addition to dialogue within the members of the organization or task force, there may remain point interactions with individuals external to these organizations. The resulting policies that are developed as a result of accessing the messages within the communication space and direct dialogue become part of the communication space, subsequently serving as new messages upon which others may draw.

Policy-makers do not monitor the communication space constantly. Rather, punctuated equilibrium is more the norm. Events drive the need for information. As needs arise, policy-makers identify messages from sources they consider credible. Local sources with whom they have interacted in the past may help policy-makers to evaluate the credibility of messages within the communication space.

4.3 Data Collection Methodology

To address the research questions defined in this study, a *post hoc* case study approach was used. Case studies are useful when qualitatively exploring new ideas, developing hypotheses, or looking at relationships. Case study techniques as outlined by Creswell (1998) were employed. These included purposive sampling, triangulation, and generalizing themes from the results. Purposive sampling involves selecting targets for surveys or interviews rather than random sampling. This focuses the sample on those directly involved in aspects related to the research questions. In this instance, interviews were chosen as the preferred instrument in order to provide depth to the initial responses. Samples were drawn from common entities to allow for comparison between and among the individual cases, i.e., cases consisted of policy-makers in several states who were likely to have some responsibilities for drought management. In some cases, information from the interviewees provided additional targets who were subsequently contacted.

Three groups were used in this study: producers (research scientists), intermediaries, and policy-makers (receivers in Havlock's model). The producers group consisted of individuals, primarily in academic settings, who had published or were affiliated with institutions known for publishing research on drought or water resources. Individuals representing the intermediaries group were similarly selected from publication records, websites and personal knowledge. Intermediaries were mostly employed in federal organizations or academic research centers. The policy-makers group consisted of state agency personnel that have some area of responsibility in monitoring, responding to, or mitigating the effects of drought in their state.

To control for threats to validity, the study was designed to use a cohort representative of the larger drought community with the study conducted in as short a time frame as possible. Threats to internal validity include history, maturation, testing, selection, regression, mortality, and selection-maturation interaction. History effects are events which occur during the study that can affect outcomes but have nothing to do with the program. An example of history effects would be a severe drought occurring during the time in which interviews were conducted. Maturation effects are natural changes in the subjects due to the passage of time. These two effects were controlled by using a short time window for the interview and monitoring drought conditions using the Drought Monitor maps. During the time of the interviews, little change was noted in overall drought patterns. Maturation effects were further controlled by limiting cases (states) to those that had updated plans during the time frame when the National Drought Monitor website and the Drought Monitor was available. This limits threats from unequal access to information.

Testing effects were controlled through the use of a single observer and a single instrument per cohort studied. This prevents changes in results due to differences in observers or measurement techniques. Participant selection processes controlled for selection effects, or non-random or differential assignments to groups. No subgroup comparisons were made. Individuals within each group had similar job functions and organizational roles. Participants were drawn from multiple regions to assure geographic diversity, such that the findings would not be a result of regional contexts. Participation decline rates were generally similar, with a slight under-representation among academic centers and a slightly elevated representation among state centers in the intermediaries group. Key individuals involved in the Drought Monitor process were included.

Interviews were conducted individually by telephone. Participants were not aware of others in the group and did not communicate about the study. This reduced the possibility of regression effects, where extremes would move toward means of the overall group from which they were selected. Interviews were a one-time occurrence, so there was no drop-out, or mortality effect, during the study. Selection-Maturation interaction is not at issue in this study because there was no contact among the group. Thus, there was no differential development of abilities (maturation).

Threats to external validity include interaction effects, interaction of selection and treatment, reactive effects, multiple-treatment interference, and irrelevant replication of treatments. Interaction effects are when participants are sensitized to the issue and more aware of the problem, raising their interest. To control for interaction effects, it is necessary to establish when and why the participant used the program or treatment. A letter of invitation sensitized participants to the nature of the study; thus those accepting the invitation may be more aware and interested in the issue. Participants were pre-selected based upon a likely interest and involvement in the subject of drought to limit the possibilities of the study sensitizing them to the problem. All those to whom a letter of invitation was sent had a recent history of involvement in drought-related research or management – those who accepted as well as those who declined.

The interaction of selection and treatment addresses circumstances where the group selected for treatment has certain traits which are not characteristic of the general population. This is likely to exist in this study. Drought is not a prominent issue among the general population, as it is in the case of the participants of this study. Therefore, findings of the study may apply only to those involved with drought management and policy. Research scientists, intermediaries, and policy-makers are representative of their broader communities, but not necessarily the general public. Therefore, findings may be extrapolated to the scientific community and interactions with policy-makers, but not extrapolated to generalizations.

The reactive effect addresses settings or conditions that may be atypical of other settings, known as the Hawthorne effect. Interviews were conducted in familiar settings, all by telephone, so participants were not placed in unfamiliar settings. Multiple-treatment interference was not an issue in the study because there was only a single treatment (i.e., one interview). Because participants were not brought to a common location for the study and the same interview questions were asked of participants in each group, results should be robust. This addresses irrelevant replication of treatment effects.

To solicit invitations for the producers group, a list of individuals was culled from conference presentations at recent AMS meetings, websites and personal knowledge. A list of 49 individuals, representing 18 institutions were contacted (Table 4.2). Eighteen individuals responded affirmatively and were subsequently interviewed. Three other individuals were identified through referrals, two of whom were interviewed. Thus, out of a total of 52 contacted, 20 were subsequently interviewed (38% response rate). Of the 23 institutions contacted, individuals from 18 distinct institutions responded (78% response rate). Six of the 20 individuals interviewed were from federal research laboratories. Five were from state-level operational entities housed within academic institutions. The remaining were faculty or staff at institutions of higher education.

Table 4.2 Research scientists who were contacted for interviews. Those highlighted were interviewed and included in the study. A * designates those identified through referral.

Name	Affiliation	Position
Dan Upchurch	ARS Cropping Systems Research Laboratory	Lab Director
Donald Wanjura	ARS Cropping Systems Research Laboratory	Agricultural Engineer
Scott Van Pelt	ARS Cropping Systems Research Laboratory	Soil Scientist
Steven Mauget	ARS Cropping Systems Research Laboratory	Atmospheric Scientist
Jean Steiner	ARS Grazinglands Research Laboratory	Research Leader
Jeanne Schneider	ARS Grazinglands Research Laboratory	Research Meteorologist
Jurgen Garbrecht	ARS Grazinglands Research Laboratory	Research Hydraulic Engineer
James Mowbray	ARS Northwest Watershed Research Center	Rangeland Scientist
Patrick Clark	ARS Northwest Watershed Research Center	Range Scientist
Stuart Hardegree	ARS Northwest Watershed Research Center	Research Leader
Bill Emmerich	ARS Southwest Watershed Research Center	Global Change
Darius Semmens	ARS Southwest Watershed Research Center	GIS / Hydrology

Table 4.2 (continued)		
Name	**Affiliation**	**Position**
David Goodrich	ARS Southwest Watershed Research Center	Hydrology
Susan Moran	ARS Southwest Watershed Research Center	Research Leader
Tim Keefer	ARS Southwest Watershed Research Center	Hydrology / Global Change
A. Scott Denning	Colorado State University	Associate Professor
David Thompson	Colorado State University	Assistant Professor
Daniel Wilks	Cornell University	Professor
Susan Riha	Cornell University	Professor
Beth Hall	Desert Research Institute	Assistant Research Scientist
Laura Edwards	Desert Research Institute	Assistant Research Climatologist
Timothy Brown	Desert Research Institute	Assoc. Prof. / Program Director
Ken Kunkel	Illinois State Water Survey	Director, Atmospheric Environment Section
Mike Palecki	Illinois State Water Survey	Atmospheric Environment Section
Scott Robeson	Indiana University	Associate Professor
Eugene Tackle	Iowa State University	Professor
Raymond Arritt	Iowa State University	Professor
William Gutowski	Iowa State University	Professor
David Kromm	Kansas State University	Professor Emeritus
Douglas Goodin	Kansas State University	Associate Professor
John Harrington	Kansas State University	Professor / Department Head
Shawn Hutchinson	Kansas State University	Assistant Professor / Director GIS
Alan McNab	National Climatic Data Center	Program staff
David Easterling	National Climatic Data Center	Program staff
Tamara Creech	National Climatic Data Center	Program staff
David Genereux	North Carolina State University	Associate Professor
Dev Niyogi	North Carolina State University	Research Assistant Professor
Aaron Wolf	Oregon State University	Associate Professor
Chris Daly	Oregon State University	Assistant Professor
Keith Muckeston	Oregon State University	Professor Emeritus
Cort Willmott	University of Delaware	Professor
David Legates	University of Delaware	Professor and Director, Climatic Research Center
Tracy DeLiberty	University of Delaware	Associate Professor
Chip Konrad	University of North Carolina	Associate Professor
Peter Robinson	University of North Carolina	Professor
* Alan Hamlett	University of Washington	Research Scientist
* Lara Whitely Binder	University of Washington	Outreach Specialist
* Philip Mote	University of Washington	Res. Scientist, State Climatologist
Amy Snover	University of Washington	Research Scientist
Eric Salathe	University of Washington	Research Scientist
Richard Palmer	University of Washington	Professor
Rezaul Mahmood	Western Kentucky University	Assistant Professor

Fifty-eight individuals representing 16 institutions were contacted for the intermediaries cohort (Table 4.3). Nineteen individuals responded affirmatively and were subsequently interviewed. No additional respondents were identified by referrals in this case. The 19 responses out of a total of 58 represented a 33% response rate. Individuals representing 16 institutions were contacted. The 19 respondents represented 9 of these institutions (56% response rate). Of the 9 institutions which the respondents represented, all but two were from either federal agencies or national centers. The remaining two were from state climate offices.

Table 4.3 Intermediaries who were contacted for interviews. Those highlighted were interviewed and included in the study.

Name	Affiliation	Position
Nolan Doesken	Colorado Climate Center	Senior Research Associate
Brian Fuchs	High Plains Regional Climate Center	Regional Climatologist
Ken Dewey	High Plains Regional Climate Center	Professor
Ken Hubbard	High Plains Regional Climate Center	Director
Brad Rippey	JAWF / World Agricultural Outlook Board	Staff Meteorologist (DM Author)
Brian Morris	JAWF / World Agricultural Outlook Board	Staff Meteorologist
Harlan Shannon	JAWF / World Agricultural Outlook Board	Staff Meteorologist
Mark Brusberg	JAWF / World Agricultural Outlook Board	Staff Meteorologist
Raymond Motha	JAWF / World Agricultural Outlook Board	Chief Meteorologist
Robert Stefanski	JAWF / World Agricultural Outlook Board	Staff Meteorologist
Tom Puterbaugh	JAWF / World Agricultural Outlook Board	Deputy Chief Meteorologist
Jon Burroughs	Midwestern Regional Climate Center	Service Climatologist
Maria Peters	Midwestern Regional Climate Center	Service Climatologist
Steve Hilberg	Midwestern Regional Climate Center	Director
Candace Tankersley	National Climatic Data Center	Program Staff (DM Author)
Dr. Tom Karl	National Climatic Data Center	Director
Richard Heim	National Climatic Data Center	Program Staff (DM Author)
Tim Owen	National Climatic Data Center	Regional & State Climate Program Manager
Cody Knutson	National Drought Mitigation Center	Water Resources Scientist
Deborah Wood	National Drought Mitigation Center	Publications Specialist
Donald Wilhite	National Drought Mitigation Center	Director
Hong Wu	National Drought Mitigation Center	Research Associate
Michael Hayes	National Drought Mitigation Center	Climate Impacts Specialist (DM Author)
Tsegave Tadesse	National Drought Mitigation Center	Research Associate
Mark Svoboda	National Drought Mitigation Center	Climatologist (DM Author)
Dennis Mileti	Natural Hazards Center	Senior Research Scientist
Greg Guibert	Natural Hazards Center	Project Manager
Kathleen Tierney	Natural Hazards Center	Director
David Miskus	NCEP / Climate Prediction Center	Senior Meteorologist (DM Author)
Doug LeComte	NCEP / Climate Prediction Center	Senior Meteorologist (DM Author)
Dr. K.C. Mo	NCEP / Climate Prediction Center	Senior Physical Scientist
J.D. Laver	NCEP / Climate Prediction Center	Director
John Janowiak	NCEP / Climate Prediction Center	Senior Meteorologist
Rich Tinker	NCEP / Climate Prediction Center	Meteorologist (DM Author)
V.E. Kousky	NCEP / Climate Prediction Center	Research Meteorologist
Wiblur Chen	NCEP / Climate Prediction Center	Senior Meteorologist
Art DeGeatano	Northeast Regional Climate Center	Director
Keith Eggleston	Northeast Regional Climate Center	Regional Climatologist
Bruce Newton	NRCS National Water & Climate Center	Director
Fred Theurer	NRCS National Water & Climate Center	Agricultural Engineer
Gary Schaefer	NRCS National Water & Climate Center	Leader, Water and Climate Monitoring
Greg Johnson	NRCS National Water & Climate Center	Applied Climatologist
Phil Pasteris	NRCS National Water & Climate Center	Leader, Water and Climate Services
Barbara Mayes	NWS Climate Services Division	Customer Liaison
Fiona Horsfall	NWS Climate Services Division	Strategic Planning
Judith Koepsell	NWS Climate Services Division	Regional Liaison, Partnership Program
Michael Brewer	NWS Climate Services Division	Federal and inter-NOAA Liaison
Myron Berger	NWS Climate Services Division	Product Development, CPC Liaison
Robert Leffler	NWS Climate Services Division	Liaison for the Climate Record

Table 4.3 (continued)		
Name	**Affiliation**	**Position**
Robert Livezy	NWS Climate Services Division	Division Chief
Derek Arndt	Oklahoma Climatological Survey	Acting State Climatologist
Gloria Forthun	Southeast Regional Climate Center	Regional Climatologist
Michael Janis	Southeast Regional Climate Center	Director
Elizabeth Mons	Southern Regional Climate Center	Service Climatologist
Kevin Robbins	Southern Regional Climate Center	Director
Kelly Redmond	Western Regional Climate Center	Deputy Director, Regional Climatologist
Richard Reinhardt	Western Regional Climate Center	Director
Jan Curtis	Wyoming Climate Center	Research Scientist, State Climatologist

For the policy-makers' cohort, 37 individuals were contacted (Table 4.4). These individuals were identified from a list of contacts provided by the National Drought Mitigation Center on their website. From the NDMC list, requests were sent to individuals in states that had updated their drought management plans since 2000. This was to assure an enhanced likelihood that the solicited individuals had some involvement in the planning process and that the information that was available to them at the time of their state plan's update was reasonably similar. Prior to widespread use of the Internet and development of the Drought Monitor, some information may have been less accessible, and therefore not necessarily comparable to this cohort. The only state selected whose plan update predated 2000 was Oklahoma, due to its proximity to where the study was being conducted. Oklahoma's plan was updated in 1996.

Table 4.4. State officials who were contacted for interviews. Highlights indicate those interviewed. A * designates those identified through referral.

State	Year of Plan	Name	Position
AL	2004	Charles Bishop	Commissioner, Agriculture & Industries
		Ronnie Murphy *	Deputy Commissioner, Department of Agriculture
		John Christy	Alabama State Climatologist
AZ	2004	Jack Lavelle	Arizona Department of Water Resources
		Larry Martinez	Arizona NRCS State Headquarters
		Sandy Fabritz *	Coordinator, drought task force
CA	2004	William J. Bennett	Chief, California Water Conservation Office
		Jennene Jones *	Former Drought Preparedness Manager
CO	2001	Brad Lundahl	Office of Water Conservation
CT	2003	Gerald R. Iwan	Chief, Water Supplies Section, Dept. of Health
		John Radacsi	Office of Policy and Management
		Sid Albertsen	Office of Policy and Management
GA	2003	Gary McConnell	Director, Georgia Emergency Management Agency
		James Setser	Chief of Programs Coordinator, Env. Protection Div.
		David Stooksbury	Georgia State Climatologist

Table 4.4 (continued)			
State	**Year of Plan**	**Name**	**Position**
HI	2004	Ms. Linnel T. Nishioka	Deputy Director, Commission on Water Resource Mgt.
		Neal Fujii *	State Drought Coordinator
		Pao-Shin Chu	Hawaii State Climatologist
ID	2001	Hal Anderson	Administrator, Dept. Water Resources, Planning and Technical Services Division
KS	Annual Update	Derenda Mitchell	Senior Legislative Liaison to Governor
		Tom Lowe	Water Resource Planner, Kansas Water Office
MA	2001	Stephen J. McGrail	Director, Massachusetts Emergency Management Agency
MD	2000	Matthew Pajerowski	Water Rights Division, MD Dept of the Environment
MO	2002	Steve McIntosh	Director, Water Resources Program, Dept of Natural Res.
NE	2000	Greg Ibach	Assistant Director, Nebraska Department of Agriculture
		Al Dutcher	Nebraska State Climatologist
NM	2004	John D'Antonio	New Mexico Office of the State Engineer
		Debbie Stover *	Drought Programs Manager
OK	1997	Albert Ashwood	Director, Department of Emergency Management
		Duane Smith	Executive Director, Oklahoma Water Resources Board
		Charles Freeman	DVM, Oklahoma Department of Agriculture
		Brian Vance	Water Resources Planner, Oklahoma Water Resources Bd.
RI	2002	Albert Scappaticci	Executive Director, RI Emergency Management Agency
		Nancy Hess	Environmental Planner, Statewide Planning Program
SC	2000	Hope Poteat-Mizzell	State Climatologist, Dept of Natural Res.
TX	2001	Jack Colley	State Coordinator, Governor's Division of Emergency Mgt.
		Lola Lemmon	State Drought Coordinator, Texas Dept of Agriculture
		Jodie Stearns *	Governor's Division of Emergency Management
		John Sutton	Asst Division Director, TX Water Development Board
		Bill Billingsley	Team Leader, Water Protection Team, TNRCC
		Richard Egg	Engineer, Conservation Programs, Soil & Water Cons. Board
WV	2003	Fred Howard	West Virginia Office of Emergency Management
		Steve Hannah *	Deputy Commissioner, Department of Agriculture
WY	2003	Patrick Tyrrell	State Engineer, Wyoming State Engineer's Office
WGA	-	Shawn McGrath	Program Manager, Western Governors' Association

The 37 individuals contacted represented 20 states. Fourteen individuals responded to the request. Of these, six were interviewed. Seven respondents referred the request to another member of their department or a different individual who served on the state drought task force. Of the seven referrals, five were subsequently interviewed. One other from the original list and one of those identified through referral agreed to participate but were unable to schedule a time to conduct the interview. The eleven interviews conducted represent ten states (25% response rate for individuals, 50% response rate for states). Four of the states were from the Western U.S., four states were in the Plains / Midwest, and two states were in the East / Southeast. This provided geographic diversity for the respondents, which included multiple climate regimes and drought characteristics.

As with selection of producers and intermediaries, those who responded to the invitation were interviewed. Follow-up requests were used as necessary until a sufficiently large number of interviews had been completed that allowed a picture of communication and use of scientific and technical information in the state drought planning process to emerge. Interviews were not successfully completed with ten states; however the ten that did respond gave sufficient variability to produce a representative sample, as will be discussed further in section 4.5. The WGA respondent represents an additional case where an individual from a non-technical background based policy recommendations upon information obtained from scientists, among others, during the NIDIS development process.

Most of those whom the NDMC listed were agency staff with some involvement in drought management or policy-making, but there were no senior policy-makers among the list. Attempts were made to solicit contact information for more senior officials involved in the process. Only one such interview was successfully conducted, with the Deputy Commissioner of Agriculture in Alabama. Nobody at a commissioner or director level responded to the requests for interviews. Thus, there is a bias toward lower levels of policy-makers, but as will be shown in Chapter 6, most of these individuals were instrumental in developing the state drought plans.

Telephone interviews were conducted between the summer of 2004 and spring of 2005 using the interview guides presented in Appendix A-C. For the producers group (Appendix A), questions focused on: (1) production of scientific reports; (2) personal communication with people in policy-making positions; (3) methods used to share information, both within the scientific community and to a broader audience, and (4) research in which they were presently engaged. Often, discussions drifted toward related topics, such as the respondent's vision of the appropriate role of science in policy-making and activities geared toward dissemination of information beyond the scientific community but not necessarily for policy applications. Interviews among the producers group were conducted during the summer and fall of 2004.

Questions asked of the intermediaries group (Appendix B) were identical to those of the producers, except that additional questions were added regarding (1) the sources of information that they used; and (2) processes used to integrate information from multiple sources. Because respondents from the intermediaries group primarily were engaged in operational aspects of drought and climate monitoring, research questions were often not asked, unless pertinent. Interviews of the intermediaries group were conducted in the fall of 2004 and winter of 2004-2005. Because of the added questions, time did not often permit asking respondents to rate various forms of communication. Thus, these rankings are presented subsequently only for the producers group.

The third group of respondents was interviewed during the winter to early spring of 2005. Experience gained from interviews of the scientists shaped questions asked of the policy-makers (Appendix C). Questions focused on the process of selecting information and involvement of scientists in the drought planning process; they did not explicitly focus on specific policy options. Questions were asked in four areas: (1) the process of developing their state drought plan; (2) organizational sources of information; (3) the utility and preferred format of scientific information; and (4) how the individual became involved in drought management (if applicable). Detailed questions regarding communications methods, such as the relative importance of journals, media, or e-mail, were dropped due to time constraints on most interviews. This allowed more time to focus on the extent to which scientists and scientific information played a role in the drought planning process while remaining within the allotted 30-minute interview window.

After interviews were completed with the producers and intermediaries groups, follow-up questions were asked of respondents (Appendix D). These questions were to allow for a comparison of perspectives between the two groups, with regards to their involvement with policy-makers. The follow-up questions were administered via e-mail in the winter of 2004-2005. Of the 20 producers who were interviewed, 14 participated in the follow-up questions. Of the 19 intermediaries, 10 participated in the follow-up questions.

Interviews from each respondent were recorded and transcribed for analysis. No respondents prohibited taping the interview and none opted to not answer any of the questions which were asked.

From their responses to each of the categories of questions, characteristics of communication were discerned, both within and between the various groups. For the producer and intermediaries groups, interview results were the principal mechanism for the analysis. In a few cases, specific reports were mentioned that were targeted toward an external community, but the majority of written communication tended to be within the community. When possible, externally-oriented reports were used to compare against self-reported communications methods.

For the policy community, three sources of information were used in the analysis: data collected from interviews, written state plans, and physical and socio-political variables of the states included in the study. Self-reported sources of information obtained from the interviews established participation by various organizations from within the scientific community. State drought plans, in most cases, provided explicit mention of the roles and responsibilities for various state organizations, and in some cases federal organizations. In some states, these included explicit mention of scientific organizations based within academic institutions or operational entities composed principally of scientists.

4.4 Characteristics of Research Scientists and Intermediaries

There were many similarities between research scientists and intermediaries, as might be expected from the two cultures theory. Within the group, there are shared backgrounds and experience that develop a similar perspective. Both the research scientists and those working in intermediary organizations were positively pre-disposed toward encouraging utilization of their research beyond the scientific community. Both generally favored similar mechanisms for conveying information, although targets for involvement and degree of interaction varied. Contrary to expectations, research scientists were directly engaged, and in many cases at a higher degree of personal interaction, than those in intermediary organizations. However, research scientists' engagement tended to be toward individuals at lower levels of organizations rather than with senior policy-making officials.

None of the research scientists mentioned drought as a specific area of research, although all worked in aspects related to drought. Climate variability, applications of research and climate forecasts, and resource management were the most frequently-mentioned descriptions of their activities. Most of their engagement outside of the scientific community occurred at local levels, primarily with individual producers or the general public. Some participated in federally or nationally-sponsored activities aimed at applying scientific knowledge to societal problems, including involvement in NIDIS, NOAA's Regional Integrated Sciences and Assessments (RISA) Program, or National Science Foundation (NSF)-sponsored programs. Approximately one-third of the respondents (7 of 20) mentioned frequent direct interaction with people in policy-making positions, with most contact either occurring as a result of involvement in state drought task forces, state climate offices, or senior officials at research centers (federal or university-based).

Intermediaries were more likely to be directly involved in drought-related activities, but most emphasized monitoring or operational aspects. Eleven of the 19 respondents produced a regular assessment of drought or climate conditions for their state, region, or on a national basis. Seven of these were Drought Monitor authors, but most produced other products independent of, but related to, the Drought Monitor. Specific products mentioned included the Drought Outlook, historical context of droughts, the Weekly Weather and Crop Bulletin, and water supply outlooks. Most, whether because of restrictions on their ability to communicate, time pressures, or preference, restricted themselves to assessment activities. One such respondent commented: “We don’t do anything in this office that would affect policy. We offer up that information so that other people can make decisions off it.”

Thirteen of the intermediaries respondents were employed by the federal government and most reported some restrictions on their abilities to interact directly with policy-makers. The six intermediaries respondents from university-based organizations reported more direct involvement, including assisting states in developing drought plans or serving on state drought task forces. Two of the respondents who work in state climatologist offices were hired specifically for monitoring and communicating drought conditions. One of the individuals interviewed reported that he was asked to lead the state drought task force, but felt uncomfortable in that role: “I didn’t feel that with my background as a researcher-scientist that I was really in a position to get involved with the politics that I certainly knew would be associated with drought.” That individual did, however, play a direct and leading role in revising portions of the state drought plan.

As a group, the intermediaries were more frequently and more deeply involved with policy-relevant processes, even though direct interaction with policy-makers was limited. Their participation occurred mostly through scientific meetings in which planning documents were generated, such as with NIDIS and other WGA initiatives. As will be shown in section 5.8, direct contact with policy-making officials is often controlled through a public affairs or legislative affairs office. Thus, scientists in intermediary organizations may not have direct access to policy-makers or their staffers.

Scientists from the intermediaries group were among the leaders of the NIDIS process, with 6 of the 19 respondents reporting direct involvement. Several respondents reported involvement in drought policy initiatives that pre-dated NIDIS, including the

Western Drought Coordination Council, the National Drought Policy Commission and the Interim National Drought Council. One respondent was active in the World Meteorological Organization (WMO). Most of these activities were similar to activities hosted by professional scientific organizations, in which the majority of participants were scientists and the outcome was producing a policy-relevant report that others could use as a basis for encouraging policy initiatives. Coming from either the NDMC or large, federal agencies, these scientists were more likely to be involved earlier in the drought planning process than their research-oriented counterparts. Their positions also provided opportunities for collaboration in national review boards through the National Academies of Science (NAS), the National Science and Technology Council, and the WMO. Recommendations from these committees reached some of the highest levels of government, including then-Vice President Al Gore.

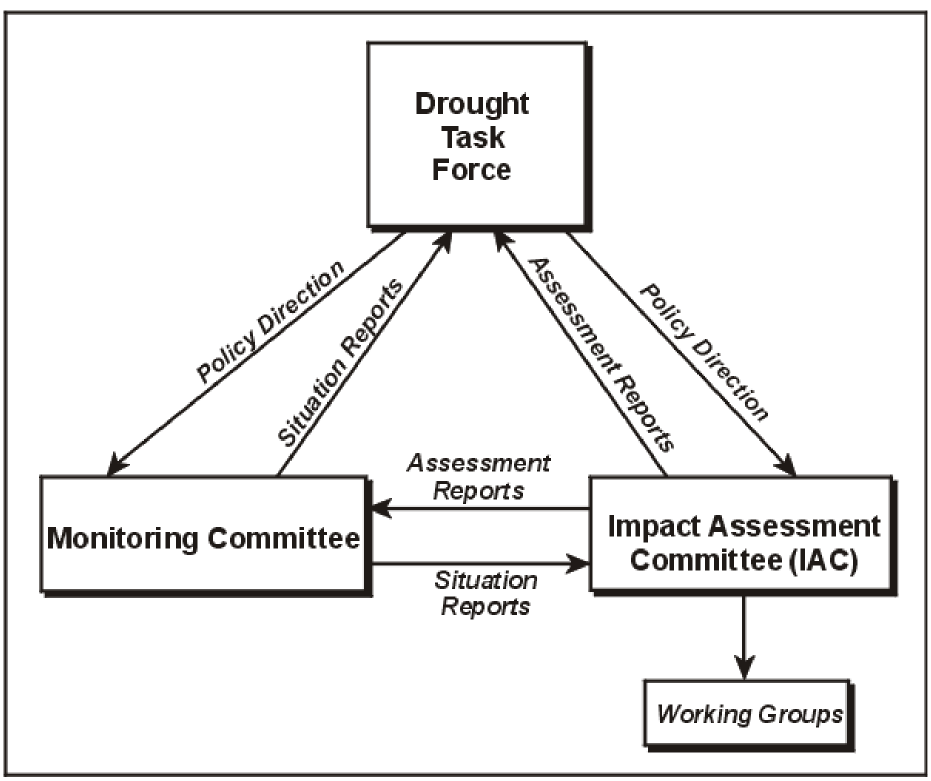
4.5 Characteristics of State Drought Plans

State plans for the ten states represented in the policy-maker interviews are summarized here. For each of the ten cases, a description of the plan's framework, a discussion of the process of creating or updating the plan, and a review of information sources consulted in the process are described, highlighting how concepts and information from the scientific community were used in the processes. Nearly all of the state plans included in this study were updated either during or shortly after a severe drought event. While drought events were the driving factor, the source of the motivation for developing or updating a plan varied. In some cases, the Governor created a task force in order to address shortcomings in response during the event. In other cases, state water boards or emergency management departments sought to improve upon information sources and, in some cases, organizational structures. Only one state reported significant legislative involvement.

State plans that were updated within the past five years have been able to address improvements in monitoring technology. Development of the Drought Monitor in 1999 provided a single focus for assessment, and new drought indices developed in the 1990s provide more versatility than those used in previous plans. This flexibility is reflected in most state plans. In addition, organizational management structures were updated that, in many cases, provide for one or more committees to address long-term vulnerability issues. An example of such a committee structure is shown in Figure 4.3.

The NDMC classifies most state plans are classified as response-oriented.

Figure 4.3. A sample structure for a state drought mitigation plan. *Source: National Drought Mitigation Center*, http://www.drought.unl.edu/.



Response-oriented plans are designed to meet emergency needs, emphasizing public safety and health and protecting property and the environment. Mitigation-oriented plans emphasize preparedness measures, including routine monitoring and reporting, conducting risk and vulnerability assessments, and in some cases defining detailed actions required of participating agencies. In some cases, mitigation may come through legislative initiatives; in other cases it may be driven by the agency or the Governor. The WGA's *Drought Response Action Plan* (1996) mentioned water codes and water permitting as policy options that could be employed to promote water conservation. A summary of the state plans, and motivation for development or updates is presented in Table 4.5.

Of the ten states selected as case studies, five of the plans were new plans and the other five update. In eight of the ten cases, the drought planning process was a direct result of an ongoing or recently-ended severe drought episode. In the two other states, stakeholder demands drove the process. California's plan was created "in between" drought episodes, and arose largely over conflict on water allocation in the Bay-Delta region of the state. Nebraska's update was driven by requests from the National Drought Mitigation Center to include more mitigation measures in their state plan. NDMC's request found a receptive governor.

Four of the plans are categorized as mitigation-oriented by NDMC; five are response-oriented and one plan (California) delegates drought management to local entities. Five of the plans were initiated by political leadership: 3 by the Governor and 2 by the legislature. Four of the remaining plans were driven by agency staff or leadership and one by request of the NDMC. The agency-initiated plans were based on deficiencies

Table 4.5. State drought plans included as case studies.

State	Year of Plan	Type of Plan	Initiated By	Revision	Reason for Update
Alabama	2004 (new)	Response	Agency	Not Required	Inefficiencies and conflict during drought
California	2000 (new)	Local	Governor	Not Required	Proactive measure sought by stakeholders
Hawaii	2004 (update)	Mitigation	Agency	5-Year	Outgrowth of state drought conference
Idaho	2001 (update)	Response	Agency	As Needed	Information from 1990 plan outdated
Kansas	2003 (new)	Response	Legislature	Annual Review	Media / public attention
Nebraska	2000 (update)	Mitigation	NDMC	Not Required	Include more mitigation measures
New Mexico	2003 (update)	Mitigation	Governor	Annual	Provide emergency assistance and improve planning during extended drought
Oklahoma	1996 (new)	Response	Governor	Not Required	Managing ongoing drought
South Carolina	2001 (update)	Response	Agency	Not Required	Experience from recent drought episodes, technology change, organizational restructuring
Texas	2001 (new)	Mitigation	Legislature	Biennial	Recent severe droughts, organizational structure, inventory of programs, assessment mechanisms and timely information

identified in responding to drought episodes, ranging from improved monitoring sources to needed improvements in communication between agencies. Plan revisions initiated by the Governor resulted from inefficiencies in response to ongoing events or to stakeholder demands. The legislative-initiated processes were a result of public demands or inefficiencies in drought response. Five of the plans do not require regular revisions; the remaining plans range from annual reviews (2 states) to biennial (1 state) to 5 years (1 state). The remaining plan is updated on an ‘as needed basis’.

4.5.1 Alabama

The Alabama Drought Management Plan (Alabama Office of Water Resources 2004) is a recent creation, following a severe drought. The plan was developed in 2004 in response to inefficiencies and conflicts during the drought episode, citing previous responses as “slow and fragmented”. The drought plan consists of a governing body, the Alabama Drought Assessment and Planning Team (ADAPT), with two permanent committees: one focused on monitoring (Monitoring and Analysis Group) and the other on assessing impacts and developing long-range strategies to mitigate vulnerabilities (the Drought Impact Group). Authority is vested in the state Office of Water Resources. The plan includes a list of potential impacts, but does not address measures to resolve them. Therefore, this would probably fit the National Drought Mitigation Center’s response-oriented plan model.

The plan includes a tiered level of drought severity, with each level linked to progressively stricter requirements. Phases are Drought Advisory, Drought Watch, Drought Warning, and Drought Emergency. Actions range from public awareness in early stages of drought to increased monitoring frequency, and eventually emergency water conservation measures at the most severe stages. Drought conditions are monitored across nine management regions of the state according to river basin boundaries, such that drought action may be declared for only a portion of the state. The drought plan was developed in order to provide guidance to the Governor for declarations of drought stages and to trigger authority to do various response measures at the state level. It also will provide early notification to public water systems in affected regions.

During the plan's development process, the Office of Water Resources conducted a series of listening sessions around the state to solicit stakeholder input. Local water districts were particularly involved at that level, tending in some circumstances to dominate the conversations. The Governor and members of the legislature were kept briefed on the process but in general had little participation in the plan's formation. In addition, other state plans were consulted and provided valuable guidance to ADAPT.

4.5.2 California

In 2000, California initiated a Governor's Task Force to look at critical water shortages. The resulting work was a technical report assessing the state's readiness for drought and the Critical Water Shortage Contingency Plan (California Governor's Advisory Drought Planning Panel 2000), which served as a final report of the task force. Neither of these are drought plans in the sense of other states, in terms of laying out agency responsibilities and triggers. They do, however, provide an assessment of water management challenges and recommended actions. The process was prompted by a call from CALFED, a state and federal partnership for managing water in the San Francisco Bay-Delta region. It came at a time in which the state had experienced nearly a decade of unusually wet years, and was a proactive measure rather than reacting to an ongoing drought situation. The Department of Water Resources was charged with convening a panel to develop a contingency plan to reduce the impacts of short-term water shortages, focusing primarily on agricultural and urban applications. Actions that could address longer-term water management issues were addressed in the CALFED's Record of Decision report in 2000. The process was driven entirely from the Executive Branch, with no direct involvement from the legislature. The NDMC classifies California as a state delegating drought planning to local authorities.

California water resources are highly managed through several state and federal water projects. The largest are the federal Central Valley Project and the State Water Project. Through these projects, water is moved throughout the state through a series of aqueducts and pipelines. Much of California's water supply originates in the northern part of the state, where multi-year droughts are infrequent. The management of supplies reduces California's vulnerability to short-term precipitation deficits. Responding to the severe drought of 1976-77, interconnections among water systems were developed to allow transfer of water to areas in need and water conservation measures were implemented. Fewer than half of California's counties declared states of emergency during the six-year drought ending in 1992, suggesting that the mitigation measures had been reasonably effective. However, environmental impacts were numerous, leading to establishment of water banks to purchase water rights. Since 1992, actions taken by federal organizations and legal requirements have reduced the water available to the state, including supplies from the Colorado River.

The review drew extensively from three documents: the CALFED Programmatic Record of Decision's (California Bay-Delta Authority 2000) Environmental Impact Statement / Environmental Impact Report on protecting water quality and supplies in the Bay-Delta region; a technical preparedness report on regulatory, environmental and physical changes occurring since the previous extended drought ended in 1992 (California Department of Water Resources 2000), and the report of the National Drought Policy Commission (2000). These formed the background for issues that needed to be addressed within the plan. Most information considered in the process came from in-house resources, the Bureau of Reclamation, or the Western States Water Council, of which the Department is a member. In addition to the formal documents, in-house research was available from the CALFED Program, which could task scientists with conducting research tied to operational needs.

The plan focuses primarily upon water transfers, development of groundwater supplies, and water conservation. Recommendations include implementation of a Critical Water Shortage Reduction Marketing Program, similar to the water banks used in 1991-1992, in coordination with other programs; financial and educational assistance to small water systems and homeowners in rural counties, which are most vulnerable to the early stages of drought; assistance for local agency groundwater programs; development of local agency integrated water management plans; conducting drought-related research and public outreach activities; and accelerate financial assistance to local agencies. Included in the research activities are seeking funding for long-range weather forecasting, climate change, and paleoclimatological studies. A state drought preparedness manager position was created and monitoring information was established on Department of Water Resource's website, but funding for both was terminated because of the state's general fund situation.

4.5.3 Hawaii

Like many other states, Hawaii's first drought response plan came in response to an extended drought. In 1999, the state Department of Agriculture initiated a drought conference to address the impacts and response to the ongoing drought. The Department coordinated two workshops, which included not only individuals and organizations within Hawaii, but solicited technical assistance from the Bureau of Reclamation and the NDMC. The NDMC's ten-step process for drought planning was a central document to the process, and was cited directly in the plan. The Governor and legislature were aware of, but not much involved in, the process of developing the first drought plan, although the Governor's Office did have a representative on the drought council. The plan requires an update in five-year increments, and was updated in 2004. The NDMC would likely classify Hawaii's drought plan as mitigation-oriented.

The State Commission on Water Resource Management (CWRM), within the Department of Land and Natural Resources, was assigned the lead role in development and operation of the state's drought program. The Hawaii Drought Plan (Hawaii Commission on Water Resource Management 2004) "seeks to establish a clear hierarchy of leadership to coordinate the actions of government agencies and private entities." The structure consists of a Drought Council, a permanent State Drought Coordinator, a Water Resources Committee, and County/Local Drought Committees. The Hawaii Drought Council serves as a steering group that coordinates activities and acts as a liaison between state agencies and the Governor's Office on drought issues. In addition, the Drought Council is responsible for risk and vulnerability analysis and providing technical assistance to local committees. The State Drought Coordinator, who works within the CWRM is responsible for coordinating drought-related actions and communications, including updating the plan, implementing specific mitigation projects, and enhancing public awareness and drought education. The Water Resources Committee is tasked with monitoring conditions and forecasts and conveying that information to the Hawaii

Drought Council and local drought councils. County/Local Drought Committees are designed to report drought conditions and impacts, manage local drought response measures and address long-term mitigation activities. Post-event evaluations are required for each of the local areas impacted.

Drought status is defined as one of three categories: normal conditions, drought conditions, or recovery. No specific triggers are defined, leaving flexibility to the Water Resources Committee and County/Local Drought Committees. The plan provides guidance for drought response actions for various agencies and specific mitigation goals with timelines. The plan includes a discussion of drought indices and their applicability to Hawaii, current monitoring and data collection activities, climate factors that influence precipitation patterns in Hawaii, and impacts on various economic sectors. As part of the 2004 update process the CWRM undertook a GIS-based analysis of drought risk and vulnerability. Whereas the 1999 plan development relied extensively on external expertise from the Bureau of Reclamation, the 2004 update process was conducted largely by agency staff and stakeholders. Some of the research included examining NDMC technical reports and different state plans, of which most were obtained from the NDMC web site.

4.5.4 Idaho

Idaho's first drought plan was published in 1990. During an extended drought period from the late 1980s to early 1990s, the Governor tasked the Idaho Department of Water Resources (IDWR) with developing a drought response plan. The IDWR coordinated with other state agency officials in developing a plan. During an extended drought period beginning in 2000, staff at the IDWR found the information included in the 1990 plan to be outdated, leading to a new version of the Idaho Drought Plan (IDWR 2001). The update process was led entirely by the IDWR, with no involvement by either the Governor's Office or the state legislature.

The IDWR has statutory authority for managing water rights and conducting an inventory, monitoring and planning for Idaho's water resources. Other agencies with statutory authority include the Idaho Water Resources Board, which develops the state water plan, and the Idaho Bureau of Disaster Services, which coordinates response and recovery programs. The Idaho Drought Plan is more of a guidance document; it does not detail specific agency actions that must be taken. A formal contingency plan may be developed based upon individual situations as needed. Otherwise, response is left to county and local governments. The plan identifies the Water Supply Committee in the IDWR as the entity responsible for monitoring conditions on an ongoing basis, coordinating with agencies, distributing public information, and encouraging conservation practices. The plan mentions that several subcommittees may be convened in support of the plan as needed: water supply; public information; agriculture; municipal, industrial and water quality; energy; fish, wildlife, recreation and environment; and economic. The NDMC considers the Idaho plan to be response-oriented.

As stated in the plan, it is "information, guidance and a framework for managing water shortage situations." As such, it does not have legal authority and cannot mandate agency actions. The document includes a discussion of drought, its history in Idaho and actions that could be taken to alleviate impacts. Also included are a discussion of indicators and their appropriate uses and limitations, an appendix of federal assistance programs, and appendix of data sources with Internet locations, a list of useful publications from state agencies, and sample public information documents. For the local levels, the plan provides examples of water rationing ordinances at four stages of severity. The document may be modified as-needed by the IDWR.

During development of the original plan, information from other states in the region was solicited from state drought coordinators. Also, the IDWR drew extensively from documents created following the 1977 drought. The 2001 update process did not examine other state plans as much, however it did draw upon information from the NDMC. In fact, citations, definitions, and examples from NDMC publications are included directly in the document.

4.5.5 Kansas

Following a three-year drought, Kansas created an Operations Plan for the Governor's Drought Response Team (Kansas Water Office 2003). While state officials felt that response functions to the drought were adequately incorporated in other state measures, people, including the media, had begun to notice that Kansas did not have a formal drought management plan. With more attention on the NDMC due to the Drought Monitor, people began to notice that the NDMC web site showed Kansas as having no drought plan. Partly in response to this, the state legislature charged the Kansas Water Office with developing a plan and conducting formal monitoring in order to advise the Governor when it is necessary to assemble a Drought Response Team. The Kansas Water Office developed the plan and worked with an individual in the Governor's Office to formulate a specific operations plan. The result includes a Governor's Drought Response Team, which is an interagency group of agency leaders that are involved in drought and have authority to commit agency staff and resources as needed. The formal structure is flexible, and left up to the discretion of the Team.

The plan specifies three drought stages: watch, warning, and emergency. During a watch, emphasis is placed on individual and local actions, coordinated through the Kansas Water Office. If drought proceeds to the warning stage, the Drought Response Team is activated and state support programs, such as hay distribution and water releases, are begun. At the emergency stage, the Team may direct water withdrawals from U.S. Army Corps of Engineers reservoirs. The decision of the status is left to the discretionary authority of the Kansas Water Office, upon recommendations from the State Drought Coordinator. The plan requires an annual review and modifications may be made at the discretion of the Director of the Water Office, although major changes require approval of the Governor.

Other state and national sources were consulted during the development of the plan. Specifically, the plan mentions that "much was learned by taking advantage of information and plans available from other states and organizations", and specifically cites the NDMC and plans from Colorado, Missouri, Montana, Oklahoma and Texas. The NDMC actively was involved in the process, including reviewing the initial draft and providing "extensive comments." In addition, the WGA's efforts were monitored, especially considering that Shaun McGrath, who is leading the WGA drought efforts, had previously been an intern in the Kansas Water Office. Other local academic sources participated, including providing a history of drought in Kansas that serves to frame considerations of drought impacts and response. State agency members of the Drought Response Team reviewed the plan to assure consistency with agency priorities. Although the plan is not considered mitigation-oriented by NDMC, the Kansas Hazard Mitigation Strategy and Kansas Water Plan do contain mitigation measures.

4.5.6 Nebraska

Drought planning in Nebraska has a long history of cooperation between state and federal agencies and the University of Nebraska. Home to the National Drought Mitigation Center, Nebraska has actively collaborated with a number of organizations within the university system. The NDMC was a major impetus for updating the state's 1986 plan. Beginning in 1998, NDMC sought to include more mitigation measures in Nebraska's drought plan, culminating in a new plan in 2000. Moderate to severe drought conditions in parts of Nebraska throughout 2000 may have helped NDMC's efforts, finding a receptive Governor, who was described as hands-on involved all the way through the process.

The Nebraska Drought Mitigation and Response Plan (Nebraska Climate Assessment Response Committee 2000) strengthens the authority of the Climate Assessment Response Committee (CARC), established within the Office of the Governor. CARC is chaired by the head of the state Department of Agriculture. The objectives of the plan are to monitor conditions; assess risks and vulnerabilities; promote the development and implementation of mitigation actions and policies; and to respond to drought emergencies. In addition to state agencies, university centers and local organizations are represented directly on CARC. The NDMC has a formal role as an advisory body to CARC. The plan includes two permanent committees: one focused on monitoring (Water Availability and Outlook Committee) and one on risk assessment (Risk Assessment Committee). Response functions are vested in the state emergency management agency. In addition to stating agency roles and responsibilities, the plan includes an inventory of possible impacts and associated mitigation actions, and is classified by NDMC as mitigation-oriented.

While CARC is a formal channel of advice to the Governor, Governor Johannes also maintained a separate Governor's Drought Council. Membership on the council is subject to the discretion of the Governor, but includes key agency officials from CARC. This allows the Governor to consider response and mitigation measures outside of a public forum. The director of the NDMC has participated in several of these meetings.

4.5.7 New Mexico

The New Mexico Drought Plan (New Mexico Drought Task Force 2003) was first created by an Executive Order in 1996, producing the first drought plan in 2000. A new task force was created in 2003, leading to the new drought plan and annual updates. The revised plan was created during the fourth year of an extended drought. The purpose of the plan is twofold: to provide increased emergency assistance and to advance planning to reduce vulnerabilities. The plan creates a Drought Task Force, composed of top agency officials, and six workgroups: monitoring; drinking water; agriculture; wildlife and wildfire; recreation, economic development and tourism; and water development. The latter two had not been activated as of the time the plan was written in 2003. The workgroups have both operational and research and development roles, including conducting demonstration projects. In addition to the workgroups, there is a Strike Team, which provides rapid response to drinking water supply problems. Individuals with expertise in hydrology, finance, construction and emergency management are on the Strike Team.

The New Mexico Drought Plan is classified as mitigation-oriented by NDMC. The plan states that “drought is essentially a human construct”, recognition that human choices affect drought impacts. The plan includes lists, by workgroup, of impacts with planned actions, responsible agencies and timelines for each impact. The annual update to the plan serves the purpose of a strategic plan, setting goals and priorities for each of the workgroups and matching those activities to legislative and executive priorities. The Governor actively is involved in the process, which provides cohesiveness among agencies and legitimacy. However, there is little legislative involvement. Apparently, many legislators are not aware of its existence, as evidenced by proposed legislation that would have set up a task force to do very similar functions.

In developing the plan and priorities, the Drought Task Force had active participation from members of each of the workgroups. A variety of individuals serve on the workgroups, including political appointees, state and federal agency officials, academics, local officials, and non-profit organizations representing producer groups or economic development groups. The group also maintains awareness of actions taken by other states and the WGA. The Arizona Drought Monitoring Committee was mentioned as one valuable source. The NDMC was useful earlier in the planning process, but has not been consulted much once the initial plan was developed.

4.5.8 Oklahoma

The Oklahoma Drought Management Plan (Oklahoma Drought Management Team 1996) was created during the height of a severe drought that, while lasting only from October 1995 through May 1996, caused an estimated $1 billion in losses. A state Drought Task Force was convened by Executive Order, with the Oklahoma Department of Emergency Management (ODEM) and Oklahoma Water Resources Board (OWRB) tasked to develop a plan. The process was entirely within the Executive Branch, with no legislative involvement. The plan implements an organizational structure for monitoring drought conditions, assessing impacts, and implementing response measures. It can be updated by the drought committee, with no other approval required. The NDMC classifies Oklahoma's plan as response-oriented.

The Oklahoma Drought Management Team is chaired by the ODEM, whose director is the State Drought Coordinator. The plan implements a phased approach to drought response: advisory, alert, warning, or emergency. Each phase is coupled with pre-defined actions. The Coordinator makes determination of the drought phase, briefs the Governor and makes recommendations on specific actions requiring authorization. The Drought Management Team is supported by three standing committees: the Water Availability and Outlook Committee (WAOC), the Impact Assessment and Response Committee (IARC) and the Interagency Coordinating Committee (ICC).

The WAOC, which is chaired by the OWRB, is charged with developing and maintaining a mechanism to monitor the approach and onset of drought events. The primary mechanism used for communicating information is the *Oklahoma Water Resources Bulletin* (Oklahoma Water Resources Board 2005), which is published monthly during normal phases and bi-monthly or weekly during drought episodes. The WAOC is activated when drought reaches the Alert phase. The IARC, chaired by the Department of Agriculture, is activated at the Warning phase. During a drought, the IARC prepares reports on drought impacts for the Governor, other state leaders, the media, and public. In addition, the IARC is tasked with defining drought impacts, vulnerable sectors, and refining the ability to respond to those impacts. The ICC is a smaller centralized group of the WAOC and IARC which is assembled during the Emergency phase. The ICC makes decisions on re-allocating resources to manage drought and drafts requests for federal assistance, funding or legislation, which are provided to the Drought Coordinator and the Governor. As drought conditions recede below the Emergency phase, the ICC prepares a final report before disbanding.

The Oklahoma Drought Management Plan describes the state's previous efforts as "crisis management", marked by frequent formation and subsequent disbandment of *ad hoc* task forces. In 1988, the Governor created the Oklahoma Drought Action Coordinating Council, which delineated agency responsibilities and recommended a State Drought Coordinator to supervise development of a contingency plan. During the same period, Oklahoma was involved with the NDMC (then the International Drought Information Center) in identifying state drought monitoring, assessment and response activities, which resulted in NDMC's 10-step framework for drought planning. These documents were used "quite extensively" when Oklahoma created its drought plan, including concepts for committee structures, drought stages, and triggers. In addition to the NDMC documents, the drought management team consulted other state plans (Pennsylvania is mentioned in the document); the state water plan, which had been updated the previous year; and the 1988 Council's report. Informal input from members of the ODEM, OWRB and Oklahoma Climatological Survey were used extensively in the original draft.

4.5.9 South Carolina

South Carolina's drought planning process was an update from a 1985 plan. Motivations for updating the plan were to reflect experience gained from dealing with recent drought episodes, technology changes, and organizational restructuring. Part of the motivation for updating the drought plan was to change from specified indices used as drought triggers to a variety of indices based upon new research and new data sources. The update process was conducted during the height of a severe drought and was pushed by the South Carolina Department of Natural Resources, the agency charged with monitoring and response. The South Carolina Drought Response Act (South Carolina Department of Natural Resources 2001) created a Drought Response Committee for each of the four regional drought management areas. The Office of State Climatologist, which is housed within the Department of Natural Resources, is charged with maintaining a Drought Information Center to convey information to the public. The drought plan establishes four drought categories (incipient, moderate, severe, extreme) and defines state agency actions in response to each of those categories. The plan focuses heavily on improvements in local resiliency, although it is not classified as mitigation-oriented by NDMC.

Unlike most other plans, this plan requires legislative involvement. The advantage of legislative involvement is that it gives the drought plan "teeth", including the ability to enable mandatory water restrictions if needed. A primary disadvantage is that, unlike in most states that have executive-focused drought plans, any changes, even minor modifications, must be approved by the legislature. Partly because the amendments had to go through the legislature, the Department of Natural Resources worked diligently to build a constituency to support the amendments and resolve as many conflicts as possible in advance of the legislative initiative. Not all conflicts were able to be resolved in advance, but the process at least brought those issues into the open such that they could be addressed. During the update process, legislative subcommittees took an active interest. Scientific information played a critical role in justifying amendments to the Drought Act:

> "The amendments to the Drought Act would not have been approved by the South Carolina General Assembly (owing to the controversial nature of droughts and water rights) without the provided scientific documentation coupled with the State's ongoing severe drought." (Mizzell and Lakshmi, 2003)

However, conflicting results and political barriers proved insurmountable in some cases, such that "science was not able to resolve all discrepancies."

The process drew from a core group of agencies and individuals who had been involved in the state's drought response program. During the update process, new groups were identified and engaged, particularly some from the private sector. The plan also drew heavily from three other sources: the state water plan, other state drought management plans, and information from the NDMC. Numerous direct conversations occurred between NDMC staff and those involved with the plan's development.

4.5.10 Texas

Texas suffered a series of short-lived but intense droughts beginning in 1996. The 1996 event was the most expensive 1-year event on record, and two years later an intense summertime drought caused $6 billion losses. With drought re-emerging in 1999-2000, the legislature established a state Drought Preparedness Council. The Council was tasked with monitoring conditions, developing an organizational structure, preparing an inventory of programs, developing a mechanism to improve timely assessment of impacts, and providing accurate and timely information to the media. The resulting State Drought Preparedness Plan (Texas Drought Preparedness Council 2001) created four committees which respond to the Drought Preparedness Council: planning and coordinating; monitoring and water supply; technical assistance and technology; and impact assessment. In addition, a special Drinking Water Task Force was created. The Task Force is designed to respond to immediate and temporary needs. The Governor's Division of Emergency Management chairs the Council.

The plan integrates into the emergency management cycle, using the categories of mitigation, preparedness, response and recovery. In the plan, mitigation and preparedness are combined due to extensive overlap in actions. For each of the three categories, specific actions and programs that may address part of the process are listed by agency. The plan also lists a set of indices that are to be used to monitor drought conditions and classify them, by region of the state, into one of five categories: advisory, watch, warning, emergency, or disaster. These categories are assessed using three functional assessment indices, each consisting of 2-5 sub-indices. Categories are climatological drought, agricultural drought, and water availability drought, recognizing the disparate impacts on sectors of the economy. The indices are reported by various agencies to the State Drought Manager, who advises the Council on status measures. The NDMC classifies the Texas plan as mitigation-oriented.

The plan states that "numerous drought plans from various states were reviewed and interviews were conducted with drought-related experts from both state and federal agencies." Through this extensive review process, the Council concluded that prescribed responses set forth in state plans are rarely implemented in a timely matter once trigger thresholds are reached. The Texas plan therefore focuses on defining specific agency actions with a biennial review process. The biennial report, which is submitted to the state legislature, summarizes activities taken by the Drought Preparedness Council, including summaries of actions by agency, assessment and response actions, management objectives for the upcoming year, mitigation efforts conducted, and success stories. The plan also serves as a resource guide for state agencies. It includes an inventory of monitoring resources with agencies and website contact information and links to three other guides: *Drought Assistance Reference Guide for State Agencies, Potential Drought Relief Programs,* and *Drought Assistance Directory for Public Officials and Drinking Water Utilities*. The plan may be amended by the Council with no approval required from the Governor or legislature.

4.6 Comparison of the States

To examine whether state drought plans were affected by differing abilities and resources of state governmental organizations, social and political information about each state was collected. For example, if a state had only a cursory drought response plan, it may be a result of insufficient resources to devote toward the planning or implementation processes. In order to assess the capabilities of government and potential levels of popular support for government action, ratings from the Government Performance Project (2005 http://www.gpponline.org/) were collected (Table 4.6).

The Government Performance Project (GPP) rates states on four measures plus an overall grade:

- Money: how well a state manages its fiscal resources, including budgeting, forecasting, accounting and financial reporting, procurement, contracting, investments and debt;
- People: how well a state manages its employees, including hiring, retention, development, and reward systems;
- Infrastructure: how well a state manages its roads, bridges, buildings, and other resources supported by capital expenditures; and
- Information: how well elected leaders and managers use information and technology to measure the effectiveness of services, make decisions, and communicate with citizens.

With regards to this study, state scores on information are likely to be most relevant to the use of scientific information in policy-making.

The GPP ratings were examined to see if they were potentially an indicator as to the type of drought plan a state would have. Each state drought plan was categorized according to the NDMC findings (shown in Figure 3.1): mitigation-oriented, response-oriented, local, developing or none. Because states developing drought plans could end up in any of the mitigation, response, or local categories, they were excluded from the

Table 4.6. Government Performance Project ratings (http://www.gpponline.org/) for each state. Drought Plan Type is according to the designation by the National Drought Mitigation Center and shown in Figure 3.1. States included in the study are highlighted.

State	Overall Grade	Money	People	Infrastructure	Information	Plan Type
AL	C-	C	C+	D	C	Developing
AK	C+	C	C+	C+	C	None
AZ	B	B	B	B-	B-	Developing
AR	C+	B-	C	C+	C+	None
CA	C-	D	C-	C	C	Local
CO	C+	C-	C+	C+	C+	Mitigation
CT	C+	C	B	C+	C-	Response
DE	B+	A	B-	B+	B	Response
FL	B-	C+	B-	B+	B	Local
GA	B	B-	A	C+	B-	Mitigation
HI	C	C	B	C-	D	Developing
ID	B-	B+	B	C+	C+	Response
IL	C+	B	C	C+	C+	Response
IN	C+	C	C	B-	C	Response
IA	B	B+	B	B	B	Response
KS	B	B+	B-	B-	B-	Response
KY	B+	B+	B	B+	B	Response
LA	B	B+	B	C+	A-	Developing
ME	B-	B-	B-	B	C+	Response
MD	B	B	B-	A-	C+	Response
MA	C+	C+	C+	C-	C+	Response
MI	B+	B	B	B+	B+	None
MN	B+	A-	B+	B	B+	Response
MS	C+	B-	C+	C+	C+	None
MO	B	B	B-	B-	A-	Response
MT	C+	C+	C+	B-	C	Mitigation
NE	B	B+	B-	B+	C+	Mitigation
NV	B-	C+	C+	B+	B-	Response
NH	C	C	C+	C+	C-	Response
NJ	B-	C+	B	B-	C	Response
NM	C+	B	C+	D+	B	Mitigation
NY	B-	C+	B-	B+	C+	Response
NC	C+	B-	C+	C+	C+	Response
ND	B-	B-	B-	B-	C	Response
OH	B	B+	B-	A-	C+	Response
OK	C+	B-	B-	C-	C	Response
OR	C+	D	B-	B	B	Response
PA	B	B+	B-	B+	B	Response
RI	C+	C+	D+	B-	C+	Response
SC	B	B+	A-	C+	B	Response
SD	B-	B+	B-	B	D	Response
TN	C+	B-	C-	B-	C+	None
TX	B	B	B	B-	B	Mitigation
UT	A-	A	B+	A	A-	Response
VT	B	B+	B	B-	B-	None
VA	A-	A	A-	A-	A-	Response
WA	B+	A-	B+	B	A-	Response
WV	C+	B-	C	C	C+	Response
WI	B-	B-	B	C	B-	None
WY	C	B	D+	C	C	Response

analysis. Only two states had local plans, so they also were excluded from the analysis.

The remaining states were then examined for shifts in the overall or information distributions of the Government Performance Project ratings. Findings are shown in Figures 4.4 and 4.5, respectively. Due to the few number of states in the mitigation and no-plan categories (6 and 7 states respectively), small shifts in grades may appear exaggerated in the results.

States with plans generally mirrored the overall distribution. Response-oriented plans were an almost identical match to the overall distribution. Mitigation-oriented plans showed a bi-modal distribution, but with only six cases, a more uniform distribution is difficult to achieve. However, nearly 60% (4 of 7) of states that did not have a drought plan received a grade of C+, nearly twice the overall national average. Thus, there may be some weak indication that poorly-performing states are less likely to have a drought plan,

Figure 4.4. Overall performance grades for 2005 according to type of state drought plan. *Source: Government Performance Project (http://results.gpponline.org/).*

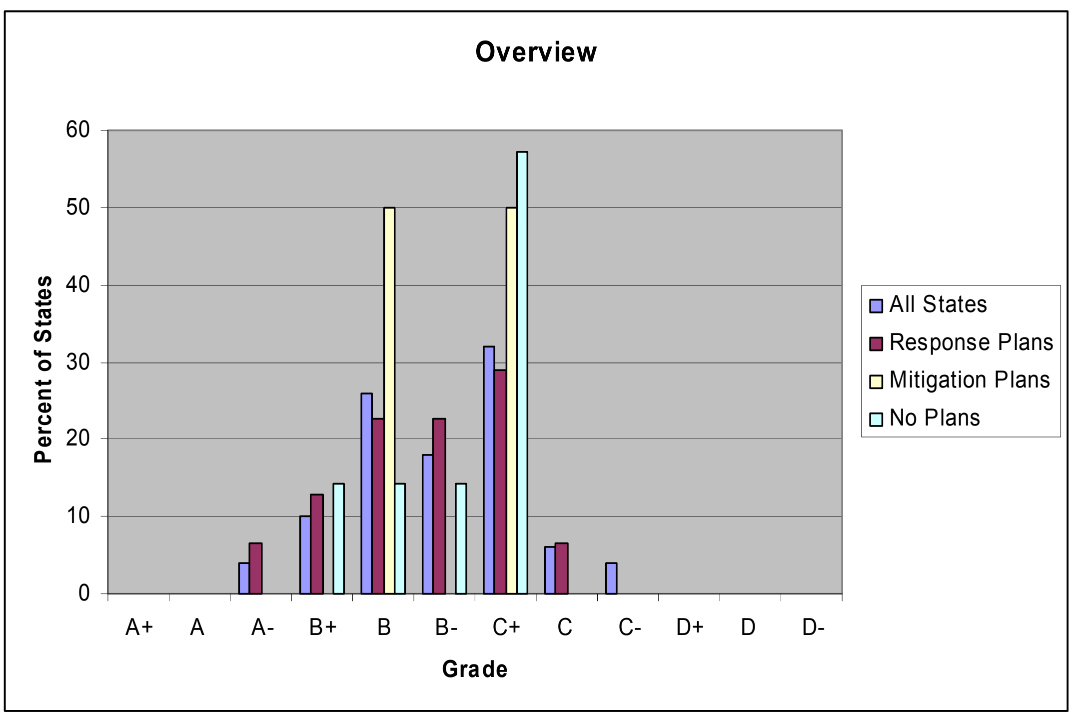
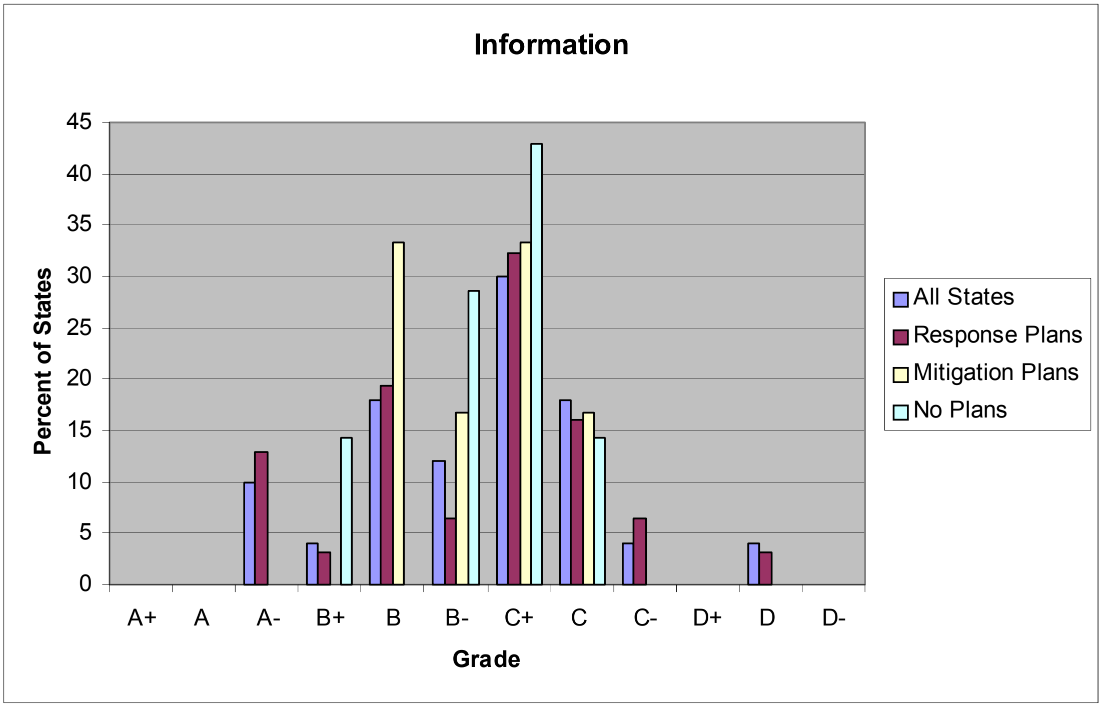


Figure 4.5. Information performance grades for 2005 according to type of state drought plan. *Source: Government Performance Project (http://results.gpponline.org/).*



but the association does not appear strong enough to warrant use as a predictor.

Similar results were found when isolating only the information element of the grading scale. As with the overall distribution, there was not a discernable difference in the distribution of response-oriented plans as compared to the general distribution. Mitigation plans were more evenly distributed, ranging from B to C, with none toward either extreme. States with no plans were similarly clustered and did not exhibit any substantial shift from the general distribution. Therefore, information grades do not appear to be a distinguishable predictor as to the type of drought plan a state will have.

Case study states were compared to the general distribution to see if these states were skewed toward one end of the GPP distribution or one type of dominant political culture. Table 4.7 shows the results. Generally, most states received scores of B's or C's in both the overall sample and the 10-state subset.

Table 4.7. Distribution of GPP grades overall and for the states included in the study. Percentages of total are shown below in parenthesis.

	Overall					Case Study States				
Grade	Total	Money	People	Infra.	Info.	Total	Money	People	Infra.	Info.
A	2 (4%)	5 (10%)	3 (6%)	4 (8%)	5 (10%)	0 (0%)	0 (0%)	1 (10%)	0 (0%)	0 (0%)
B	27 (54%)	29 (58%)	29 (58%)	25 (50%)	17 (34%)	5 (50%)	7 (70%)	6 (60%)	3 (30%)	4 (40%)
C	21 (42%)	14 (28%)	16 (32%)	19 (38%)	26 (52%)	5 (50%)	2 (20%)	3 (30%)	5 (50%)	5 (50%)
D	0 (0%)	2 (4%)	2 (4%)	2 (4%)	2 (4%)	0 (0%)	1 (10%)	0 (0%)	2 (20%)	1 (10%)

4.7 Summary

Communication models were discussed in this chapter as the framework upon which the study was constructed. Basic elements of communication include a sender, message, and receiver. Information is encoded by the sender, transmitted via the message, and decoded by the receiver. This communication happens within an external environment featuring competing distractions (noise) causing distortion of the messages. Feedback gives verbal or nonverbal clues to the sender as to whether the message was received as intended.

Senders who are considered competent and credible and tailor information to the receiver's needs are likely to be valued sources to the receiver. Messages whose content is credible, plausible, and contextual, that are transmitted in a timely, accessible, and reliable fashion, are best received. Receivers are more receptive to messages if they have personal relevance and come from a trusted source. Both the processes of encoding and decoding the message are dependent upon the perceptions and interpretations of each of the individuals participating in the communication. Language cannot capture the complexity and meaning of the communication, and may be understood differently, leading to distortion of the message. The use of jargon increases the complexity of communication and can also cause distortion.

These elements of basic communication focus upon discrete instances. Communication is a process, an aggregate of these discrete occurrences. The structure of communication, including those perceived as credible sources, is tempered by organizational structures. In a post-modernist environment, messages may become separated from the source. A communication space, filled with competing messages, becomes a source upon which receivers may draw. This includes policy-makers, such as those developing state drought plans, or other scientists. Direct links between senders and receivers co-exist with the communication space.

A *post hoc* case study using purposive sampling was employed in this study. Fifty-one individuals were interviewed over a nine month period from summer 2004 through spring 2005. The sample included 20 individuals representing the producer community, 19 representing intermediary institutions, and 12 representing the policy-making community. Interview guides were used to conduct the telephone interviews to assure consistency in questions and validity of results. For the scientists (producers and intermediaries), interview questions focused on the production and transmittal of information and on perceived use of the information. Questions asked of policy-makers focused on their state's drought plan development process, sources of information consulted, and the utility of scientific information.

Both producers and intermediaries favored similar methods for conveying information. Both were engaged, although producers usually targeted individuals not in policy-making positions, such as individual farmers or local community organizations.

Intermediaries were more engaged in drought-related aspects, including direct participation in the Western Governors' Association's initiatives, both the National Integrated Drought Information System and efforts pre-dating NIDIS.

Ten states were used as case studies. All had drought plans either created or updated since 2000, except for Oklahoma's which was created in 1996. Ongoing drought was a motivating factor in eight of the ten state's drought planning processes. Plan initiation and development was either governor-led or agency-led, with only one case of significant legislative involvement. In most cases, plans focused on updating monitoring indices and improving inter-agency communication structures. Five plans are considered response-oriented, 4 as mitigation-oriented, and one as local by the National Drought Mitigation Center. The case study states were found to be similar to the general population by comparison of Government Performance Project ratings. States with plans generally mirrored the overall distribution, both in aggregate scores and when isolating only the information element of the GPP ratings.

Results of the interviews will be presented and analyzed in the context of the communication models presented in this chapter. Chapter 5 examines the scientist community, including producers and intermediaries. Chapter 6 examines results from the policy-makers community and compares them to the findings from the scientist community.

CHAPTER 5: THE SCIENTIFIC COMMUNITY

Scientists use many different forms of communication. Some, such as peer-reviewed journal articles and scientific conferences, are aimed at communicating among themselves. Others, such as public presentations and task forces, are aimed at transmitting information externally. Direct contact, including through meetings, collaboration in local or state organizations, briefings, and personal conversations, is preferred over written forms of communication.

Research scientists are as likely to be externally engaged as are intermediaries, but usually at lower levels of organizations. Intermediaries tend to get involved earlier in the process and at higher organizational levels. However, intermediaries tend to be more reactive than their university-based counterparts. Their involvement is usually initiated by a request for information or participation. Research scientists were found to be more likely to seek individuals who may benefit from use of their findings.

Several barriers to involvement were found in this study. The most direct barrier is restriction on contact with the public and policy-makers. This was especially apparent in federal organizations, but also existed to a lesser extent within universities. Requirements that information be cleared by a public information officer both slowed the communication process and made some staff wary about what could and could not be said. Another barrier that is more common to the academic community is the university rewards system. Tenure and promotion decisions emphasize peer-reviewed publications and research, and typically downplay the value of service and extension. Young faculty members are constrained to publish in journals, which according to their own responses were not an effective means of communicating with policy-makers. A third barrier found in this study is a concern over advocacy. Scientists, both in the producers and intermediaries groups, mentioned concerns about being perceived as just another interest group. This is an outgrowth of the two cultures barrier, in which scientists eschew the normative environment of policy-making for more objectively-based endeavors. When scientists are externally engaged, most try to remain objective, preferring statements of fact over opinion or interpretation.

Despite the barriers and concerns over perceived advocacy, scientists do engage actively in the policy-making process. Views of the process were mixed. Some scientists believed that scientific information was manipulated to support pre-determined decisions, while others thought that information was used appropriately. Sixteen of the 39 respondents mentioned selective use. Only eight respondents were generally positive on use, while the remaining 15 were mixed or non-committal. Most striking, however, was that those who viewed the process negatively were not necessarily disengaged from the process. A positive view of the process did not guarantee engagement either. A typology of the way in which scientists engaged in the communication process with four categories emerged from this study: collaborators, consultants, educators, and critics. Collaborators are those who view the policy-making process favorably and are actively engaged in the process. Consultants are those with a positive view of the process but tend to be engaged only when called upon. Educators are those who are actively engaged, but take a negative view of the process. They try to change the process through involvement. Those who hold a negative view of the process and avoid involvement are critics. This is discussed in more detail in Section 5.11.

5.1 Interaction Between Scientists and Policy-Makers

Consistent with the characteristics of scientists described in Section 4.3, intermediaries were more likely to have served on or directly interacted with a member of a state drought task force or commission. Six of ten respondents to the follow-up questions (Appendix D) answered affirmatively. Of these, four served directly as committee or subcommittee members, including one who chaired a subcommittee. The other two answered questions from a state drought task force and advised state commissions through other members. The producers were less likely to have direct contact, although 5 of the 14 respondents indicated that they had participated. Two of these served as committee or subcommittee members, having been invited through the state climate office. The other three mentioned *ad hoc* or informal roles. One responded to requests from their organization chief, who was a state drought task force member. The others responded to e-mail and phone calls by various members or were invited to meetings.

Respondents were asked to describe their frequency of interactions with individuals from state, federal, private-sector, academic or scientific organizations, using a scale of routine, frequent, occasional, or not at all. The results are shown in Table 5.1. Research scientists (the producers group) reported that most of their interaction occurred with individuals from academic organizations or scientific associations. They indicated little interaction with the private sector. Intermediaries indicated that most of their interaction occurred with federal agencies or academic organizations. The respondents indicated less frequent interaction with scientific associations than the producers group and slightly more interaction with the private sector and with state agencies.

Table 5.1. Reported frequency of interaction for producer and intermediary groups. The order shown is ranked according to producers' responses. Routine interaction is considered part of normal business, such as a regular meeting. Frequent is interaction that occurs often, but not at regularly-established intervals. Occasional represents sporadic interaction, such as when an event defines the need for information.

	Producers (N=14)				**Intermediaries (N= 10)**			
	Routine	Frequent	Occasional	Not at All	Routine	Frequent	Occasional	Not at All
Academic	6	5	3	0	5	4	1	0
Federal	4	5	5	0	7	2	1	0
Scientific	4	5	3	2	0	4	6	0
State	1	6	7	0	3	2	4	1
Private	1	1	7	5	1	4	5	0

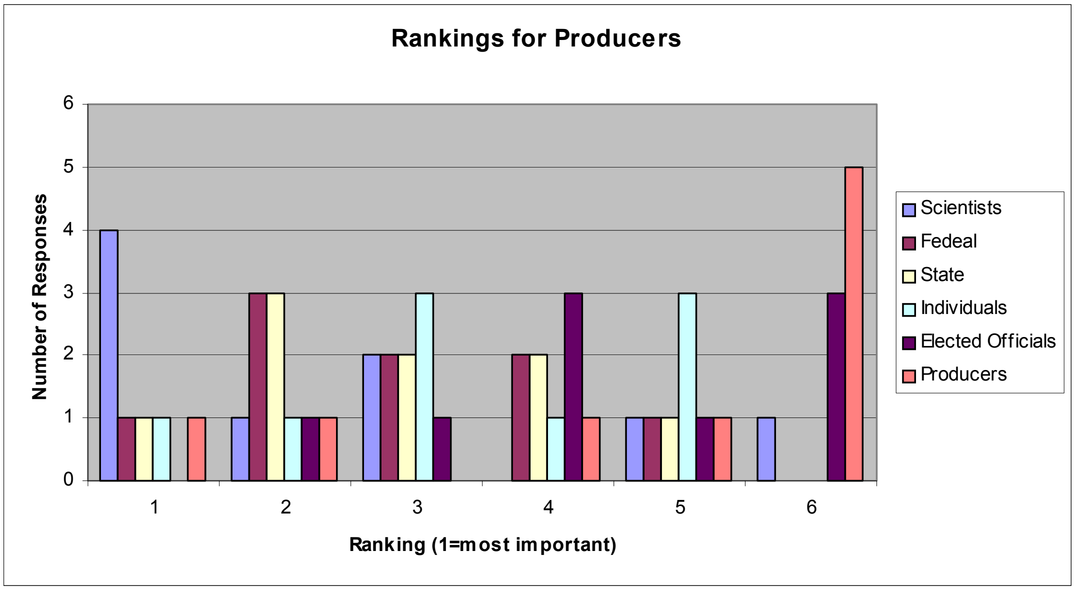
This largely may be reflective of the environment in which they work. Research scientists were mostly based on university campuses, and therefore might be expected to mention more interaction with academics than their intermediary counterparts, most of whom worked in federal or state agencies. Combined, the producers seemed to prefer interaction with other scientists, mentioning the universities and scientific associations as the most common interaction, while the intermediaries' operational orientation was apparent in their mention of federal and state agencies. The intermediaries' less frequent interaction with scientific associations may be attributable to their time constraints. Whereas interaction within scientific associations is rewarded in the academic environment, it is not as important in operational agencies. Therefore, individuals in operational agencies may tend to focus more effort on activities and interactions that help them with their daily responsibilities, such as collecting information for the products they produce, rather than traveling to meetings. Also, among federal agencies, travel funds are sometimes more limited, which may further act as a barrier to participation in scientific associations.

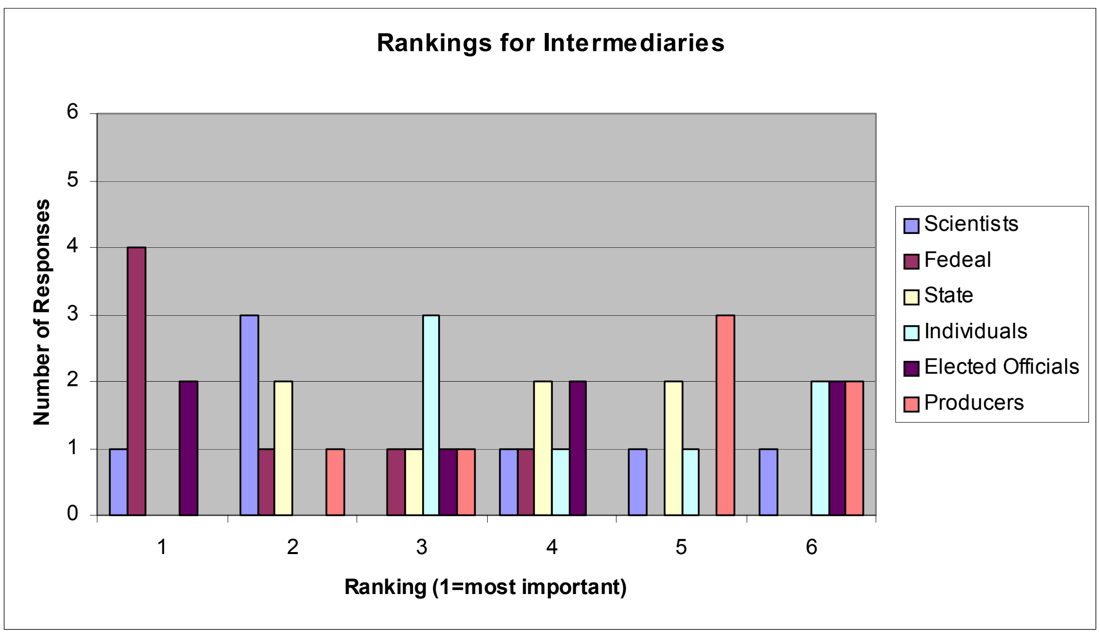
Table 5.2. Rank-ordered importance of targets for communicating findings for producers and intermediaries groups. Lower scores indicate more importance.

Rankings for Producers (N=9)							
	1 (Most Important)	**2**	**3**	**4**	**5**	**6 (Least Important)**	**Average**
Scientists	4	1	2	0	1	1	2.6
Federal	1	3	2	2	1	0	2.9
State	2	2	1	2	2	0	3.0
Individuals	1	1	3	1	3	0	3.4
Elected	0	1	1	3	1	3	4.4
Producers	1	1	0	1	1	5	4.7
Rankings for Intermediaries (N=7)							
	1	**2**	**3**	**4**	**5**	**6**	**Average**
Federal	4	1	1	1	0	0	1.4
Scientists	1	3	0	1	1	1	2.4
State	0	2	1	2	2	0	2.8
Elected	2	0	1	2	0	2	2.8
Individuals	0	0	3	1	1	2	3.3
Producers	0	1	1	0	3	2	3.6

Each group was asked to rank the importance of targets for communicating their findings: other members of the scientific community, individuals, producer or trade organizations, state officials, federal officials, or elected officials or their staff members. Categorical rankings are shown in Table 5.2 and graphically in Figure 5.1. Five of the producers respondents and three intermediaries respondents did not rank-order their communications priorities, so those responses were excluded from the analysis. Among the research scientists, other scientists were considered the most important target for communications, with four of the nine responses rating other scientists as the highest category. State and federal officials followed closely with individuals next. Elected officials and producer organizations received the lowest ratings, with five of the nine respondents ranking producers as last.

Figure 5.1. Rank-ordered importance of targets for communicating findings for (a) producers (top) and (b) intermediaries (bottom). Lower scores indicate more importance.





Intermediaries indicated federal officials as their most important targets, with four of seven respondents ranking them as most important. The remaining categories were fairly evenly distributed, with scientists having a slight edge as the second most-important target. Individuals and producer groups received the lowest marks. Elected officials were the important targets for two of the respondents while two respondents ranked elected officials as least important. Part of this may have to do with restrictions on communication within federal agencies.

Policy-makers also may contact individual scientists directly. Items mentioned as cues for policy-makers included familiarity with an organization or program, word-of-mouth from others in the community, or awareness of a report or book that the scientist had published: “More than once it’s because we’ve written a book on the subject and a number of articles, they’ve contacted us and asked us to come.” Others noted that through conference presentations, workshops, websites, referrals from other agencies, or contacts through local offices, state or federal officials who need information seem to find sources. Once a connection is made, especially if the request comes from a staffer or agency official, the individual and agency respond. One respondent noted that “everything is driven by requests for information.”

Mostly communication occurred along pre-existing organizational channels. For example, if a state water management agency director were seeking input, he might contact others within his organization, who might then contact an individual at a university-based research center that collaborated closely in the past on other issues below the scope of senior management. Sometimes, however, this communication can occur because of the scientists placing themselves in an external setting. Attending Chamber of Commerce breakfasts and interacting with civic clubs place scientists in a forum where they are likely to meet elected officials or other local policy-makers. Sometimes even chance meetings, such as conducting field work, will present opportunities for scientists and policy-makers to cross paths.

Sometimes it is not necessary for scientists to speak directly with policy-makers. One respondent identified a goal of his organization as building the technical capacity within other organizations, so that when a policy-maker needs scientific information, she has people around her who can respond as soon as they are asked. Typically, this is a top-down model, driven by the policy-makers' need for information, but sometimes it can lead to a bottom-up push for new policies.

To examine this chain-of-referral from the scientists' perspective, respondents were asked how they answer a request for information when they do not necessarily know the answer. Most respondents, both research scientists and intermediaries, reported that they would answer the questions directly provided that the question was within their area of expertise. One of the research scientists noted the Certified Consulting Meteorologists code of ethics, which states that they will answer questions only in areas where they claim to have expertise. Another researcher stated that he would refer a media request to another expert or organization, but if a decision-maker was requesting the information then he would find an answer so the decision-maker did not need to search around. Most respondents mentioned that they would refer to organizations, although some noted they may refer to individuals with expertise in the given area. One of the respondents in an operational environment noted that there are too many things going on in order to follow everything, and they would be more likely to refer to another expert, especially in matters at state or local levels. Intermediaries mentioned a willingness to formulate an answer, but would suggest other sources if the individual wanted to investigate more thoroughly.

5.2 Preferred Methods of Communication

Respondents were asked how they preferred to communicate information to other scientists, to decision-makers, and to the general public. Responses are summarized in Table 5.3. For communicating with other scientists, research scientists mentioned conference presentations and peer-reviewed journal articles as their preferred mechanisms. Personal communication was mentioned by two of the fourteen respondents. Scientists in operationally-oriented organizations (the intermediaries group)

Table 5.3. Preferred methods of communication to different target audiences. The number of times the method was mentioned in the follow-up questions is indicated in parenthesis. Respondents often mentioned multiple means so the total number of responses adds up to more than the number of respondents.

	Producers	Intermediaries
Communication with other scientists	• Peer-Reviewed Articles (10) • Conference Presentations (7) • Reports (2) • Personal Communication (2) • Meetings / Workshops (1)	• E-mail (6) • Peer-Reviewed Articles (5) • Conference Presentations (4) • Websites (3) • Personal Communication (3) • Public Presentations (2) • Media (1)
Communication with decision-makers	• Meetings / Workshops (7) • Personal Communication (5) • Reports (3) • Conference Presentations (2) • Direct Mail / Letter (2) • Brochure (1) • Peer-Reviewed Articles (1)	• Websites (6) • E-mail (5) • Personal Communication (4) • Public Presentations (3) • Media (2) • Conference Presentations (1) • Briefings (1) • Via Other Organizations (1) • Reports (1)
Communication with the general public	• Media (5) • Websites (4) • Meetings / Workshops (4) • Personal Communication (3) • Open House Events (3) • Civic Groups (1) • Extension (1) • Reports (1)	• Websites (7) • Media (5) • Meetings / Workshops (3) • E-mail (3) • Public Presentations (2) • Personal Communication (1) • Via Other Organizations (1)

favored faster means of communication. E-mail, websites and listserves were mentioned by most, although the traditional, formal publication channels of conference presentations and peer-reviewed journal articles were not forgotten (4 of ten respondents mentioned these means). Personal communications, lectures and news media were other means mentioned by intermediaries.

For contacting decision-makers, including policy-makers, research respondents mentioned a variety of mechanisms. Many favored some sort of group presentations or briefings, and written reports also were mentioned. Some form of one-on-one conversations were mentioned by six of the 14 respondents. Two mentioned referred publications as useful, although both indicated other means (presentations and reports to sponsors) were important as well. One respondent mentioned oral presentations followed by a written technical report, suggesting the need to get the decision-makers' attention before providing details. Brochures and memos also were mentioned as preferred methods. The intermediaries group again was more likely to rely on electronic communication. Six of ten respondents mentioned e-mail or websites, but nearly all mentioned multiple methods. Personal communication via workshops, conferences, and lectures were mentioned. The verbal nature of communication was emphasized, with only two respondents mentioning publications (formal or informal). Two of the respondents mentioned second-hand influence through other organizations.

Media was mentioned as an important means of reaching the general public by both groups. Six of the 14 research scientists who responded and 5 of the 10 intermediaries mentioned media or news releases as important. General presentations, including workshops and open house events were mentioned by respondents from both groups. Three producers and 7 intermediaries mentioned the Internet or web sites as important methods for reaching the public. Other methods mentioned included peer-reviewed journals and extension handouts.

Respondents were asked to mentally set aside time and resource constraints to envision the most effective means of communicating outside of the scientific community. Research scientist respondents mentioned many of the existing forms of communication, including web pages (5 responses), meetings with small groups (5), media (5), personal interaction (4), and extension or outreach programs (3). Other methods mentioned were brochures, worksheets or checklists, partnering with communication specialists such as journalists or science museums, and publishing more in trade publications or popular magazines. Intermediaries similarly mentioned meetings with small groups (6), use of the web (3), personal interaction (2), and the media (2) as effective means of communication. One respondent mentioned developing more interactive tools for the web and another mentioned developing case studies to help users interpret information. Trade magazines and public service announcements were mentioned by both groups. Several unique responses by the intermediaries were providing instruction, citizen panels, working with trusted sources, and finally "semaphore flags work quite well."

During the interviews, research scientists were asked to rate various information sources as very useful, somewhat useful, not very useful or not at all useful. Their responses are shown in Table 5.4. The study design called for the same rankings to be asked of intermediaries; however due to the increased length of the interview guide for intermediaries, the rankings process often consumed too much time and had to be shortened. Thus, direct comparisons between the two groups are not possible, but

Table 5.4. Producers' rankings for selected communications methods (n=20).

Method	Very Useful	Somewhat Useful	Not Very Useful	Not at all Useful
Personal Contact	15	5	0	0
Meetings	16	3	1	0
Written:				
Journals	15	4	0	1
Reports	6	11	2	1
Newsletters	1	9	7	3
Indirect:				
Websites	8	10	1	1
Media	9	5	6	1
Popular Journals	4	8	5	3
E-mail	3	7	6	4
Direct Mail	2	8	6	4
Internet News	4	4	0	12

information on how the various methods are used was collected in both instances. Five categories of communication emerged from the interviews (in order of importance): one-on-one or small-group encounters, meetings, collaborative activities, written communication, and indirect communication. These are discussed in more detail in the following sections.

5.3 One-on-One or Small Group Encounters

Both groups mentioned personal conversations as the most effective means of communicating. All research scientists rated personal contact as either very useful (15 respondents) or somewhat useful (5 respondents):

> "If we talk to other state [officials] or anyone up in [the state capital] about research that we're doing, that seems to pass on the knowledge more than any published piece of information or what we've talked to fellow researchers about."

> “Conveying information needs more of a personal touch, I think. The reason is that policy-makers are so busy and drought is just one issue in a multiple number of issues they have to look at. Sometimes just getting on their radar screen is really important.”

Direct contact includes one-time responses to requests for information, personal conversations (either individually or in small groups), and briefings (Table 5.5).

Responding to requests for information is one means by which communication channels may be established. Most regular contact between scientists and those external to the scientific community occur at lower levels of organizations. Communication may be a one-time or ongoing occurrence, depending upon the circumstances. Relationships cultivated through these interactions may open conduits useful for relaying information at a later date. Contact is generated by the policy-maker about as frequently as it is by the scientist.

Direct, personal conversations can occur in many setting. Examples offered by respondents included speaking with individuals through group settings, identifying and subsequently collaborating with innovative individuals, working with mid-level people in state agencies, contacting policy-makers via organization legislative affairs staff, and

Table 5.5 Advantages (+) and disadvantages (-) of direct communication methods as mentioned by respondents.

Method	**Advantages / Disadvantages:**
Inquiries for Information	+ Establishes channels between scientists and decision-makers - Initiated by policy-maker (one-way initially) - Usually occurs at lower levels of organization
Personal Conversations	+ Elaborating on or clarifying previous information - Often occurs among individuals below organizational policy-making levels
Briefings	+ Keeping agency staff informed + Moving information upward through organization

even having a drink with a legislator. Most regular contact involved individuals in lower levels of state or federal organizations. Respondents noted that information provided to these individuals often found its way upward in the target organization as the individuals briefed agency officials.

Personal conversations allow individuals to clarify interpretation and elaborate on information previously provided:

> "[It allows you to] augment what you have said previously or reinforce a particular point or bring something to their attention that might not have come to their attention in a more formal briefing."

> "You get a feel for how they view things, can have a lot of feedback, kind of know what the other side of the coin is thinking about. We're on the science side, they're on whatever side, whatever the agency's role is. I think that's very useful."

Sometimes this contact occurs through an intermediary. One respondent mentioned contacting the university's legislative affairs office to get a message to the state's Senators: "that's very effective, it's almost like you are talking to the lobbying group." The respondent who mentioned having a drink with a legislator as a good means to convey information also noted a limitation: "unfortunately I tend not to give them a million dollars to go along with it, so they don't necessarily listen very well, but at least they get the message."

Communication may continue over a period of years, or it may be concentrated over a short time. A scientist working with an individual in the early stages of a drought planning process, for example, may have frequent conversations with a member of a drought task force, but as the individual becomes educated on the topic contact may drop off. Other times, after an initial education period, individuals may contact the scientist on an as-needed basis for further information. If a good rapport was developed, the scientist may initiate conversation when new information is available or to inquire about the process.

In more than one circumstance, a relationship that had been developed between a scientist and an agency official became a conduit for information to policy-makers as the official moved upward in the organization's management structure. One example was a colleague at the university who became the town Mayor. Subsequently, that individual became the state's Secretary of Natural Resources. As both Mayor and Secretary, the individual called the scientist for advice. Another wanted to promote scientifically-based management practices, so he identified an innovative individual from a workshop and developed a pilot study. Subsequently, that person could be invited to talk at workshops among his peers, making the new practice appear to come from the producer community rather than the science community. Others have used formal channels to get messages to policy-level individuals. One respondent mentioned using an ongoing relationship with mid-level people to filter messages up to a smaller group of policy-level people.

More structured than the *ad hoc* interactions, personal briefings provide another avenue of direct contact between scientists and agency staff or policy-makers. Several respondents, mostly from federal organizations, mentioned regular briefings for agency officials. Briefings provided opportunities for the scientists to keep top staff informed of what was going on. One respondent noted that these agency officials "seriously considered" the advice from scientists. Most had little background in science or weather, but they kept requesting briefings. Also, these small settings provide opportunities to answer questions and may lead to follow-up questions. Most briefings were by-request, but some respondents have been successful at initiating the briefings. In one case, a researcher noticed a downward trend in groundwater levels that could potentially become a problem. In order to draw attention to the issue, he made presentations before groups, including legislators, engineers, and staff from the executive branch.

Some respondents reported developing materials for briefings which others gave. These included providing images or bullet points. Through their directors, information was provided to top levels of the organization as well as having been used in Congressional subcommittee hearings. Information provided through these channels travels farther than information conveyed through personal conversations, flowing both upward and downward through the chain-of-command in organizations.

5.4 Meetings

Questions posed on meetings were focused on scientific conferences or meetings sponsored by a state or federal agency, but most respondents mentioned presentations or tours as useful methods for reaching a non-scientific audience (Table 5.6). Because all of

Table 5.6 Advantages (+) and disadvantages (-) of types of meetings as mentioned by respondents.

Method	Advantages / Disadvantages:
Scientific Conferences	+ Exchanging information within the scientific community − Not effective for conveying information outside of community
Internal Seminars	+ Interchange of ideas among colleagues
Public Presentations	+ Discussion with a diverse audience + Generating follow-up requests for information - May not draw much attention if issue is not on public agenda
Tours	+ Awareness (general public and policy-makers) - Difficult to convey complex topics

these involve scheduled events, often for large-groups, these forums are combined into a single category. Research scientists rated meetings similar in effectiveness to personal communication. Sixteen of the 20 respondents rated them as very useful, three as somewhat useful and only one as not very useful.

Scientific meetings generally were not seen as a way to reach policy-makers, but most respondents found them very useful with regards to information exchange among scientists:

> "From the policy standpoint, I would say that you don't necessarily meet policy-makers at scientific conferences, but conferences are very important in terms of sharing information that may be very valuable ultimately to policy-makers in our own area. So if we know of research that helps people out, that's important."

> "I try to attend one or two conferences a year that deal with issues pertaining to subject areas that I'm interested in."

In addition to conferences sponsored by professional societies, internal seminars were mentioned as a useful means of "interchanging ideas with colleagues." Internal seminars are presentations within academic departments or research groups for the purpose of sharing research and ideas with their immediate colleagues. Some of these seminars may expose individuals to research outside of their disciplinary boundaries, which they may then integrate for communicating to policy-makers.

Public presentations were mentioned by several respondents as an effective means of reaching a diverse audience, sometimes leading to follow-up direct communication:

> "Many times we will host one of these conferences and invite people to come. The result of that, as well as other outreach activities, then people start to ask us. So it goes both ways. We try to be proactive in terms of increasing the awareness of climate issues and then also to respond to specific needs that result from that."

In some instances, public presentations are made by the scientists' agency, but in other cases they may result from several agencies working collaboratively:

> "I have contacts with senior officials in the NRCS and USDA Bureau of Land Management and Forest Service. Some of it was working relationships. Some of it was moving into a new position and going out and meeting some of the folks in these different agencies and establishing contacts that way. As a unit, we put on tours, joint presentations with some of the agencies or presentations of our own."

The advantage of the collaborative presentations is that audience members are more likely to identify with one or more of the agencies, helping the scientists to make a connection with these audiences. These methods are particularly effective during times of drought, when public attention is geared on the issue and the audience is more receptive. Presentations in public forums such as these in many cases lead to requests for similar presentations in other venues or follow-up direct contact.

Some organizations sponsor tours or 'field days' for their facilities. These informal settings may not be the best vehicle for conveying complex information, but it does help scientists to conceptualize how their research might be applied to societal problems:

> "We frequently have tours, like groups who are related or interested in agriculture, come through here. I speak to groups from a size as small as 10 to as big as 50 here, at least a half a dozen times per year. They are very useful, not only for them but for me, because it's been in the process of talking to these customers that I've understood the questions I was trying to answer were not the ones they needed answered. That has forced the dramatic evolution in my approach to the whole problem in the last five years."

These tours also expose policy-makers to research being conducted that may be relevant to the issues with which they are dealing. One respondent noted that during one such tour, a highly politically-connected individual "heard one of my general presentations and got back to me and said I want more."

5.5 Collaborative Activities

None of the communications methods questions focused specifically on collaboration, but collaborative activities frequently were mentioned throughout the interviews. Collaborative activities may include internal, programmatic activities or external involvement in organizations, boards, and planning activities (Table 5.7). Activities contained within the scientific community included collaboration with colleagues who where engaged in outreach activities, program reviews and planning, interdisciplinary research, and involvement in activities of professional societies. Externally-oriented activities included involvement in local organizations, participation on government-sponsored panels, boards, or task forces, and partaking in large projects whose goal is to transfer scientific knowledge into operations. These methods were

Table 5.7. Advantages (+) and disadvantages (-) of collaborative activities as mentioned by respondents.

Method	Advantages / Disadvantages:
Internal Collaboration (colleagues, program review)	+ Transitioning basic research to applications, where processes are parsed according to each participants specialties + Linking individual research projects to agency goals - Not voluntary (program reviews)
Professional Societies	+ State-of-the-science assessments + Validate claims for action - Focus on a few prominent, national issues only - Local chapters not actively involved in state policy-making
Local Organizations	+ Technical assistance with program implementation, leading to new ideas that may subsequently alter policy + Less competition for policy-makers' attention + Development of closer, sustained relationships
Panels & Boards	+ Integrating perspectives tied to specific issues

considered generally effective and often involved sustained interaction beyond a single instance of direct contact, presentation, or meeting.

5.5.1 Collaboration within Organizations

Collaboration with colleagues who have externally-oriented roles allowed scientists to focus on their research and leave the applications to somebody else. State climatologists and departmental outreach coordinators often were mentioned as individuals who could fulfill this mission. One respondent described his relationship with a state climatologist as "I feel thankful that he is doing it and I'm not doing it." Another noted that "just due to the presence of the state climate office here, my work gets more exposure." Interdisciplinary research falls along similar lines, in that information can be aggregated into a more holistic picture, which subsequently may be conveyed to policy-makers and the general public.

Formal review from national program management is another vehicle that puts research into applications-oriented perspectives. National programs must justify their budgets to Congress, and increasingly they are being required to demonstrate how their programs affect society. While this type of collaboration may not be voluntary, it does appear to be productive. One aspect is that national program staff guides research at lower levels of the organization such that research is focused upon the policy problems they are tasked to address. The process was described as follows:

> "We have some national mandates, but those actually were generated, say every five or ten years, by having large numbers of stakeholders meet and identify the major topics of interest, developing a national research plan for the agency, and then for individual units coming back with those guidelines in mind and having the local stakeholders indicate which of those national programs or projects are

> most important locally and components within those which are most important for this unit to work on."

Another dimension is that individual scientists' communications with national program staff feeds research results upwards through organizations to levels where interaction with policy-makers becomes increasingly likely.

5.5.2 Professional Societies

The other type of collaboration largely internal to the scientific community that was mentioned was participation in professional societies. Organizations including the National Academies of Science, the American Association for the Advancement of Science (AAAS), the American Meteorological Society, the Brookings Institution and the Intergovernmental Panel on Climate Change (IPCC) were mentioned. Some of the committees on which scientists served had guiding policy as one of their goals. Often, executive summaries were produced. Information from these panels often reaches top policy-makers:

> "I go and meet with these regional panels to talk about the role of drought in their strategic planning. That will get written into a report that the Council will endorse, and that's pretty high-level. That report will be available directly then to the Secretary of Interior, Secretary of Agriculture."

> "A lot of people go to those and reports come out of the policy forums and people are constantly briefing reports and strategic plans. In that sense, you have some senior leaders who developed the strategic plans, but it's vetted in the community and that is used as leverage to effect policy change. However, unless you have somebody's ear, you cannot effect policy change."

One such effort that was directly related to drought was revising the American Meteorological Society's statement on drought (adopted December 2003). Scientists serving on the AMS Applied Climate Committee formed a small subcommittee to develop an initial draft. The draft was then revised by the full committee. Afterwards, the draft was posted on the AMS website for public comment. The committee then addressed each comment, similar to a journal article review process, before releasing a final version. While the statement was not aimed specifically at policy, it was developed to represent the current knowledge on drought. Statements by professional organizations, like this drought statement, may be used by others within the policy arena to validate their claims for policy initiatives. Similar efforts by the NAS, the Brookings Institute and the IPCC have led to a summary of findings and policy recommendations, although none of the respondents mentioned involvement in formulating the report recommendations.

Professional societies are encouraging their members to become more engaged with policy-makers:

> "A number of societies like the AGU [American Geophysical Union] and the AMS are increasingly calling on their members to be more involved, and I think that is a very good move because certainly what we found in applying science in the natural resources realm is that policy-makers are very interested in what science says. They may not want to heed it, but it really takes effort on the part of the scientist to step forward and identify the pieces of the research that are relevant."

While collaboration with professional societies may increase access to scientific information on Capitol Hill, it does not always work at all levels. One respondent noted that the societies tend to focus on a few prominent issues:

> "For the issues that you have coming up, AGU, AMS, other professional organizations are great avenues, but again within that they are dominated somewhat by these very broad hot-button issues. Many times these are not issues that everyone cares about. There needs to be a more localized ability. Like the local chapters are not that involved. AMS at the national level is, but I don't know of any local AMS chapter that is actively involved in such kind of policy-making at the state level."

As evidenced by this example, policies that are set in the state houses usually do not have active engagement by professional societies. In the case of drought, since most policy initiatives occur on a state-level basis, professional societies may not be a good conduit for scientific information.

5.5.3 Local Organizations

While professional societies may not reach local levels effectively, externally-oriented involvement with local agencies was mentioned as a way in which research may be transmitted. Often, this will be more focused on program implementation, but experience with the process of implementing changes may be a source for new policies. Economic development districts engaged in resource management were mentioned by several respondents. One advantage of working with local or regional organizations is that competition for attention is less than it would be at state or especially federal levels. This enables development of closer relationships, which increases the receptivity of the information provided. Another advantage of close collaboration that was mentioned was that scientists "have opportunities to explain it in terms that they would understand, and sometimes to go back and maybe do an analysis that would be more applicable to their needs." If local offices are affiliated with parent agencies, such as Farm Service or Natural Resources Conservation Service (NRCS), information can then travel upwards and reach policy-makers indirectly. Similarly, local organizations work with individual producers and businesses, allowing information to travel downward to finer scales.

5.5.4 Government-Sponsored Panels and Task Forces

Another means of involvement with others outside of the scientific community is through participation in government-sponsored panels, boards or task forces. Panel discussions are especially useful, because they bring different perspectives to the table:

> "A scientist often gets to hear what might be termed the political reality of the policy-maker, the constraints they are faced with because of law, because of financial means, because of the responsibilities they have or don't have in their position. We can say things that are more useful to them by understanding what their restrictions are, what their capabilities are."

Some of these panels lead to further interactions. In one instance, a scientist was invited to address a group of state legislators as a result of his involvement in an agency-sponsored panel. In another instance, a scientist became involved with a strategic planning process. Even if it does not lead to further interaction, the process of learning about issues can be valuable. One scientist served on a panel with the state's Secretary of Agriculture, who has since become a United States Senator. Getting enough of a Senator's time to participate in a panel is very difficult, but the learning that occurred earlier in the Senator's career became a reservoir of information upon which he could subsequently draw.

State drought task forces are an excellent example of this collaboration. Officials from state agencies, some of whom have scientific backgrounds and some who do not, gather on a somewhat regular basis to discuss climate conditions and expectations, review response policies, and perhaps review and revise drought plans. Eight respondents had direct experience with state drought task forces. In all cases, they found them to be receptive of input, both from them and from other scientists on the task forces:

> "They do listen to us, they do listen to [other organizations] and various other things are taken very well into account. We do have a strong say in it."

> "Those states in which the drought planning process has been the most successful have always had the support at that senior level, the Governor or somewhere up there. But usually then we're working with some of the technical people who are at a lower level."

> "You can be dealing typically with somebody off the Governor's staff, but more than likely an agency has been put in charge of developing the plan, whether that's emergency management or natural resources or water. The agency head then will be the one typically you're briefing or making recommendations to. Obviously most of the time it's much larger, broader. They've brought in a lot of other agencies and then working groups are put up and they're the ones developing the plan and then it funnels back up at that point, trying to involve as many stakeholders as possible in the process that are well below an agency level, right down to the farmer or water user or producer."

Research on the variability of precipitation, groundwater and surface water were mentioned as forming a basis for state planning efforts. In some cases, scientists had an opportunity to provide summary documents as "sort of a foundation for them moving forward and deciding what they want to tackle and do in these advisory capacities."

On a planning basis, large national or international projects provide opportunities for scientists to interact directly with policy-makers. The NIDIS proposal developed by the Western Governors' Association is an example of this process. The WGA hosted several meetings that included scientists from state and federal agencies along with local, state and national water resources managers. The discussions resulted in a plan that clarified the information needed by the policy-maker community and the capabilities of the science community. NIDIS not only aims to develop a system of real-time drought information, but it seeks to improve the drought management planning process and to recommend needed research to address shortcomings in the ability of states to plan and respond to drought. Thus, it ties the basic research to stakeholder needs. Other federally-sponsored programs, such as the RISA program, similarly seek to tie research and applications to stakeholder needs. In the process, social scientists are able to learn more about effective communication processes, thus advancing the state of knowledge as well.

5.6 Written Communication

Journals, reports and books are written methods mentioned by respondents as ways in which they communicate with others (Table 5.8). Some of these techniques are aimed at other members of the scientific community, but some methods are designed with non-scientists in mind. An overwhelming majority of research scientists (15 of 20) classified journals as very useful, although many respondents qualified the rating with the caveat that journals are useful for communicating among scientists and staying current on the state of scientific knowledge. Four of the remaining five respondents ranked journal articles as somewhat useful, with one respondent ranking them as not at all useful.

Table 5.8. Advantages (+) and disadvantages (-) of written forms of communication as mentioned by respondents.

Method	Advantages / Disadvantages:
Journals	+ Communication within the scientific community, particularly among producers / research scientists - Lack of time to read articles - Rarely useful outside of the discipline
Reports & Newsletters	+ Analysis of an event or decision process + Usually assessment in nature, but sometimes may take the form of 'white papers' related to specific policy issues + Often contain details not found elsewhere + Communicating agency activities and operations - Difficult to know that the reports exist - Mostly seen by scientists as not substantive
Books	+ More detail on a subject + Reaching a broader audience than a journal or report - Suitable writing style requires great effort

Reports generally were viewed positively, but not as strongly as journal articles. Eleven of the 20 respondents rated reports as somewhat useful, while six ranked them as very useful. Two said reports were not very useful. Newsletters were seen as marginally useful, but elicited little elaboration from the respondents. Nine respondents ranked newsletters as somewhat useful while 7 ranked them as not very useful. Three ranked newsletters as not at all useful while only one felt that they were very useful.

One respondent noted that journals, reports and books are static. The nature of scientific research is that findings are published, and sometimes subsequently refuted by other findings. The problem is that even if an original study has been refuted, there is no way to retract that from the record, even if the author becomes convinced of the errors.

> "You do not necessarily have the same position month after month. Your viewpoint towards how it affects policy may change, and you should have an ability to go in and modify or update your perspective on a particular subject."

One suggestion was to utilize technology to create an "electronic blog version" of the research, designed for use both inside and outside of the scientific community. The respondent suggested that professional societies may be an appropriate vehicle to implement such an initiative.

5.6.1 Journals

In general, journals were not a prominent means of communication among scientists from operational agencies. Most noted they had little time to read journals, much less publish in them. Scientists in the intermediaries group were more likely to write and present conference papers, where they would be in a more interactive environment. Some noted that they did make an effort to read articles in areas in which they are interested, and one respondent mentioned that he at least skims articles from journals he receives.

Journals and research summaries are almost all geared toward other scientists. Respondents recognized the limitations of journals as an effective means of communication outside of the disciplines:

> "I'm saying how I communicate my research results and there's another set how I should communicate with actual customers. How do I get my professional findings across to the people which are peer-reviewed and looked at – it's the professional environment so there scientific journals are important. But if I go to customers or people who are actually going to use and apply some of the work I have, they don't get it out of scientific journals, they get it out of contact."

> "The end goal of that, most of the time, is to publish a paper in a scientific journal that your average farmer will probably never lay eyes on. So one of the big questions is how do we get this information out to a group of end users?"

> "Unfortunately, most of the policy-makers don't read a lot of technical journals."

Not all of the respondents felt that journal articles never reach outside of the discipline, but most did. Yet despite the limitations of reaching only a small, targeted audience, professional communication through journal articles and conference papers serves an important purpose. Many respondents mentioned the process of collaboration with colleagues, often across organizational lines and sometimes even across disciplinary lines. This process helps them to formulate a perspective of where their research fits into the broader puzzle, and may be useful for them when they engage in other forms of communication. In addition to collaborating on the writing, in-house reviews were mentioned as a way of keeping informed on the research colleagues are doing and obtaining feedback on the effectiveness of communicating their results.

5.6.2 Reports

The majority (14 of 20) of the research scientists had either not issued independent reports, aside from journal articles and conference presentations, or had issued reports that were focused on assessments and did not specifically offer guidance to policy-makers. Assessments included state-of-the-research in a subject area, analysis of climate and trends, or overviews of the performance of indices. One respondent mentioned performing a post-mortem on a drought episode, but stuck to an assessment of the lessons learned: “We are not a policy-making organization. We do provide the information to other state agencies to take that into account, but anything that is policy-oriented or connected with regulation, we sort of consciously steer away from that.”

The other research scientists tentatively engaged in policy-relevant recommendations. Often, these types of reports were targeted toward state or local decision-makers rather than top policy-makers specifically, although not in every case. Reports may have been issued as an initiative of the scientist as a means of bringing scientific research to operational decision-makers or policy-making officials, or it may have been by request of agency officials, who sought scientific guidance for their decisions. The most engaged research scientists produced a series of white papers that described the scientific background, expected changes, and considerations for water managers. These represented tremendous investments of resources by the scientific organizations: “It can become challenging to find the right balance between an executive summary that hits the high points while not obscuring the relevant technical information as well. It’s taken us a long time to learn how to do that effectively.” This investment of time may be a factor in why research scientists are not more actively engaged with policy-makers.

Much like the research scientists, scientists in operationally-oriented organizations tended to produce reports and products that are more assessment in nature rather than policy-oriented documents. Because the scientists in the intermediaries group were all from operational environments, all produced some form of reports. Most produced weekly, monthly, or seasonal assessment products, including the Drought Monitor, the Drought Outlook, the Weekly Weather and Crop Bulletin, a monthly climate assessment, and a drought status report. Most viewed their role as providing information for others to use as ‘grab and go’ documents:

“We let other people use that information as they see fit. We don’t have the expertise.”

> “[Our organization] usually isn’t in the business of recommending action.”
>
> “[Our publications are] certainly not in the policy arena at all.”
>
> “I feel that a good assessment given to a thoughtful and well-prepared professional in another field will result in their determining their recommendations and plan of action. I feel they probably know their discipline better than I do.”
>
> “If I’m concerned about something that is going on, other people will have a better hand on what we can do about it in the future, to look back and see if things can be made better, but I’m trying to come up with something that somebody can have in their hot hand and show to somebody else that might need it.”
>
> “I generally don’t like advocacy in the kind of role I play. I feel that my job is basically to put the facts in front of people.”

Some noted that information they produce finds its way into reports that others produce, including information that is provided to governors and senior agency officials. Some of the materials produced were targeted toward in-house applications, either directly within the organization or for use by field offices.

Scientists' attitudes toward in-house reports were mixed. Some found them more effective at communicating outside the discipline:

> "Someone [at a federal agency] doesn't care about a journal article, so reports they'll take advantage of. They usually ask us to write those."

> "If the reports aren't too technical then some people will take the time to read those."

Others felt that reports were not an effective means of communication because "they're obscure and hard to get at." But once discovered reports could be quite useful:

> "A lot of times there will be these reports put out after a drought that will have all these precious nuggets of lessons learned and that type of thing that are really helpful."

> "There's a lot of good stuff out there if you know it's out there or you can find it. There could be a lot of states where a report like that is done and we never hear about it."

The reports themselves may be summaries of ongoing research or they may be documents specifically targeted toward policy-makers or agency officials. Some reports may find application at a later date. One respondent wrote of preparing an analysis of historical drought conditions during "wet times" that later proved prescient during severe drought conditions several years later.

The exception to this pattern was the National Drought Mitigation Center. These scientists produced both routine products as well as direct advice for policy-makers. Scientists at the NDMC are operationally-oriented through their involvement in the Drought Monitor. However, these scientists have dual roles. The NDMC was established as a conduit of information on drought to encourage and assist state, local and federal officials with drought planning and mitigation activities. NDMC scientists produce publications that provide guidance on monitoring, conducting risk and impact assessments and the planning process. These documents are used by state officials as they develop drought plans, and often lead to direct interaction and requests for recommendations. Scientists have actively participated in developing drought plans, have conducted studies at the request of federal agencies, and target information for use by multiple arenas of government.

5.6.3 Books

Two respondents mentioned having been involved with publishing books. One highlighted the difficulty encountered in writing for a non-technical audience:

> "The [publisher] really insisted it would be a popular audience, which means that writing a report with words of less than 4 syllables is incredibly difficult. Part of the whole thing was to point out what we know, what we don't know about the climate, and therefore also in a sense the water of our state."

In general, these respondents felt that it was a positive means of conveying information: "I think the level of detail far beat out an article. The audience was far broader than articles tend to reach."

5.7 Indirect Communication

Indirect methods of communicating with policy-makers included websites, the media, e-mail and direct mail (Table 5.9). Of these, websites and media were viewed most positively. Websites were ranked as very useful by 8 research scientists. Ten ranked them as somewhat useful, one as not very useful, and one as not at all useful. Nine respondents ranked media ranked as very useful, five as somewhat useful, and 6 as not

Table 5.9. Advantages (+) and disadvantages (-) of indirect forms of communication as mentioned by respondents.

Method	**Advantages / Disadvantages:**
Websites	+ Increases organization's visibility + Follow-up contact + Disseminating routine products used by staffers / briefings − Difficult to sort out good ones from bad ones − May disseminate misinformation − Difficult to find them
Media	+ Drawing attention to research + Follow-up contact + "Highlighter" for issues on the public agenda − Inaccurate portrayal of information − Self-promotion of personal agendas
E-mail	+ Delivering targeted information + Effective means for communicating among scientists + Sending information to agency officials who then feed information upward in organizations + Discussion process / consensus-building - May disseminate misinformation - Volume can be overwhelming
Direct Mail	+ Notification of reports or meetings + Passing information through other organizations communication with membership − Shortcuts system of peer review

very useful. Popular journals were viewed as very useful by 4 respondents, but most viewed them as somewhat useful (8) or not very useful (5). Three respondents found them to be not at all useful. E-mail had a wide distribution, with 3 ranking it as very useful, 7 as somewhat useful, 6 as not very useful, and 4 as not at all useful. Direct mail had a similar distribution, with 2 ranking it as very useful, 8 as somewhat useful, 6 as not very useful, and 4 as not at all useful. Internet news sites were the least useful, with 12 of the 20 respondents ranking it as not at all useful. Four others ranked it as somewhat useful and the remaining 4 as not very useful.

5.7.1 Websites

Many responses related to websites centered around the difficulties in sorting out the good ones from the bad ones. Just as they can be a good vehicle for disseminating information, they can be an equally good vehicle for disseminating misinformation. Another concern with websites was being able to find them: "if you can't get it with Google or something like that, then how do you even know it's there, unless you've got good links from other sites." Another respondent saw websites as useful "only after we have initiated some contact and the targeted audience knows to look at us." Because web pages are dynamic and linked pages or products frequently move, respondents reported difficulties keeping information current on their own websites, much less keeping up with others.

Yet despite the difficulties in managing the flow of information, it does seem to increase an organization's visibility and attract follow-up contact that may be more productive. Many of the intermediaries produce routine products which are disseminated via websites. These products have been used by staffers to brief agency officials, Secretaries and Congressmen. Another advantage of the web is that other sites can be linked, multiplying the number of ways in which a user can reach the information's originator.

5.7.2 Media (Including Popular Journals)

Media appeared most useful to scientists as a means of drawing attention to research. Several respondents noted that contact with them increases following an interview. Similarly, following issues being discussed in the media can be a “highlighter” for the scientist as to questions he may receive from either policy-makers or the general public. Some scientists have learned how to use the media to their advantage. One noted that if he can get a message to a key source, others will tend to copy that source and the message will become widely distributed.

Working with the media, though, can be difficult. Most respondents expressed concerns about the media’s ability to portray scientific results accurately. Respondents commented that “information gets jumbled in translation” and that qualifications on statements made during interviews often do not appear in the final article. One respondent commented that being taken out of context was a hazard of the profession, and that scientists had to learn to say things carefully but not so carefully as to be bland and unused. Another risk is that the media is used as a means of self-promotion, via organization press releases, and that the full range of scientific opinion does not get captured by individual media reports. Some programs do a better job of conveying scientific information, with programs such as NOVA geared toward educating a lay audience. Popular journals were most useful for reaching local audiences through regionally-focused magazines rather than national publications. Several respondents contributed articles to Weatherwise, a popular magazine for weather enthusiasts, and others reported having been interviewed by writers for National Geographic.

5.7.3 E-mail

Questions related to e-mail communication elicited comments similar to websites: "some of them are lousy, some of them are good" and that misinformation can be passed easily through e-mail. E-mail can be useful for delivering targeted information, such as a newsletter or notice of a meeting or workshop. Overall, e-mail was generally viewed as an important means for communication among scientists, although the volume of mail could be overwhelming. One described e-mail lists as useful "except there's too much e-mail in them."

Even though e-mail may not reach policy-makers directly, it has proven an effective means for delivering information to state agency officials who can then feed information upward through their organizations or state drought task forces, ultimately reaching the policy-makers. A prime example is the Drought Monitor's "exploder" list, which includes both scientists and state agency staff charged with monitoring drought conditions in their respective states. Through ongoing discussions of drought status, participants on the list share ideas and discuss new research. In the process, somebody almost invariably will provide a summary of relevant articles or reports, making those publications accessible to a wider audience. The Drought Monitor was described as "both a process and a product, and the process is the discussion that takes place prior to its issuance."

5.7.4 Direct Mail

Direct mail similarly was mentioned as a means of sending out reports or notices. One respondent used mailing lists from meetings to provide written executive summaries back to the participants. Others mentioned collaborating with other organizations to provide information via their mailings or newsletters. Policy-makers who receive information from an organization such as the Western Governors' Association are more likely to be receptive than if information was mailed directly from the scientist's organization. Newsletters produced by local organizations are similarly more likely to be read by their membership, providing avenues for scientists to reach external constituencies. One concern that was raised was that direct mail "shortcuts the entire system of checks and balances of your information. It may be highly effective, but I don't like it."

5.8 Barriers to Communication.

What is particularly stunning is that all of this effort to communicate with policy-makers occurs not just without organizational support, but in many cases in spite of organizational barriers. Scientists working in federal facilities are, in many cases, actively discouraged from publishing information for use by policy-makers. Scientists in universities often face a system that rewards professional publications, but places little value on interaction beyond the peer-review system. Some professional societies hold policy forums, but reports from these usually offer a state-of-the-science overview with some recommendations for further research. Although individual scientists find means of reaching policy-makers, the lack of institutional support limits the ability for science as a body to engage policy-makers: "the institutional issues are important; they determine the shape of the possible solutions."

5.8.1 Federal Facilities

People in intermediary organizations generally expressed an interest in assisting policy-makers, but were constrained by institutional requirements and by time. In many federal organizations, staff are not allowed direct contact with people in policy-making positions or staff support for those policy-makers; rather communication has to be made through official channels, such as an office of Public Affairs or Legislative Affairs. This limited many intermediaries to a role of providing information on-request through branch chiefs and limited opportunities for direct interaction.

Most of the respondents interviewed reported having to follow a chain-of-command structure for interacting not just with people in policy-making positions, but even with the media. Typically, requests go through a public affairs or legislative affairs office, and then are passed down through the division directors and managers to the staff who can provide answers. Often, those answers are passed back up the chain for response, rather than establishing direct links between the source and the consumer. Scientists reported:

> "We are really not supposed to talk directly to the managers who are requesting information. [The organization] is really insistent upon following the chain-of command."

> "As a federal employee, we are not allowed to make unofficial contact with politicals."

> "Just working through the bureaucracy to get to the right personnel, I think that's sometimes a challenge."

> "We're kind of encouraged to assume 'just the facts ma'am' type of attitude. We're kind of discouraged from offering policy recommendations."

> "Use your common sense, because you don't want to get in trouble here. You will get yelled at if you do something wrong."

The other frequently-mentioned constraint was time. Most intermediaries were consumed with operational duties, such as developing and issuing routine products, that they had little time to search out opportunities for communication or interaction beyond their immediate environment.

It is not just a matter of control of information by the parent agency. Some respondents noted that the chain-of-command approach has some positive aspects relating to the message that is ultimately communicated:

> "It's all got to be monitored properly. You don't want one person saying one thing and bypassing the directors of various agencies."

> "You always have to be very careful not to step on somebody's toes or hand out information that contradicts something they've already gotten."

But even in those offices, there are ways in which research can be presented in a format useable by policy-makers:

> "One that we do have to do – we are required to do, and I think it's actually a pretty good idea – is that anytime we publish a paper we are required to write what's termed a technical abstract, which is an abstract that should be understandable to say, somebody who is say a congressional aide. So that whoever might want to use our work in framing policy, or in determining policy, will be able to understand what we are doing."

This kind of interaction, though, varies by organization. Some organizations are closer to "the customer base" than are others. The USDA, through local field offices, has a very close relationship to the people whom they serve, while NOAA tends to have a more distant relationship.

5.8.2 Academic Reward System

Research scientists, on the other hand, generally had fewer such operational requirements, such that they could devote more attention to a subject area in which they were interested and develop one-on-one relationships with individuals who might benefit from the shared knowledge. Furthermore, many of the research scientists interviewed were from universities which, while perhaps not actively encouraging or rewarding such outreach activities, at least did not constrain communication to the degree reported among federal organizations. However, emphasis on peer-reviewed publications common to tenure-track faculty positions inhibits time that can be spent on outreach activities.

Application of the research, especially with regards to formulating policy, receives little attention and little reward within the university academic structure. Basic research is given priority over applied research:

> "I am also a product of current academic structure, which probably gives you more value for your research activities than outreach or policy-making activities. They basically quantify your contribution based on the quality and quantity of research you have done, beyond the classroom. That restricts you from doing the amount of outreach activities you want to do or if you want to get involved in policy-making. Also, I believe, that our academic training is such that we get excited about pushing the boundary of knowledge. Trying to convey that to the public and the politicians – yes, we do that when we are in difficult situations, such as when funding is getting eliminated and things like that. But our training, the structure of academia, the structure of all the professional organizations is such that you do not get much recognition of doing this, like for example outreach or getting involved in the policy-making, unless it is your field of research. In other words, applied research gets less credit than basic and fundamental research."

> "There needs to be a fundamental change at the university level. There has to be a more direct link, even from say my graduate research assistant who if he or she has an idea that he or she thinks will advance science in some way at a policy level, should have an ability to communicate that, as a citizen or whatever."

> "The experience I have had is that it finally doesn't really matter, the research reports. There are numerous scientists who do outstanding work and virtually something in their work can be used towards policy at some level, but none of that really gets translated. One of the reasons I have seen is that there is no specific contact that is ever made with the state or congressional level, and the process itself is poorly understood. It is often ignored, and not even something that is encouraged at the university level."

> "Essentially the tenure system is such that in order to get seniority in the university and the faculty, you basically have to go with the existing infrastructure. So if you are a rebel and believe in other issues, you aren't going to get that promotion. That in itself is the root of where the problem lies."

With a lack of incentives, a young faculty member or graduate student would be better served by producing peer-reviewed publications than she would by engaging in outreach or policy activities.

The peer review process itself can be a barrier for some. Respondents noted that findings that do not conform to conventional wisdom face greater scrutiny in the peer review process than do other studies, and that those that conform to a reviewer's perspective are more likely to be published. This creates gatekeepers on official information channels that negatively impacts science. Because the academic reward system is heavily tied to professional publications, those researchers with contrary studies face greater barriers to publication, and either come under pressure to conform to the mainstream view in order to get tenure or cease publishing. A related concern was that extreme perspectives or findings are sometimes heavily promoted:

> "Outlandish claims based on one small segment of a study with the database that's enormous, [making] grandiose conclusions based on that small sampling of data, is where red flags go up and I get a lot more suspicious."

> "There's a lot more mileage to be gotten from a study that results in a gloom-and-doom forecast than one that comes out and says everything is status quo and there's no problem."

These "gloom-and-doom" types of studies not only make it through the peer-review process, but often are heavily promoted by journal editors.

Universities do make some effort at applications. Formal outreach programs, extension programs, and civic presentations provide avenues for reaching outside of the university, at least at local levels. However, these activities are sometimes the first to be cut when budgets get tight:

> "Theoretically, universities are perfectly positioned to do that, because they're supposed to take the long-term view. That's why we have tenure and things like that, where people can be here for a couple of decades and advance the line of research in great detail and with great consistency. The outreach programs, such as the extension program here, has been repeatedly cut back, so while we're positioned to do it, many times there's not the funding or resources to make it happen. But [the university] has people on the ground all over the state, extension agents working with farmers and ranchers. They're pretty savvy people typically, and as long as they are kept abreast of the latest research going on at the university and at others of course, then they can be pretty effective that way."

While these types of programs, given adequate resources, have been effective at grass-roots levels, reaching senior policy-makers is a much more daunting task. In fact, universities sometimes prohibit contact between faculty or staff members and senior government or elected officials:

> "The university has its own organizational agenda, where individuals, centers, research groups, departments, whatever it is, there are specific guidelines in certain cases to explicit instructions that researchers cannot directly approach their congressional representatives. That is in my view poor strategy, because it may so happen that the university may benefit at times. There should be a more direct opportunity for scientists to interact with policy-makers, and right at the academic level, if we want to make any meaningful progress in linking science and policy."

Getting permission to collaborate on activities at top levels sometimes takes great effort, yet one more barrier to effective application of scientific information.

5.8.3 Competing Sources

In addition to federal and academic barriers, even if information does make it into the policy arena, there are further barriers. In some cases, even doing quality work and summarizing it for policy-makers does not guarantee use. Information may be ignored, it may be difficult to get organizations with different jurisdictional authorities to collaborate, and it may be dwarfed by information coming from well-funded organizations:

> "I do believe that there is a tendency, especially in federal science, to try to please the master, as it were, by doing customized studies that fit the needs of certain people above you and brings a conclusion that doesn't make them angry. I think when you are looking at science out in the world, in academics, and independent institutions, there is a better tendency to produce what I would call independent science that has not been influenced by who's asking for it and so forth. You can just look at several billion dollars worth of global change research and how that's not being referenced or used at all in setting policy."

> "So that in any given area you have a multitude of groups that have, to some degree, to collaborate in the management and protection of bodies of water, be it surface water, be it ground water, whatever it is. It's a very messy area, and the law is different in every state. The law actually gets in the way of doing anything that is coherent in terms of resource allocation and conservation and protection of resources, for pollutants, etc."

> "There is a problem in that science as a body does not have a lot of money to lobby. On the other hand, the agricultural industry does have financial resources to get their message across. So if there is an issue about an environmental concern, generally they're going to hear more from who have the money to talk."

For those who have gone to tremendous efforts to get their message to policy-makers, having it be ignored can be quite discouraging.

Finally, even if communication is allowed and encouraged, scientists still face the barrier of communicating across the cultural divide:

> "I think there is of course the culture that real scientists are unintelligible to anyone other than other real scientists, and if you are intelligible you are therefore an inferior scientist. Apart from that being a load of BS it's not very helpful."

> "In order to get there we often have to describe where all of this information is coming from so that they have kind of a comprehensive understanding of the problem and its uncertainties. As you can imagine for the policy sector that is quite challenging, because they're not necessarily scientists, they don't necessarily have the training for even interpreting scientific information of any kind. It can become challenging to find the right balance between an executive summary that hits the high points while not obscuring the relevant technical information as well. It's taken us a long time to learn how to do that effectively I think."

> "There is always a disconnect between scientists and senior management, simply because scientists do not always have the best means of communication for conveying their point."

The multiple processes used by scientists to communicate to a broad audience – other scientists, policy-makers, agency staff, the general public – help to surmount this barrier. Producing multiple documents that summarize information for different audiences almost assures that some relevant information is transmitted between the two. The process of producing such documents also creates a repository of information that may be called upon on-demand.

5.9 Developing a Message

Discussions with intermediaries included questions on the process of integrating information for policy-makers. From their open-ended responses, a process consisting of four general elements emerged. It actually is an iterative process, but is presented here as a sequence for clarity. The first element is identifying reliable sources of information. The second element is evaluating the quality of information. Even if a source is considered reliable, an individual finding or study may contradict something from another reliable source, and a decision must be made as to which is correct. Third is the process of consolidating information. This includes summarizing information for the audience, and also clarifying opinions from facts and expressing limitations of the information. The fourth element is communicating the message to the policy-maker. Respondents noted that direct lines of communication are preferable, but there are other avenues that may be equally effective.

5.9.1 Identifying Reliable Sources

Regardless of organizational source, respondents offered some descriptions of qualities they look for in sources. Most mentioned factors such as direct access to information, direct experience and local knowledge, or an understanding of the customer base. The most favored sources seemed to be mid-level or operational individuals:

"It's the grunt people, the people who are doing the work, who are more useful"

"Typically the staffers are the ones in the know"

Usually these would be people with whom the scientist has a working relationship A source's ability to understand the complexity of the issue was described as an important characteristic. Another respondent mentioned wanting the "fewest filters" between the source and him, with any filters being unbiased or at least known biases.

Federal government sources were across-the-board viewed as reliable sources of information. People mentioned trusting "official" sources of information and described them as having "factual information" and "no vested interest" in the outcome. Even so, one respondent noted that it was good to compare sources: "even though we're the government, we don't have all the answers. Sometimes it's good to have someone looking over your shoulder to make comments and observations or new ways of doing things." State agencies were viewed positively as well, but information tends not to be kept up to date as the issue fades from the attention of agency officials. Although agencies may be hit-or-miss, state boards or task forces were good sources of information: "If you bring those people together they can contribute all their information and they usually come up with some pretty good stuff."

Universities were seen in a similarly positive light, but some expressed more caution. University centers that were active in drought, such as the NDMC or the Climate Assessment for the Southwest (CLIMAS) program in Arizona, were described as trusted sources, but biases of some sources were not always clear. One federal official noted that some academics believe that they have a better solution than the federal agency, and such sources tend to take on an advocacy position in trying to get the federal agency to change its practices. Professional societies were generally trusted sources, but not seen as particularly relevant. One respondent commented that he was as likely to hear about issues through users as he was through professional channels and another commented that there was “not much new from professional associations”. Some, more on the local level such as civil engineers or stormwater professionals, were good links to the private sector and local decision-makers, and were therefore a good source of information.

The media was viewed as useful, but with some degree of skepticism toward their credibility. The media, including popular journals, were a good source for collecting background information: “I’m getting a flavor, both on the scientific and political agendas, of what is actually the latest thing going on.” While the media could provide background information, most commented on concerns of inaccuracies:

> “A lot of times a reporter will go to a meeting and you might get four different opinions on a topic and they’ll just pick one, the one they think will get the biggest response, the sensational view.”

> “There’s a lot of misinformation that goes out from the press and science journals these days.”

There is also such a volume of information via the media, especially web-based access, that there may be great information available but there is not enough time to look at and evaluate many sites.

5.9.2 Evaluating the Quality

From whatever sources a scientist may choose, information must be evaluated. Even the sources viewed as reliable may sometimes conflict. Scientists described going through a process to evaluate information:

> "We have to be careful about the type of information that we put together because we don't want to rush to judgment and pass along really bogus information that's going to get ourselves in hot water, because it's going to go to people who may be making some major decisions."

> "To a degree all information is useful. It's up to you to distill what's worthy and what's not."

> "Data is data, it's a matter of the way it is interpreted that really lends itself to a sense of objectivity."

> "I think [evaluating the quality of information] is part of the reason I have an education and get paid for what I'm doing. A lot of the research is looking at the long-term and ways of doing things better. Clearly if I see that it has potential I'll monitor it and see how it progresses over time."

Experience is how scientists best described the process:

> "Over time there becomes sort of an institutional capacity. What I mean by that is that you get a feel for it and so there just comes a time where that becomes more comfortable. You're kind of sifting through it and doing an objective thing in your mind, almost like a computer would do, except its not quantitative."

This subjective process boils down to essentially they know the right answer when they see it.

Although being a subjective process, a few cues were distilled from the interviews. Track record, organization affiliation, the source's capabilities, consistency, and review processes were mentioned as factors in the evaluation process. Scientists knew individuals and organizations that provide quality work, constituting what the respondents described as a track record. Both individual and organizational affiliation were important elements of judging the track record, although an organization of unknown quality did not preclude using an individual scientists' work. Some organizations have motivating factors that may bias their reporting, which was a consideration mentioned by several respondents. Relevance of the individual's and organization's credentials to the issue was important. One respondent mentioned a preference for well-vetted processes in which multiple scientists contributed as compared to individual academicians.

Although peer review was not essential, many indicated a preference for some sort of review process. In the follow-up questions (Appendix D), respondents were asked to rate on a scale of one to ten (10 highest) the importance of peer-review. Research scientists placed more emphasis on this than operational scientists. Six respondents ranked peer review as most important (10) with the others rating it highly at eight (4 respondents) or 9 (2 respondents). Two respondents ranked peer-review as unimportant (1), but offered the caveat that peer review was important to them but that they did not feel that it was considered by agency officials. Several noted problems in the time the peer-review process takes, noting that peer-reviewed information may not be available when the users need the information. Intermediaries also ranked peer-review as important, although there was recognition of the limitations. Three of the intermediaries respondents rated peer review as most important (10). Two respondents rated peer-review as 6, three rated it as 7 and one as 8. The other respondent rated it as not important (1). Respondents noted the importance of peer review for developing consensus and credibility, but that it was not always necessary. Other forms of review, such as agency reviews and "official information" were seen by some as equally valid. Respondents noted that peer review does not always work, and in fact can eliminate alternate claims that could be equally valid.

State reports were cited as an example of quality work that had not necessarily gone through a scientific peer-review process. Others mentioned an openness to all information, provided that it met fundamental tenets of research and were not just assertions. Key factors in such assessments were relevance of the study to the issue, whether appropriate data needed to support results were used, and whether the individual or organization had the ability to put resources towards the information. In the latter case, a lack of resources might signal that some corners were cut in the process. Reviewing sources with a critical eye is essential. Following links to the source of information was one way in which manipulation of the data could be assessed. This is consistent with the model construct of credibility of the message being an important factor in receptivity.

Commonalities and consistencies between sources were a signal of confidence in the outcome. In cases of inconsistencies, respondents offered a range of options. Some mentioned that they would favor the more credible sources, others mentioned putting disclaimers on the recommendation: "if it's coming in from left field and right field, your opinion stays in left and right field, unless you have some firm basis for moving toward one or the other." Corroboration with other information, outside of physical measurements, might give an indication of which way to shade a statement.

5.9.3 Consolidating Information

Because policy-makers frequently operate under time constraints, information must be condensed for them. These usually take the form of short summaries or bullet-points. Scientists mentioned the importance of tailoring information to the specific audience and of placing information into the policy-maker's context. Analogs were mentioned as a useful tool to frame the context of the information. Respondents mentioned the importance of sticking to facts, or clearly delineating where opinion or interpretation comes into play, and of having clearly-stated limitations regarding the applicability of the information presented.

Sometimes technical information is lost when information is condensed into executive summaries or bullet points. Scientists were asked whether or not they were willing to provide summaries, even if that meant losing important details. Of the research scientists, 9 indicated a willingness or requirement to do so. Two of these mentioned that a good summary can convey limitations. One was willing to provide a condensed version, but only with the ability to attach supporting documents. Three indicated some uncertainty about whether or not they would. One mentioned that if there was a strong consensus, they would be willing to do so, but otherwise not. The remaining respondent said in general that he would not, unless the audience was aware of the limitations of the science. Only one of the respondents from the intermediaries group expressed an unwillingness to provide a summary or bullet points. Several frequently provide executive summaries and most have found ways to convey uncertainties within summaries or bullet points. One mentioned the importance of supplementing the summary with references for more detailed information. Others noted that it will happen with or without their input, and that if it is going to happen anyway that they would prefer to be the ones to do it. Two of the respondents mentioned the importance of writing skills, with each word carrying more weight and brevity leading to an impression of certainty.

Formats may vary depending upon the target audience. The first consideration is length. Officials want information condensed to executive summaries or bullet points, usually no more than a page. The information must be relevant to the issue and informative, which means, as one respondent stated, "you better think who you're writing for before you start typing." Within the summary, information needs to be customized:

> "As far as I can tell the scientific information is getting out in a way that lets decision-makers get enough information to do their job. But you also have to be careful of overwhelming them. So you try to rely on objective information but you try to filter out all the stuff that might be superfluous to the problem."

Scientists mentioned making the official aware of what is in the literature as well as conveying their own knowledge. Some preferred including an attachment that would provide additional details or references to other experts. In some cases, there are opportunities to iterate on a document before providing it to the policy-maker. For those trying to reach policy-makers through web sites, one respondent mentioned building layers of information with progressively more detail. This allows senior officials to get a "big picture" of the issue while those working in more detail have access to information about the data and uncertainty. Some scientists felt uncomfortable with distilling information to that extent: "they ask for bullets and I give them the full ammunition."

Another consideration is how to convey information. Respondents mentioned several approaches that helped to make information relevant to policy-makers. One is by asking questions such as "how can you possibly use this information?" or "what decisions do you make?" This provides the scientist with some measure of the policy-maker's operating environment, such that the scientists can frame research into an appropriate context. Foremost is the necessity to match information to problems: "A combination of knowing what their responsibilities are and who that individual is allows you to be far more effective in conveying scientific knowledge that you have in a way that can be useful for them." This requires tailoring information and presentations for particular requests and sometimes issuing the same information in a variety of formats:

> "It is important to communicate at a variety of levels, so that people who are in the front lines trying to supply water to a city see the scientist's view on things, a view of the science, what we understand, what we know about things. Then there's maybe more understanding of the issues that we face, and perhaps more receptivity to actions from a higher level of government."

It is critical that scientists approach this as a process, rather than a single request for information. As individual decision-makers move around in organizations, opportunities for access open. Through experience, these individuals learn whom they can trust. One respondent noted: "they need to know a bit about you. It works so much better when they are as likely to call you as you are to call them."

Another way is to frame issues using analogs or odds. Analogs provide a baseline that helps officials to narrow options:

> "Looking at the past, pulling out examples from the past, has been a very effective way of doing things. Particularly for droughts, because our big drought came a few years before your big drought, which means it was 80+ years ago now. To be able to look back at that, particularly in the droughts we have had in the last couple of years, and compare things, puts things into perspective. I also find that it has been very effective. This is the kind of thing that goes very well in an informal setting, when you can simply say 'well you know, we can remember that these things can happen, they have happened in the past, it is going to happen again' and then we can push into the things that we think might be happening in the future."

The advantage of this approach is that it frames an issue in objective terms. If a policy-maker recognizes that the event in which they are immersed is not the worst on record, that knowledge may be a tool to spur examination of alternatives to increase societal resiliency. Framing information in terms of odds is a concept familiar to most people, but the information producer has to be careful not to let the most likely odds convey a sense of certainty.

The other consideration is to not stretch beyond the limits of the knowledge which the scientist possesses. If there are limitations or uncertainty in the data, these need to be stated so that the policy-maker is aware of areas where there may be disagreement. Presenting information with confidence assessments, caveats, or evaluation measures of the quality of the information are methods mentioned by some scientists. Some scientists think that it is necessary to provide pre-packaged solutions, but realizing that the information is only part of the policy-making process is important:

> "They don't want us to be risky. They want facts. They're getting bombarded by the press and whomever and they want to be able to state facts and they don't want to themselves get in trouble by misstating facts, so they're comfortable with us providing only facts."
>
> "Hope they have enough common sense and reasoning to listen to all the experts to make up their own professional judgments."
>
> "They're big kids, they'll make a decision. They have to live with that. You're just trying to give them everything that could be of value and then they have to discern what to do with it."

Providing background on sources, highlighting differences, and encouraging people to look for themselves to decide were described as useful. It is also important to separate opinions from fact not just for the sake of the policy-maker, but for the scientist: "The thing in science, all you have is your credibility and if you lose that, you don't have anything anymore, you're just shot."

5.9.4 Communicating the Message

Once information has been collected, evaluated, and condensed, it is important to have the proper means to communicate that message to policy-makers. Methods used vary from direct communication to using intermediaries:

> "Direct communication is by far the best. That way you can explain, even if it's briefly you can still explain. You don't want to talk above them in scientific language because it will turn them off. You want to talk in laymen terms, in their language if you will."
>
> "If you do a good job of explaining whatever position that it is, [people with direct lines to decision-makers] can definitely influence the policy-makers."
>
> "I know of no Governor who is reading the Oklahoma Climate Survey and pulling those numbers off the table. It's always through sets of intermediaries."
>
> "Every one of our people is somehow involved at the state level in a drought task force, if they exist."
>
> "Kind of a second-order, influencing the main public mechanisms by which they get their information. The way these outfits work is they have trusted sources of information, a lot of times insiders or friends or long-established contacts, but because they work in a public arena and they get called to the carpet for things, they look for corroboration. They don't like to be lone ducks on issues generally. They kind of like to be in the middle of the pack."

Several other communication channels mentioned were working with Hill staffers, contact via office management, and collaboration with other agencies. Understanding that those seeking information are often under tight time constraints means that having relevant information at-hand is essential. From whatever source, the Internet has made access to information much easier for the scientists. Whether it is online journals, e-mail discussion lists, web sites, or the media, there is a plethora of information: "we have all this communication going on and these products that are out there for people to look at, you don't have to start doing backflips trying to come up with something, like we used to have to do."

5.10 Perceptions of How Policy-Makers Use Scientific Information.

Respondents cited intentional misuse, policy-makers' limited comprehension of science and scientific processes, time and resource constraints, and difficulties finding information or applying it to the policy arena as factors which affect appropriate use of scientific and technical information. Selective use of scientific information was cited in several cases. Phrases like "cherry-picking", science being "selectively used to support a position", and "decisions based on political positions" describe this set of perceptions. Adherents to this mind-set generally believe that decisions are based upon political pre-dispositions and scientific information is used as cover for those decisions. Partisan issues come into play as well, with "Democratic climatologists and Republican climatologists" competing for their favored policy positions.

The ability for policy-makers to manipulate scientific information is made easier by the variability inherent in science:

> "It all sounds good at least to the uninitiated, so even if there was a 99% consensus that there might be this thing called global warming happening, there are ways that policy-makers can get information from the other side and use that to justify inaction."

Even if there is a relative consensus on an issue, there are always scientists whose opinions differ, such that any single opinion can be used to justify policy decisions. Often, fringe views may be used to justify inaction.

Less pernicious is the perspective that policy-makers misuse scientific information, not because of intent but because of difficulty in understanding scientific information and processes. Respondents noted a great variability among policy-makers, with some being more receptive than others:

> "In some cases, I think they are doing a great job, for example those policy-makers that are supporting the drought assessment have gotten the message. But then again, you take another set of legislators and they have no idea what's going on. It's so case-specific."

One explanation offered for why some policy-makers are not more actively engaged or perhaps unintentionally misuse scientific information is that they don't understand scientific processes:

> "We are at a point where our society is becoming almost scientifically illiterate. We're having trouble even getting people into graduate school in science. The elected officials generally do not have a strong scientific background, and yet they are making decisions that are based on rigorous scientific analyses that they don't fully comprehend, neither do their staff members."

> "I think the general political process is attuned to and used to dealing with ambiguity in its inputs as they come from other sources, a whole variety of public opinions on this issue and that issue, but the fact that this goes on with science too isn't really widely appreciated."

Concerns mentioned by these respondents are that those using the information are unable to evaluate scientific conclusions critically and that policy-makers' preference for definite statements runs contrary to the probabilistic nature of most science. Their perception is that policy-makers "ignore the probability and simply use it as fact", not necessarily intentionally but because probability doesn't fit into the policy-makers decision processes. Perceptions of policy-makers are similar to direct experiences scientists may have had with journalists: "It's like having a newspaper journalist write an article on you, they invariably get a lot of things wrong, just because we're in a highly technical and specialized field. It can be frustrating." Sometimes this leads to a fatalistic viewpoint of the policy process: "We'll never understand how elected officials operate, because we're not in that area, and they'll never understand what we are really talking about – completely understand."

According to this perspective, policy-makers are making a good-faith effort to use scientific information: “many decisions are greatly influenced by what the policy-makers perceive as science.” The difficulty, however, is that policy-makers have trouble discerning quality scientific results from “pseudo-science”:

> “The fact is if you have valuable information that is supported by the majority – the people in your scientific community – I’m very frustrated that that isn’t weighted more than those results that come from the far edges of science or even pseudo-science, which are sometimes treated with equal respect from the media because they just aren’t informed and they aren’t knowledgeable about science.”

The nature of scientific research lends itself to a range of conclusions. The media, and by extension policy-makers, tend to be drawn by the dichotomies of the extremes, but “real science is usually in the middle somewhere, complicated and covered with welts and hard to fathom.”

Because of the complexity, information presented by scientists can be unintentionally distorted:

> “Policy-makers, elected officials, the popular press, all want to you make a definite statement. They want a quote. They want us to be simplistic, to give simple answers to the questions, and science rarely allows you to do that, particularly when you are dealing with something as complex as drought or weather information. I think scientists need to be very cautious in the way they say things.”
>
> “I think a lot of the political types, even their staffers, are really uncomfortable with some of the materials presented to them.”
>
> “The same numbers are there but they’ll interpret it differently, using past experience or other research that might not be available to others.”

The difficulties here are in applications. The complexity of science makes it difficult for those not trained in the discipline to apply it to situations. That leads to problems of using broad-brush applications that lead to inefficient, if not incorrect outcomes. One example cited was in distribution of drought assistance. Because of limitations of data sources and difficulties applying new technology to assessments, drought assistance is often provided – or denied – on a county-level basis, even though parts of the county may or may not be suffering effects of drought. If a county is declared eligible for assistance but doesn't actually need it, that leads to an inefficient outcome. If drought assistance is denied but portions of the area are suffering impacts, local or state policy-makers will come under pressure to respond, even though the federal government does not perceive the need to react.

Sometimes these difficulties in distinguishing "good science" from "pseudo-science" create opportunities for dialogue between the two, such as was the case with the film *The Day After Tomorrow*. Some scientists viewed the film as an opportunity to discuss the science on a national stage; others were more reticent: "I just can't be supportive of efforts to use a tainted product like that to try to get people to talk about climate change when you really should just talk about the reality of the situation."

A contributing factor to policy-makers' incorrect applications of scientific information is that although policy-makers may understand the information, they do not have sufficient time to conduct a thorough investigation. Another factor is that information may not integrate easily into the context in which they operate:

> "I also realize that policy-makers are under a lot of stresses and being pulled in a lot of different directions. I actually have high regard for a lot of the policy-makers, because just the amount of hats they have to wear are tremendous."

For their part, policy-makers do want, and often seek, a scientific perspective on issues. One respondent commented that the use of scientific information in policy decisions has improved over the past ten to fifteen years. Another noted that "these policy-makers do want feedback, they don't want to operate in vacuum." The challenge is linking the two:

"I think there is generally good science that's being done but I'm not convinced that science is reaching the end-user and it's not clear how much of that science is making its way back into policy."

One way in which policy-makers resolve this situation is to latch on to only a few, or perhaps a single, source of information:

> "Media or policy-makers, they don't really have the willingness or time to research out what is it that they want to understand. As long as they just get one representation that's being called a meteorologist or a climate person and they get that person's opinion, often thinking that person provides a complete view of the entire field and will provide a balanced viewpoint. But more often than not, it is a person's individual viewpoint which gets translated."

In some circumstances, this information source may not have gone through the rigorous peer-review process as other information has:

> "Because of the rapid communication we have in our society today, I have a deep concern that policy-makers have access so early on in the research that they are susceptible to using information that has yet to have been scientifically validated. My concern is that we can bias or influence policy before we have scientific peer-review of the results."

Once information from incomplete or insufficiently reviewed sources gets into the policy-making process, it becomes difficult to alter perceptions. Information often gets passed upward through organizational channels. At each stop along the way, information becomes further simplified, and sometimes distorted. As 'bad science' gets incorporated in the process, it becomes nearly impossible to extricate, instead becoming part of the belief-system on which senior officials make policies.

5.11 Engagement in Policy-Relevant Activities

Given these perspectives on the use of scientific information, how should scientists engage policy-makers? As with their perceptions of policy-makers, there is a range of attitudes toward involvement. There are some scientists who feel that their job is to do the research and let the results speak for themselves, and others who see the need for active participation in policy-making. Some are engaged indirectly, through outreach programs for example, while others are more directly engaged but tentative.

Scientists' involvement in the policy process is not always reflective of the way in which they view scientific information is used by policy-makers. One might expect that scientists holding a more preferential view of policy-makers may be more likely to be engaged in the process than those who view policy-makers' motives with skepticism, but this was not always the case. Some who view policy-makers in a negative way are nonetheless engaged in the process, trying to improve it despite its problems. Others who view policy-makers positively choose not to be engaged, often letting the results "speak for themselves". These dimensions lead to four different roles of scientists: collaborators, consultants, educators and critics (Table 5.10).

All four roles were evident in each of the two groups of interviews. Research scientists from the producers group seemed to exhibit more characteristics associated with consultants, namely a generally positive disposition toward policy-makers but a preference for providing information and not interpretation. Intermediaries generally

Table 5.10. Scientists' roles within a communications network, according to expectations of use and style of engagement.

Expectations of Use	**Style of Engagement**	
	Active	**Passive**
Information will be Used / Interpreted Correctly	Collaborators	Consultants
Information will be misused / misinterpreted	Educators	Critics

exhibited more skepticism of policy-makers, but were more likely to be engaged in the process, suggesting a preference toward the educator role.

5.11.1 Collaborators

Those who view policy-makers positively and are actively engaged at some level, even indirectly, can be considered collaborators. These individuals are more likely to be involved in state drought task forces, work directly with state or federal officials, or participate in other hands-on types of activities where they routinely interact with policy-makers or those who have access to policy-makers on a routine basis. Collaborators usually take a long-term perspective of the process and will remain engaged and available over an extended period of time. Collaborators recognize the need to shape information so that it is useable by different communities. Respondents from this group mentioned terms like context, ambiguity, filter and translate. They recognized the demands on the time of policy-makers and the necessity to condense information.

Collaborators recognize that policy-makers need people upon whom they can rely for information, and that information needs to be structured in a way that makes it useful for applications.

> "[The] Field of Dreams approach is 'we will build it they will come', so you do your science and you put it out there and the naive expectation is that policy-makers, water managers, etcetera will begin to use these brand-new wonderful tools that you made. The reality is that no, they won't. There are many reasons for that. One of them is just that it's brand new. You have to bring this whole thing into the context of professional practice, which is a very important thing in water management, particularly in the perception of professional risk."

> "I simultaneously believe that it is important that we, as managers of science organizations, do use our knowledge to influence policy-makers, and I'm talking now specifically about elected officials, that we should engage the policy-makers in discussions so that we have provided them with accurate information, including

> an interpretation that would be appropriate for them to use in making policy decisions."

Among the reasons cited for why scientists do not do a better job of engaging others outside of their community was the lack of a reward system that would encourage scientists "to step out of our comfort zones and go make a point in a state capitol or Washington D.C."

Collaborators recognize that scientific information is not always easily used by policy-makers, and that they, as scientists, need to be actively involved to help assure effective use of the information:

> "Policy-makers essentially can't act unless they have appropriate information on which to make their decisions. I can ask the policy-maker to make the decision, provide them with no information, and the answer is probably no better than flipping a coin. So the idea is that if you've got information, then you can assess the level of risk and whether that level of risk warrants taking action or not. So I think therefore we need to be present and there to express current state of knowledge and current state of uncertainty."

> "I also see enough of how policy-makers think and work to recognize that they are in every decision balancing a huge number of factors and that the compelling case that science might make may ignore those other factors. That's often what leads the scientist to think that his or her research has been ignored in a decision."

> "Pure science by itself in some ways is valueless. In order for science to really function effectively in society, people have to bring value to it, which is where the political process gets into play, and where it gets messy, where scientists don't like to go."

Some scientists have taken it upon themselves to directly provide this integrating function:

> "You need somebody to translate the science for senior managers and policy-makers into lay terms, into their terms. When you get into acting as a communicator or as a person who translates information, you can see your critical role. You can effect change, but by taking the science, taking the information, and making the key points available to people who are the decision-makers, who are the policy-makers. They don't understand the science. You'd have to take several pieces of information or several scientific journals or whatever and boom, three bullets. That's what you have to be able to do to get the message across."

> "They have too much information to filter through. You may have some groundbreaking science, but you're not going to get anywhere unless you can translate it for the policy-makers. What you need to do is to have some intermediary who can look at the forecast, translate it and say 'this is what it means for you, this is what it means in the long-term, this is what we have to do because of the information that the science is producing."

But even those who try to become involved do not always have a clear idea of how to engage these policy-makers, describing the process of translating basic information into decision-making as "a completely undefined, poorly resolved subject." Even translating information within scientific disciplines is a challenge, as respondents noted difficulties communicating with hydrologists and consulting engineers, much less communicating with those outside of the physical sciences.

Not all scientists need to be actively engaged with policy-makers or other consumer groups. One respondent noted three subgroups of scientists: theoretical researchers, applied researchers, and an applications group.

> "The applications group is the one that might be best suited to work directly with policy. Not to say that some of these other scientists shouldn't go and give talks when invited or go to The Hill and give testimony. It might help the cause that prominent scientists are apt to do that."

Scientists in this applications group are the ones who need to invest in understanding those who are using the scientific information. Getting close to the consumer and building trust is a critical element in the effective transfer of scientific information: "The farther away the information source, whether it was the state government or the federal government, the less it was trusted." It was also mentioned that it is important to be seen as 'one of them'. Going through the training and certification processes that others outside of the science community do builds credibility:

> "I go to these workshops or meetings where these scientists kind of see this for the first time and they get all excited about this. I'm glad they're excited but they've got a long ways to go before they really get it. I ran across so many scientific folks who think they are doing applications but they're not. They're not doing this kind of interaction. They're not really thinking about the end-to-end stuff. It's developing that rapport. I've gone through the training, gotten my certificates, so I know what they go through. I don't claim to have it all, but I'm conscious of it."

Being able to understand the perspective is an important element that enables these communication channels to be developed.

5.11.2 Consultants

Those who view policy-makers positively but are not actively engaged with the process can be considered consultants. These scientists see their role as limited to the production of knowledge and responding to others when called upon, similar to the notion of ivory-tower experts. Reasons for detachment include philosophical concepts of the role of science, time or resource constraints, or a preference to leave applications to others. Scientists in this group may interact indirectly through colleagues, most likely within their organizations, who are actively engaged with policy-makers. An example is a university faculty member who discusses his research and views regularly with another faculty member who is the state climatologist.

Scientists in an consultant role express a preference to stick to the facts, although some expressed a willingness to provide interpretation if asked:

> "You can get a pretty quick read as to what they understand and what they don't. In those cases I'm more of a neutral provider. A lot of times though, eight out of ten times, they're going to ask you to interpret."

> "What they do with it though is typically they'll spin it. You can't control that, but you can provide the data, give your take on it if they ask you for it. Typically

they don't just take the data and go, they want or ask for some evaluation, synthesis or interpretation."

"When a policy-maker needs an answer, he'll talk to his Hill staffers. They may have 24 hours to turn around and write a position paper on an issue. They have very short turnover times, production times for these pieces of work. They would love it if they can just call a scientist who's an expert and say 'what do you think about this?' If there's not a scientist handy, they'll call whomever they can find. What they want is convenience. If all the scientists ever do is publish papers, that really doesn't cross the barrier into the policy realm very effectively."

Being available to provide that service, when called upon was viewed as essential. Scientists in consultant roles often have knowledge of issues within their organization, describing activities as "dealing with the weeds" and being accessible to senior officials for providing advice on major policy issues.

There is a degree of uncertainty among consultants in just how far they should go in assisting policy-makers. Most consultants saw their role as providing "transparent and objective" advice, or being the consult, leaving it to decision-makers to determine what to do with the information:

"The role of science is providing inputs that you have to sort out and not as much in providing the answers but as providing the inputs. It's not very well understood, what science is about. Particularly the role of science and technical information is not making your decisions for you, but facilitating and acting as an assist."

"To equip policy-makers with the best up-to-date information to make a sound decision"

Some were concerned about jeopardizing the credibility of the profession:

"If scientists are viewed as being simply another biased constituency that just really downplays the potential role that they can play. And it's a crucial role that they have to play. They can't really afford to muck that up."

"The politics can be so closely intertwined with relief and drought that it can be a very blurry picture if you're not careful. No doubt about it, it makes you more aware that you've got to stay out of the political arena and stay away from

> pressure. You also have to think every time you get a piece of advice, even if it's from somebody trusted, to make sure there's no political sway in that."

> "One of the issues is that scientists have to maintain their sense of objectivity. Obviously nobody's completely objective because our personal opinions end up coming into play, but nonetheless I think maybe from that perspective one of the most important things is just open communication and the peer review system, that any ideas that people put out there are subject to discussion and evaluation. That's probably the most important way. The shortcoming of that of course is that doesn't necessarily get information into the hands of the policy-makers."

Others mention concerns of a loss of respect and not being trusted by the general public. Scientists in this group view their role as establishing credibility and degrees of confidence related to information. Their role is one of providing information to those who request it, but keeping a distance from how the information is used. The way in which science might be used in policy decisions in this model is one in which there is a "group of people in the middle, who just want the facts, who are just trying to base policy on the best available science … that is divorced from your own political beliefs."

Helping policy-makers to digest information was a tough issue for some. These consultants see the importance of providing advice, but expressed uncertainty over how much interpretation to provide:

> "There is too much information and they get confused. They don't want to get everything, usually just because there's no time to get everything. So they want it simply presented, but they want the best and most complete information. How can we as scientists deliver that? Tough question."

> "It's kind of like you serve the buffet and then you let them come and eat. That's kind of what I've been taught. I don't know if you actually then serve them up and take them the plate or not."

> "We are not recommending policy per se; we are providing information to *help* the development of policy. We are not making policy ourselves, nor do we make policy recommendations, but we provide information that will help the policy-makers make the policy."

Respondents in this group mentioned a need to be aware of the needs of policy-makers to guide their research, but then preferred to "partially disengage" from the process and conduct the research before transferring the information back into the policy process. Those who cited opportunities in program evaluation fit this model. Policy goals are set and stated and become the basis upon which an objective evaluation of program results may be made. While this is a dated model of program evaluation, it is nonetheless a role in which some scientists feel comfortable.

One way in which information may be integrated is through federal agencies and programs. Respondents noted that research proposals usually require justification of how the research will impact society. The cumulative effects provide a repository of information about the state of the current research and how it applies to societal problems. The difficulty is that this information is not always linked to policy-makers: "I think we should be called to justify why society should support what we are doing. But that's sort of going in one direction, it's not really making sure this information is really getting passed on to all the people in the right way." Even if this is not available to policy-makers, however, it does cause scientists who are writing proposals to think of their research in broader terms and to seek opportunities for applications beyond the scientific community.

5.11.3 Educators

Those who view policy-makers negatively but are engaged can be considered educators. Rather than eschew the process, educators seek to improve the process, either through direct interaction or through affecting the general environment in which the discussion takes place. Scientists from this group may use methods such as the media or the Internet to call attention to misuse or misinterpretation of scientific information. Educators believe that, while many policy-makers may misuse scientific information, there are some who are willing to invest the time to learn about scientific issues and apply the information properly. Outreach programs are a primary method used to interact outside of the science community, providing both an opportunity for training and a vehicle for transmitting information. Like collaborators, educators also take a long-term view of the process, and attempt to foster relationships over an extended period of time.

Scientists as educators take a more adversarial view of the policy arena. In some cases, they view policy-makers as using "snippets of science" to support positions, but this tends to be attributed to a lack of clarity:

> "You could have a good plan and you get to the policy-making and they may not go strictly with your plan. There's a lot of negotiation going on there. But I think science should be the backing for decisions, when at all possible."

> "In some cases they're really truly not aware of it. In other cases maybe it got to the staffer and didn't move on up or it wasn't understandable. It has to be written at a level that they can understand, and a lot of it isn't. There needs to be a retooling of the way we present this information to a short-sighted policy-maker versus your peer-reviewed journal, because they are totally different. On the other hand you can present them with some really good science and it doesn't matter, it can just totally be ignored."

> "In general, I think the value of research is somewhat undervalued, unfortunately. It's an afterthought or it's the first thing to be cut, things of that nature."

Educators noted a tendency toward short-term horizons, which is especially problematic for mitigation efforts that are long-term in nature. Others see policy-makers no differently than society in general, with increased polarization in all things, not just in science, and an erosion of the public's capacity for critical thought.

Educators, however, do not resign themselves to a situation in which scientific information is not used effectively. They do engage policy-makers, much in the role of a teacher:

> "Basically you're starting over every time and it has to be at a very basic level. You do come across some that have the vision to see through that and see past when they're in office or when I'm director of this agency, and boy, that's when you see it click and it works great. But it can be very frustrating on the opposite extreme. You educate, you educate, you educate. It gets in there, the science people know it. But then it goes to OMB or something and they take it out."
>
> "I think all we can do is to continue to educate and try to give them some background. If we can find policy-makers who are patient enough to sit still and listen repeatedly to the caveats and background that we put behind the information we give them, then they can make more effective decisions."
>
> "Even if you are mandated to do something by the policy-makers without any science first, the first thing you should do is dive into the science before you make any kind of decision."

Educators view their role as giving policy-makers not necessarily what they want, but what the scientist thinks they need. Through studies and demonstrations of techniques, educators believe that policy-makers can be convinced of courses of action on their merits.

Scientists may become frustrated that policy-makers are not always as engaged with them as they may like, but maintaining communication channels creates opportunities for dialogue when the policy-community is ready. Often, the scientists are the initiator of the communication:

> "Mostly it's we are pushing on legislators and directors of agencies, we're saying please come to our meeting, we have something important to tell you, please pay attention to this report, things like that. Almost always we contact them."

This helps to build recognition among the policy-making community that there is a reservoir of expertise available to them when needed. The drought planning process is one such example of sustained efforts aligning with the attention of policy-makers:

> "We've had this window of opportunity in the last few years to really talk about drought and what it can do to people and how they can plan for it. They're very accepting of that right now because we already have been going through this drought. They see how serious it is and maybe how they've been affected and maybe they think we could have planned a little bit better for this."

Involvement in drought policy issues during the late 1990s created ideas that were already integrated into policy solutions when the droughts of the early twenty-first century drove Governors to direct attention to drought planning and mitigation.

These types of communication channels can be developed at multiple levels of organizations. Some scientists prefer to work toward the top of organizations, often through senior leadership. Awareness of an issue creates opportunities for scientists to address possible solutions:

> "To make it effective and put it into place you have to bring it to the attention of the senior policy-makers so that they're aware that it's out there. Because I think that policy-makers are not aware of everything that is out there."

> "The people who go out and bang doors down and do things like that see the policies get changed."

Much of this may be done "below the level or interest or attention of politicians", where scientists can collaborate with program managers or agency officials rather than elected officials or senior agency administration. The NIDIS initiative was cited as one example of this process, in which scientists and lower-level government officials designed a plan and left the lobbying up to the sponsoring organization (in this case the Western Governors' Association).

Some of the scientists interviewed mentioned outreach to 'grassroots' levels as an indirect means of influencing policy-makers. Many educators engage in outreach activities, usually with individuals or small groups, most of whom are not directly engaged with policy-makers:

> "I think most of the research that we are doing in our project here is oriented to providing, making available new scientific information for use by the public and by our customers. Some of the research we do will ultimately affect policy-makers who are related to policy in an indirect way, but we are not advising directly policy-makers as to what to do. We are not a think tank."

> "The best thing to do is just go right to the level of the county meetings and all that and work in the grassroots level. Because what happens is if you have a tribal nation or some sort of fairly well-connected water district and they go up through their political ties, then if they start getting good vibrations that the work that you're doing is benefiting them then there's probably more of a chance of you being recognized as a legitimate source of information. Just going to Congress and pronouncing something won't get you anywhere, but if you can get someone else to do it for you, that goes a lot further."

Respondents engaged in outreach activities noted that policy-makers "start giving attention once they see this is an effort that has grassroots appeal" and that "bubbling up of the grassroots seems to have a sense of validity." Building a constituency enables scientists to be more effective when they need to reach policy-makers:

> "The elected officials really aren't going to respond very positively to what you have to say unless there are a fair number of stakeholders that are going to put pressure on them to do something. These guys, these elected officials are getting hammered on by every interest group you can think of and they're very busy. Unless there is a large number of stakeholders in their constituency that are pounding on them, they probably won't do anything. I would say that it really probably needs to be a combination of both, but you probably need to preface your pleas to your elected officials with an on-the-ground campaign to try to get some of the stakeholders behind you first."

Producer groups were mentioned by several respondents as good conduits for reaching policy-makers. Almost every individual agricultural producer is associated with a commodity organization, and those organizations often have access to policy-makers.

The process of ongoing communication, often at the lower levels, and of providing useful information when needed creates credibility for organizations. Long-term relationships between scientific organizations and government agencies, active participation in groups outside of the scientific community, and local sources of information were some of the factors mentioned that increase a scientists' credibility:

> "Probably our most effective role is that we are scientists who are, as an agency I would say we are a pretty good agency when it comes to climate-type work, across the state, and publish and participate in national meetings, and interact with our peers. We also have this great opportunity by virtue of where we are to actually supply the information to state and local level. I think, first of all, scientists like myself and others, ought to be willing to do that, to make the effort to put their information in understandable format, present it, take the opportunity to interact with officials and lay groups and talk to them. I think it's just in part a matter of deciding that this sort of outreach activity which is not necessarily rewarded in an organization, or let's say if you are in a university department it's not clear that that is rewarded, but scientists should do that. Maybe there should be a more definitive reward system for that."

This interaction creates a "level of trust and recognition" that enables individual scientists to participate in the policy process. Working with trusted local sources, such as Agricultural Extension offices, provides inroads with local policy-makers who then feed information upward to state policy-makers.

5.11.4 Critics

The critics tend to concentrate their time and efforts on communication within the scientific community. Whether it is because they are busy or because they do not believe information will be used properly by policy-makers, they find more rewards in professional publications, interacting at scientific conferences, and conducting research. The extent of their involvement is primarily through professional societies.

Scientists characterized as critics derided the policy process, making statements such as policy being "driven more by dollars and cents than by science" and that the policy process is "politicians telling other politicians what the science is telling us, and sometimes they're not very accurate." Several respondents noted a tightening of constraints on external communication over the past several years, with more directives being handed down through federal agencies "concerning what we can say and who we can talk to." The distrust of political motives was apparent in several statements:

> "Decision-makers have their own goals and agendas. They will do what they want to with the information that is provided to them, regardless of what caveats are put out."
>
> "The general public, to be frank about it, with their limited education that they might have, I do believe they are very suspicious about the politics and science these days when it comes to global warming, at least in this country. They think it's a scam."
>
> "It just seems to be too much in the way of mandates from the federal government to study and prove things that there may be already an agenda or pre-conceived answer to. How do we get out of that mess? I don't think we can. I think the culture is well-established at this point."
>
> "Prudence lined up against stacks of money is always a tough proposition."
>
> "I would say it's probably getting to their door but whether it's being allowed to come in or not is a very mixed bag."

Like the educators, critics noticed polarization of the policy process, but rather than engaging others to remedy the causes, they withdraw into scientific isolation.

Not all critics were as distrustful of motives. Some placed blame on the scientific community for creating problems by over-simplifying the science:

> "I am not always convinced that we are any better off for all the elaborate information and monitoring products that we are creating, because it sometimes results in folks at the working and decision-making level thinking that they don't need to know and understand their problems, that somebody else will answer it for them."

This leads decision-makers to rely too heavily on the scientists for answers, rather than developing solutions based upon their own interpretation and perspectives.

Some scientists fall in the critics' model due to other factors, not necessarily a philosophical choice. Some organizations in which scientists work discourage involvement in policy-making processes, or in some cases even contact with policy-makers. Others choose not to be involved because of time constraints: "You can always say we need more communication, but then I look at my daily work. The last thing I need is to have more people knocking at my door asking me what I think of this, that, and the other thing." Another respondent said he "would rather spend time doing solid research and I would like somebody else who's communicating that result to the politician, policy-maker."

5.12 Summary

From the interviews conducted during the course of this study, it is apparent that scientists use a variety of means to communicate, both within the community and externally. Regarding drought, there is an extensive network within the community with active communication channels and frequent opportunities for collaboration. Many of the scientists in operational organizations were themselves consumers of research, often using information sources distilled by other, trusted individuals or organizations.

Externally, scientists establish active communication channels between themselves and targeted user groups, including individuals representing state agencies, federal agencies, local organizations, and producer groups. Scientists from both the research and intermediary groups were active in drought planning processes, with scientists from the intermediary group having become involved earlier.

Communication was found to occur through five different mechanisms: direct communication, meetings, collaboration, written, and indirect communication. Direct contact proved problematic in some cases, with agency restrictions on federal personnel, but information did appear to be conveyed through responding to requests for information. Meetings were found to be effective at reaching outside of the scientific community, particularly invited presentations to a general audience. Both research scientists and intermediaries found journals to be useful for scientific communication, but of little use outside of the scientific community. Websites and the media were also considered useful, although many respondents indicated some concerns about the quality of information carried by either means. E-mail was not generally effective outside of the scientific community, but it was an excellent communication tool among scientists, particularly e-mail discussion groups involved with the Drought Monitor publication.

Most of the scientists interviewed in this study indicated a preference for monitoring tools and assessments, although a few were more actively engaged in providing policy-relevant advice. Most of the community was responsive, responding to requests initiated by decision-makers or the media, rather than actively promoting their information. The internal communication created inventories of information which could be readily tapped by a number of individuals when requests for information were made. Time constraints were mentioned as a reason why they were not more actively engaged with policy-makers.

Scientists were found to have a generally positive attitude toward policy-makers, although most voice some concerns about either intentional or unintentional misuse of scientific information. Those with a generally positive view were most likely to engage policy-makers either through collaborative activities or in a consulting role. Those choosing the consulting role expressed a belief that the job of scientists was to present the facts and that decision-making should be done by others. Collaborators were more likely to iterate information and solutions directly with decision-makers, often at lower levels of organizations, in the hopes that solutions would migrate upward through the agency.

Scientists who were more distrustful of the policy community assumed roles of either educators or critics. Educators see a positive purpose for science, in conveying information as a basis for policy decisions in a way that eventually policy-makers would need to recognize. Outreach programs and collaboration with local organizations were a primary means of reaching a broader audience. Critics felt that their efforts were best directed toward more receptive audiences, such as other scientists or professional societies.

CHAPTER 6: DROUGHT AND THE POLICY COMMUNITY

The primary conduit for information from the scientific drought community into state policy development is through staff at state water management agencies. Often, these agencies have people with scientific or technical backgrounds that are able to communicate and actively participate with scientists in the drought community. During the process of developing state drought plans, they generally appear to be actively engaged with individuals and organizations who can provide guidance on developing a state drought plan. In a few cases, there was active involvement by officials on state drought task forces, usually departmental heads or executive office appointments, but in most cases plans were developed by a few individuals at a staff-level within the agency charged with the responsibility for monitoring drought conditions. In some cases information may flow upward from technically-oriented subcommittees, such as a monitoring committee.

The interviews with those identified as members of the policy community led to three types of involvement: drought advisors, drought coordinators, and agency leaders. Drought advisors are scientists who have formal roles in the policy-making process, but lack authority to implement the policy. These are often individuals from university-based centers or federal agencies. Drought coordinators are more directly immersed in the process, and often work within the agency tasked with the responsibilities for responding to drought. These individuals are the ones who are usually tasked with reporting on drought conditions, coordinating responses among agencies, and keeping the plan up to date. Agency leaders are senior officials in agencies directly affected by drought, including water resources, agriculture, and emergency management. Their primary role is one of critical review, delegating most authority for planning to lower levels of the organization. These individuals do take an active interest in the process and during drought episodes will become a primary conduit for the flow of information to their state's executive and legislative leaders.

Individuals in any of these roles exhibited few problems with accessing, understanding, or applying scientific information. Some described a learning-curve when they became involved in drought planning, but even those with less technical backgrounds were able to utilize the scientific information that was available to them. Most were quite trusting of the advice they received from the scientific community. Information from sources such as the National Drought Mitigation Center and other state drought plans were frequently mentioned as useful. Major barriers appeared not so much in creation of the policy documents, but in implementation of the plan's recommendations. In eight of the ten cases, the planning process was initiated in part because of recent or ongoing drought events. As these events ended, the impetus behind the planning and mitigation activities faded, such that gaining legislative approval and appropriations for implementation became difficult.

6.1 Characteristics of Drought Plan Developers

The backgrounds of the policy respondents varied considerably. Most had some technical backgrounds, and those who didn't learned through years of experience. Backgrounds represented included meteorology, climatology, geography, business, journalism, hydrology and forestry. One described having come into the drought management position “not knowing a whole lot about drought,” but through participation in NDMC-hosted meetings and reading reports, the individual quickly became sufficiently familiar with the subject.

Most of those interviewed had some formal responsibility in drought monitoring, preparedness, or mitigation in the state. Two of the respondents served on committees and were not directly involved in drafting the plan. The remaining nine individuals were either the primary authors or served on the primary state drought committee. Drought management constituted the “sole and entire job” for only three of the respondents. In most cases, drought management was incorporated into other organizational duties. In all cases, those who became involved in drought management either actively sought the position or embraced the opportunity when assigned.

Overall, those representing the policy community found scientific information to be accessible, understandable, and relevant. Information was easy to locate, particularly through web sites and sources such as the NDMC. Scientists were also accommodating, making “every effort” to provide officials with useable information. Sources such as task committees were able to evaluate scientific information and develop relevant recommendations for inclusion into state drought policies. In some cases, officials either established an ongoing dialogue with scientists or were able to use existing communication channels to retrieve information. In three of the cases, officials had established direct contact with Don Wilhite, the Director of the NDMC, earlier in their professional careers, making them familiar with the NDMC’s work. In other cases, the people involved in the process brought their varying expertise to the process, such that it was difficult to know how much information from scientific reports infiltrated into the decision-making process.

Local sources of scientific expertise were mentioned as quite useful in the planning process. Local scientists in one state proved very effective in translating “heavy data” into useable concepts:

> “I don’t like to use that word (simple) when talking about scientific data because there’s no such thing as simple scientific data. But they made it so a good working-level technical person and a real professional stakeholder could understand the location of the problem and the extent of it … They made a special effort and I think they were very successful with it.”

Furthermore, these scientists often have to provide this information under difficult circumstances: “whatever we needed they would do their best, and I mean in some cases with limited funding.” In one instance, the state drought task force visited a university-based research center in the state. The group found the center to be “a great source of information as far as new research and new methods that are being developed in order to assist water management decisions.” Research on water quality, soil nutrient losses, drought impacts, crop decision aids and groundwater is conducted at the Center, and computer models are used to evaluate economic and environmental impacts of different practices. Because of an abundance of such local expertise, the task force in that state did not draw heavily from out-of-state sources such as the NDMC, other than reviewing other state drought plans.

6.1.1 Drought Advisors

Drought advisors are scientists who have formal roles in the drought task force, but did not directly participate in drafting the plan. Often, drought advisors will be individuals from university-based technical organizations, such as a state climatologist or a member of a state geological survey. They may also be from state or federal agencies, such as members of the NRCS, U.S. Geological Survey (USGS), Bureau of Reclamation, or NWS. Most often, these members serve on monitoring groups and synthesize information on drought status for the state drought committee. While they may lack authority in directly creating policy, they serve in an influential role in which they could certainly advise those who are drafting the policies.

In the process of the policy interviews, two individuals were identified who fit this drought advisor role, both from state climate offices. Primarily, they saw their role as keeping others informed of current situations and providing advice upon request. This includes building databases and spreadsheets of various drought indices such that they "have gathered the datasets we think are necessary to answer virtually every question that comes along now." While some in similar positions may be more involved in discussing mitigation or response ideas, one of the respondents summed up the attitude that both seemed to share: "I don't get into the nitty gritty of those documents. To me, if I'm told to appear at a meeting, I appear at a meeting." The two respondents mostly focused upon operational information sources and measures, but did mention the use of planning-type sources of information.

6.1.2 Drought Coordinators

Drought coordinators are those who are more directly involved in developing the state drought plans. Typically, drought coordinators have technical backgrounds and serve in the state agency with primary responsibility in drought management. They are directly immersed in the details of the planning process and actively seek outside assistance from other state agencies, in-state academic organizations, and in some cases national centers. Drought coordinators usually are the ones tasked with keeping the plan up to date, producing routine reports on drought conditions, and coordinating responses among state and federal agencies.

Drought coordinators exhibited few problems with understanding and using information from within the scientific drought community, although some mentioned having to conquer a learning curve when they first took their positions. Two of the respondents mentioned relying upon external expertise in the initial stages of the planning process, but over time building institutional capacity that allowed them to take a stronger role. In one case, guidance from the NDMC was used "as a springboard for some of the things that we wanted to do." In another case, the respondent reported that in "the first go-around we kind of relied more on the expertise of [a federal agency's] technical assistance and in this revision we got a little more involved and did a little more research."

6.1.3 Agency Leaders

Agency leaders are individuals at a deputy administrator level or higher in the organizational chart. They come from agencies with programs that are directly affected by drought. Most do not write state drought plans directly, but they serve on state drought task forces and actively are involved in programmatic decisions. Generally, agency leaders will delegate most drafting and reporting duties to an individual drought coordinator and trust that the drought coordinator will thoroughly examine sources to develop an appropriate state response, and in some cases mitigation, plan. Their roles are not passive, however, in that they will critically review recommendations, especially with regards to how plans affect programs within the agency in which they serve. In some cases, representatives from the Governor's Office may be similarly involved, but in most cases agency officials are the primary policy-makers. Legislative officials are rarely involved in details, but do provide statutory authority to some state plans.

6.2 The Value of Scientific Information

Scientists who served on state drought committees or subcommittees were well-versed in sources of information within the scientific literature. "I read tons of stuff every day" commented one respondent, including academic sources, journal articles, and newspapers. This background made it easy to evaluate the quality of information sources. Some of those who had to learn more on-the-job were able to understand scientific and technical information. Experience over time helped them to overcome a learning curve: "that doesn't mean to say that I've not had to do any education of myself. Becoming familiar with the terms and different facts has been part of that learning curve I spoke of." Scientists, for their part, exhibited patience with state officials, often working with them iteratively to understand and apply concepts. Over time, these relationships have developed to the point where university-based centers collaborate on regular meetings and workshops where scientific information is presented and discussed. These kinds of activities were described as considered "relevant in the fact that it gives us some interesting things to consider about what we might look forward to in the future."

Respondents were mixed on preferences for summarized information versus detailed reports. Some officials preferred having details to examine substantiating information and justification for recommended actions: “I’m one of the in-the-trenches type folks and I need to have the full report in order to really adequately incorporate the information in what I do.” Others “would definitely take the scientific word” if time did not permit a more thorough evaluation of information. All mentioned wanting access to a detailed report, even if they did not have time to read it. One respondent said that in the early stages of becoming a drought coordinator, detailed information was more important. As comfort levels increased, the respondent expressed a preference for summarized versions. Others prefer detailed information if it is in a subject area in which the individual is personally knowledgeable and interested, but otherwise summarized information is acceptable, especially for quick reports. Summaries were also good for getting the officials’ attention. If information was seen to be relevant, some officials stated that they would contact authors or agency staff for further details or clarification. Information in a variety of formats was seen as critical to one respondent: “You got the technical-level people that need one thing, but it’s got to be backed up by good science. If you haven’t got the science, it just won’t stand the test.” General information, such as charts and maps, technical summaries and scientific reports were essential for different purposes and audiences.

Peer review was not viewed as essential. “I know the scientist purists would make a big fuss about it but frankly it often takes so long for people to get stuff peer-reviewed that if it’s something you’re looking for in a timely fashion peer-review becomes more of an obstacle.” Respondents generally relied upon their own expertise or trusted sources to determine the quality of information. While none were willing to wait upon the peer review process, information that had been peer-reviewed, or at least reviewed by a scientific organization, was preferred if available.

Although finding and understanding information was not a problem, getting work from journals to the real world was identified as a challenge. Among barriers cited was that existing research published in journals was not always directed to questions the official wanted answered. While state plans were often consulted in plan development or update processes, they were not always applicable. Geographical differences affecting the nature of water sources made some plans conceptually relevant but with fundamental differences in the mechanics of monitoring and responding to drought. Another barrier was that information was not always seen as having practical relevance. Scientific information was described as "interesting" and useful for providing background and concepts to consider, but did not always fit in short-term drought management situations. Other times information was so general that it was useful for conveying a point but did not address operational needs.

6.3 Communicating with Senior Officials

While most drought coordinators and those directly involved in the process want detailed information, the same is not always true of senior policy-makers. Two factors seem to be associated with this: a lack of time and generalized knowledge. With respect to the pressures of time, respondents noted problems in condensing information:

> "You know bureaucrats as well as I do. They aren't going to look at it. Everybody wants a summary. It's like if you put a bill in front of Congress, you've got 200 pages of information there and the devil's in the details. But everybody just wants a summary of it. That's just the way it is. They don't want to spend six days

> looking at that information trying to make a full understanding of it. They just want a simple understanding of what's going on. That's where you can lose some of your main emphasis, by not looking at the details."

> "You've got to realize you're in a meeting format where people are looking for five to maybe ten minutes of your time. Things tend to get blended out that way unfortunately. That's the nature of the beast. I don't think there's any way you can get around it. You just try to highlight the most important aspects of what you're seeing and maybe throw in a few caveats in there and your five to ten minutes of fame are over."

> "As so often happens, there is a gap between the decision-maker and the scientist. They're dealing with so many pieces of legislation every day. I cannot give them a journal article to read as justification for the change. They're not going to read it. They don't have time to read it."

The process of distilling information was described as having "always been a big struggle."

In terms of communicating information to others, including members of the parent committee or the general public, several officials noted that those with greater technical capacities could understand information provided much more easily than those with less advanced skills:

> "There is a bit of disconnect there in the way the user interprets some of our products. The water manager nails what we put out there every time. He knows exactly what we mean. But the farmer doesn't quite know how to interpret what these things are."

> "You're trying to summarize what those people (members of the monitoring committee) are saying. So yes, you do lose some of that. That's just the nature of transfer of information from person to person as you go up the line. You know that if you gave somebody a general statement that the sky is blue by the time it gets down so many iterations the sky all of a sudden turned green. It's that type of issue. Information tends to get blended over as it goes up the process."

> "We still have kind of a disconnect between the science side. I'm kind of in the middle. I'm partially on the science, partially on the government."

> "I know bureaucrats like that everything's got to be black and white but we found that black-and-white issues don't work with USDA recommendations for grazing relief. There have been so many modifications. We've done this in the past where,

> say like you had to be 80% of normal precipitation over an exact period of time. Those tend to fail. There are so many other minor things that are pointing against those black-and-white issues. You've got to show a lot of flexibility."

One of the results of this pre-disposition toward quick answers is that visual signals may mask important underlying details. One respondent expressed reservations about using the Drought Monitor as a source, because "they tend to play catch-up mode," but noted that it was something that the committee and the public wanted to see: "Unfortunately, regardless of what labels you put on the Drought Monitor, the public is looking at that color scheme and less so on the labels applied to that."

Because of time constraints under which senior officials operate, information must be summarized. One respondent noted that doing so on a routine basis helps them to convey information at more critical times. Through a regular summary distributed to agency officials, legislative leaders, and the Governor's office, an institutional memory is created:

> "As long as we're regularly doing this publication and we're regularly monitoring and we're informing people of the situation, that is a tremendous help in the eventuality of the next drought. It will better prepare us just by it's on the forefront of people's minds."

Persistence pays dividends. Even though senior officials may not have time or the background to understand some of the complexity with which drought coordinators deal, through "a lot of back and forth" the officials become educated to the point where information can be more easily conveyed. A scientific basis for decisions helps:

> "You want to use stuff that has some credibility within the scientific community. I think it helps us sell what we're doing as the best. I think it gives the public confidence that what we're doing makes some sense."

Information presented in written format or on a webpage is more prone to misinterpretation. Personal communication can help bridge the gap: "People just seem to be more comfortable when they talk to a human being. They trust them more than just words on the page." These direct interactions provide opportunities to clarify information and highlight relevant points before it gets passed further on up the organization. Public meetings also can convey technical information effectively. Information summaries disseminated through the media were found to be "a really effective form of getting the information out to people."

One of the biggest barriers to implementing mitigation measures is getting appropriation of funds. Funding is always a barrier, in that "the problem comes down to when you want to implement some of these mitigation things. It's not a popular thing to spend money on." Larger initiatives also require the attention of the legislature, for both appropriation of funds and the authority to act. The problem, as described in one case, is that policy-makers don't have "the time and the willingness to focus on some of these tough, tough policy issues." Even though proactive measures are written into many drought plans, respondents described a response-oriented implementation and a hesitancy to tackle the complexity of state water laws that must be addressed for many mitigation measures.

Even though major initiatives may not be addressed until the next disaster emerges, some states have been successful in undertaking smaller projects. In one state, hazard mitigation funding from FEMA has been used to support some projects. One respondent described mitigation measures as an adaptive process, "one that we really can't do much about until we're faced with a real critical situation." But having developed scientifically-based mitigation measures appears to pay dividends. The mitigation measures that were developed during the "wet times" suddenly become viable as higher-level administration, the Governor and legislators pay attention during drought times. "Having a drought definitely stimulated political interest. Nothing like a good disaster to get politicians involved."

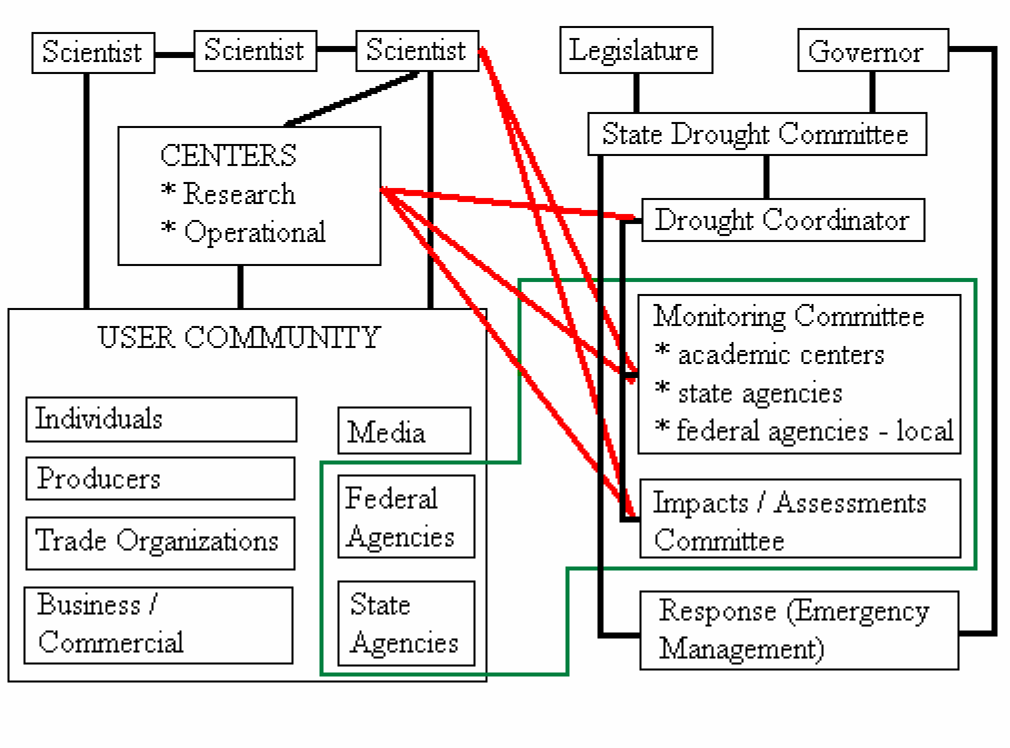
6.4 Information Flow Between the Two Communities

Based upon information collected in the interviews with policy-makers, it is apparent that scientific information is effectively utilized in drought planning. The process by which this generally occurs is that the need for drought planning is passed down from state officials, through agency leaders, to a drought coordinator or task committee. One or more individuals on the task committee then recruit scientists, mostly from within the state or federal agencies with local offices, to the committees. The committees and/or drought coordinators review a variety of scientific information to develop a plan appropriate for the state. The plan is then presented to the main task force / coordinating committee, which is then typically forwarded to the Governor or state legislature for approval. Thus, while the people charged with policy-making may not actively evaluate scientific information, trusted staff members within their agencies do so on their behalf. Generally, recommendations are accepted, and a scientific basis for recommendations appears to be an asset.

Scientists who are invited to participate in task committees, such as monitoring, impacts, or vulnerability assessment committees, come from a variety of agencies. State climatologists or geologists are represented on many state committees, and represent the transfer of knowledge directly from academic institutions. Soil conservationists with the NRCS, NWS staff from local forecast offices, and staff from the USGS are conduits of information from federal agencies to state task forces. Locally-resident knowledge from within state agencies enters the process through staff participation, especially from state departments of water resources, agriculture, and emergency management. Nearly all of these participants come from scientific or technical backgrounds and are aware of the state-of-the-knowledge in their disciplines, either through academic sources such as journal articles or more commonly through interaction among other members of their communities.

A conceptual diagram of the information flow between the science community and the drought policy community is shown in figure 6.1. The scientific community is represented on the left side of the diagram. The black lines indicate channels of

Figure 6.1. Linkages between the scientific and drought policy communities. Routine interactions within the scientific community and targeted user groups are shown on the left side of the diagram. A conceptual state drought planning structure is shown on the right. Black lines indicate primary communication channels within each group. Red lines indicate primary communication channels between groups. The green box shows overlap in membership between the two communities.



communication within the science community. The scientists represent individual producers – scientists who conduct research in university or research center settings. These individuals share information among themselves through established communication channels, including journal articles and scientific conferences. Some, but not all, of the scientists have direct links to user groups or science-based centers, such as the NDMC or NOAA organizations. Contact between scientists and user groups are typically either initiated by the scientist through venues such as outreach programs or general services which are mostly responses to information requests originating from members of the user community.

On the right side of the diagram is the state-level drought policy community. Participants may include the state legislature, the Governor, and state agencies. Typically, the Governor or the legislature establishes a state drought committee to coordinate response to an ongoing drought situation and make recommendations for improving preparedness. The drought committee usually establishes one or more subcommittees. Most plans include a monitoring committee, responsible for assembling assessments of climate and weather conditions and making operational recommendations to the drought committee, and some sort of impacts or assessment committee. The Impacts committee may have both operational duties, in reporting the impacts of ongoing climate anomalies, and longer-term planning, including conducting vulnerability assessments. The response function is usually delegated to the state emergency management agency, which reports directly to the committee and the Governor. In most cases, the state drought committee appoints a drought coordinator, usually a staff member within a state agency involved in drought management. This drought coordinator is charged with monitoring conditions, advising the state drought committee, and drafting the state drought plan. Often the drought coordinator will be the primary conduit of information from the monitoring and impacts committees, although the committee chairs may report directly to the state drought committee or even serve as members of the committee.

The subcommittees represent a reservoir of scientific and technical information upon which the state drought committee may pull. Technical staff within the state agencies are often tasked to serve on these subcommittees. In addition, technical staff from related federal agencies which have an in-state presence serve on the subcommittees. Local NWS offices, USGS personnel and NRCS soil conservation staff are frequently involved. Academic centers, housed within the state universities, often participate. Examples include the state climatologist or state geological survey. This provides a direct source of scientific expertise into the drought monitoring and planning process.

This expertise is often tasked with more of the day-to-day monitoring and detailed assessments process. In terms of developing overall drought policy, including issues of organizational structure, drought categories and associated actions, and mitigation measures, the drought coordinator and subcommittees draw from a wider source. These are indicated by the red lines connecting the two sides of the diagram. The most frequently-mentioned external links were to other state plans and resources from the National Drought Mitigation Center. These are indicated by the red lines connecting the drought coordinator and the subcommittees to the scientific centers. In addition, scientists serving on the subcommittees bring their own knowledge and expertise into the process, which is informed through conventional scientific channels, such as reading journal articles and attending scientific conferences. Thus, there is a link from individual scientists into the planning process via subcommittee members. Drought coordinators may participate in similar communication, but from the interviews it did not appear that this was typically a primary source, although notable exceptions did occur. During the plan development phase, the subcommittees may independently draw from similar sources. Notice especially the overlap (green line) between federal and state agency members of the user community and subcommittee members.

People appointed into drought coordinator positions usually have a scientific or technical background, or have gained expertise in the subject area through years of experience. Those who did not have a formal education in a scientific discipline did not appear to have difficulty accessing, understanding, or utilizing scientific or technical information when compared to their counterparts with science-based educational backgrounds. Thus, lack of a scientific background does not appear to be an impediment to the effectiveness of a drought coordinator. These drought coordinators are critical in the process, acting as the primary conduit between scientists who serve on committees and the agency leadership represented on the state drought committee.

Eight of the ten states examined in this study cited information from the National Drought Mitigation Center as an important part of their process in developing or revising the state drought plan. One official found the NDMC's information to be an important part of the process, describing the resources as "outstanding." Nine cases mentioned other state drought plans as sources, suggesting that even if NDMC resources were not directly consulted in the process, there is a strong likelihood that NDMC information would have an indirect effect through other state plans that had directly included the Center's information. Several of those interviewed mentioned the importance of the Internet and the Drought Monitor in the process. The Internet eases access to state plans, reports, and information from organizations such as the NDMC. Some of the research by one state drought task force included examining NDMC technical reports and different state plans, of which most were obtained from the NDMC web site. In two cases, NDMC information was used, even though no direct contact occurred between the state drought coordinator and NDMC staff. The Drought Monitor was mentioned as useful for drawing attention to the issue, especially in the case of Kansas where a plan was developed partially because the NDMC website, which was getting more traffic due to hosting the Drought Monitor, showed Kansas as having no formal drought plan. It was also useful for capturing drought severity in a simple image, which could easily be conveyed to agency leadership to underscore the importance of the drought planning process.

6.5 Policy Implementation

The process of writing state drought policy documents is largely apolitical. Development of the plans includes a seamless collaboration between representatives of the scientific community and technical staff from state agencies. Working together, the two groups develop draft state drought policy plans, which are typically adopted as official state policy almost unaltered by the state's political leadership.

Nakamura and Smallwood (1980) classify this process as discretionary experimentation. In this model, policy-makers support abstract, undefined goals and delegate broad discretionary authority to implementers to refine goals and means. The advantage of this model is that policies are more innovative, including addressing means that may not occur to senior policy-makers. Discretionary experimentation fits toward the more autonomous end of a spectrum, ranging from close control by policy-makers (classical technocracy and instructed delegation models) to increasing degrees of delegated authority (bargaining, discretionary experimentation, and bureaucratic entrepreneurship). Nakamura and Smallwood state that the bargaining and experimental scenarios are “characterized by higher potential for conflict and disagreements and require more sophisticated analysis of their political, as well as technical, feasibility. However, they may provide the only practical options for implementing more innovative policy goals” (1980, 179). In more extreme circumstances, agency implementers may formulate both the goals and means (bureaucratic entrepreneurship).

In the case of drought, political leadership sees the need for drought policy, but lacks clear goals or defined means to create policy. Consequently, the executive branch delegates the task to agency officials, who in turn delegate the task to more junior levels of their agencies. Because of vague goals and guidance, there is considerable autonomy among the individuals involved to draft the plans. Ultimately, these plans run into problems of confusion over objectives, defining relationships between agencies, internal conflict relating to resource allocation, and relationships with senior political leaders (Nakamura and Smallwood 1980). When it comes time to allocate resources or adopt legislation to implement features of the policy, there may be little support at top levels for doing so.

The politics of drought and the politics of science re-emerge in the implementation process. Policy prescriptions that can be implemented below the scope of engaged stakeholders can be implemented with ease. This includes technical issues related to the selection of indices used for early detection of drought conditions and methods for communicating between agencies to coordinate response to drought. These two are the central components of the response-oriented drought plans. Mitigation plans, however, are much more complex. These entail re-allocation of water uses, changes in behavior, and socio-economic dislocations. Although mitigation measures are written into the policy documents, the disjuncture between goals of the technical staff and senior leadership may undermine the political will to tackle the more complex issues.

Most of the plans studied were initiated by either state agencies or by governors. Legislative leaders, except in the case of South Carolina, have had little direct involvement. Implementing mitigation measures, however, rarely can be implemented by executive order or independent agency action. Allocation of funding, resolution of disputes, and changes in the legal system, rise to legislative prominence, often in the context of contesting proposed action. Unless senior political leadership has buy-in to the drought plan, mitigation measures, no matter how innovative, are not likely to move forward. As one of the interview respondents noted:

> "there's not a lot of regulatory powers, in part because a variety of independent groups have resisted that. They don't want to be managed from the top down, even if it is a good idea, or even if the steps that are being imposed are good."

This makes it more difficult for mitigation-oriented drought policies, many of which must rely upon some form of regulation.

Thus, even though scientists are engaged in the policy process, on the whole they still operate similarly to earlier models of involvement. Scientists tend to partition scientific and technical components within the policy issue area, leaving values and stakeholder interest to others. They then deal with that portion of the policy process, somewhat in isolation of the other elements. The result is that conclusions drawn by the scientists, and those with whom they work at a technical agency level, do not reflect adequately the broader community required to address policy solutions. This creates implementation barriers, leading to failure of at least portions of the resulting policy documents. If the policy issue is not prominent on the political agenda, political leaders may adopt the plan but choose not to invest resources (financial or political) to address with some portions of the recommendations. Internal activities, such as improved monitoring and communication between agencies that can be accomplished with minimal new resources, are adopted, but solutions that may activate stakeholder opposition remain unimplemented.

6.6 Summary

Individuals within state agencies tasked with developing or updating state drought plans experienced little difficulty in accessing, interpreting, or applying scientific and technical information. They were able to identify and use the information easily, in part, because of an actively-involved scientific community. The National Drought Mitigation Center played a dominant role as a repository of information useful to state drought coordinators, and local expertise helped to tailor that information to address each state's individual needs.

Three roles of participation were identified in this study. Drought advisors were scientists who had formal roles in the drought task force, but did not participate directly in drafting the plan. These individuals most likely served on, if not led, monitoring subcommittees. Drought coordinators are those individuals, often at middle levels of state agencies, who are tasked with developing a coordinated response to drought. Often, they are the ones who develop the first draft of the drought policy document. Typically, drought coordinators have technical backgrounds and serve in the state agency with primary responsibility in drought management, but some came from non-technical backgrounds. All were able to learn on-the-job. Agency leaders were those individuals at a deputy administrator level or higher from agencies directly affected by drought. Most did not write state drought plans directly, but they were involved in review and implementation issues. In some cases, representatives from the Governor's office were similarly involved, but legislative officials were rarely involved in the process.

Strong interaction between individual scientists and intermediary organizations (such as the NDMC) with state agency officials was documented. Drought coordinators drew primarily from intermediary organization, other state drought plans, and monitoring and impact sub-committees. These subcommittees drew from similar sources as well as from individual scientists. Thus, producers had an indirect link to the state drought plans. Drought plans were developed by the drought coordinator in coordination with subcommittees and a parent state drought committee. Once vetted, the drought plan was sent on to the Governor and legislature for approval.

In general, respondents preferred summarized information with access to more detailed information if needed. They generally trusted information from the scientists with whom they interacted. Peer review was not considered essential. Respondents would rather have timely access to information their sources considered trustworthy, rather than waiting on a lengthy peer review process. Engaging senior officials was challenging, due to time constraints and the need for generalized knowledge. Respondents expressed concerns about distilling information to the extent that it masks important details, but recognized that visually-interesting summaries were what senior officials wanted and would use, regardless of the scientists' preferences. Regular summaries were useful in keeping the policy issue active at senior levels, such that as drought conditions begin to re-develop it would be easier to re-engage senior officials.

The key barrier was not communication between scientists and the individuals tasked with developing state drought plans; rather it was implementation of policy recommendations. One reason for the disconnect is that drought planning follows a discretionary experimentation model (Nakamura and Smallwood 1980). In this model, vague goals are passed down from senior political leadership, and agency officials deal with complexity and uncertainty to develop policy proposals. In the process, the delegated officials develop their own goals and means to address the problems. Both the means and goals may be at odds with senior policy-makers preferences. The result is that plans may only be partially implemented, especially if there are provisions that require expenditure of substantial financial or political resources. A compounding factor is that legislative interests are rarely represented in state drought policy processes. While response and monitoring measures may be implemented by executive order, mitigation measures often require legislative action.

CHAPTER 7: CONCLUSIONS

This study revealed a vibrant knowledge community, in which scientific expertise on drought-related information is actively shared with state policy-makers. Contrary to expectations, policy-makers had little difficulty accessing, understanding, or utilizing scientific and technical information during the drought-planning process. Scientists made every effort to make information available to state drought task force members and to provide information in a variety of formats preferred by policy-makers. Policy-makers, even those without a scientific background, did not exhibit any difficulty in being able to use the information coming from the scientific community.

Thus, in the case of drought policy, there did not appear evidence supporting the two cultures theory. Key findings in this study are:

1. *There is no substantial cultural gap.* Communication between scientists and those directly involved in developing state drought policies exhibited little difficulty in utilizing scientific information and advice.
2. *The organizational structure posed more of a barrier to communication than did the technical nature of the material.* Restrictions on communication between scientists and those in policy-making positions inhibits what scientists and policy-makers both described as the most effective form of communication: direct contact. Academic rewards systems, such as tenure and promotion, created an additional barrier through emphasizing scientific communication over service and outreach activities.

3. *Policy-makers have little difficulty accessing, understanding, and utilizing scientific and technical information.* The first drafts of state drought plans are usually created by individuals at lower levels of state organizations. Most have some scientific or technical background, but even those who did not were able to conquer a learning curve and easily understand scientific information and advice.

4. *Research scientists are as likely to engage decision-makers as are intermediaries, but at more local levels.* Most research scientists sought opportunities to apply their knowledge to societal issues. Predominately, this took the form of close collaboration with local decision-makers, not necessarily in a policy-making context. Research scientists often focused their efforts on individual farmers or producers, local water managers, or economic development groups, especially relating to operational decision-making.

5. *Intermediaries are more likely to be engaged in federal initiatives, and earlier in the process than research scientists.* Staff at federal organizations or national centers were among the first to be contacted by policy-makers seeking advice. This was especially pronounced regarding their involvement in Western Governors' Association planning activities. Their participation occurred primarily through working groups, in which they actively collaborated with policy-makers. Resulting documents created a framework for broader participation by other members of the scientific community and a cross-section of policy-makers and stakeholders.

6. *Both research scientists and intermediaries tend to be passive.* Involvement by either group likely was initiated by a request coming to the scientist. Time

constraints were mentioned by several respondents. Those in operational environments described themselves as being overwhelmed with deadlines, such that they had little time to seek out new opportunities. Research scientists had more ability to initiate contact, but they too often pursued collaboration after contact was initiated by another individual.

7. *Internet communication is a key feature of a drought knowledge community.* Communication both within and external to the scientific community is enhanced by Internet-based tools. E-mail discussion lists, especially the 'drought exploder' list used to produce the weekly Drought Monitor publication, and websites were excellent vehicles for scientists to communicate with each other, develop some degree of consensus, and distribute summarized information to external audiences. Regular publications gain attention and identify individuals willing and capable of assisting policy-makers who need scientific or technical expertise. The internal communication process creates shared knowledgeable among the participating scientists, such that policy-makers need not be directed to a single individual who possesses some specialized expertise.

8. *Implementation issues are more important than communication issues.* While scientists appear to be active in the policy process, they are not immersed in it in a way that can address major policy issues that involve socio-economic or demographic dislocations. By partitioning problems so that they can focus attention on scientific or technical components, resulting policies lack underlying political support because they fail to address competing values or stakeholder

issues. Thus, while portions of plans may be readily implemented, more controversial components are unlikely to be addressed by political leadership.

Findings suggest that the drought community is organized in such a way that any barriers to communication between scientists and policy-makers are easily surmounted.

At the outset of the study, a series of research questions (RQ) and five key areas were outlined. The research questions guided the study throughout, and led to the key findings cited above. The research questions are addressed directly below and then discussed in more detail in the five key areas in sections 7.1 through 7.5. Recommendations for changes that would facilitate integration of scientific and technical information with the policy-making process are offered in section 7.6, followed by some concluding comments.

RQ1: Does a gap really exist between policy-makers and sources of scientific and technical information? There is no substantial cultural gap. Policy-makers exhibited little difficulty in utilizing scientific information and advice and scientists made adequate efforts to convey information in a useable format. Communication networks and knowledge communities aided access to and interpretation of scientific and technical information.

RQ 2: Do policy-makers seek scientific and technical information in circumstances where such information could be an important component in decision-making? Do they know where to find such information? Is information available in an understandable format and context? Policy-makers actively seek information and have little difficulty accessing, understanding, and using it. Primary sources of information include technical staff within state agencies and scientists in state organizations or local institutions of higher education. These individuals work directly with policy-makers or their surrogates to provide relevant and useable information to senior policy-makers.

RQ 3: Does the scientific community make an effort to contribute its knowledge to policy users? If not, why not? Individuals within the scientific community actively promote information for use in drought planning. Both producers and intermediaries are engaged, but producers usually in more local arenas. Both tend to be passive, often responding to invitations to participate or requests for information, but once involved they become active participants.

RQ 4: What factors either facilitate or act as barriers to the communication of scientific and technical information between senders and receivers? State drought task forces and the Internet, especially the 'drought exploder' e-mail discussion list, are facilitators in the transfer of knowledge between the scientific and policy communities. Restrictions on communication, especially within federal agencies, and academic rewards systems act as barriers. External outreach programs, including university-based extension programs, are a facilitator for the transfer of knowledge, but insufficient and unstable funding bases for such programs are a barrier.

RQ 5: How do policy-makers integrate scientific and technical information with other sources of information? How do they deal with information from multiple

sources, especially when it may conflict? First drafts of plans are usually written at a working level of relevant state organizations, often, but not always, with in-house technical expertise. Advice from committee members, including local scientists, and trusted sources guides the document drafter's processes.

RQ 6: What is the role of intermediary organizations as conduits between knowledge producers and knowledge users? Intermediary organizations are a key link in the process, through drawing attention to an issue through participation in national efforts and developing visible produces. Intermediary organizations produce inventories of information, such as library resources. Such organizations are a repository of shared expertise which may be tapped by the broader knowledge community during the policy-making process.

RQ 7: What mechanisms would facilitate integration of scientific and technical information with the policy-making process? The principal barriers are not related to understanding of scientific and technical information, rather they are organizational structures that inhibit direct contact. Mechanisms to facilitate integration are discussed in the recommendations, section 7.6 below.

7.1 Informing Policy Decisions with the Best Information Available

As a whole, the scientific community makes an effort to contribute its knowledge to policy-makers. The scientific community synthesizes information on issues, such as drought, on a routine basis. By placing information on websites, making presentations at state and federal meetings, and other general outreach types of activities, scientists continually re-package information for different audiences. The result is that when information is needed by a policy-maker, a suitable format for information delivery is available from one or more scientific organizations. Initial contact is equally likely to be established by either party. Research scientists were more likely than intermediaries to establish initial contact with local decision-makers, but were less likely to engage in direct policy applications.

Information is integrated through reliance upon trusted sources and personal expertise. For senior policy-makers, this integration function is typically performed through an appointed state drought coordinator. That individual usually has either a scientific or technical background or has gained an ability to understand and apply scientific and technical information through experience working in a state agency. Advice from members of the scientific community appears to be integrated effectively into state agency operations plans, especially in those drought plans that stipulate specific mitigation actions. The scientific perspective seems to frame the options, and then other factors are considered that may alter those recommendations. Information that fits within expectations and is consistent with the drought coordinator's expertise seems to be preferred. Scientific review was a cue, but not a necessary condition that would favor selection of one source over a competing source.

Members of both the intermediaries and policy-makers groups mentioned making judgment calls on the quality of an information source based on perceived credibility and ease of use. Relevance and timeliness were important criteria for the message, according to policy-makers. Information that did not match the issue being addressed was often set aside, due to time constraints associated with trying to extract relevant information from the message. Context for the receiver also was important. Several scientists provided examples of fashioning information into the user's conceptual framework, using tools such as analogs and historical precedents.

7.2 Difficulties Arising Because of the Two Cultures Phenomenon

A key finding from this study is that this communication between the two communities is not only vibrant, but occurs in spite of barriers. Barriers associated with conforming messages into a format and context which policy-makers could use were virtually absent. The way in which scientific research is organized, partitioning problems into disciplinary areas, theory-driven research compared to application-driven policy, and the importance of value judgments in the policy process were surmounted by the knowledge community. Shared information provided in multiple formats and communicated through multiple channels created multiple levels of information which was accessible to a wide audience, from maps and charts for senior policy-makers, to executive summaries for managers, to technical reports for agency staff. There did not appear to be insurmountable barriers regarding message format, applicability, relevance or credibility. Thus, while any individual piece of information may face barriers, the aggregate knowledge did not.

While on an individual basis, scientists and policy-makers may not interact, there are organizational and professional structures that provide conduits of information between the two communities. With regards to inclusion of scientific and technical information in the drought planning process, it is clear that those developing state drought policies have adequate access to information, and that information is generally understandable and useable. While gaps may exist on an individual level or in other subject areas, no evidence in support of the two cultures theory was found in this case.

What became more apparent, however, were institutional barriers that restricted direct contact with policy-makers. These included channeling contact through public affairs or legislative affairs offices in federal agencies and a reward system skewed towards scientific communication in the universities. University tenure systems reward those who conduct basic research and publish in scientific journals more than those who conduct outreach programs or interact in public settings. Applications-oriented research, and in some cases research that contradicts prevailing beliefs, face difficulties in the peer review system, with members of the scientific community acting as gatekeepers on publications. Without publications, tenure becomes unlikely, forcing young scientists to conform to the basic scientific interaction model and leave applications to others.

Despite active engagement and effective communication, there was some divide in that most scientists preferred not to develop policy recommendations. Most scientists, both from the academic research community and federal organizations, preferred to provide assessments, only offering interpretation or opinion if pressed. A few scientists did engage in policy recommendations, but they appeared more the exception than the rule.

7.3 Linkages Between the Scientists and Policy-Makers

Scientists were found to occupy a number of roles. Following Morin's (1993) model, some scientists tended toward basic research, some towards applied research, and some towards a development role. In this case, the development role is represented by those actively engaged with drought policy-makers, through participation in drafting plans and directly providing advice to drought councils. The National Drought Mitigation Center was a key source of information, along with local scientific expertise residing in state and federal agencies and in academic institutions. From analysis of the interviews, four roles were identified for scientists: collaborators, consultants, educators, and critics. Collaborators possess a positive view of policy-makers and are actively engaged in the policy-making process, often iterating formats of information to make it useable by different policy-makers. Consultants also possess a positive view of policy-makers, but see their role as one of providing information upon request. Consultants prefer to stick to the facts as much as possible, and leave interpretation to others. Educators and critics have a more negative view of the policy-process, expressing the belief that scientific information is often manipulated to support pre-determined policy preferences. Educators try to overcome that problem by engaging the external community, often using outreach programs at local levels to build grass-roots support for policy changes. critics see little hope of changing the system and prefer to focus more internally within the scientific community, with the extent of their external involvement relegated to functions such as participation in professional societies.

Research scientists in the producers group were more likely to make personal, sustained contact than were their counterparts in intermediary organizations. One factor for this was that intermediaries focused more on operational aspects, with most of their communication coming through indirect means such as the Internet and media. Both producers and intermediaries exhibited a predilection for passive involvement, responding to requests-for-information rather than actively soliciting their involvement. Some members of each group exhibited more direct and aggressive involvement.

The link to the policy side comes primarily through state agency staff. Senior policy-makers look toward their agency staff as sources of information, who then conduct the research necessary to complete their assigned task. Thus, while those formally charged with creating policy may not actively seek relevant scientific or technical information, they indirectly seek such information through their charges to their staff. Staff members, in turn, appear to know where to locate information and mentioned few problems with using information that was provided to them. Consistent with Havlock's (1969) communications model, utilization was enhanced if the source of the message was viewed as competent, credible, and provided externally-oriented formats.

It was found that intermediary organizations play a critical role, particularly the National Drought Mitigation Center which was specifically mentioned in eight of the ten state drought plans examined in this study. While intermediary organizations are an important factor, they are not absolutely necessary. Some states have developed drought management plans using local sources of expertise, including individual scientists from the producer community directly. Individual producers, however, may be influenced by intermediary organizations. For example, a scientist may participate on the Drought Exploder e-mail list and, through that, obtain information that becomes included in a state drought plan. In this case, the channel of information would be from producers to intermediaries back to producers and then directly to receivers. This should not imply that the process could not be done without intermediaries. Drought planning prior to establishment of the NDMC included scientific expertise. But intermediary organizations are clearly a facilitator and a key component of the knowledge community that helps to shape drought policy.

7.4 Processes of Scientific Communication

Mechanisms by which information was transmitted between the two communities included direct contact, meetings, collaborative activities, written communication, and indirect methods. Direct contact and meetings were rated most effective of all forms of communication. Direct contact included personal conversations, briefings, small-group interactions, and responding to requests for information. All of these provided opportunities for one-on-one or few-on-few interactions, allowing scientists to re-formulate the message to suit particular circumstances and gain immediate feedback on the applicability of their research.

Meetings included scientific conferences, which provide an integrating function, and public meetings, which provide external contact and visibility. Scientific meetings help to keep researchers aware of new ideas and tools while public meetings provide societal context to scientific information. Public meetings sometimes lead to follow-up contact, which can be quite beneficial at bridging communication gaps.

Collaboration among scientific colleagues and local organizations was mentioned frequently as a conduit for sharing information. Scientists who preferred not to interact externally found that discussing their research with a colleague who was externally-oriented was a vehicle to transmission of their research. Professional societies provided similar avenues, through periodically synthesizing the state-of-knowledge on various topics. Participation in local chambers of commerce or civic clubs allowed some scientists to reach beyond their community and establish two-way communication and develop applications of their research at local levels.

Written formats did not convey much information to the policy-community, but scientific journals were seen as important for developing consensus and credibility within the scientific community. The importance of peer review diminished with distance from the source. Research scientists viewed peer review as very important, intermediaries as somewhat important, and policy-makers as not important. Intermediaries recognized that while they would prefer peer review, it was generally not viewed as important outside of the scientific community and therefore should not hold back information that could be of value to policy-makers. Members of the policy community were concerned that time spent in the peer review process delayed the release of relevant information, although if peer-reviewed information were available that would be viewed as more credible. Written reports were useful between scientists and intermediaries, but not as much in relating to policy-makers. Most reports focused on assessments and did not offer recommended actions or solutions of value to policy-makers, but they provided valuable background for intermediary organizations, if the reports' existence was known and readily accessible.

Indirect methods of communication were useful, but not without problems. Websites, media, and e-mail were all used extensively by scientists to communicate. E-mail was primarily used for communication within the scientific community. The Drought Exploder e-mail list, associated with the weekly production of the Drought Monitor, was an especially important venue for exchanging knowledge about drought research, as well as assessing drought conditions. Websites and media were externally-focused, and most of those interviewed expressed concerns about the quality of information and ways in which information was presented.

Consistent with expectations, research scientists were more likely to engage in more traditional forms of scientific communication, including journal articles and scientific conferences. Intermediaries published less, and were more likely to communicate through electronic means.

Most scientists were willing to provide summarized information, but would prefer to do so only if they had the opportunity to attach supplemental details. Scientists recognized that what they write or say will be condensed at some level for senior policy-makers and that their message would be transmitted most effectively if the scientists themselves were the ones to prepare the summary. This preference matched well with policy-makers' preferences. Most policy-makers expressed a preference for summarized information in most cases but would like access to detailed information into which they could delve if time permitted.

7.5 The Role of Knowledge Communities

The science community and drought coordinators in state agencies were found to resemble knowledge communities, which share information, problem definitions, and alternatives among themselves. As Stone (1996) stipulated, knowledge communities try to influence the adoption of favored policy prescriptions and program implementation. That appears to be the case in this study. Routine scientific interaction, such as the Drought Exploder e-mail list, and public presentations continually shape the state of knowledge about drought processes, impacts, and mitigation measures. This internal communication within the scientific community provides inventories of information that can be accessed through multiple entry points. Drought coordinators access these inventories during the drought planning process by contacting members of the knowledge community directly as well as indirectly, through other state plans and reports.

The planning process has taken the step of integrating scientific and technical information into the social, economic and political frameworks of the states. The result is that there are concrete, defensible recommendations for policy actions should a window of opportunity open (Kingdon 1984). The drought planning process is really one of linking two of the three streams: problems and policies. Scientists actively contribute to linking solutions (policies) to problems faced by individual states through collaboration with members of their state drought committees or drought coordinators. Since most of these state plans were developed or updated during the last major drought episode, we have yet to see how they will respond when the politics stream conjoins with the problems and policies streams. The implementation measures that scientists and policy-makers have developed collaboratively may be given an opportunity once drought again appears on the agenda of senior policy-makers in the state legislatures and Governors offices.

7.6 Recommendations

The findings of this study suggest that the process of transferring scientific and technical information to the policy community works well. However, there are some barriers that could be removed and facilitators that could be enhanced to improve the process. The most prominent barriers that emerged were issues associated with academic rewards systems, required clearance on public statements, activities that foster communication within issue areas, funding for extension and outreach activities, and policy implementation. The following recommendations are offered to address these barriers.

Recommendation 1: Professional societies should facilitate issue-specific workshops as forums for scientists and policy-makers to directly engage, not only in national arenas but through state and local chapters in which local decision-makers may be involved.

Professional societies are in an excellent position to engage both the scientific and policy communities. Through issue-specific workshops, the state of the science can be addressed, providing policy-makers with guidance on current knowledge, uncertainties, and suggested applications of that knowledge. As the National Academies of Sciences (2004) noted:

> "Professional societies have the opportunity to facilitate [interdisciplinary research] by producing state-of-the-art reports on recent research developments and on curriculum, assessment, and accreditation methods; enhancing personal interactions; building partnerships among societies; publishing interdisciplinary journals and special editions of disciplinary journals; and promoting mutual understanding of disciplinary methods, languages, and cultures."

One such example is the AMS Policy Program, which holds policy forums on sector-specific activities. The program has held policy forums on hurricane preparedness and response (June 2000); weather, climate, and energy (October 2001); improving responses to climate predictions (April 2003); weather and highways (November 2003); implementation issues study for the global earth observation system of systems (December 2004); and a forum planned on Hurricane Katrina (December 2005). All of these policy forums have been held in Washington, D.C. Typically, a report summarizing the workshop is produced along with an executive summary (4-page cardstock) containing recommendations. Professional societies may be able to survey the political agenda to find appropriate and timely issues for such workshops.

As noted earlier, this may be effective at the national level, but more attention needs to be given to state and local issues. Local chapters rarely host such workshops. Findings and recommendations from national workshops may not address problems on the local agendas and may not be applicable to local circumstances. Thus, local chapters should undertake similar workshops to develop summary reports and recommendations for their communities.

Recommendation 2: Scientists should seek employment in legislative or executive staff positions to be a resource for top policy-makers.

Communication between scientists and policy-makers was enhanced through the presence of skilled staff in state agencies. Senior policy-makers were able to rely upon the staff members' expertise when developing state drought plans. In turn, staff members consulted regularly with colleagues in state and federal organizations, universities, and the private sector. These staff members were able to synthesize the scientific and technical information presented to them, along with the values and constraints provided by other stakeholders and state officials.

Because drought planning is conducted mostly through state agencies, such as water resources, agriculture, or emergency management, there were already capable staff in positions to lead such efforts. It is not clear if similar individuals exist in state legislatures and Governor's staffs, other state boards or commissions, or their federal counterparts. In recent years, scientific organizations such as the AAAS and AMS have made efforts to train scientists to work on Capitol Hill through fellowship programs. As the number of trained scientists available to legislators increases, the accurate and effective use of scientific and technical information should be enhanced. Such efforts should be undertaken at state levels to address policies not on the national agenda.

Recommendation 3: Academic departments should review their hiring, tenure and promotion policies and assure that service activities are given equal weight to research activities.

University tenure and promotion criteria were seen as barriers to applied sciences and outreach activities. An emphasis on scientific publications in journals, cited as among the least effective means of reaching policy-makers, guides individual faculty members toward more traditional and disciplinary scientific research. Furthermore, research grants, another often-used metric for tenure, tend toward discipline-specific areas due to the disciplinary nature of reviewers. There are comparatively few opportunities for inter-disciplinary, applied activities to compete for funding sources. Yet the externally-oriented, inter-disciplinary activities such as public workshops and meetings that are downplayed in tenure decisions are among the most effective means of communicating with policy-makers.

In a report by the National Academy of Sciences (2004) on the state of interdisciplinary research in academia, the committee found that "collaboration is often impeded by administrative, funding, and cultural barriers between departments, by which most research and teaching activities are organized." The academic promotion and reward system and department-based budgeting structures of universities were cited as particular problems which create "drag" on interdisciplinary research. Without structural changes in the metrics by which faculty are judged, changing the tenure system will prove problematic.

The NAS report recommended changes to the system that awards grants, urging that "funding organizations should regularly evaluate, and if necessary redesign, their proposal and review criteria to make them appropriate for interdisciplinary activities." Assuring that reviewers of inter-disciplinary proposals themselves are engaged in inter-disciplinary research and activities will address some of the bias toward disciplinary boundaries. To aid funding agencies in identifying appropriate reviewers, those requesting funding should take care in nominating potential reviewers.

Recommendation 4: Universities should assure adequate and consistent funding for outreach activities, including Extension programs.

Respondents who collaborated with colleagues in extension programs all noted that outreach extension activities are the first thing to be cut during budget shortfalls. The NAS (2004) report addressed this issue as well: "Allocations of resources from high-level administration to interdisciplinary units, to further their formation and continued operation, should be considered in addition to resource allocations of discipline-driven departments and colleges. Such allocations should be driven by the inherent intellectual values of the research and by the promise of IDR in addressing urgent social problems."

Extension programs have proven remarkably effective in transferring scientific knowledge to non-technical audiences. Programs have been responsible for major shirts in agricultural practices and are well-positioned to address a host of local environmental issues, such as water quality and land management practices. These programs require a steady input of scientific research from universities. As problems have grown in complexity, the need for inter-disciplinary academicians to supply this research has grown. Both the research and the outreach programs are essential parts of the universities missions to be good stewards of their communities.

Recommendation 5: Delegate discretionary authority on public and legislative contacts to the unit director levels of federal organizations, supplemented by active internal dialog among unit directors and the organization's public affairs and legislative affairs offices.

The requirement for contact to be cleared by a public information office introduces two barriers into communication between scientists and policy-makers. First is the formal restriction on direct contact. If contact is not allowed, then information must be provided through indirect means, such as summaries communicated via an intermediary. Second is a concern some federal employees have over statements they may make. Even if contact is approved by a public information officer, employees may be reluctant to offer interpretation or opinion, fearing that a review of their comments may jeopardize their employment.

The goal of oversight is to assure consistent and accurate information is provided to those who request it. It is in the interest of the agency to assure this, because inconsistent statements often lead to political problems for the agency. Thus, some form of oversight is necessary. Transferring this authority downward in the organizational hierarchy to the unit director level may address some of the employees concerns. The unit director, in turn, may choose to allow staff to directly answer questions. In the first instance, staff may have direct contact with the individual requesting the information, or at most have only one intermediary. This is the most effective means of communication and allows opportunities to clarify information or offer interpretation if asked. In the second instance, regular contact between the unit directors and staff often helps to develop trusting relationships. This may ease concerns over offering interpretation or opinions, something often wanted by policy-makers or their staffers.

In order to protect the parent agency's interests in assuring a consistent message, unit directors should inform the public affairs or legislative affairs office of any contact, including what information was provided. Regular meetings among unit directors can clarify guidelines governing contacts and develop appropriate responses to anticipated questions. Some sensitive issues may be retained at the headquarters level.

Recommendation 6: The scientific community should build grassroots constituencies to encourage implementation of measures written into policy documents.

Getting measures written into policy documents appears easy when compared to the challenges of implementation. Many state drought plans have specific mitigation actions written into them, but wither for lack of funding. In many cases, by the time a drought plan is completed, the immediate threat has ended and politicians have turned their attention to other issues. Generating the political will to follow-through on the mitigation efforts can be challenging.

Building local constituencies and working with larger politically-active organizations can help to bridge this barrier. One policy-maker interviewed in this study reported that lobbyists for other organizations often kept members of the drought committee informed of issues. In order to generate their interest in drought, mitigation measures must be framed in a context that benefits them. Cost savings and environmental benefits of water management are two advantages that can help build necessary constituencies. These local constituencies can be useful for implementing some measures during the 'wet times' or can be drawn upon when the next drought occurs and political windows of opportunity re-open.

Local chapters of professional societies are well-positioned to help build and maintain these constituencies. State agency officials, federal officials, and even university faculty and staff, have restrictions on their involvement in political activities. Non-profit societies face no such restrictions. Working through local chapters, members could recruit external advocacy groups to encourage state legislatures to address mitigation provisions in the state plans.

Recommendation 7: Promote the development of knowledge communities around policy-issue areas using both formal and informal communication in which issues are discussed and policy-relevant documents generated.

Knowledge communities are an important link in synthesizing scientific information into policy-relevant documents. The scientific community should emulate the knowledge community built around drought, expanding to other areas on the national, state, and local agendas. A key facet of the drought community is the combination of federal, state, and local agencies and academic researchers. While the National Drought Mitigation Center is a centerpiece of the community, being the home to the weekly Drought Monitor, the product succeeds because of an equal partnership among the participants. Five separate entities participate as lead authors of the weekly product, and scores more participate through the ‘drought exploder’ list.

One respondent described the drought monitor as “a product and a process.” Communication between members of the knowledge community, both through formal means such as publications and scientific conferences, and through informal means such as the e-mail list and workshops, the latest scientific knowledge is debated and integrated into operational documents and advice to policy-makers. Members of the knowledge community periodically produce a variety of documents for different audiences, including white papers, summaries, bullet points, and regular publications distributed via the Internet. This completes the link of accessibility to the policy community.

Similar efforts in other issue areas in which scientific expertise could contribute should be developed. Scientific conferences, hosted by professional societies, provide a venue in which a collection of scientists who specialize in the issue area may congregate. Once a core group is established, a communications network must be constructed. E-mail distribution lists, web-based conferencing (blogs), or similar methods allow for rapid, shared communication. Awareness of the community spreads through the science community through use of products developed by the group and through presentations at meetings, publications in journals and newsletters, and word-of-mouth. A weekly, or at least monthly, product helps draw attention to the group and build an external constituency. It is important for this knowledge community to distill its research into summarized documents, which provides a link to the policy community.

7.7 Final Comments

The fact that so many scientists are willing to engage in policy-relevant communications, despite the barriers, encourages the use of scientific information by policy-makers. Established connections between academic and agency scientists provide a conduit of information into the state drought planning process. Plans that have been developed or updated in recent years reflect the transfer of this knowledge, especially in those stipulating mitigation actions. However, political will and action to implement these measures is lacking. The plans create a basis upon which senior policy-makers may draw, but all officials interviewed who mentioned mitigation measures in their state plans also believed that little would be done until a new crisis emerged. How scientists are involved in the process of implementation would be a fruitful area of follow-on research to this study.

This study revealed a remarkably vibrant and active knowledge community. The ease with which information is exchanged between scientists and policy-makers is remarkable. Credit goes both to the scientists and to the policy-makers who are engaged in this process. Both groups have invested time and resources to understand the other and to tailor information to meet specific needs. As C.P. Snow (1964) said, the middle ground is where creative chances occur. These individuals within the drought knowledge community are without doubt creating those creative chances. Even though some of the ideas which have emerged from this collaboration have yet to be implemented, there will certainly be opportunities in the future at which such ideas may be tested and refined.

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APPENDIX A: INTERVIEW GUIDE FOR PRODUCERS

1. **Production of scientific reports**
   This first set of questions deals with production of scientific reports.

   - Have you or your organization issued reports or technical papers related to drought in the last three years? (yes/no)

   - (If yes; otherwise proceed to next question) Did these reports or technical papers contain specific recommended actions? (yes/no) If yes, to whom were those actions targeted?

   - Have you recently (last 3 years) participated in studies sponsored by a national professional association, such as the National Academies of Sciences, that reviewed issues related to drought? (yes/no; if yes, ask for additional details)

   - (If yes; otherwise proceed to next question) Did the report include specific recommended policy actions? (yes/no) If yes, to whom were those actions targeted?

2. **Personal Communication**
   The next few questions address personal communication you may have had with policy-makers.

   - Do you have direct, personal communication with individuals in policy-making capacities, such as senior officials in federal or state government or elected officials? (yes/no – if no, skip to question 4)

   - How did that contact originate?

   - What was the nature of the initial communication? (examples: a briefing on drought status, a board / commission meeting, asked for advice)

   - Do you maintain regular contact with that official or other policy-makers? (yes/no). If yes, how often do you communicate with him/her?

3. **Communications Methods**
This next set of questions addresses the way in which you share your research with others.

- With regards to your ability to share information, either with other members of the scientific community or a larger audience, I'd like you to rate each of the following media as 'very useful', 'somewhat useful', 'not very useful', and 'not at all useful'. If you are not familiar with the item, you may answer 'don't know'.

	Very Useful	Somewhat Useful	Not Very Useful	Not At All Useful	Don't Know
Scholarly Journals	☐	☐	☐	☐	☐
Professional Meetings	☐	☐	☐	☐	☐
Published Reports	☐	☐	☐	☐	☐
Popular Journals	☐	☐	☐	☐	☐
E-mail Discussion Lists	☐	☐	☐	☐	☐
Press Releases / Mainstream Media	☐	☐	☐	☐	☐
Program Newsletters	☐	☐	☐	☐	☐
Information Received in the Mail	☐	☐	☐	☐	☐
Organization or Personal Website	☐	☐	☐	☐	☐
Internet News Sites	☐	☐	☐	☐	☐
Direct Contact with Researchers	☐	☐	☐	☐	☐

4. **New Drought Research**
This final set of questions addresses new research you may be conducting related to drought.

- Within the last three years, have you submitted proposals for funding that deal with drought, soil moisture, land-atmosphere interaction, or climate variability? (yes/no – if no, interview is concluded)

- Were any of those proposals funded by a federal or state agency? (yes/no – if no, interview is concluded)

- Did any of those proposals include policy recommendations as a deliverable?

APPENDIX B: INTERVIEW GUIDE FOR INTERMEDIARIES

1. **Production of scientific reports**
   This first set of questions deals with production of scientific reports.

   - Have you or your organization issued reports or technical papers related to drought in the last three years? (yes/no)
   - (If yes; otherwise proceed to next question) Did these reports or technical papers contain specific recommended actions? (yes/no) If yes, to whom were those actions targeted?
   - Have you recently (last 3 years) participated in studies sponsored by a national professional association, such as the National Academies of Sciences, that reviewed issues related to drought? (yes/no; if yes, ask for additional details)
   - (If yes; otherwise proceed to next question) Did the report include specific recommended policy actions? (yes/no) If yes, to whom were those actions targeted?

2. **Personal Communication**
   The next few questions address personal communication you may have had with policy-makers.

   - Do you have direct, personal communication with individuals in policy-making capacities, such as senior officials in federal or state government or elected officials? (yes/no – if no, skip to question 4)
   - How did that contact originate?
   - What was the nature of the initial communication? (examples: a briefing on drought status, a board / commission meeting, asked for advice)
   - Do you maintain regular contact with that official or other policy-makers? (yes/no). If yes, how often do you communicate with him/her?

3. **Communications Methods**
These next questions address the way you present information as well as how you receive information about drought.

- Scientists communicate findings through a number of different media. With regards to your ability to convey information to policy-makers, I'd like you to rate each of the following media as 'very useful', 'somewhat useful', 'not very useful', and 'not at all useful'. If you are not familiar with the item, you may answer 'don't know'.

	Very Useful	Somewhat Useful	Not Very Useful	Not At All Useful	Don't Know
Scholarly Journals	☐	☐	☐	☐	☐
Professional Meetings	☐	☐	☐	☐	☐
Published Reports	☐	☐	☐	☐	☐
Popular Journals	☐	☐	☐	☐	☐
E-mail Discussion Lists	☐	☐	☐	☐	☐
Press Releases / Mainstream Media	☐	☐	☐	☐	☐
Program Newsletters	☐	☐	☐	☐	☐
Information Received in the Mail	☐	☐	☐	☐	☐
Organization or Personal Website	☐	☐	☐	☐	☐
Internet News Sites	☐	☐	☐	☐	☐
Direct Contact with Researchers	☐	☐	☐	☐	☐

4. Institutional Sources

The next set of questions deal with sources of information on drought.

- In addition to providing information developed in-house, sometimes policy-makers may be looking for information synthesized from multiple sources. I would like you to rate each of these same media regarding their utility as a source of information to you. Rate each as ‘very useful’, ‘somewhat useful’, ‘not very useful’, and ‘not at all useful’. If you are not familiar with the item, you may answer ‘don’t know’.

	Very Useful	Somewhat Useful	Not Very Useful	Not At All Useful	Don’t Know
Scholarly Journals	☐	☐	☐	☐	☐
Professional Meetings	☐	☐	☐	☐	☐
Published Reports	☐	☐	☐	☐	☐
Popular Journals	☐	☐	☐	☐	☐
E-mail Discussion Lists	☐	☐	☐	☐	☐
Press Releases / Mainstream Media	☐	☐	☐	☐	☐
Program Newsletters	☐	☐	☐	☐	☐
Information Received in the Mail	☐	☐	☐	☐	☐
Organization or Personal Website	☐	☐	☐	☐	☐
Internet News Sites	☐	☐	☐	☐	☐
Direct Contact with Researchers	☐	☐	☐	☐	☐

- As I read a list of types of organizations, please rate each as ‘very important’, ‘somewhat important’, ‘not very important’ or ‘not at all important’ to you in providing policy-relevant information on drought. If you are not familiar with the type of organization, you may answer ‘don’t know’.

	Very Important	Somewhat Important	Not Very Important	Not At All Important	Don’t Know
Personal / Legislative Staff	☐	☐	☐	☐	☐
Senior State Agency Administration	☐	☐	☐	☐	☐
Other State Agency Staff	☐	☐	☐	☐	☐
Federal Agencies	☐	☐	☐	☐	☐
State Boards or Commissions	☐	☐	☐	☐	☐
Nonprofit Organizations	☐	☐	☐	☐	☐
Academic / University Sources	☐	☐	☐	☐	☐

Scientific Associations	☐	☐	☐	☐	☐
Private-Sector Firms	☐	☐	☐	☐	☐
Media Sources	☐	☐	☐	☐	☐

- (Repeat this question for each organization rated as very or somewhat important) You mentioned that ____________ (type of organization from above list) is a 'very important' source of information. What characteristics make it important?

- (Repeat this question for each organization rates as 'not very' or 'not at all' important)
  You mentioned that _____________ is not very important or not at all important in providing policy-relevant information. What characteristics make it difficult for you to use information from that source?

- Are there any specific organizations that you use as sources of drought information? (yes/no). If yes, could you provide an example of how you use the information from one of these organizations?

5. **Integrating information with other sources**
   This final set of questions addresses issues related to diverse and sometimes conflicting sources of information.

- Scientific findings are often presented with caveats or uncertainties. When information from multiple studies conflict, how do you make a determination as to what to use and what to discard?

- You mentioned that some organizational sources are more important than others. Does the source of the information or study affect which study you tend to believe?

- If there is a great deal of uncertainty in the scientific community regarding a topic for which you need information, are you more likely to wait until some consensus emerges or to proceed with the report or recommendations based on the information you have at hand?

- Scientific information is only one input into the policy-making process. What other inputs are important to your considerations on drought management? How important do you consider scientific information relative to those other inputs?

APPENDIX C: INTERVIEW GUIDE FOR POLICY-MAKERS

1. STATE DROUGHT PLAN

- Has your organization made any changes in policies or plans related to drought management in the last three years? (yes/no) If yes, please describe the process.

- What motivated those changes in policies / plans (federal requirement, state law, legislative study, executive order, agency initiative, public demands, new research)?

- Did any state commissions or task forces provide advice to these policies / plans? (yes/no) If yes, please name the commission(s).

- What were the sources of information that you considered during making / revising drought politics and procedures? What were your primary sources in-state? Out-of-State? Federal?

- If academic reports or studies were used in the decision-making process, were recommendations from the reports relevant? (yes/no)

- Do you have any regular update to plans, such as a five-year review? Does your agency undergo a strategic planning or review process that would include a review of your involvement in drought planning and monitoring?

2. ORGANIZATIONAL SOURCES

- Are there any specific organizations that you use as sources of drought information? (yes/no). If yes, please describe how you use the information from each organization.

- What characteristics make these sources important to you? (look for words like credibility, trust, relationship, understand information)

- Are there characteristics of other sources that make them difficult for you to use? (look for phrases like ‘don’t know how to contact them’, ‘information doesn’t match my needs’, ‘I can’t understand the information’)

- Do you have direct, personal communication with individuals conducting research on drought? (yes/no)

- If yes, how did that contact originate? (Select the answer that best describes the situation.)

  ☐ I approached the individual or his/her staff

  ☐ The individual or his/her staff contacted me

  ☐ The individual and I were at a common meeting

  ☐ The conversation occurred in the context of a task force / study meeting

  ☐ Other: ____

3. USING SCIENTIFIC INFORMATION

- Do you think that scientists make adequate efforts to provide you with useable information?

- Is information on drought accessible? Understandable?

- Does it matter if information has been peer-reviewed by members of the scientific community?

- Would you rather have information as bullet points or executive summaries, or would you rather have information elaborated with more detail, including caveats and uncertainties behind the information presented?

- Do you find a detailed assessment difficult to understand? To apply?

4. EXPERTISE

- (If applicable) How did you become the drought coordinator for your state? Was there a formal position for which you applied / were appointed? Were you already in the department and the responsibility was assigned to you? Did you volunteer?

APPENDIX D: FOLLOW-UP QUESTIONS (PRODUCERS AND INTERMEDIARIES)

1. Have you either served on or directly interacted with a member of a state drought task force or commission? If so, please describe those circumstances, including when that took place and how (if known) they identified you to invite you to serve?

2. How would you characterize your interactions with each of the following (routine, frequent, occasional, or not at all)? Please respond based upon your complete interaction, not just with regards to interacting with policy-makers.
   - State government:
   - Federal government:
   - Private sector:
   - Academic / universities:
   - Scientific associations:

3. Please rank the following (1-6) by their importance to you as targets for communicating your findings (1=highest):
   ___ other members of the scientific community
   ___ individuals (farmers, water managers, attorneys, etc.)
   ___ producer / trade organizations
   ___ state officials
   ___ federal officials (including staff at federal agencies)
   ___ elected officials / staff members

4. What are your preferred mechanisms to relay information to scientists? To decision-makers (either at a policy-level or agency operations)? To the general public?

5. In an ideal world, free of time and resource constraints, how would you focus your efforts to communicate your knowledge outside of the scientific community?

6. On a scale of 1-10 (10=highest), how important is it that information be peer-reviewed before providing it to the public, agency officials, or policy-makers?

7. Would you be willing to put your information into bullet form or an executive summary, even I that means an inability to convey caveats or uncertainties?

8. When an individual from the media or a decision-maker contacts you for information, are you more likely to formulate an answer yourself or to refer them to another organization that may have more expertise in the area?