

**ANALYSIS OF INSTITUTIONAL INNOVATION
IN THE NATURAL RESOURCES
AND ENVIRONMENTAL REALM:
THE EMERGENCE OF
ALTERNATIVE PROBLEM-SOLVING STRATEGIES
IN THE AMERICAN WEST**

by

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EXECUTIVE SUMMARY

It is now widely acknowledged that the solutions to many, if not most, natural resource and environmental problems do not lie solely in the natural sciences or engineering, but entail modifying institutional arrangements that determine how individuals and organizations interact with the natural environment. To fully understand the workings of natural resource institutions requires an understanding of the many human and non-human components associated with given situations and the manner in which these components interact to facilitate or impede the achievement of management objectives. This is a formidable intellectual challenge, spawning a variety of distinct terms, assumptions, and methodological tools found in disciplines such as law, economics, political science, public administration, and many related social sciences.

In order to more effectively meet the challenge of institutional analysis, new techniques and concepts are needed to evaluate alternative institutional arrangements in a more consistent, comprehensive and rigorous manner than is typically observed. Tools are particularly needed to better predict the functioning of evolving and prospective institutions, and to address what is becoming an alarming trend in the natural resources literature: to endorse or denounce various institutional problem-solving strategies based on dogma rather than intellectually sound analysis. In this country and era, “advocacy research” of this type is most typically associated with the so-called *alternative problem-solving strategies* emphasizing collaboration, negotiation and/or market processes, efforts which can be distinguished from many of the more “traditional” institutional problem-solving strategies, particularly regulation and litigation, by their emphasis on voluntary action and “positive” (i.e., the carrot rather than the stick) incentives. *Alternative problem-solving strategies* currently enjoy broad political support in the West and elsewhere, as evidenced by recent policy statements of the Western Governors’ Association, the National Performance Review, the Environmental Protection Agency, the Western Water Policy Review Advisory Commission, and dozens of other public and private entities.

This report is a preliminary step toward identifying appropriate conceptual and methodological tools for institutional analysis in the natural resources and environmental realm. The era of *alternative problem-solving* provides a stimulus and a context for this endeavor.

Tools for Institutional Description and Analysis: Basic Concepts

The approach to institutional analysis featured in this report is largely derived from the *institutional analysis and development (IAD) framework*

developed through the work of Elinor Ostrom and colleagues at Indiana University's Workshop in Political Theory and Policy Analysis. At the heart of the conceptual framework is the notion of institutions as set of *rules* that specify who is involved in resource management and use, what roles they can play, what actions they can (and cannot) take, what subject matters they can (or are expected to) deal with, the information and resources they can draw upon in performing their roles, the ways in which they can make individual and collective decisions, and the benefits (and costs) they can expect to receive. Institutional rules, together with actors and the environment, comprise an *action situation*, the appropriate unit of institutional analysis. In this report, a variety of concepts and terms useful in the analysis of natural resource and environmental *action situations* are organized within the *IAD framework*, then applied to case studies to compare various problem types and solution strategies.

The various components of natural resource *action situations* interact to form different classes of resource problems. For purposes of institutional analysis, it is useful to distinguish among four problem types. The first is *depletion* problems, which describe situations in which the rate of consumption of a given resource is perceived to be too high (e.g., overgrazing, groundwater declines). Depletion problems are frequently associated with so-called *open access* and *common pool resource* (CPR) situations, circumstances in which institutional rules poorly control access to resources and/or levels of use. The second, and closely related, problem type is *underinvestment* problems, in which the anticipated future availability of a given resource is smaller than desired, presumably due to inadequate investments in resource management. This phenomenon is most typical of so-called *public good* situations, which involve resources that, once provided to one party, are automatically available to all (e.g., clean air, biodiversity). In such situations, ensuring that all potential beneficiaries pay for the possible benefits can be a difficult challenge. The third and most ubiquitous problem type discussed herein is *maldistribution* problems, situations in which the existing distribution of a given resource is insufficient to satisfy the needs of all potential users (e.g., water scarcity). A special sub-set of maldistribution situations are *externality* problems, which occur when resource use by one type of user diminishes its availability (or quality) for other user types (e.g., most pollution situations). Institutional rules that allocate rights and/or costs and benefits poorly—either in terms of equity or efficiency—can contribute to these problem types.

This typology of problems derives heavily from the economics literature, which is primarily concerned with those institutional rules describing the direct interaction of actors and resources. This level of the institutional rules is known as the *operational choice* level. Two additional (higher) levels also exist: the *collective choice* and *constitutional choice* levels. In the evaluation of problem-solving strategies, the *collective choice* level rules demand particular attention, as these rules describe the group (i.e., “collective”) processes available for

modifying the *operational choice* level rules, and thus, for solving the four problem types identified. These *collective choice* processes include such familiar mechanisms as agency rule-making, litigation, market exchanges, and bargaining and collaboration. In utilizing these tools, managing conflict is a primary concern. *Value conflicts* arise when participants share fundamentally different value structures; *interest conflicts* describe situations when the overall goals of participants are not in question, but the allocation of costs and benefits is of primary concern; and *cognitive conflicts* involve situations in which inadequate knowledge or understanding slows progress. The selection of appropriate problem-solving strategies is largely dependent upon considering the opportunities and constraints provided by the *operational choice* level and *collective choice* level rules.

Lessons from the Case Studies

Three case studies are presented to demonstrate the utility of the institutional analysis concepts described herein, and to identify a few different ways in which the tenets of *alternative problem-solving* have found expression in modern natural resource and environment conflicts. The first case examines problems associated with groundwater overdrafting in the South Platte Basin of Colorado. In that region, the failure of Colorado law to adequately manage groundwater usage resulted, for a time, in a situation in which senior surface water rights holders were vulnerable to reduced flows due to water table declines attributable to unregulated groundwater pumping. This essentially created a spatial and temporal *externality* situation, in which the water demands of junior groundwater appropriators were elevated above those of senior surface rights holders. Groundwater overdrafting also created *depletion problems* affecting groundwater pumpers. While scientific uncertainty about the surface water/groundwater connection slowed efforts to address these highly related problems, legislative action eventually established a framework of rules under which technical expertise and a new collaborative group—Groundwater Appropriators of the South Platte (GASP)—have produced a solution heavily reliant on cooperative action, negotiation, and market incentives, all nested within a framework of private property rights and regulatory oversight.

The second case study addresses issues of forest management in the Applegate region of Oregon. The Applegate region is utilized to provide a specific context for an issue that is widespread in the West: determining appropriate timber harvesting levels. In this case, the *depletion problem* takes on a special character as a high-profile endangered species controversy is injected into the debate, highlighting *underinvestment* and *externality* problems characteristic of the modern environmental movement. While enactment of the Northwest Forest Plan of 1994 is the culminating event in the institutional history

provided, it is the role and presence of collaborative groups in the region that is of particular interest, as many natural resource scholars see the Applegate region as an important laboratory in *alternative problem-solving*—a perception that is only partially accurate. As shown by the case study, it is the relationship between the *alternative problem-solving strategies* and the traditional means of conflict resolution that is of particular analytical interest.

The most complex of the three cases involves environmental restoration in the Truckee-Carson River Basins. In that region, the distribution (or *maldistribution*) of a limited water resource has created a host of problems, including *underinvestment* problems associated with endangered species and migratory waterfowl. The interplay of water allocation regimes and species protection is a problem found throughout the West; the Truckee-Carson case provides one specific context for analyzing a set of issues that is discouragingly universal to the region. In order to focus on the most illuminating aspects of this situation, the case study primarily focuses on events surrounding the Truckee-Carson Pyramid Lake Water Rights Settlement Act of 1990, but places this event in a nearly 100 year context beginning with the initial development of the region under the auspices of the prior appropriation doctrine and the Reclamation Act. Prior to this time period, an *open access situation* presumably existed—just as it did for water resources in the South Platte before enactment of the prior appropriation doctrine and for forests in the Applegate region prior to establishment of national forest reserves. Major post-Settlement Act strategies employed for environmental restoration prominently involve *alternative problem-solving* techniques, including water marketing and collaborative watershed management.

The case studies presented provide some insights into the nature of *alternative problem-solving* and, more specifically, the type of institutional environment within which this class of solution strategies can best flourish. Two factors appear to be most salient in creating an environment conducive to success: (1) the prior resolution of fundamental *value conflicts*, and (2) the existence of adequate problem-solving incentives. In the Applegate and Truckee-Carson cases—as well as dozens of similar cases throughout the West—the passage of the Endangered Species Act, and its enforcement by the courts, was the essential action needed to resolve the *value conflict*, paving the way for *alternative problem-solving strategies*. This is more than a little ironic given that many of the proponents of *alternative problem-solving* see these strategies as the preferred alternative to the regulation/litigation model embodied by the Endangered Species Act and similar value-oriented legislation.

The salience of the second factor, incentives, in each of the mechanisms lumped under the heading of *alternative problem-solving strategies* derives from the fact that each is highly dependent upon achieving agreement among all key participants. In various ways, each of the case studies illustrates the importance of incentives in modifying behavior. In the South Platte case, a fear of losing

water rights was a key behavioral consideration, while in the Applegate and Truckee-Carson cases, the costs of environmental regulation were a strong stimulus for reform. In addition to these incentives imposed by problem-solvers, the problems themselves feature important incentive structures, perhaps best described using the concept of *symmetry*. In *symmetrical* situations, such as *depletion* and *underinvestment* problems, all parties have at least a partial incentive to resolve problems; whereas in *asymmetrical* situations, such as *maldistribution* and *externality* problems, some parties are benefitted by the status quo. It is expected that *alternative problem-solving strategies* will not emerge in the *asymmetrical* situations unless additional incentives (either positive or negative) are provided, but may independently emerge in the *symmetrical* situations. This is the pattern shown by the case studies.

Concluding Thoughts

This report reflects a growing desire among many parties in the natural resources community to bring a greater level of scientific scrutiny to the description, analysis and, ultimately, the design of institutional arrangements. The conceptual framework described herein, while far from perfect, is an initial step in that direction. However, while not minimizing the potential contribution of institutional analysis to improved resource management, it must be acknowledged that even the most informed and academically rigorous processes of institutional design will not be sufficient to craft arrangements stable over long time periods—especially at the *operational choice* level. Many of the factors prompting natural resource and environmental problems—such as growing demands on resources, technological innovations, changing social values, and the consequences of past rule-making exercises—are not easily controlled, and to the extent that their ramifications can be managed, this activity must be viewed as an ongoing challenge, much as we accept government to be a permanent fixture of modern civilization.

Increasingly, a diverse coalition of policy-makers and advocates are encouraging the use of *alternative problem-solving approaches* to address natural resource and environmental problems. There is reason to be optimistic about these approaches emphasizing voluntary, incentive-based decision-making, often occurring in collaborative or market settings. In many geographic and substantive areas, these approaches are making a positive contribution to management regimes, providing problem-solvers with a bigger and better toolbox. The enthusiasm for *alternative problem-solving strategies*, however, is somewhat disconcerting. The three case studies reviewed in this report were sufficient to illustrate two major limitations on the use of these tools: first, when significant *value conflicts* are unresolved; and secondly, in situations primarily featuring problems with *asymmetrical* incentive structures. Further analyses will

likely identify additional insights into the proper, and improper, application of these approaches. The discipline of institutional analysis is the proper setting for these investigations, utilizing concepts and methodologies drawn from a wide variety of academic pursuits.

SECTION I: INTRODUCTION AND OVERVIEW

Purpose and Scope of this Research

The rules that govern the allocation and management of western natural resources are of special concern to many parties, given the wide variety of uses and values associated with the region's land and water resources. By formally defining the limits of acceptable and unacceptable action, laws are a key component of the institutional arrangements that control these resources. An understanding of the law, consequently, is an essential prerequisite to the evaluation of natural resource institutions. Institutional arrangements, however, always involve more than just the formal rules known as law. They normally also include a maze of informal rules codified, for example, in cultural and social norms, in agency practices, in disciplinary biases, in business norms, and in behavioral patterns, evolving over time in an incremental and largely uncoordinated manner through the normal functioning of governmental and socioeconomic processes. These rules help determine which people and organizations are involved in the use and management of resources and largely determine how they interact.

It is now widely acknowledged that the solutions to many, if not most, natural resources problems do not lie solely in the natural sciences or engineering—although these disciplines will continue to play a major role in explaining and shaping the physical environment. The solutions largely reside in the modification of those institutional arrangements that specify the manner in which people and organizations interact with each other and with the natural environment.¹ This is where the attention of the Natural Resources Law Center, and several other public policy research organizations, is focused. To fully understand the workings of natural resource institutions requires a clear understanding of the many human and non-human components associated with a given natural resource situation and the manner in which these components interact—a formidable challenge. To accomplish this in an academically rigorous fashion can require the application of conceptual and methodological tools found in a variety of social science disciplines, including political science, public administration, economics, and more specialized sub-disciplines such as public choice and organization theory. Very few individuals or organizations have the necessary background or inclination to effectively evaluate institutional arrangements from such a broad perspective, even though the careful description

¹ Note that the terms organization and institution (and institutional arrangements) are not equivalent in the language of institutional analysis. An organization is a specific agency, interest group, or similar body, and is one of many players that have a role in an institution, which is best described as the set of rules associated with a particular subject area or resource (e.g., the Columbia River management institution).

and analysis of institutional arrangements is perhaps the most pressing current research need in the realm of natural resources.

In order to more effectively meet this formidable challenge, new techniques and concepts are needed to evaluate alternative institutional arrangements in a more consistent and rigorous manner than is typically observed (Francis, 1990). These tools are particularly needed to better predict the functioning of evolving and prospective institutions, and to address what is becoming an alarming trend in the natural resources literature: i.e., to endorse or denounce various institutional problem-solving strategies based on dogma rather than intellectually sound analysis. In this country and era, “advocacy research” of this type is most typically associated with institutional strategies associated with collaboration and/or markets, efforts which can be distinguished from many of the more traditional institutional problem-solving strategies, particularly regulation and litigation, by their emphasis on voluntary action and “positive” (i.e., the carrot rather than the stick) incentives.²

Several authors have recognized this transformation in natural resource problem-solving strategies, away from inflexible command-and-control regulatory programs to efforts that stress flexibility, efficiency, pragmatism, and perhaps most importantly, voluntary action. For example, John (1994) has coined the term “civic environmentalism” to refer to a broad class of suddenly popular problem-solving tools that prominently feature “bottom-up” and collaborative strategies in environmental problem-solving. This substantive area is also the focus of research by Hockenstein et al. (1997), who review the application of market-based tools to resolve pollution problems. In a much more diverse range of subject matters, Osborne and Gaebler (1992) describe the emergence of “entrepreneurial governments” that rely heavily on incentives and techniques drawn from the private sector.

In this report, the term *alternative problem-solving* is used to describe those strategies being utilized in the American West (and elsewhere) to bring greater creativity, efficiency, and voluntary action to the resolution of natural resource problems. In the 1980s, this trend was perhaps most frequently expressed by calls for privatization and resource markets; in the 1990s, the most salient development has been the rapid proliferation of watershed initiatives/councils, forestry partnerships, and other types of “collaborative

² In other locations and time periods, different problem-solving approaches have enjoyed similar popular support. For example, the preference of socialist societies for centralized planning and regulation, as opposed to decentralized market institutions of the capitalist West, is well known. Dogma of either sort preempts sound analysis and biases the search for solutions to real problems.

groups” seeking innovative and voluntary problem-solving.³ Also important has been the emergence of alternative dispute resolution (ADR) tools in the natural resources realm, often drawing upon the bargaining orientation so characteristic of the market-based strategies as well as the multi-party focus typical of the collaborative groups (Bacow and Wheeler, 1984; Bingham, 1997). While each of these classes of problem-solving tools is distinct in structure and often reside in different locales on the spectrum of political ideology, proponents of alternative problem-solving strategies generally share a faith in decentralized control and voluntary (incentive-based) action, ideas which have found an increasingly receptive audience in the West and elsewhere.

Report Organization

By emphasizing voluntary and localized action, these new strategies may, in fact, be the panacea for most of the chronic and seemingly intractable resource management disputes in the West, or they may be additional tools to be suitably used only in specific types of problem-solving exercises. To answer this fundamental research question in an effective manner will require less ideology and more scholarship, utilizing concepts increasingly being categorized within the evolving literature of “institutional analysis.”

This project provides an initial step in fulfilling this need by outlining (in Section II) an integrated approach to institutional description and analysis, based in part on an approach known as the *institutional analysis and development (IAD) framework* (Ostrom et al., 1994).⁴ The concepts identified are then applied (in Section III) to a general discussion of institutional problem-solving techniques—including the so-called “alternative” approaches—applicable in the natural resources and environmental realm, followed by a review of three case studies (in Section IV) from the western United States useful in highlighting various approaches. In the concluding pages (Section V), the focus of the report turns to issues associated with institutional analysis at a macro level, primarily focusing on the analytical challenge of investigating broad trends in institutional

³ Several detailed reviews of collaborative resource management are available. Useful watershed group case study inventories are provided by the Natural Resources Law Center (NRLC, 1996), Yaffee et al. (1996), and Kenney (1997). Forestry group case studies are provided by Wondelleck and Yaffee (1994). These increasingly common groups are typically ad hoc, voluntary, and regionally-oriented public/private partnerships organized in hopes of addressing and resolving resource management problems that established institutions and organizations have failed to solve. Both the market-based and collaborative strategies are “institutional” in nature in that they call for modifying the rules that specify how people and agencies interact in the control and use of natural resources.

⁴ Much of this “framework” is applicable to the description and analysis of other types of institutions, including those in frequently studied and diverse sectors such as health care, transportation, and national defense.

arrangements and problem-solving. Preliminary conclusions are provided regarding the use of the institutional analysis framework presented herein and the role of alternative problem-solving strategies. Some remaining research needs are also identified.

An Introduction to Institutional Analysis

The analytical framework presented in this paper is unavoidably complex, and requires the use of a variety of concepts and terms that are unfamiliar to many parties involved in natural resources research. To better assist the reader in navigating through this complex maze, the following paragraphs provide an overview of the major concepts that will be encountered on this journey. A more complete discussion of these and related concepts and terms is featured in Section II.

Fundamental Terms and Concepts

Many social scientists have found that given the many components of institutional arrangements, the variety of resources (and other considerations) they are designed to deal with, and the wide range of problems that they are expected to address, the description of institutions can be extremely difficult to do in a manner that is comprehensive, useful, and standardized. Most of the techniques currently used focus on one or more discrete elements of institutional functioning, often featuring unique terms and assumptions not readily transferrable to the other approaches. While many excellent ideas can be found within this body of conceptual and methodological tools, a need persists for a comprehensive analytical approach. Some efforts, such as the body of work known as the “policy sciences” (Brunner, 1997), are an attempt to integrate ideas into a coherent and comprehensive framework. A major contribution of the policy sciences is to underscore the value of frameworks that provide structure without losing sight of the significance of each case’s unique context. While many ideas from the policy sciences—especially this emphasis on context—are relevant to the study of institutional arrangements, the study of institutions is notably different in that the institutional analyst is not just concerned with investigating decision-making exercises *per se*, but primarily focuses on describing and analyzing the different salient qualities of the institution before and after these transitional periods. Fortunately, several important advances have been made in recent years to foster a more integrated and coherent conceptual approach to the study of institutional arrangements (Gregg et al., 1991; Ostrom et al., 1994). This report builds upon these recent advances.

Describing institutional arrangements requires, at a minimum, the use of terms and concepts to account for all those formal and informal “rules” that specify who is involved in resource management and use, what roles they can

play and what actions they can (and cannot) take, what subject matters they can (or are expected to) deal with, the information and resources they can draw upon in performing their roles, the ways in which they can make individual and collective decisions, and the benefits (and costs) they can expect to receive (Ostrom, 1986). All this information, specified in various types of “rules,” combine to form an *institution*, or more generally, *institutional arrangements*. Describing institutional arrangements also requires terms and concepts describing the broader environment in which these institutional rules function. Of particular significance is a consideration of the physical and actor/behavioral environments, which when combined with the institutional rules, constitute a particular *action situation*.

Once all components of the action situation are given appropriate labels, it then becomes possible to systematically organize information gained from case studies and the “war stories” of parties involved in resource management and use. These data can be used to identify general types of natural resource problems and solution strategies, illuminating linkages and relationships among situations that may otherwise appear to have little in common. Distinct types of institutional problems can be identified, based largely on considerations such as resource access and behavioral patterns, rather than the more generic—and analytically limited—problem schemes based on substantive criteria, such as “water supply” or “air quality” problems. Similarly, various types of institutional structures emerge. For example, some may be characterized by highly decentralized and individualistic decision-making (e.g., an unfettered water market); others by more centralized control exercised through rigid hierarchical processes (e.g., national forest planning); still other institutions may be best characterized by their use of positive or negative incentives (i.e., rewards, such as tax breaks, or penalties, such as fines).

By reviewing the functioning of different types of institutional arrangements under different stresses, the descriptive terms begin to take on an analytical value, giving rise to models which are not only useful in describing existing situations, but in identifying those types of arrangements that may have the greatest potential applicability in related or future situations. Identifying appropriate arrangements, however, is only half the challenge in an institutional problem-solving analysis. The other need is to consider the mechanism by which institutional arrangements change in response to natural resource problems, something which requires an appreciation of the multi-level quality of institutions (Ostrom, 1986; Ostrom et al., 1994; Ciriacy-Wantrup, 1970). To fully describe and understand how problem-solving occurs, the analyst must account for the movement of issues among hierarchal institutional levels, and must also be cognizant that different types of issues and conflict resolution strategies are available at each level.

Several academic disciplines recognize the multi-level character of institutional arrangements. While it can be extremely difficult to precisely define the boundaries between levels, and different authors utilize different assumptions

about the total number of levels, it is relatively common to acknowledge the existence of three primary institutional levels.⁵ Rules at the first level, known herein as the *operational choice level*, are those that describe the relationship between resource users/managers and the resource itself. Institutional rules (also known as *rule sets*) at the operational choice level are a subject matter frequently addressed in the economics literature, where the interaction of human enterprise and natural resources (as an input of production) is of primary concern. The next highest level is the *collective choice* level, where policy-makers, interest groups, and other involved parties establish the rules which guide activity at the operational choice level. The rules for such collective rule making are established at the even higher *constitutional choice* level where the basic characteristics of the American political system are codified. Constitutional choice level rules can generally be considered to be immutable in most case studies. Activity at the collective choice and constitutional choice levels is generally sparked by the existence of a natural resource problem that cannot be resolved by utilizing existing operational choice level rules. Political science, public administration and related policy sciences are among the academic disciplines that focus on these higher levels of institutional activity, where the issues of concern are likely to have as much to do with concerns such as determining who has the right to make decisions or what processes or forums they will use, than simply the substance of the operational choice level rules that these parties eventually establish.

These basic ideas are central to the institutional analysis framework described throughout this report.⁶ While a complete understanding of these concepts is not essential—nor is it expected—at this point, the reader should appreciate that these ideas reflect the above assertion that institutional analysis demands a broad focus, drawing concepts from a variety of scholarly endeavors. This is a formidable cognitive challenge, requiring the integration of seemingly distinct terms, concepts, assumptions, and related elements comprising academic inquiry. This challenge is the primary subject of the following two sections.

⁵ Several authors utilize various forms of the levels concept, complete with different terminologies (e.g., Ciriacy-Wantrup, 1970; Ostrom et al., 1994; Gregg et al., 1991). Most recognize the utility of using an “operational” level, describing the interaction of resource users with the resource, and a “constitutional” or policy level, where the basic parameters of the sociopolitical system are described. It is the intervening level (or levels) where different conceptual approaches are most commonly seen, as this is the level (or levels) where the greatest variety of policy/administrative innovations occur.

⁶ To recap, *institutions* can be conceptualized as sets of *rules*, organized within a three-tiered system of *levels*, that describe how activities and relationships are ordered among parties involved in a given substantive and geographic area. These rules comprise one of three components of a particular *action situation*, which also includes a consideration of human behavior and the qualities of the physical environment.

SECTION II: CONCEPTS IN INSTITUTIONAL ANALYSIS

The Rhetoric of Science

A primary responsibility of academic inquiry is to promote the examination of information and ideas in a manner guided by precise, reproducible, and presumably value-neutral, criteria and procedures, in contrast to the more explicitly political exercises driven by ideology, dogma, and undoubtedly, self-interest. To approach this ideal requires scholars to be very clear about methodological assumptions and tools, something that can be particularly challenging in those social sciences that are not readily amenable to well-established quantitative techniques such as statistical analysis. This general observation is particularly relevant to the evaluation of those alternative problem-solving approaches featuring voluntary, ad hoc collaboration, which are commonly evaluated using largely unsophisticated case study techniques.

The way in which all scientists go about their business of making the world understandable changes over time, in response to the ebb and flow of prevailing conceptual and methodological assumptions. One of the ways of conceptualizing scientific activity which appeals to the post-modern intellect has come to be known as the rhetoric of scientific activity (McCloskey, 1990). This conceptualization has the merits of encompassing scientific theorizing, empirical testing, and applying scientific knowledge to practical problems, all without forcing a choice between formalism and empiricism.⁷ It distinguishes between *fact*, *logic*, *metaphor* (or *models*), and *storytelling*, while relating them to each other. To these four categories we add *language*, which is the basic prerequisite for thinking and communicating, and without which fact, logic, metaphor, and storytelling would be meaningless.

Language

Language is the first essential in all scientific or practical discourse. A language names the variables (i.e., the subject matter of concern) and provides the terms for describing relationships between them. It also provides some syntax, or structure—more precise in quantitative (e.g., mathematical) than non-quantitative (e.g., verbal) modes of communication. Without adequate language, there is no possibility of precise communication or analysis. The choice of language can be highly salient as it sets the direction and tone of subsequent inquiry, naming only what is deemed important enough to be investigated while failing to name other elements of the situation which will then be ignored or

⁷ “Formalism” refers to research methodologies that rely on the standardized testing of explicit theories, while “empiricism” describes research methods that are primarily reliant on observation and experience.

overlooked. Inadequate language is a prevalent problem in institutional analysis.

Scientific discourse uses both common language and specialized languages, which are, hopefully, less ambiguous, albeit less comprehensive, than common language.⁸ The natural sciences (e.g., physics, chemistry, and biology) make liberal use of specialized terms or jargon, such as electron, enzyme, and epithelium, which have no meaning in common language, although these sciences also make liberal use of terms from common language. Some professions, most notably medicine and law, use Latin terms, thereby avoiding the ambiguities inherent in common language. The social sciences, perhaps unfortunately, mostly use common language terms, but give them specialized meanings, thereby inviting confusion and misinterpretation. Like all social science research, this report uses such common terms frequently, but where they are given specialized and restrictive meanings, they are defined accordingly.

Fact

Facts are the "real world" elements with which we deal. Some methodologists have called them sensory impressions, others data. In any case, the point is that they represent the external and objective reality which our analyses attempt to explain. Philosophers may argue over whether there is an objective reality, but the working scientist, like the man in the street, finds this argument impractical, if not downright meaningless.

Of course, the facts which we observe are only those aspects of reality which our language, our concepts, and our experience lead us to notice. They represent some of what is "out there," however partial and biased the perception. The old parable about the three blind men describing an elephant in very different terms corresponding to their very different experiences of the elephant applies in equal measure to all of us. Facts are tricky, because they derive not just from objective reality but also from the experience and knowledge of the observer. This phenomenon can be particularly salient in social science research reliant on second-hand data provided through interview research. Nonetheless, there is a hard and unforgiving edge to fact which we may mistake, but cannot ignore.

Logic

Logic refers to those rules and working assumptions (axioms) of a particular analytical process which must be obeyed. There may be different logics—e.g., Euclidian versus Lobachevskian-Riemannian-Bolyain (i.e., non-Euclidian) geometries—but each such set of rules must be internally consistent, and whichever logic is chosen must be followed consistently throughout the analysis. Without logic there is no discipline, no consistency, and no predictability—essential qualities of true academic inquiry. The Euclidian logic

⁸ Mathematics is the epitome of a specialized language, whose terms have no empirical referents until we assign them. This is not true of common languages, the referents of which are established by common usage. Mathematics also has the most powerful, if limited, syntactical relationships.

of the engineer, the Riemannian logic of the astronomer, and the Boolean logic of the computer programmer are close to the surface and readily acknowledged in these fields.⁹ But most of us, social scientists included, are not explicit, and perhaps not even conscious, of the logics which undergird our thinking. This can be particularly disconcerting in the early stages in a discipline's evolution, as methodological advances cannot be readily pursued without critical review of the underlying logic.

Metaphors

Metaphors, also known as *models*, are sets of variables and relationships between those variables which, together, "explain" the workings of certain classes of phenomena. The variables and relationships must be included in the terms of the chosen language, and the relationships between variables must obey the rules of the chosen logic. Metaphors introduce the crucial "if, then" propositions which tie facts together and make sense of empirical observations. They enable us to predict what may happen under selected and specified conditions.

Metaphors are general, in the sense that their terms refer to classes of like individuals, not to particular individuals. For example, a model of how bees fly must apply to all bees, not just one bee. Similarly, metaphors are not specific to individual situations, but are intended to apply to all situations of a particular kind. Medical researchers, for example, are concerned with developing better models of this or that disease, knowledge that medical practitioners must then extrapolate to the treatment of specific individual patients. One creates, revises, or expands metaphors, while the other applies those metaphors to individual cases.

Stories

Stories represent the grand culmination; the integration of facts, logic, and metaphors which attempt to interpret sense data and account for the workings of the real world in specific contexts. Stories, unlike metaphors, are situation-specific. They refer to particular individuals—perhaps many individuals—but not to abstract classes of individuals. History is storytelling, for it recognizes facts and interprets those facts through the use of (perhaps inexplicit) metaphors. When different metaphors are utilized, two historians can interpret the same event in radically different terms. For the social scientist heavily reliant on case study and interview data, an appreciation of the underlying metaphors utilized in the presentation of that information is essential.

Scientific stories are told in combinations of common language and the appropriate specialized language(s). We all tell stories, but the difference between the stories we tell as scientists and those which we tell as non-scientists lie not only in the language employed, but also in the degree to which we are explicit

⁹ A detailed review of major frameworks in logic are well beyond the scope of this research. This subject is perhaps most directly explored in historical summaries of mathematical thought. One concise introduction to this material is available at <http://kalypso.cybercom.net/~rbjones/rbjpub/maths/math003.htm>.

about the facts, logic, and especially, the metaphors upon which those stories are based. Non-scientists rely heavily on anecdote, but seldom acknowledge the underlying metaphors when storytelling. Indeed, Polanyi¹⁰ suggests that we may be able to recognize and articulate only about ten percent of the knowledge (i.e., metaphors) which underlie our everyday discourse. Scientists, on the other hand, distrust anecdote and decry anecdotal evidence, although often remaining highly dependent upon these information sources.

The Institutional Analysis and Development (IAD) Framework

Of the many possible approaches to institutional analysis, perhaps the most complete and promising derives from the work of Elinor Ostrom and her “public choice” colleagues at Indiana University. Expanding on Ostrom’s earlier work entitled *An Agenda for the Study of Institutions* (Ostrom, 1986), this group of researchers has more recently expanded their thinking to form an *institutional analysis and development (IAD) framework* (Crawford and Ostrom, 1993; Ostrom et al., 1994). This body of research, when combined with related and derivative investigations (e.g., Gregg et al., 1991), has resulted in a framework that provides an overarching way of looking at resource management and other societal activities. It supplies the language which is the first requisite for institutional analysis, and provides a way of relating the facts, logic, metaphors (models), and stories which, together, constitute institutional analysis. Consequently, this framework, augmented by a variety of related concepts, is at the heart of the institutional analysis approach described in this report.

The Action Situation

At the core of the IAD framework is the notion of an *action situation*, mentioned earlier, which is defined herein to consist of three broad and interrelated components: the physical environment, the actors (and their behavior), and the institutional rules.¹¹ Every case study, at every significant

¹⁰ Philosopher Michael Polanyi, 1891-1976.

¹¹ This tripartite characterization of the *action situation* is somewhat different than the approach described by Ostrom et al. (1994:28), which defines action situations more generally as the “social space where individuals interact, exchange goods and services, engage in appropriation and provision activities, solve problems, or fight ...” Seven types of variables are used by Ostrom et al. to fully describe *action situations*. The scheme utilized in this report seeks to more concisely capture the range of variables that interact to create problems within this “space,” and in doing so, blends concepts described by Ostrom et al. using both the *action situation* and *action arena* terminology.

point in time, presents a unique action situation comprised of these core elements. Of these three components, it is the institutional rules that are the primary focus of institutional analysis and, more specifically, the IAD framework. This is not to imply, however, that the institutional rules are the overriding factor in determining resource conditions. To the contrary, the action situation concept is predicated on the belief that these outcomes are determined by more than rules, but are also controlled in part by the nature of the physical environment in which people and groups find themselves and by the innate behavioral characteristics of individuals and groups. The emphasis in institutional analysis is upon rules—rather than environmental science and engineering on the one hand or upon biology and sociology on the other—simply because institutional rules are explicitly human creations, subject to deliberate modification through individual and, more commonly, collective action. The physical environment and the actor/behavioral component provide a context within which these rules operate and are changed.

Institutional Rules in Context: The Physical and Actor/Behavioral Components of the Action Situation

The environmental component of the action situation can, in theory, be defined to include the full range of variables that somehow affect (and are affected by) outcomes of the actions taken, and are neither actors nor institutional rules. However, in the realm of natural resource studies, this component is best defined quite literally as the physical environment of land, water, air, and biota organized within discrete landscapes and featuring well established biophysical processes. Among those processes that may prove influential in particular situations is the tendency of water to flow downhill, a gravitational reality that typically results in upstream water users impacting downstream users, but not vice versa (McDonald, 1997). These and other important qualities of the physical environment may derive from natural landforms and processes, or may be associated with the “built” environment—e.g., a stream regulated by impoundments and diversion structures.¹² In either case, the qualities of the physical environment in any particular action situation must be assumed to exert an influence over, and be influenced by, the actor/behavioral component and the institutional rules.

The set of actors involved in an action situation includes both individuals and organizations associated with a given subject matter, such as a particular natural resource. Determining what types of roles these actors may play is primarily an issue addressed by the institutional rules. In evaluating the actor/behavioral component, it is important to make some assumptions about the

¹² Several additional salient qualities of the physical environment are provided in the discussion of operational choice level problem types.

expected behavioral patterns of these actors. Social scientists treat this issue in a variety of ways, most of which have to do with the psychology of individuals, the behavior of organizations, and the importance of learned behavior (Brunner, 1997). Three perspectives are most pervasive: the adaptive, problem-solving animal characterization of biology and psychology; the “rational decision maker” construct of economics; and the socialized and rule-bound actor (or “organization man”) of sociology. The model (or metaphor) of human behavior which seems most useful for institutional analysis is an amalgam of these three that recognizes the overriding importance of self-interest, but which also acknowledges the importance of learning and socialization in determining behavior—a consideration known as *embeddedness* (Granovetter, 1985). This behavioral metaphor is further refined by considering the constraints on rational decision-makers attributable to limited time, money, capability, and other resources, factors that lead to the “satisficing” behavior described by Simon (1982) as *bounded rationality*. The advantage of such an eclectic view is that the human actor is seen as powerfully influenced by rules, but capable of evaluating those rules and changing them rationally, as experience and social learning accumulate.

Institutional Rules and Levels

Institutions can perhaps best be envisioned as sets of rules that constrain and expand the behavioral options available to various actors in a given environment. Institutional analysis, therefore, is the review of how well these rules lead to desired outcomes, something that is most easily measured using the problem-solving orientation featured in this report. To do this in a consistent and rigorous fashion requires the development of a taxonomy (i.e., a language) of different rule types. It also requires an appreciation of institutional levels. Both needs can be satisfied within the IAD framework.

Ostrom (1986) has distinguished seven types of institutional rules: *scope*, *position*, *boundary*, *authority*, *information*, *aggregation*, and *payoff* rules. The first type is the *scope* rules, which define the domain of applicability (i.e., the substantive focus) of the rule set. The second type is the *position* rules, which define the positions (i.e., roles) which actors may occupy. Position rules are closely related to the third rule type, *boundary* rules, which define how actors can enter or leave positions. The fourth rule type is the *authority* rules, which define the actions which occupants of positions may, may not, must, or must not take. Fifth is *information* rules, which define what information shall be provided by whom and to whom. The sixth rule type is *aggregation* rules, which map the actions of occupants of individual positions into collective or aggregate outcomes. Finally, the seventh type is *payoff* rules, which define how outcomes or impacts (i.e., benefits and costs) are to be distributed. These rule categories supply a key component of the vocabulary for institutional analysis.¹³

¹³ Examples of these rule types are provided later in this section.

Another key concept is that of institutional levels. As mentioned earlier, it is useful to distinguish between three general levels: *operational choice*, *collective choice*, and *constitutional choice* levels. The first, or lowest, level of decision-making and action is the *operational choice* level. The decisions made at this level directly determine how resources are used. Decision-makers at the operational choice level are often natural resource users of some sort. They decide upon actions to divert and store water, to operate reservoirs, to maintain minimum streamflows, to graze cattle or sheep, to cut timber, to recreate, and other on-the-ground activities. In taking these actions, they are guided by the set of operational choice rules associated with a given institution, which may contain such familiar elements as water rights, grazing lease terms, timber sale contracts, mining permits, and other rules that specify accepted patterns of interaction between humans and natural resources.

Operational choice rules are made and revised at a second, and higher, decision-making level. It is called the *collective choice* level. Rule-making activity at the collective choice level normally occurs in group settings (hence its name), unlike the frequently individual decision-making which occurs at the operational choice level. A variety of such group settings can be found, including legislatures, courts, committees, and “collectives” of various kinds. The kind of behavior which occurs in these settings usually involves bargaining, voting, litigating, or other interactive modes. Natural resource planning is, itself, an activity carried out at the collective choice level. Market transactions are also collective choice level activities, although of a different kind. Here the decision-making group may consist of only sellers, buyers, and enforcers of contracts.

The collective choice rules, which define the mechanisms for making operational choice rules, are in turn made and changed at the third, or *constitutional choice*, level. The name given to this level reflects the analytical assumption that this is the highest decision-making level to be considered. Furthermore, the constitutional choice rules are not considered to be open to change. Basic “constitutional” elements are technically open to change, of course, but not normally within the context of natural resource planning and decision-making.¹⁴ Legislatures and courts will frequently appear as participants in constitutional choice level action situations in many analyses.¹⁵

¹⁴ For example, it is unlikely for a natural resources dispute to lead to changes in basic governmental structures, such as the existence of three branches of government.

¹⁵ Note that it is possible and common for a particular individual or group to be active at more than one institutional level. For example, a person holding the position of “resource user” at the operational level may be a member of an interest group active at the collective choice level. Since each position (or role) has its own set of associated rules, it is analytically useful to consider this as two separate components of the institution—even if, from the standpoint of the individual involved, the roles are viewed as part of the same overall activity.

Description and Preliminary Analysis of the Action Situation: An Example

Any particular action situation at any given moment is best analyzed in a bottom-up fashion, considering only a single level of decision-making and action at a time. This is not to say that the three levels are independent of each other; nothing could be farther from the truth. However, for analytical purposes, it is easiest to first analyze an action situation by focusing only on the operational choice level rules. Undoubtedly in a problematic situation¹⁶ amenable to an institutional solution, one or more deficiencies will be identified in the operational choice level rules. In such a case, a subsequent analysis is then called for of the collective choice level rules, which is where action must be taken to resolve the operational choice rule inadequacy. Should those rules also be shown to be inadequate, then the opportunities for action at the still higher constitutional choice level must be examined, as it is that level where the collective choice level rules can be changed. How many such individual analyses may be required will depend upon the nature of the identified problems and the opportunities for problem-solving.

In order to complete an institutional analysis, the rules (or rule sets) that comprise the institution must be investigated and described. To show how this can be done, consider a simple hypothetical example of the control of a developed stream system that supplies water to a municipality (M&I uses) and which also supports an aquatic/riparian ecosystem with both intrinsic and recreational values. Begin the review of this situation with a consideration of the *scope rules* at the operational choice level. The scope rules define the domain of the rule set, in this case the water supply of the region and how it is used. Note that this particular scope rule includes management of a municipal water supply system as well as the non-consumptive, instream-flow needs of the environment and community. This particular scope rule thus does not include a number of elements which are found in many other water management cases—e.g., commercial navigation activities. Nor does it include all manner of existing rules which are not directly relevant to water resources management, such as automobile traffic laws and the procedural regulations of local civil courts.

The *position rules* determine what roles are available for participants. At this level, we are concerned with the stakeholders (water users) of various kinds, focusing primarily in this case on the “M&I consumptive users” and “non-consumptive users of instream flows.” The “reservoir operator” is another obvious and necessary position, as is the manager of the “municipal water providing utility” and also the “monitor of instream flows.” A position must exist for every type of decision-maker at the operational choice level. All of the

¹⁶ The term *problematic situation* (Dewey, 1938) should not be confused with the term *action situation*. As discussed later, a *problematic situation* refers to a condition in which one or more parties is dissatisfied, but where no problem-solving activity has yet been initiated.

occupants of a single position type are subject to exactly the same set of other rule types (i.e., scope, boundary, authority, information, aggregation, and payoff rules). In other words, all occupants of a single type of position are homogeneous from the point of view of institutional analysis, otherwise more than one position type should be recognized.

The *boundary* rules determine how people and organizations can enter or leave positions. For example, adequate protection of instream flows might require that a representative of the state fish and game department fill the position of monitor of instream flows, while a technically-trained official representing the entity owning the dam would likely be designated to fill the position of reservoir operator. In theory, some individuals may fill two or more positions. For example, a water resources engineer may be selected to fill both the reservoir operator and instream flow monitor positions. Regardless of the arrangement in use, the institution's boundary rules specify the requirements for filling positions, and may include information about the needed (or prohibited) qualifications, affiliations, and employment/service terms of the particular individuals.

The *authority* rules define what these various players may do, must do, may not do, and must not do.¹⁷ For example, the very title of the reservoir manager's position implies that (s)he controls storage and releases from the reservoir. In a particular case, the authority rules for the reservoir operator might dictate, for example, that the occupant of this position may make hourly releases from the reservoir, that (s)he must empty the reservoir by May 1, that (s)he may not release sufficient water to meet municipal requests if minimum instream flow requirements are thereby imperiled and if the municipality has not implemented water conservation programs and, that (s)he must not release less than the amount of water required to meet minimum instream flow requirements. These rules may be codified in statutes, operations manuals, and other formal sources, or may derive from more subtle origins such as disciplinary codes of conduct, unofficial "standard operating procedures" of an organization or network of individuals, or even social mores.

The *information* rules describe what information is produced and transmitted between the various parties in an institution. Although information rules are often not shown in system models, they can be very extremely important in describing how an institution functions. In our hypothetical water management case, for example, information rules will be important when municipal water conservation measures must be invoked, because people must be taught how and when to conserve water in order to make this a viable component of a water

¹⁷ What a position holder may do is commonly called a right. The lack of a right indicates that the party must not take the action in question. What a position holder must do is commonly called a duty. The absence of specific and critically important duties is a common source of water resource policy disputes, whereas the violation of a right is typically a litigious matter.

management scheme.¹⁸ Similarly, information on the streamflow rate at critical locations downstream of the reservoir must be collected and transmitted to the reservoir operator as a normal part of resource management.

The *aggregation* rule maps individual decisions into an aggregate outcome. This is often a difficult rule type to understand, but a good example is the situation-specific application of the “first in time, first in right” principle of the doctrine of prior appropriation, through which scarce water supplies are allocated among competing demands.¹⁹ The rules of reservoir operation may also be of particular salience. In the hypothetical example, the aggregation rule would determine how the actions of the reservoir manager, water utility manager, and instream flow monitor combine to produce an outcome composed of water deliveries and instream flows. Our example suggests that the minimum instream flow requirement will be satisfied first, that the flood control objective of emptying the reservoir by May 1 will be satisfied next, and that the municipal water supply demands will be satisfied last.

Payoff rules can also be difficult to describe, especially at higher institutional levels. The payoff rules determine the distribution of benefits and costs in particular outcomes. Payoff rules are particularly salient in influencing behavior, as they are likely to specify winners and losers of various management schemes. In our hypothetical example at the operational choice level, both consumptive and non-consumptive water users receive benefits and bear costs—although in times of shortage, it appears as if non-consumptive users will receive the majority of benefits. More explicit types of payoff rules include municipal water rate structures and cost-sharing rules for project construction or maintenance.

To complete the preliminary analysis of the action situation at the operational choice level will require some effort to consider the context provided by the physical and the actor/behavioral environments. Given the focus in this example on a water system, it is likely that a hydrologic model (or metaphor), perhaps utilizing an input/output approach, could be appropriate and useful. Of course, a different set of metaphors would likely be sought in a case involving the management of a forest, which has many different physical qualities than the water resource, such as a lack of mobility. The nature of the actor/behavioral environment can be generally assumed, as mentioned earlier, to be governed by bounded rationality—i.e., individual self-interest tempered somewhat by

¹⁸ The ET (evapotranspiration) watering schedule displayed on Denver television stations during the summer months is an effective information rule of this type.

¹⁹ Compare this aggregation rule to the proportional sharing philosophy that guides action in riparian systems (Lord and Kenney, 1993).

sociocultural constraints (Simon, 1982).²⁰ This assumption can be applied to natural resource institutions of all types, although there is considerable historical evidence to suggest that western water conflicts evoke behavior that is abnormally passionate and contentious.²¹

Management options may be thought of as sets of operational rules which influence the behaviors of resource users and managers interacting with a given physical environment. Water law—whether court-made riparian sharing, administrative permitting, or historically-based appropriation—is a good example of such rules. Contractual assignment of storage or water deliveries from federal reservoirs, along with the reservoir operating rules which implement them, is another good water-related example, as are the set of water pricing policies and possible water conservation measures in use by a municipal water utility. Similarly, management options pertaining to land management are often best characterized in terms of property rights, or more limited forms of tenure—such as grazing leases or timber sale contracts. The projected outcomes, or impacts, of adopting and implementing a particular set of rules in a given action situation are determined by the interaction of all seven types of rules with the other elements of that situation, namely the characteristics of the physical environment and the actor/behavioral component.

In most situations and time periods, the set of operational level rules associated with a particular institution satisfactorily operates to manage the human-environment interface. In some cases, however, problems exist in resource use or management. In order to identify the needed institutional reforms in those cases, a more detailed institutional analysis is required. This analysis must include a consideration of problem types and problem-solving options, and must also feature a consideration of the rules at the higher institutional levels—particularly the collective choice level—in addition to those at the operational choice level.

Natural Resource and Environmental Problems

The IAD framework is a static one, which is to say that it enables us to describe, analyze, and design institutions at specific points in time. Institutional change is primarily a result of problem-solving activity—individuals and/or

²⁰ As explained by Dubnick and Bardes (1983:171), a “decision-maker behaving under conditions of bounded rationality will not seek to achieve a *maximization* of given goals and objectives . . . but rather will select that course of action which will be *satisfactory* in its attainment of that goal or objective.”

²¹ Mark Twain is normally credited with the saying, “Whiskey is for drinking, water is for fighting.”

groups encounter situations which they deem to be unsatisfactory, and they act, not always successfully, to change those situations for the better.²² In most natural resource situations, the perceived nature of the problems or potential solutions hinges, in some way, on interrelationships between actors, thereby necessitating some degree of collective activity.

John Dewey (1938) called the initial experience of dissatisfaction, prior to any attempt to analyze and improve upon it, a *problematic situation*. As those who experience such a problematic situation attempt to understand and resolve it, they do so by defining one or more problems. This problem definition step may be overtly intellectual, in which case at least some of the metaphors employed are explicit and recognized, or it may be largely non-intellectual, in which case habitual ways of thinking are invoked, with the underlying metaphors remaining unrecognized. Some authors (e.g., Schneider, 1989) refer to these habitual mechanisms of simplifying otherwise complex decision-making efforts as *decision heuristics*, something which may need to be included in the inventory of institutional rules—especially the information and aggregation rules.²³

Problem definition has been called the most important step in problem-solving, because the way the problem is formulated shapes the nature of the potential solutions which are conceived, evaluated, and ultimately tried. A water shortage, for example, might be defined by an economist as deriving from inadequate (too low) pricing regimes; an engineer may see the problem as a lack of storage facilities; a geographer might cite the inappropriateness of development in an arid region. Problem definition is followed by the search for options (potential solutions), the evaluation of those options, selection of one or more options to be acted upon, implementation, and perhaps eventual evaluation of the outcome. This sequence, or something very much like it, is widely recognized as the appropriate process of problem-solving.

Problems at the Operational Choice Level

Problematic situations can occur at any of the three levels of decision-making and action. At the operational choice level, we distinguish four types of natural resource and environmental problems. They are *depletion*, *underinvestment*, *maldistribution* and *externalities*. All four are fundamentally alike, in that they describe situations in which some party or parties are not receiving the benefits of resource management to which they aspire. They may then bring the perceived inadequacy to established resource management agencies, to legislatures, to conflict resolution forums (such as courts), or they

²² Long-term institutional innovation in natural resource institutions is discussed by Munro (1988), who identifies paradigmatic change as the key driving factor. This phenomenon is briefly discussed in Section V.

²³ Perhaps the most classic text exploring decision heuristics is Wildavsky's (1987) review of the federal budgeting process.

may devise ad hoc instruments for problem resolution, such as the use of collaborative groups. Many operational choice level problematic situations contain elements of one or more of these problem types.

Depletion describes a condition in which current resource use threatens to diminish future use. It may be defined technically as a shift in the time-weighted distribution of use rates towards the present (Ciriacy-Wantrup, 1970). Conservation, the opposite of depletion, may be defined as a shift in the time-weighted distribution of use rates towards the future. Neither depletion nor conservation is intrinsically good or bad, per se, when they are defined in this way. When depletion is perceived as a problem, it is because there is disagreement among parties who prefer high current use rates and those who advocate a shift in use rates to the future (conservationists) or those promoting an agenda of non-use (preservationists).²⁴

Depletion and *underinvestment* are closely related, and often accompany each other as aspects of a problem situation involving natural resources. Underinvestment describes a condition in which the anticipated future provision of resource-related goods and services is smaller than desired, presumably due to failure to invest sufficient capital and/or labor in resource management.²⁵ Underinvestment problems are generally associated with renewable resources, as future flows of these resources can be augmented by current investments. Conflict may occur over appropriate levels of current investment and implied future levels of availability of resource-related goods or services, just as conflict may occur over the appropriate state of conservation/depletion.

The final two types of operational choice level problems, maldistribution and externality problems, are also closely related.²⁶ In fact, externalities can be considered to be a special sub-set of the maldistribution category (Schmid, 1978). Any situation in which the allocation of a finite resource-related good or service is perceived by one or more parties to be inadequate is a *maldistribution*. In common parlance, maldistribution problems are frequently described as scarcity situations, indicating that the available quantity of the good or service in question is inadequate to satisfy all demands. Inevitably in such situations, an allocation

²⁴ Examples include the harvest of timber at a rate exceeding natural regeneration and the withdrawal (or “mining”) of groundwater at a rate exceeding recharge. These “unsustainable” practices are problematic only when there is a concern over future shortages.

²⁵ An example includes concerns over inadequate fiscal or legal attention devoted to the preservation of endangered species.

²⁶ Depletion and underinvestment problems share the common quality of *symmetry*, while maldistribution and externality problems are *asymmetric*. The meaning and significance of these terms are described in Section III.

mechanism of some sort must be employed.²⁷ Those parties most disadvantaged by the nature of the allocation mechanism are most likely to indicate the existence of a maldistribution problem.

The special case of *externality* problems occur when the use of a resource-related good or service by some parties diminish the availability of other goods and services received by different parties (Pigou, 1938). This relationship is often not recognized by existing institutional rules, in part since the cause and effects may be separated by space (a spatial externality), time (temporal externality), or both.²⁸ Externalities typically happen when more than one kind of good or service is produced by a single resource—a condition described by economists using the term *joint production*, which refers to the interrelatedness of two or more different kinds of goods or services. Normally, some level of use by the first party and some level of external cost suffered by the second party will be viewed as reasonable, but a higher than appropriate external cost is actually incurred because the first party need not take such costs into account (Baumol and Oates, 1988).²⁹

Problems at the Collective Choice Level

The resolution of operational choice level problems typically requires action at the institution's collective choice level. While this is sometimes a relatively mundane and simple exercise, problematic situations—of fundamentally different types—can also arise at the collective choice level, as participants seek to change the operational choice level rules. Parties acting at the collective choice level can encounter one or more of three general types of problems, or more accurately, types of conflicts: *interest conflict*, *value conflict* and *cognitive conflict* (Lord, 1979). These types of conflicts are primarily shaped by the unique nature of the particular field-level management problem and by the characteristics of the collective choice level rules.

²⁷ For example, the demand for hunting licenses, rafting permits, and/or water supplies far exceeds the supply in many cases, forcing the use of various allocation systems that inevitably favor some parties at the expense of others.

²⁸ Despite the widespread use of the externality terminology, particularly in the economics literature, a standardized definition remains elusive, with each author defining the term with regard to that feature they deem most significant (Baumol and Oates, 1988). As discussed in Section III, it is the concept of asymmetry that is central to the definition of externalities in this framework.

²⁹ Unregulated pollution is the classic example of an environmental externality. For example, a factory in an urban area discharging smoke is using the atmosphere for waste disposal, which reduces the ability of city residents to use the atmosphere for clean (healthy) respiration. In an uncontrolled situation, the factory has no obvious incentive to consider this unintended impact.

The Procedural Focus of Collective Choice Level Rules

In order to understand the nature of these conflicts, it is necessary to first appreciate the types of arrangements described by the seven rules categories at the collective choice level, which unlike the operational choice level, have more to do with the process of decision-making than the substance of such deliberations. The collective choice level *scope rules*, for example, describe the set of operational level rules that can be reviewed, revised, replaced, or added through collective action. They do not directly address the human/resource interface. For example, in a market-oriented water institution, the collective choice scope rules are likely to be those that describe the rules of marketing, contracting, and related components associated with multiparty free market transactions, while the operational choice level rules would focus on how rights holders (and non-rights holders) can actually utilize the region's water resources.

Collective choice *position rules* are likely to specify positions for policy-makers (including program administrators and regulators) and, in those situations where rights to natural resources are privately held, for buyers and sellers. Positions for policy advocates, such as interest groups, and advisory bodies are also common at this level.

Of particular concern at the collective choice level are the *boundary rules*, since they determine who has a seat at the decision-making table. Many of the most salient modern innovations in natural resources governance have been those that have modified the collective choice level boundary rules to provide environmental interests with a greater role in decision-making (MacDonnell and Bates, 1993). Examples of such innovations include modern planning processes requiring public participation, a broadened legal definition of "standing" in natural resource disputes, public interest regulations limiting the exercise of private rights, and the proliferation of collaborative groups that welcome broad participation in problem-solving. Traditional extractive users have long been recognized at this level, through mechanisms such as grazing boards and by virtue of holding private property rights (or leases) for various resources or resource uses.

Conceptually, *authority rules* at the collective choice level are generally much less diverse and complicated than those at the operational choice level—although the administrative law attorney may disagree with this characterization in practice. At the collective choice level, authority rules typically focus on the obligations and powers of participants in collective decision-making processes, such as the right to vote, the obligation to disclose information, the opportunity to attend meetings, and perhaps the requirement to provide dues.

Information rules, like boundary rules, are often particularly crucial to the success of collective choice level processes. Various forms of group interaction at the collective choice level—from bargaining and collaboration at one extreme to litigation and regulation at the other—are highly dependent upon the provision of information that is accurate, credible, comprehensive, and perhaps most

importantly, universally available. Many different mechanisms and tools can be used to provide this information: these arrangements are specified in the collective choice level information rules.

Aggregation rules at the collective choice level are also frequently of high importance. For example, an institution reliant on a unanimity decision-rule is likely to feature very different qualities than one utilizing majority-rule or some other system. As discussed later, the nature of the aggregation rule is normally highly influential in determining what types of issues a collective choice level institution can, and cannot, address.

The final category of *payoff rules* can be difficult to identify, in large part because two fundamentally different types of benefits can be ascribed to participation in collective choice processes. The first class of benefits are associated with the actual act of participation, and can include such nebulous rewards as the “good feeling” and “sense of participation” that can derive from group action. Of course, these benefits can be offset by costs such as the frustration and expense often associated with collective action—especially those actions that do not result in real problem-solving. The other and presumably more important class of benefits are the changes in operational level rules resulting from collective choice action which, ideally, result in the solution of those field-level problems that likely initiated the collective choice action. It is this class of benefits that are primarily featured by the bottom-up problem-solving orientation described in this report.

The focus at this level on collective, rather than individual, action also influences the selection of metaphors useful in the analysis of the other components of the action situation. For example, at this level, the characteristics of the natural environment are likely to prove less important than at the operational choice level. Instead, qualities of the built (i.e., manmade) environment may be particularly salient, such as the physical distance between participants, the structural characteristics of meeting place facilities, and the quality of technologies used to support communication and bargaining.³⁰ Similarly, collective choice level analysis may require the use of different metaphors relating to behavior than those used at the operational choice level, primarily since models of independent individual action may fail to consider interdependence between actors, the very essence of collective choice level activity. Economics supplies some models of two-person negotiation and bargaining, but perhaps the most promising models of n-person interaction, in which the actors are both cooperative (all want to solve the problem) and competitive (they prefer different solutions) are found in the mathematical theory of games (von Neumann and Morgenstern, 1964; Luce and Raiffa, 1957).

³⁰ A variety of potentially important qualities of the natural and built environments can be described using the concept of “spatial linkages,” a framework developed by White (1961).

The Problem of Conflict at the Collective Choice Level

Having now described the typical content of the collective choice level rules, it is possible to return to the discussion of the three conflict types experienced at this level. Perhaps the most obvious type of conflict is *interest conflict*, in which it is the economic and other direct impacts upon stakeholders which cause disagreements over how resources should be allocated, managed and used.³¹ In some situations, gains to one side may come only at the expense of corresponding losses to another, a so-called *zero-sum* game.³² In some of these situations, forging agreement may require finding options which provide benefits to all, or converting the *zero-sum* game to a *positive-sum* one.³³ As discussed later, whether or not this modification of the payoff rules is a prerequisite to problem-solving is largely dependent on the type of problem-solving strategy employed at the collective choice level.

A related type of conflict occurring frequently in natural resource and/or environmental problem-solving is *value conflict*. As the name implies, this type of conflict occurs when participants do not share common values. In the natural resources realm, value conflict is perhaps best illustrated by preservationist statutes such as the Endangered Species Act, which is based on the controversial philosophy that the existence value of a species is inherently greater than any economic or other anthropocentric value that may be constrained through species protection (Kenney et al., 1998).³⁴ In this and other value conflicts, opposing sides disagree fundamentally about what is morally right and wrong, a quality that can make value conflict particularly difficult to resolve in a satisfying manner.

The final major category of collective choice level conflict occurs when people simply disagree about the “facts of the case.” This can be termed a *cognitive conflict*. Nobody ever has complete and accurate information about

³¹ For example, parties involved in a water development scheme will each likely be in competition with each other for favorable cost-sharing terms and related issues relating to the allocation of project benefits.

³² The language and metaphors of mathematics, and more specifically, game theory, are particularly well-suited to the analysis of collective decision making.

³³ A special sub-set of positive-sum outcomes are the Pareto optimal solutions. A positive-sum outcome is one in which the collective benefits to all parties exceed the collective costs, whereas a Pareto optimal outcome is one in which all individual participants either receive net benefits, or are at least not harmed by an action. In some situations, a positive-sum outcome may not be Pareto optimal if one (or more) specific individuals are required to bear the majority of the costs, or are disproportionately excluded from receiving the benefits.

³⁴ The best national example of value conflict, however, does not come from the natural resources or environmental realm. It is the conflict over abortion rights, an issue that features relatively little interest or cognitive conflict.

many of the complex situations which characterize natural resource and environmental problems.³⁵ In fact, the notion of complete and accurate information may itself be illusory. Furthermore, we all tend to believe those explanations which are consistent with our own preferences and self-interest. Consequently, cognitive conflict is almost always a complicating feature of natural resource and environmental problems.

³⁵ For example, recent debates regarding global warming have indicated a lack of common understanding about the existence, magnitude, and potential causes of the phenomenon.

SECTION III: SOLVING NATURAL RESOURCE AND ENVIRONMENTAL PROBLEMS

The conceptual framework described in Section II provides a consistent set of terms and concepts that can be used to describe various action situations and problems characteristic of the natural resources and environmental realm. In this section, the focus is on problem-solving strategies. As discussed below, several types of problem-solving strategies are currently available to the resources management community, with the so-called “alternative” strategies currently enjoying the greatest support. In the following pages, some of the most salient characteristics of this era of alternative problem-solving are described, compared, and analyzed with respect to generally accepted principles in institutional problem-solving. This effort yields some several observations about the proper matching of problems and problem-solving strategies, knowledge that suggests new metaphors (or models) potentially useful in the investigation of specific case studies.

Note that given the dynamic quality of institutional problem-solving, it can sometimes be difficult to maintain the distinction between the operational choice level rules and those at the collective choice (and higher) levels, especially given the fact that the output (or substantive result) of a rule-making exercise—i.e., the operational choice rules resulting from collective choice level activity—is often largely shaped by the nature of the decision-making process.³⁶ Because of this connection, the following discussion of alternative problem-solving strategies freely moves between elements which are largely procedural in nature and those which are more substantive in nature. Many of the arguments—several of which are provided below—in favor of new, “alternative” strategies of problem-solving follow this pattern, suggesting that these “strategies” are best characterized as complex mixtures of institutional rules of several types and at multiple levels. This imprecision is generally not problematic for descriptive purposes, but in some cases needs to be addressed as part of the institutional analysis process—particularly when the issue of concern is the matching of problems to appropriate problem-solving strategies.

³⁶ This fact has long been recognized by political scientists, who utilize the term “forum shopping” to describe how parties strategically select those collective choice processes which are most likely to result in operational choice level rules of greatest benefit to their interests. Along a similar vein, dispute resolution theorists use the concept of BATNA (Best Alternative To a Negotiated Agreement) to describe the strategic thinking utilized to determine when a negotiated solution is a strategically appropriate option for a given party (Fisher and Ury, 1981).

The Rise of Alternative Problem-Solving Strategies

A tremendous variety of strategies can be utilized to implement institutional solutions to natural resource and environmental problems. These problem-solving strategies can be classified based on a wide variety of criteria. One criterion frequently utilized in the social sciences literature is to distinguish between approaches that are *hierarchical* (or vertical) and those that are *non-hierarchical* (or horizontal).³⁷ In terms of institutional rules, the degree of hierarchy utilized in a problem-solving approach is usually best determined by reviewing the aggregation, position and boundary rules.³⁸ The most hierarchical approaches recognize only a single decision-maker, whereas in a highly non-hierarchical system, several parties will be directly involved in decision-making. The formal aggregation rule in a hierarchical system is thus quite simple; a single decision-maker makes the decision. Other actors may have significant responsibilities (e.g., providing information) and significant rights (e.g., the power to appeal decisions), but the ultimate power to decide is highly concentrated in one individual or body. Conversely, in non-hierarchical systems, the aggregation rule must transform the preferences of a large group of decision-makers into a common or collective decision. Approaches such as judicial and agency rule-making are generally classified as hierarchical, while strategies such as collaboration and market systems are considered non-hierarchical; however, these are generalizations with many exceptions.³⁹ The hierarchical/non-hierarchical categories are best viewed as points on a continuum, rather than as discrete options.⁴⁰

³⁷ A variety of different terms are used to describe this criterion. For example, see the schemes of Dahl and Lindblom (1957) and Wildavsky (1987).

³⁸ Of course, rules of all types are important to the functioning of the overall institutional regime.

³⁹ For example, seemingly autonomous decision-makers—such as regulatory agencies—must, as a practical matter, engage in a certain amount of multi-party negotiation and bargaining as part of rule-making. A certain amount of deal-making is also seen in judicial settings. At the other extreme, while free markets often involve thousands of decision-makers (i.e., buyers and sellers), systems characterized by monopoly or oligarchy may not be so clearly non-hierarchical.

⁴⁰ The concept of hierarchy can be somewhat confusing given the levels concept, which assumes that all problem-solving exercises feature an inherent “hierarchical quality,” since activity at higher levels (particularly the collective choice level) is needed to produce rules at the operational choice level. This observation does not invalidate or undermine the use of the hierarchical/non-hierarchical criterion, but it does suggest that the concept is most relevant in the analysis of decision-making strategies when defined with respect to a specific level. The focus in this section of the report is primarily on collective choice level activities.

Another criterion is between the *compulsory* approaches based on proscriptions, and the *non-compulsory*—or voluntary—approaches based largely on incentives. Compulsory approaches are typically hierarchical, employing the coercive power of the state to specify behaviors which are either required or forbidden. Violations of specified behaviors lead to formal sanctions designed to punish disobedience and prevent further transgressions. In contrast, non-compulsory (i.e., voluntary) problem-solving approaches do not explicitly require or forbid certain behaviors, but instead provide incentives for problem-solving that are highly reliant on voluntary action.⁴¹ Compulsory approaches are often best described by focusing on authority rules, while payoff rules are of particular salience in the non-compulsory approaches.⁴² Regulatory programs, administered largely through administrative rule-making and judicial actions, are typical examples of compulsory strategies, whereas market-based and collaborative mechanisms are typical of the non-compulsory approaches.

In the context of problem-solving, the compulsory/non-compulsory criterion has relevance at both the collective choice and operational choice levels. In compulsory strategies at the collective choice level, decision-makers are required to make decisions. For example, water pollution control regulations typically require federal or state agencies to set and enforce standards, and if they do not, then a judge is normally compelled through litigation to force such action. These actions often result in compulsory operational choice level rules, frequently codified in permits. Non-compulsory strategies at the collective choice level of an institution are those featuring decision-makers acting voluntarily. These interactions may occur in the context of collaborative groups, the functioning of markets, negotiations, and similar activities usually reliant upon bargaining. At the operational choice level, non-compulsory strategies include agricultural subsidies to encourage soil conservation practices, heightened admission fees to ration the use of overcrowded parks, and water rate structures designed to encourage conservation.

As suggested earlier, there is frequently a correlation between the collective choice process and the resulting “nature” of the operational choice level rules. The compulsory/non-compulsory concept can be useful in illustrating this connection, as compulsory collective choice processes often result in compulsory operational choice level rule rules, and non-compulsory collective

⁴¹ Of course, in many cases the underlying incentive may be to avoid the restrictions and penalties that may result if a compulsory strategy is later employed to address an unresolved problem. For example, landowners of critical habitat often voluntarily agree to Habitat Conservation Plans to protect endangered species, an action that is undoubtedly prompted in many cases by the desire to be protected against future regulatory actions associated with the Endangered Species Act. Thus, even the non-compulsory strategies are likely to have compulsory elements, at least for some parties and/or relating to some types of actions.

⁴² However, as observed earlier during the discussion of hierarchical/non-hierarchical approaches, all rule types are important.

choice processes often result in non-compulsory operational choice level rules. This, of course, is simply a generalization based on observation, and is not a normative assumption about how natural resource and environmental problems should be addressed.

The distinguishing characteristic of those problem-solving strategies that have risen to prominence in recent decades—the so-called *alternative problem-solving strategies*—is that they are predominantly non-compulsory (voluntary) in nature. These strategies are “alternative” in the sense that they have largely arisen as an alternative to well established compulsory strategies used in many subject areas, including, for example, most command-and-control regulatory programs. Prominent examples of alternative problem-solving strategies include many market mechanisms, which can range from somewhat hierarchical to highly non-hierarchical depending on the number of parties involved in making transactions, and various forms of collaborative groups, many of which in the modern era are largely non-hierarchical in that decisions are made through processes stressing group consensus.⁴³ Other examples include various forms of “alternative dispute resolution” (ADR), which can range from the highly hierarchical option of binding arbitration to much more non-hierarchical means such as mediation and facilitation (Bingham, 1997).⁴⁴ ADR processes are frequently entered into voluntarily in hopes of avoiding a more compulsory strategy, such as litigation.

The Use and Limitations of the Compulsory Tools

An extremely wide variety of compulsory strategies are used in all facets of public policy to address or head-off problematic situations. In the natural resources and environmental realm, many of these approaches either involve restricting access, prohibiting certain types or levels of use, mandating specific actions, requiring investments in public resources and services through taxation, or various policies of redistribution. Included in this range of actions are operational choice level rules prohibiting motorized vehicles in designated Wilderness Areas, regulations outlawing water diversions by non-riparians or non-rights holders, catch limits (or catch-and-release policies) in public fishing grounds, property taxes to finance regional flood control programs, mandatory use of pollution-control equipment, and management plans that formally

⁴³ A group which acts only as an advisory body to a more established and authoritarian decision-maker is better classified as a hierarchical system. Many of the well-known collaborative groups arising in the 1990's, especially those concerned with watershed restoration, are significant in that they are highly non-hierarchical in comparison to typical advisory bodies. It is these modern collaborative types are prominently featured in this report.

⁴⁴ ADR is generally defined to include a broad spectrum of voluntary procedural options, usually featuring the services of a neutral party, utilized for settling disputes by finding mutually acceptable options (Bingham, 1997).

prioritize various uses at the expense of other potential activities. Among the most well-known and controversial of the compulsory strategies are those programs pertaining to water and air pollution control, which are primarily driven by a command-and-control regulatory framework. In a command-and-control program, users of a particular resource are required to meet specific standards, often specified in a permit and, in an effort to achieve administrative simplicity and equity, often defined in terms of a technology requirement. For example, a requirement that all municipal wastewater plants utilize a form of secondary (i.e., biological) treatment is a classic command-and-control strategy.

Technology-based command-and-control programs for pollution control in the United States have, in many situations, been highly effective (if not always efficient) in protecting natural resources. For example, investments of tens of billions of dollars between 1970 and 1985 increased the percentage of the nation's population served by wastewater treatment plants from 42 to 74 percent, resulting in a net decrease in municipal organic waste discharges of 46 percent despite significant population increases; similarly, investments in industrial wastewater treatment plants have reduced discharges of toxic metals into the nation's water supplies by almost 98 percent (Adler et al., 1993). Similar technology-based programs pertaining to air pollution have also produced notable gains in environmental quality, especially in high-profile cases such as smog control in Los Angeles.

However, two related weaknesses of compulsory problem-solving approaches frequently provide a strong stimulus in favor of other (i.e., alternative) problem-solving approaches to supplement, or even replace, command-and-control and other compulsory strategies. The first weakness is one of efficacy. This concern has been aptly summarized in the context of pollution control by the National Academy of Public Administration (NAPA, 1997:200):

The command-and-control approach works relatively well when it is focused on large point-sources of pollution which have limited, homogeneous and well understood options for pollution control, such as industrial facilities or the manufacture of mass-produced products, such as cars. Command-and-control approaches work less well when the targets are more numerous and diverse, and when there are many options for control.⁴⁵

This concern is perhaps best illustrated by the declining effectiveness of the nation's water quality control programs due to the inability of existing arrangements to effectively deal with nonpoint source pollution. Nonpoint source

⁴⁵ This idea has also been clearly articulated by the Western Governors' Association (1998): "As large, easily identified sources of pollution are controlled, the threat to the environment has shifted to diffuse, numerous, and smaller scale sources that are more difficult to control through enforcement-based command and control regulation."

pollution is largely responsible for the increased concentration of many pollutants nationally, such as nitrogen and dissolved solids (Adler et al., 1993). Many ambient water quality standards have not been met, and deadlines for compliance have been frequently extended (NAPA, 1994). The same pattern can also be seen in air pollution control.

The second concern involves the economic inefficiency of many compulsory strategies. Again, this issue has been most exhaustively addressed in the literature of pollution control (Baumol and Oates, 1988). Programs which provide uniform restrictions on behavior are notoriously inefficient in that they ignore the fact that the regulated community is rarely homogeneous. Some parties have greater opportunities to minimize problem-causing behavior than do others. Due to their inherent lack of incentives, however, the compulsory strategies provide no mechanism or stimulus for these parties to strategically exploit their different situations and to promote economically efficient pollution reduction.

Concerns over efficacy and inefficiency not only apply to operational choice level rule sets, but can also be applied to the collective choice level processes that are used to establish these on-the-ground resource management regimes. For example, litigation, a largely compulsory and hierarchical problem-solving approach, is often considered to be poorly suited to addressing multidimensional problems so typical of natural resource situations. The legal system is designed to manage conflict, but not to manage resources, and although one side may block another from achieving its aspirations, neither side can count on the courts for ongoing planning and management. Complaints over high costs and inadequate representation of all interests are also common. According to Bingham (1997:12), it is these types of concerns that best explain the proliferation of ADR processes in the 1980s⁴⁶:

Why have so many individuals, groups, and governmental institutions become interested in ADR? The answer tends to fall into two categories. People are either deeply frustrated by the length of time and costs associated with getting to a decision (*efficiency concerns*), or they judge that the decisions that are

⁴⁶ During the period 1974 to 1985, nearly 200 environmental disputes were mediated in the United States, a sharp increase from previous eras (Bingham, 1997). Beginning in the mid-1980s, federal and state governments began to explore mechanisms for incorporating ADR processes into many facets of public policy decision-making, including natural resource and environmental issues. Prominent examples at the federal level include the Negotiated Rule-Making Act (NRMA) of 1990 and the Administrative Dispute Resolution Act (ADRA) of 1996. NRMA provides a framework and procedural requirements within which agencies are encouraged to assemble stakeholder groups for the purpose of administrative rule-making, while ADRA requires agencies to fully investigate and consider opportunities for utilizing ADR in a variety of decision-making settings, including rule-making, issuing/revoking licenses and permits, contract administration, and dispute resolution.

made do not meet the needs of those involved as well as they could (*quality concerns*). Most are concerned about both.

Similar concerns have prompted the emergence of collaborative groups in the 1990s (Kenney, 1999; John, 1994).

The Emergence of New Tools

Over the past two decades, one of the most prominent of the “alternative” problem-solving approaches has been the emergence of market-based mechanisms to manage resources and address natural resource problems (NAPA, 1994; NAPA, 1997; Hockenstein et al., 1997). As suggested above, many of these incentive-based innovations have been utilized to address the externality problems associated with water and air pollution. Air quality, in particular, has been the focus of several notable experiments in incentive-based problem-solving, based largely on strategies featuring pollution taxes, marketable permit systems, and offsets. Among the most successful efforts cited by the National Academy of Public Administration are “the sulfur dioxide reductions achieved through the cap-and-trade system established in the Clean Air Act Amendments of 1990, the elimination of lead from gasoline through a cap-and-trade phaseout system, and the rapid end to the production of ozone-depleting chlorofluorocarbons through a tax-and-trade system” (NAPA, 1997:25).

Despite the strong theoretical justification for such tools and their notable successes in several areas, incentive-based tools are still relatively uncommon in many natural resources and environmental issue areas (Hockenstein et al., 1997; NAPA, 1997). The permit trading systems which have been used in air pollution control are still relatively uncommon in most of the United States,⁴⁷ and similar programs for water quality are virtually non-existent (Hockenstein et al., 1997; Hoffman, 1996).⁴⁸ Modern policy initiatives concerning TMDL’s (total maximum daily loads) may provide the stimulus needed to encourage market-

⁴⁷ Ironically, emissions charges have been utilized much more frequently in several European nations, including those with a history of suppressing free market initiatives.

⁴⁸ As Hoffman (1996:10) observes, permit trading programs for water quality have a high potential, but raise many troubling administrative issues: “Because the watershed concept looks at the ecosystem as a whole, including all of its pollutant inputs, assimilative capacities, and biological and geophysical features, it has the potential to be more equitable in that, in theory, the most critical or most easily (or cost-effectively) controlled sources of a pollutant would be targeted for reduction. However, in practice, the scientific and enforcement tools needed to make watershed permitting function as envisioned are absent. For example, there are few effective means of enforcing nonpoint source controls of rural discharges; and urban and suburban stormwater flows are hard to define and quantify. The pitfalls, then, may include resorting to imposing more controls on readily identified and quantified point sources, while the real culprits continue to discharge unabated.”

based programs in water quality management.⁴⁹ Relatively little success has been achieved to better utilize market forces to modify resource using practices involving federal water, rangelands, timber, hydropower, and recreational resources, all of which are typically subsidized (Munson, 1994).⁵⁰ In theory, many depletion problems on public lands and waterways could be addressed, at least in part, through incentive-based programs that discourage excessive consumption.⁵¹

One of the areas where market mechanisms have been most aggressively utilized in the West is in the reallocation of water resources. Acting on the belief that many of these resources have been “maldistributed” in economic terms, water markets have facilitated the transfer of water supplies from low-valued uses (mostly agricultural) to high-valued uses (mostly urban) in some regions of the West (NRC, 1992). Incentive-based tools have also been used in municipal water rate codes to discourage excessive use,⁵² and to encourage waste reduction in agricultural networks. One of the best known of these experiments is the arrangement between the Imperial Irrigation District (IID) and the Metropolitan Water District of Southern California (MWD) in which MWD finances water-conservation practices on IID lands, with the conserved water leased to MWD at favorable rates (Wahl, 1989). Interestingly, this arrangement was the brainchild of an environmental organization, the Environmental Defense Fund, the type of group that has historically been hesitant to deviate from traditional compulsory approaches in natural resources and environmental management.

⁴⁹ The total maximum daily load (TMDL) concept is an approach to water quality management that bases the amount of total discharges allowed on the natural assimilative capacity of a particular water body. Once this level is determined through biophysical research, permits with specified emission quantities that collectively match this total are allocated among dischargers, a process sometimes known as a waste load allocation (WLA). The process of allocation can be a subject of considerable debate, as can the rules regarding the reallocation of permits through market processes—a feature of some WLA proposals/systems. Marketable permits have been traded on the Fox River (Wisconsin) since 1982 (Tietenberg, 1992; Gregg et al., 1991), and several entities—including EPA—are actively investigating opportunities for further applications of this tool (Hoffman, 1996).

⁵⁰ The term “subsidy” is used in many different ways in a variety of contexts, but is most commonly applied in the realm of natural resources management to one of two particular situations (Kenney et al., 1998). The first is when beneficiaries of a resource use do not pay the full costs associated with providing the resource benefit (e.g., irrigation water subsidies, below-cost timber sales). The second situation involves the transfer of public resources to private hands for a price that is below what would have been achieved through a free market transaction (e.g., preference hydropower rates, hardrock patenting procedures).

⁵¹ For more conceptual and case specific information on this subject, see the work of the Political Economy Research Center.

⁵² Martin et al. (1984) review the potential for urban water conservation through improved pricing mechanisms.

Many of the incentive-based programs emerging in recent decades fall into the category of management options known as performance-based tools (NAPA, 1997:2):

[Performance-based tools] include information management systems, market-based controls, compliance-assurance strategies, regulations which encourage firms to choose among compliance strategies, and new partnerships with states and businesses. What those approaches have in common is that they provide incentives for regulated parties to improve their overall environmental performances without specifying how they should do so. ... The increased emphasis on performance-based management responds to two social goals: increasing the cost-effectiveness of pollution controls, and ensuring that those controls are targeted at improvements in the environment.

This class of alternative problem-solving strategies differ from many of the compulsory strategies not only in their reliance on incentives, but in their refocus on the “ends and means” of program operation. Many compulsory strategies, particularly the technology-based command-and-control programs, operate exclusively by specifying the “means” of problem-solving (e.g., required use of a technology), rather than focusing on the “ends” (i.e., the field-level outcomes). Programs such as the NPDES (National Pollution Discharge Elimination System), for example, have the implicit goal of reducing pollution, but are not often administered in practice with an eye toward meeting a specific water-quality standard. Failure to do so has resulted in many basins that do not meet water quality standards, even though all dischargers may be in compliance with the technology-based effluent requirements.⁵³ This approach is inconsistent with the performance-based philosophy.

Incentive-based (non-compulsory) approaches are often better suited to performance-based management in that they frequently utilize the marketplace, rather than a regulatory entity, to determine the most efficient means of achieving goals—encouraging innovative bargains, new technologies, investments, and other actions that are conducive to on-the-ground problem-solving (Osborne and Gaebler, 1992). Of course, market-based mechanisms can also be utilized to determine the ends in a natural resource management situation; for example, the amount of aluminum mined each year is not determined in a policy-making setting, but is instead driven exclusively by market forces. Unfortunately, on many occasions in U.S. history, an over-reliance on market mechanisms to determine the ends of natural resource and environmental policy has led to “market failures” resulting in depleted or degraded public resources, providing

⁵³ This is the situation that has prompted the recent calls for TMDL management based on the waste load allocation concept.

the stimulus behind the creation of many management and regulatory agencies and associated programs (Hays, 1957). For this reason, in most problematic situations it is considered appropriate to utilize some form of governmental decision-making process to determine the overall goal (i.e., the desired ends of resource management), utilizing the marketplace exclusively to focus on the means (Osborne and Gaebler, 1992; Hockenstein et al., 1997).⁵⁴

Many of the other “alternative” strategies (other than market-based tools) are more appropriate for addressing the challenge of determining the desired ends of resource management. The most prominent of these tools in the modern era are various forms of collaborative groups concerned with resource management or restoration. One example is provided by “watershed groups” (also known as watershed councils, partnerships, alliances, or initiatives), which are generally ad hoc, voluntary associations of both governmental and non-governmental parties organized to address water-related problems at regional scales such as watersheds. At least 100, and probably as many as 400, active watershed initiatives can now be found in the West, almost all having originated since 1990.⁵⁵ Many additional watershed initiatives nationally are described in the work of Yaffee et al. (1996).⁵⁶ Groups concerned with forestry management are also increasingly common (Wondelleck and Yaffee, 1994).

While these collaborative groups may find a role in addressing both the ends and means of problem-solving strategies, it is the role of identifying common aspirations (i.e., ends) that is frequently the most salient contribution to the management environment. Too frequently in the modern era, the inability of the resource management agencies to successfully manage conflict leads to clogged courts and paralyzed resource management—also known as gridlock. Collaborative groups are often a more practical way for the affected interests themselves to resolve their differences and help to set new goals for the resource management community (NRLC, 1996).

To the extent that mutually acceptable goals can be established, these multiparty groups can also frequently be useful in designing implementation strategies (means) that avoid many of the traditional bureaucratic roadblocks to effective resource management (NRLC, 1996). Among the most serious of these impediments is intergovernmental fragmentation (Kenney, 1997). These

⁵⁴ Osborne and Gaebler (1992) address this issue in the terms of “steering” and “rowing,” arguing that public bodies are best suited to the steering role while market forces are adept at rowing.

⁵⁵ Seventy-six case studies of western watershed initiatives are provided in *The Watershed Source Book* (NRLC, 1996), published by the Natural Resources Law Center, with an ongoing revision of that work expected to yield at least 300 additional cases.

⁵⁶ Hundreds of case studies can be found on-line at sites maintained by Purdue University’s Conservation Technology Information Center (<www.ctic.purdue.edu/>) and the U.S. Environmental Protection Agency (<www.epa.gov/surf/>), among others.

potential roles and benefits of collaborative groups have been highlighted in several scholarly works and agency reports, including those of National Performance Review (NPR, 1993:14), established to “reinvent government” in all subject areas, including natural resources:

The traditional approach to managing ecosystems and the resources contained within them has been piecemeal. Responsibility has been fragmented across numerous federal and non-federal agencies and jurisdictions. An improved federal approach to ecosystem management would be based on ecological, not political, boundaries. It would then seek and consider input from all stakeholders affected by federal responsibilities in the area. Within such a framework, federal agencies, state, local, and tribal governments, businesses, public interest groups, citizens, and Congress could work in collaboration to develop specific strategies, refocus current programs and resources, and better ensure the long-term ecological and economic health of the country.

A New Paradigm of Natural Resource and Environmental Problem-Solving?

To say that many alternative problem-solving approaches currently enjoy broad political support would be an understatement. Rather than forcing a trade-off between economic efficiency and social equity (a traditional point of debate among conservatives and liberals), the alternative problem-solving approaches promise to aid both causes, promoting improved efficiency by using incentive-based tools (including markets) to devise the “means” of resource management and problem-solving, and utilizing inclusive, collaborative, and largely bottom-up collective choice processes to craft “ends” which are increasingly defined in practical (i.e., performance-based) terms.

At the federal level, many of the most important innovations are occurring as part of the Administration’s ongoing efforts to reinvent government through the National Performance Review (NPR, 1996). Among the agencies most significantly impacted by this changing philosophy have been the Environmental Protection Agency, a point recently expressed by Deputy Administrator Fred Hansen (1997:4):

When President Clinton came to Washington, one of his first orders of business was to begin reinventing the process and the systems of [environmental] regulations. . . . For five years we have been doing just that, and in early 1997 we announced the creation of EPA’s Office of Reinvention and gave it the mission of coordinating, enhancing, and expanding our efforts to reform the environmental regulatory system.

The agency has responded to this challenge by creating many new initiatives, including Project XL, the Common Sense Initiative, and the National Environmental Performance Partnership System (NAPA, 1997).⁵⁷

In addition to these largely market-oriented programs, the agency has also been a leader in promoting community-based, collaborative decision-making processes, such as watershed initiatives, as a useful supplement to traditional regulatory schemes:

The agency has both a national interest in and responsibility for supporting watershed approaches. The interest stems from the belief that the diverse sources of aquatic ecosystem impacts will best be brought under control through a combination of cooperative and mandatory measures tailored to the needs in specific watersheds with wholehearted support from watershed stakeholders. EPA's responsibilities include definition and ensured compliance with basic water programs; development of national standards and tools; funding; and national assessment of status and progress. (EPA, 1996:5).

Perhaps the best example of the broad political acceptance of the alternative problem-solving approaches, however, is found in a recent policy resolution of the Western Governors Association, which begins with the assertion that the "nature of environmental and natural resource problems is changing" and that "innovative solutions hold the prospect of achieving the desired environmental outcome and increasing economic wealth" (WGA, 1998). Among the key elements of these "innovative solutions," according to the governors, are replacing command-and-control programs with incentive-based systems, increasing the role of sound technical and socioeconomic information (especially relating to costs and benefits) and public education in decision-making efforts, a greater reliance on physically relevant administrative boundaries (i.e., a problemshed focus), and perhaps most importantly, a commitment to collaboration, not polarization:

The old model of command and control, enforcement based programs is reaching the point of diminishing returns. It now frequently leads to highly polarized constituencies that force traditional actions by governmental authorities without first determining if they are the most effective way to protect environmental values. Successful environmental policy

⁵⁷ Project XL and the Common Sense Initiative are EPA's "flagship" efforts. Project XL (a loose acronym for "excellence") is a pilot program encouraging regulated parties to devise and implement alternative strategies of environmental compliance. The Common Sense Initiative is notable for tailoring pollution control strategies on an industry-by-industry basis, rather than a pollutant-by-pollutant approach (NAPA, 1997).

implementation is best accomplished through balanced, open and inclusive approaches at the ground level, where interested public and private stakeholders work together to formulate critical issue statements and develop locally based solutions to those issues. Collaborative approaches often result in greater satisfaction with outcomes, broader public support, and lasting productive working relationships among parties. Additionally, collaborative mechanisms may save costs when compared with traditional means of policy development, and can lessen the chance that an involved party will dispute a final result.⁵⁸

Additional calls for alternative problem-solving approaches can be found in the work of the Western Water Policy Review Advisory Commission, EPA's new Clean Water Action Plan, and in recent efforts to amend the Endangered Species Act (ESA)—one of the most controversial of all natural resource regulatory programs. Of particular note is the recent Kempthorne (R-Idaho) bill, which calls for a move away from the ESA's regulatory tools to mechanisms based on incentives, such as tax breaks, to encourage voluntary cooperation of private landowners in species recovery.

To the extent that these new proposals and policy statements focus on the command-and-control elements of the compulsory strategies, especially those dealing with pollution control, the alternative problem-solving strategies enjoy almost uniform support. When the eyes of reformers focus more on the management of public lands, then the debate is livelier, as the goals of resource management are not so easily defined as they are in the pollution control arena, and the merits of utilizing market forces and collaborative processes are less clear. One concept that illuminates this debate is that of subsidies, which are frequently asserted to be a contributing factor to problems of resource depletion. This concern was recently articulated in a short-lived bill authored by Representative George Miller (D-California) proposing that “no timber, minerals, forage, or other natural resource owned by the United States, no Federally owned water, and no hydroelectric energy generated at a Federal facility may be sold,

⁵⁸ The governors have expressed similar ideas elsewhere. One example is found in a 1993 publication calling for an environmental policy framework “based upon improving the way we establish environmental priorities, creating better pricing signals, encouraging voluntary initiatives, working within ecosystems, and resolving disputes without litigation” (WGA, 1993:i; remarks of WGA Chairman, Fife Symington). More recently in the Summer of 1998, the Governors endorsed a “philosophy” known as *Enlibra*, a term used to describe a new approach to environmental and natural resources management stressing balance, creativity, cooperation, and results.

leased, or otherwise disposed of by any department, agency, or instrumentality of the United States for an amount less than fair market value, as determined by such department, agency, or instrumentality.”⁵⁹

Proposals of this type often lack political viability in that they promise to redistribute costs and benefits (through modified payoff rules) in a zero-sum manner that harms current position-holders, and since they are vulnerable to criticisms that market prices are insufficient to capture all resource values—such as the values of public goods (Kenney et al., 1998). A similar class of arguments assert that economic efficiency is not an appropriate goal of resource management or problem-solving, and that governmental intervention (usually of a regulatory nature) has often been preceded by significant environmental problems associated with market failures or inappropriate privatization.⁶⁰ Privatization and related “property rights” initiatives are perhaps the most controversial of all modern institutional problem-solving options, in that they promise to achieve the benefits of incentive-based, market transactions of resources or resource-use rights—you cannot sell what you cannot own—at the societal cost of position rules that exclude some parties from decision-making activities.⁶¹ The system of property rights needed to implement water markets, for example, ensures that some third-parties will undoubtedly be powerless to participate in decisions that will affect them (NRC, 1992; Oggins and Ingram, 1990).

While concerns of this nature focus most directly on the market-based elements of the alternative problem-solving strategies, the emphasis on collaborative action—a featured element in many alternative strategies—can also be controversial. The criticism of several national environmental organizations directed at western watershed initiatives is illustrative. One of these criticisms is that locally-oriented, collaborative processes change the locus of decision-making power in some situations, working to the disadvantage of interests that are more comfortable (and effective) acting through congressional lobbying and litigation than through the community-based efforts. As explained by Sierra Club chairman Michael McCloskey (1996:7):

⁵⁹ H.R. 919, the Public Resources Deficit Reduction Act of 1997, § 101(a).

⁶⁰ Another element that is occasionally part of these arguments is the idea market-based instruments lack any notion of right or wrong, and inappropriately provide a sense of legitimization to activities that impart some degree of environmental damage (Hockenstein et al., 1997).

⁶¹ Implementation of the Endangered Species Act frequently highlights the conflict between regulatory programs designed to express public interests and private property rights. This source of conflict was addressed, in part, by the 1982 amendments to the act providing the opportunity for landowners and federal agencies to jointly devise Habitat Conservation Plans (HCPs) that provide some resource protection while allowing some land development and use.

Few of the proposals for stakeholder collaboration provide any way for distant stakeholders to be effectively represented. While we may have activists in some nearby communities, we don't have them in all of the small towns involved. It is curious that these ideas would have the effect of transferring influence to the very communities where we are least organized and potent. They would maximize the influence of those who are least attracted to the environmental cause and most alienated from it.

Also of concern is the reliance on consensus, an aggregation rule that presumably can promote "lowest common denominator" decision-making, and the related suspicion that many groups organize simply to promote an avoidance of needed environmental regulations (Benson, 1996).

Concerns of this nature are aptly illustrated by the "Oregon Plan," a strategy of endangered species recovery endorsed by the state and federal government (Larmer, 1997; National Association of State Foresters, 1997). In Oregon, state leaders were initially successful in convincing the U.S. National Marine Fisheries Service not to list as endangered wild coastal salmon populations in central and northern Oregon, but to instead let the state pursue restoration of these imperiled populations through its Coastal Salmon Restoration Initiative (CSRI). Given that the CSRI is largely reliant on the activities of voluntary watershed initiatives and private landowners, the strategy marks a significant deviation from the competing regulatory approach defined under the Endangered Species Act, which critics describe as inefficient, ineffective, and disruptive to private rights. Opponents of the Oregon Plan fear that the sole motivation of the effort may be to simply avoid the negative costs of regulatory compliance, with salmon restoration being, at best, a secondary goal. Proponents generally counter that salmon restoration is indeed a major goal, while conceding—but not apologizing for—the fact that avoiding the high costs of compulsory strategies is also an important objective.

Recent judicial challenges of the Oregon Plan have successfully limited the scope of the effort. Nonetheless, the plan is still widely viewed as a model for future natural resource and environmental management in the West by several parties, including the Western Governors' Association (WGA, 1998), supporting the concern that many of the alternative problem-solving strategies are being unduly promoted not due to their proven track record, but rather to the disappointing record of many of the "traditional" approaches more highly reliant on compulsory strategies. Even many proponents of alternative problem-solving are quick to acknowledge that the application of these tools is limited.⁶² It is a

⁶² For example, Hockenstein et al. (1997) advocate the creation and application of a new breed of market-based tools for pollution control only while conceding that the track record of past efforts is somewhat spotty and disappointing. Bingham (1997), while promoting a greater use of ADR in implementing the Clean Water Act, Endangered Species Act, and National Environmental Policy Act, cautions that ADR may be a poor alternative in

challenge of institutional analysis to determine which strategies are most applicable for solving which problems, rather than to simply endorse new strategies by documenting the shortcomings of traditional (usually compulsory) approaches. As Bingham (1997:4) has observed:

In the legitimate search for alternatives to improve our capacity to resolve complex issues, we should not make the mistake of assuming that existing tools should be disregarded. If something must be “alternative” to be worthwhile, we will miss the value in what we are doing right already.

Institutional Problem-Solving Approaches

Natural resource or environmental problems can be solved by manipulating one or more of the three elements of the action situation: the physical environment, the actor/behavioral component, or the institutional rules. Technologically advanced societies typically look towards the manipulation of the physical environment first, because it is frequently less controversial, less difficult, and less uncertain than are attempts to manipulate behavior. Cutting trees, chaining rangeland, and building dams are all examples of manipulating the natural environment, as are planting trees, nurturing grasslands, and removing impoundments. In many cases, however, opportunities for a technological fix are not readily available, or if they are theoretically available, can only be pursued after significant institutional reforms.⁶³

Often, the best long-term solutions are those based on manipulating the behavior of resource users, discouraging (or prohibiting) problem-causing actions while promoting problem-solving behaviors. Again, these types of solutions cannot normally be pursued without first modifying institutional rules, as it is these rules which, when combined with the opportunities and constraints provided by the physical resource, largely shape human behavior. Resource use and environmental protection regulations are examples of using rules to shape behavior, as are market prices, taxes, subsidies, and other forms of non-compulsory strategies so popular in the modern era of alternative problem-solving.

situations where compromise is impractical. Kenney (1997) describes a “guarded optimism” for western watershed initiatives, sufficient to merit additional experimentation and support, but also suggesting a need for more critical and detailed analysis.

⁶³ For example, a dam cannot be built (modifying the physical environment) until it is formally authorized (a modification of the institutional environment).

Approaches to Solving Operational Choice Level Problems

The typology of operational choice level problems introduced earlier (depletion, underinvestment, maldistribution, and externality) does not define natural resource and environmental problems in terms of the resource itself⁶⁴; i.e., this report does not talk about water problems versus endangered species problems versus forestry problems, and so on. These terms typically lack analytical value, and are consequently better suited to practical discourse than scientific communication. Instead, this report primarily defines operational choice level problems in terms based on desires and behavior, having observed that human motivations are normally closely correlated to the set of opportunities, constraints, and incentives (or disincentives) provided by the interaction of the physical environment and the institutional rules, both of which can, to varying degrees, be manipulated in given situations. This perspective is typical of the discipline of economics, which is particularly well suited to the study of the individual decision-making behavior characteristic of the operational choice level. As described below, each of the four operational choice level problem types present unique challenges in problem-solving.

Solving Depletion Problems

While depletion problems can theoretically arise in a variety of situations, they are most commonly associated with so-called *open access* and *common pool resource* situations. An *open access* resource is one which is open to one and all. Access and use is not controlled, and overuse can therefore not be regulated or otherwise prevented. This open access state may be due to the natural characteristics of the resource itself, as in the case of fugitive resources which cannot be readily contained (e.g., ocean fisheries), or may simply result from a situation in which rules have not yet been adopted to prevent access to a given resource (e.g., public lands in the frontier West). In those cases where access can be regulated, at least in part, a *common pool resource* (CPR) situation can arise if the rules serve to limit access to a given group or class of individuals, but do not regulate resource use by individuals within the specified group. This situation is often found in systems featuring communal ownership of range, forests, water, wildlife, and other resources (Bromley, 1992; Ostrom et al., 1994). From the standpoint of problem-creation and problem-solving, a CPR situation is normally highly analogous to an open access situation.

Open access and CPR situations need not be problematic if levels of use are low in relation to levels of available supply; these situations can be stable (Bromley, 1992). In many of these situations, however, individuals will excessively consume natural resource goods or services, causing the depletion problem that Garrett Hardin (1968) termed a “tragedy of the commons.” In large

⁶⁴ In fact, this typology can conceivably be applied to a broad range of public problems that has little or nothing to do with natural resources.

part, this situation arises due to a lack of congruence between individual and collective incentives. Those individuals who consume resources at the highest (and most unsustainable) levels receive all the benefits of consumption, but bear only part of the costs—providing an incentive for this continued behavior. In the case of an open access resource, the costs of resource depletion are spread across society as a whole; in the case of a CPR, costs are borne by the specified population entitled to utilize the resource. As long as costs are spread equally, but benefits are directly proportional to levels of use, all individuals have an incentive for excessive consumption and depletion—and perhaps more insidiously, have a disincentive for conservation, knowing that the resources they conserve will only serve to provide additional benefits to the more profligate and uncontrolled consumers.

From the standpoint of institutional analysis, the distinguishing characteristics of open access and CPR problems are the absence of any or adequate boundary rules to control entry to the position of resource user, and/or the lack of authority rules specifying adequate limits on levels of consumption by these position-holders. The result is a payoff rule encouraging depletion. Taken together, these rules deficiencies almost ensure that a problem will eventually occur as demands on resources grow. This is a condition of avoidable and undesirable social costs: early exhaustion and/or resource degradation in the case of a stock resource such as a confined aquifer, and overuse—with attendant lower productivity or even extinction—in the case of a flow resource such as a fishery. The remedies for such problems must feature a change of operational choice rules which create barriers to entry (boundary rules) and/or which restrict the rate of use by all entrants (authority rules). Potential solutions can include management regimes featuring permit, fee, and/or private property systems controlling access or use; the informal adoption of social standards or norms advocating restricted consumption; and non-institutional solutions such as fence-building.

Solving Underinvestment Problems

Much like depletion problems, underinvestment problems can occur in a variety of contexts, but are most commonly associated with resource situations and rule sets of a particular type. Often, these situations are described using the term *public goods* and the related concept of the *free rider*. A *public good* is one that, once provided to one party, is automatically available to all, with increasingly usage not influencing supply in an appreciable manner. While this may seem like an uncommon situation, it is not—especially in the realm of natural resources and the environment. Examples include the preservation of endangered species and the protection of a given region from a natural hazard

(e.g., a city protected by a flood control project).⁶⁵ The human benefits⁶⁶ associated with these actions can be enjoyed by all parties—no one can be excluded—and this enjoyment does not deplete the level of the benefit or resource.

These situations are problematic only in that it is difficult to secure necessary investments in these actions, since those parties who chose not to pay—the so-called *free riders*—cannot be excluded from enjoying the benefits of the investments made by others. The typical result is underinvestment; i.e., a situation in which total societal investment in a resource or good is lower than would otherwise be expected given the magnitude of the expected societal returns from such investments. In some cases, this problem of underinvestment may simply reflect a lack of societal resources available to devote to a desired action or program, a situation most commonly associated with depressed economies or developing nations. These problems may defy an institutional solution. In the developed world, however, underinvestment problems are frequently amenable to an institutional solution.

Institutionally, the distinguishing characteristics of underinvestment problems (such as public goods situations) are the absence of boundary rules which control entry to the position of resource user (i.e., beneficiary) and the nature of the payoff rules, which state that the marginal benefits from increased entry, and thus increased resource use, are costless. Taken together, and in the context of resources which are often costly to maintain and manage, these rule deficiencies lead to underinvestment and, thus, under-provision of the resource. The problem is not only that private investment is impossible, because it can produce no return (due to the impossibility of excluding non-paying users), but that public investment is problematic because there are no market signals as to the level of benefits produced by different levels of investment. The typical remedy for this problem is not to change the boundary or payoffs rules, options which are often technically infeasible or uneconomical. Rather, it is to adopt new information rules (and/or create the new position of information provider) which result in the production of better information about the magnitude of potential benefits and to facilitate the use of this information in public decision-making, a higher level consideration. The educational activities of many public interest and environmental organizations, for example, have been key to the partial resolution of several underinvestment problems involving clean air and water, endangered species protection, historic landmark preservation, and other resource-related goods and services characteristic of public goods situations.

⁶⁵ The classic examples of public goods are national defense and public television/radio.

⁶⁶ Note that the concept of benefits is not limited to economic return, but can include other types of values. For example, the rationale for protecting endangered species prominently features the non-economic “benefit” known as “existence values,” as well as more explicitly economic benefits associated with ecosystem stability (Daily, 1997; Kenney et al., 1998).

Solving Maldistribution and Externality Problems

The distinction between maldistribution problems and the special sub-set of maldistribution situations known as externalities is somewhat tenuous and frequently insignificant. However, the issue of problem solving—and more accurately, the *literature* of problem-solving— can illustrate some important distinctions. All maldistribution situations, including externalities, feature situations in which one or more parties are denied access to a limited resource due to the actions of another resource using party. Desires exceed available resources, and the needs of some parties are not satisfied. This is a very general type of problem, perhaps most frequently seen in the West in water quantity disputes.

The natural resources literature generally distinguishes externality problems from other maldistribution problems in that in externality situations, the use (or abuse) of the resource by one party inadvertently or indirectly diminishes the ability of other parties to utilize the resource in question in a different way, location, or time.⁶⁷ Furthermore, this cost imposed on the externality bearer is not compensated or otherwise offset by the externality generator, thereby creating no incentive for the generator to modify his/her behavior (Baumol and Oates, 1988; Pigou, 1938). The most familiar examples of externalities involve pollution of air and water resources by industrial activities, and the associated impacts borne by recreationists, water supply providers, and a host of other affected parties. However, many other types of externality situations exist. One of the more interesting examples is the cedar applerust problem, in which owners of wild lands harbor cedar trees, the alternate host for the apple rust fungus, and thereby impose costs of reduced yields, diminished fruit quality, or high protection expenses upon nearby apple growers. The costs associated with this spatial externality may exceed the benefits yielded by the presence of the cedar trees, at the margin if not in total.

Solving an externality problem generally requires either enacting a partial or full prohibition on the externality causing behavior, or establishing a system of private rights to the resource in question, allowing the different parties to arrive at an appropriate allocation through some form of bargaining (e.g., a market transaction). As discussed later, it is this second approach that is favored in the economics literature, as the regulatory, command-and-control, programs for environmental protection are typically shown to be inefficient (Baumol and Oates, 1988). To achieve these reforms usually entails changing the position and authority rules, as the distinguishing characteristics of externality problems are an absence of position rules which recognize the position of externality bearer and the absence of authority rules which require the externality generators to

⁶⁷ The term externality is used so frequently and inconsistently in the economics literature that a definitive definition is highly elusive (Baumol and Oates, 1988). Consequently, the use of the term in this report may not be completely consistent with other documents, an unfortunate but largely unavoidable situation.

consider the effects of their actions upon others. Boundary and payoff rules can also be important. Taken together, especially in the context of a resource which is mobile in space or time, these rule deficiencies can lead to social costs in excess of the benefits with which they are associated, as well as to possible inequities among resource users.

The underlying assumption in the literature of externalities is that reforms need to be pursued to promote a greater efficiency in resource use and allocation. Determining the “appropriate” level of externalities is a rich subject in economics (Baumol and Oates, 1988; Coase, 1960). Generally, it is assumed that the appropriate balance between externality generation and mitigation is the point at which the marginal costs of preventing the externality equals the marginal benefits of mitigation, a point which is best (i.e., most efficiently) reached using market mechanisms. Implicit in this perspective is that some level of externality generation (and harm to the bearer) is appropriate, an idea already codified in the existing institutional rules which have allowed the externality-causing behavior to occur. Some scholars, such as Schmid (1978), argue that by taking the existing distribution of rights for granted, many of the most important problems may be completely overlooked by the classic economic problem-solving rationale. Perhaps the problem is not simply one of *inefficiency* in allocation and use, but is one of distributional *inequity*, or more generally, an inappropriate—or “mal”—distribution. The term *maldistribution* is utilized to capture this general notion of “inappropriateness” in distribution, which can conceivably be defined in terms of efficiency or equity, unlike the term externality which is almost always applied in the scholarly literature to situations defined as efficiency problems. In both situations, needed institutional reforms typically entail modification of position, authority, and/or boundary rules, actions which can collectively address the problematic incentive structure underlying the payoff rules.

Approaches to Solving Collective Choice Level Problems

The rules at an institution’s collective choice level describe the mechanisms and forums available for changing the operational choice level rules and, thus, for solving operational choice level problems. Several types of arrangements for group interaction and decision-making typically exist at the collective choice level, including legislatures, courts, markets, and various forms of formal and informal committees. Often, efforts to solve operational choice level problems are impeded by conflict at the collective choice level. As discussed earlier, three types of conflict can be identified: interest conflict, value conflict and cognitive conflict. The types of mechanisms and forums most useful at the collective choice level in a given situation are largely determined by the nature of the conflict they must address.

Solving Interest and Value Conflicts

Interest conflicts typically result when different parties are in competition for control of a finite resource or benefit. Interest conflicts differ from *value conflicts* in that the latter involves conflicting parties who share philosophically incompatible ideals about the appropriate distribution of resource uses, whereas interest conflicts typically involve disputes about how to “divide the pie” among potential beneficiaries with largely similar goals.

Many of the best natural resources examples of interest and value conflicts in the West can be found in the realm of water development politics. Participants in regional water development planning processes, for example, may conflict over the appropriate location of water projects and allocations, or the cost-sharing rules associated with the development scheme. Prior to the environmental era, these disputes were primarily interest conflicts, as different sets of water development proponents battled to secure maximum benefits for their constituencies (Terrell, 1965). In more recent decades, environmental interests have worked to inject a preservationist ideal into these disputes, bringing an strong element of value conflict to water development politics (Gottlieb, 1988).⁶⁸

Typically, interest conflicts are addressed through bargaining activities, which can occur in the context of market exchanges, planning processes, the authoring of legislation, and related mechanisms of give and take. These efforts are most successful if the zero-sum nature of the conflict can, at least partially, be ameliorated, allowing for some positive-sum (ideally, Pareto optimal) exchanges. The modern reallocation of western water supplies through water markets, for example, provides benefits for both buyers and sellers—otherwise the transactions would not occur—thereby allowing new benefits to be obtained in a manner that does not otherwise increase the overall water supply.⁶⁹ Frequently, new information and/or authority rules must be established to facilitate these exchanges, providing data about potentially viable exchanges, and authorizing (and enforcing) bargains.

A slightly different way in which interest conflicts involving western natural resources are frequently addressed also involves changing seemingly zero-

⁶⁸ One of the best case studies illustrating the changing face of western water development politics is provided in Ingram’s (1990) account of events surrounding the enactment of the Colorado River Basin Project Act of 1968, an event occurring during a major era of transformation in the western water development industry.

⁶⁹ Of course, the impacts of water marketing may not be so universally positive to those parties excluded from the decision-making environment (Oggins and Ingram, 1990; NRC, 1992). Rural communities and the natural environment, for example, are “parties” frequently excluded from water marketing arrangements, a situation that could be characterized as resulting from deficient position and boundary rules at the collective choice level that only recognize buyers (i.e., those with financial resources seeking water for legally recognized beneficial uses) and sellers (i.e., those with marketable water rights). Many states have attempted to remedy this institutional deficiency by creating the position of “public interest reviewer,” a role normally falling to State Engineers or the judiciary.

sum situations into positive-sum outcomes. In this particular situation, the conflict is made positive-sum for the participants by enlarging the benefits package, with costs shifted to the federal taxpayer. This approach is described by Lowi (1964) as the distributive political mode, but is perhaps more commonly known as pork barrel politics. In these situations, all involved participants are provided with perks of some sort (such as subsidies)—i.e., the “pie” is expanded—and the situation is made positive-sum.

Of course, the key in this and many related situations is to make the problem positive-sum by shifting costs to unrepresented parties, a strategy that is difficult to justify as it is reliant on position and boundary rules of questionable merit. In many other situations, however, advances in information services or technologies may be able to create a positive-sum situation by eliminating inefficiencies, a strategy with greater normative appeal.⁷⁰ If no viable mechanism for creating a positive-sum outcome can be discovered, then the problem may go unresolved, or it may only be resolved through a mechanism that does not require agreement among conflicting parties, such as a judicial proceeding.

Value conflicts are notoriously difficult to address since they rarely offer any opportunities for bargaining or compromise. Bargaining away differences is impossible, since the values involved are non-compensatory. Additional factual information usually has little impact upon the positions of the contending parties, because the conflict is not over facts, but over how those facts are valued. Resolving these disputes, therefore, can often be a lengthy and contentious process, frequently driven by prominent judicial decisions, incremental legislative or administrative rule-making, and perhaps most importantly, a long-term change in prevailing societal values.⁷¹ These may require action at the so-called constitutional choice level of the institution, where fundamental issues of process and substance are typically addressed. Changes of this magnitude often arise from broad movements (e.g., civil rights movement, environmental movement), rather than arising from a single, isolated resource use controversy.

Solving Cognitive Conflicts

Cognitive conflicts arise due to a lack of common understanding of key processes or data associated with a given problematic situation. The current national (perhaps global) epidemic of frog deformities and mortality is a particularly confusing problem, as was the earlier national crisis over bird population declines eventually traced to the use of pesticides, namely DDT. Other situations may not feature a lack of scientific understanding, but only a lack

⁷⁰ For example, a positive-sum water transfer between the Imperial Irrigation District and Metropolitan Water District of Southern California was made possible by a canal lining effort that greatly reduces seepage losses in the irrigation district (Wahl, 1989).

⁷¹ Munro (1988) and Kenney (1993) are among those authors that emphasize the importance of paradigmatic change in shaping long-term natural resource management policies.

of communication among stakeholders about concerns or preferences. In cognitive conflict situations, the decision-making group organized to address the problem cannot determine an appropriate action to take because of a lack of data (facts) or differing understandings (metaphors) of the implications of those facts, deficiencies that can be addressed in a variety of ways that, in one way or another, prominently involve the information rules.

Cognitive conflict resolution requires resort to information sources which are credible to all participants, such as scientific authorities (e.g., expert consultants or panels) or perhaps simply collaborative efforts where different opinions, concerns, and values can be communicated. The success of these efforts is likely to be largely driven by the rules that describe the type of information that is required for decision-making, how and by whom it will be produced, and how it will be shared and utilized. Adaptive management is an increasingly popular framework of institutional rules for dealing with these situations, based on a cyclical strategy of research, pilot projects, monitoring, and program reassessment (Lee, 1993).

Additional Considerations in Matching Problems and Solution Strategies

Natural resource and environmental problems occur when the various elements of the action situation interact in a manner that causes some needs or desires to go unsatisfied. As discussed earlier, various institutional problem-solving strategies can be employed to address each of the four operational choice level problem types. Before considering which institutional reforms can or should be pursued, however, it is important to appreciate that certain factors can be particularly salient in creating these problems and in limiting the opportunities for problem-resolution.

Scholars have identified many characteristics that distinguish natural resources and which can be utilized to classify them with respect to problem analysis and resolution (Bromley, 1992). One conventional distinction—introduced earlier in the discussion of depletion and underinvestment problems—is that between renewable (a.k.a. flow or reproducible) resources, such as plant and animal populations, and non-renewable (a.k.a. stock or irreproducible) resources, such as mineral deposits. A useful sub-categorization is to distinguish between those flow resources which have a critical zone and those that do not (Ciriacy-Wantrup, 1970). For example, all plant and animal populations have a certain “minimum viable population” (MVP) threshold that must be met or exceeded, otherwise extinction is inevitable. A water supply source may have no such limitation. Another common distinction is between resources that are mobile and those that are fixed in space or time. Migratory birds and flowing water (sometimes known as fugitive resources) are good examples of mobile resources. Unlike fixed resources such as land, mobile resources can be difficult to physically possess in a given place or time, creating special challenges in resources law and management. For example, mobile

resources are often associated with externality problems—particularly, spatial externalities.

While all of these characteristics can be used to describe the quality of physical resources and environmental systems, a slightly different set of concepts is needed to describe the interplay of environmental characteristics with other elements of the action situation. From this perspective, three related concepts emerge as being particularly salient: *manageability*, *excludability*, and *symmetry*.

The concept of *manageability* refers to the extent to which the physical properties of a resource in a particular situation lend itself to deliberate manipulation (i.e., management). From a problem-solving standpoint, this is often the significant feature of the renewable/non-renewable criterion. Renewable and non-renewable resources can feature very different management issues attributable to their different physical characteristics. For example, both renewable and non-renewable resources are subject to depletion. However, renewable resources such as forests, fisheries, and flammulated owls are able to reproduce and renew their stocks, whereas non-renewable resources such as petroleum pools, gold-bearing veins, and limestone deposits are fixed in quantity.⁷² Consequently, the management challenge of renewable resources is generally to achieve sustainability, which can be pursued through the manipulation of supply, demand or both (Clark, 1976). For non-renewable resources, the challenge is typically to achieve an optimal rate of exhaustion (or preservation), which may be influenced by the development of new technologies or substitute goods (Dasgupta and Heal, 1979).

A closely related concern is *excludability*. Excludability refers to whether the resource in question (in a given situation) lends itself to the physical exclusion of some potential users from the flows of goods and services which it yields. For example, in the modern West it is now relatively easy to exclude possible timber harvesters from logging a particular tract of forest land, something which was not true a century ago (and is not true of the Amazon jungles today). By contrast, it is virtually impossible to exclude anyone from breathing the air in a metropolitan airshed. Clean air, once provided to some, is then available to all. Defined in this way, excludability is not a static physical characteristic of a resource, but is a description of how that characteristic relates to the current state of technology, infrastructure, and/or social organization seen in a given action situation.

The importance of excludability is due to the management techniques which it permits or proscribes. For example, private property and market-based management techniques cannot be employed in the case of non-excludable resources, for property is meaningless and marketing is impossible if resource-

⁷² The distinction between renewable and non-renewable is not an absolute one. For example, the deep aquifers underlying many southwestern cities are technically renewable, but the rate of recharge is so minor compared to current withdrawals that these resources should probably be considered non-renewable. As a practical matter, a resource is renewable only if can regenerate at a rate that has significance in relation to a human management time frame.

related goods and services cannot be withheld from those who will not pay for them. Public goods, mentioned earlier, are an important type of non-excludable resources. So are open access resources, like ocean fisheries, which are not joint in supply but which, because of their non-excludability and their depletable, are especially vulnerable to exhaustion and extinction (Steelman, 1998).

The third salient characteristic of a resource use situation is *symmetry*. A resource may be said to be *asymmetric* if the use of resource-related goods or services by one user group impacts other user groups, but not vice versa. Conversely, in a *symmetric* situation, users are likely to simultaneously impose costs on themselves as well as others. The classic example of asymmetry is the upstream paper mill which uses the river to dispose of residuals, which in turn affect downstream fish populations, and thus the catch rates of downstream fishermen.⁷³ The classic symmetrical situation is provided by the case of the commonly-owned grazing land which is susceptible to overuse, and consequent degradation (Hardin, 1968; Ostrom et al., 1994; Bromley, 1992). In these situations, individuals are likely to simultaneously (and reciprocally) impose costs upon themselves as well as others.

Symmetry or asymmetry is important because it strongly shapes the possibilities for conflict resolution and problem resolution. It is much easier to get agreement to reduce shared costs than to reduce costs imposed only upon others. Depletion and underinvestment problems tend to have symmetric elements which favor certain kinds of conflict management and resource management solutions, while externality and maldistribution problems, being basically asymmetric, encourage a different set of problem-solving strategies. Understanding relationships of this type is central to the challenge of matching problems and problem-solving strategies. This issue is explored further in Section IV, as three case studies in natural resource and environmental problem-solving are reviewed.

⁷³ Note that the underlying resource characteristic in this case is the mobility of river water, which carries pollutants away from the paper mill.

SECTION IV: CASE STUDIES

Introduction to the Three Case Studies

In the following pages, three case studies are presented to demonstrate the utility of the institutional analysis concepts described herein, and to identify a few different ways in which the tenets of alternative problem-solving have found expression in modern natural resource and environment conflicts. The first case examines problems associated with groundwater overdrafting in the South Platte Basin of Colorado. In that region, the failure of Colorado law to adequately manage groundwater usage resulted, for a time, in a situation in which senior surface water rights holders became fearful of reduced flows due to water table declines attributable to unregulated groundwater pumping. This essentially created a spatial and temporal *externality* situation, in which the water demands of junior groundwater appropriators were elevated above those of senior surface rights holders. Groundwater overdrafting also created *depletion problems* affecting groundwater pumpers. While scientific uncertainty about the surface water/groundwater connection slowed efforts to address these highly related problems, legislative action eventually established a framework of rules under which technical expertise and a new collaborative group—Groundwater Appropriators of the South Platte (GASP)—have produced a solution heavily reliant on cooperative action, negotiation, and market incentives, all nested within a framework of private property rights and regulatory oversight.

The second case study presented addresses issues of forest management in the Applegate region of Oregon. The Applegate region is utilized to provide a specific context for an issue that is widespread in the West: determining appropriate timber harvesting levels. In this case, the *depletion problem* takes on a special character as a high-profile endangered species controversy is injected into the debate, raising highly familiar issues about the balancing of economic and environmental interests. These environmental concerns highlight *underinvestment* and *externality* problems characteristic of the modern environmental movement. While enactment of the Northwest Forest Plan of 1994 is the culminating event in the institutional history provided, it is the role and presence of collaborative groups in the region that is of particular interest, as many natural resource scholars see the Applegate region as an important laboratory in alternative problem-solving—a perception that is only partially accurate. As shown by the case study, it is the relationship between the alternative problem-solving strategies and the traditional means of conflict resolution that is of particular analytical interest.

The most complex of the three cases involves environmental restoration in the Truckee-Carson River Basins. In that region, the distribution (or *maldistribution*) of a limited water resource has created a host of problems,

including *underinvestment* problems associated with endangered species and migratory waterfowl. The interplay of water allocation regimes and species protection is a problem found throughout the West; the Truckee-Carson case provides one specific context for analyzing a set of issues that is discouragingly universal to the region. In order to focus on the most illuminating aspects of this situation, the case study primarily focuses on events surrounding the Truckee-Carson Pyramid Lake Water Rights Settlement Act of 1990, but places this event in an approximately 100 year context beginning with the initial development of the region under the auspices of the prior appropriation doctrine and Reclamation Act and ending with the situation as of 1996. Prior to this time period, an *open access situation* presumably existed, as did a broad set of issues associated with the settlement of Anglo populations in territories inhabited by Native Americans. The initial settlement of these issues is largely outside the scope of this case, which is on the modern goal of environmental restoration.⁷⁴

Conjunctive Management of Water Resources in Colorado's South Platte Basin

Case Study Description⁷⁵

A variety of institutional arrangements are utilized by western states to coordinate the management of surface and tributary groundwater.⁷⁶ Some states, such as Arizona and California, rely heavily upon water supply districts or similar organizations while others, such as Colorado and New Mexico, pursue this integration primarily through complex frameworks of water rights law. Given the frequently different regimes for water allocation and management between surface water and groundwater, “conjunctive management”—i.e., the coordinated management of surface and groundwater—can be a formidable institutional

⁷⁴ Since 1996, several issues have remained under debate; the conflicts in the Truckee-Carson Basin will likely continue for many years. By stopping the analysis at 1996, it is possible to provide some closure to the analysis. A similar rationale is utilized to stop the South Platte case in the early 1990s, and the Applegate case in early 1998.

⁷⁵ This case study is primarily adapted from the work of Lord in Gregg et al. (1991). Additional background information is available in Hillhouse (1975), Young et al. (1986), and MacDonnell (1986, 1988).

⁷⁶ “Tributary” groundwater, also known as alluvial groundwater, is groundwater that interacts with surface water flows, presumably by contributing to surface water flows during low-flow periods and by receiving inflows from surface systems during wet periods. Non-tributary groundwater, in contrast, refers to water resources located in deep aquifers and lacking a significant hydrologic connection to surface waters. Tributary groundwater is generally considered a renewable resource, while non-tributary groundwater is considered non-renewable—at least given the normal time frames upon which water allocation and management decisions are based. The focus in this study is primarily on tributary groundwater.

challenge, especially when this challenge is addressed during a period of conflict and with incomplete scientific understanding. This case examines some of the strategies used to achieve conjunctive management in the South Platte Basin in northeastern Colorado, from the earliest days of the Colorado territory to approximately 1990, with the greatest emphasis on events from 1957 to 1974.⁷⁷

Colorado Water Law: The Initial Framework of Property Rights

In the latter half of the 19th century, as Colorado evolved from a territory into a state, a framework of laws regarding water emerged (MacDonnell, 1986, 1988). In Colorado, as in other western territories and states, the common law riparian doctrine was judged to be inappropriate given the frequently arid and semi-arid conditions of the West. Riparian law was not well suited to dealing with conditions of scarcity, or to situations in which water usage occurred far from the stream channels. Consequently, out of the mining camps of California (circa 1848) emerged a series of rules known as the prior appropriation doctrine, first recognized by Colorado in 1879. The prior appropriation regime for surface water is based on the notion that all surface waters are owned by the state but can be “appropriated” by individual water users under certain conditions, resulting in the establishment of private usufructuary rights.

Acquiring a surface water right under prior appropriation requires a party to make a diversion from a natural stream course and put it to a “beneficial use,” such as irrigation. The amount of the right corresponds to that amount beneficially consumed, and in times of shortage, those rights established first are satisfied completely before more “junior” rights holders receive any water (i.e., the so-called first-in-time first-in-right, or seniority, principle). The enforcement process is known as a “call” on the river, and is administered by the State Engineer. Surface water rights are transferrable through market exchanges, given that such transfers do not impair the rights of other recognized appropriators, a determination in Colorado made by a system of water courts. While Colorado is unique in its use of a water court system, these other elements of prior appropriation are found in similar form in all western states.

In stark contrast, rules governing the allocation and use of groundwater resources in Colorado were largely non-existent until recent decades, in part due

⁷⁷ While the resolution of water supply issues through a form of conjunctive management is the focus of this case, it is worth acknowledging that in recent decades, the primary natural resource issue in the Platte Basin has involved environmental issues: namely, the fate of the endangered whooping crane, and the responsibilities of the federal government and Colorado, Wyoming, and Nebraska in addressing this problem. Actions to address this problem are ongoing, and include efforts to prepare an Environmental Impact Statement. The omission of this issue from this case study is not intended to suggest that environmental issues are unimportant, but simply reflects a desire herein to illustrate a different set of concerns. Environmental issues involving endangered species are prominently featured in the following two cases involving forest resources in Oregon and water/wetlands resources in Nevada.

to a lack of scientific understanding about the workings of the hydrologic system underground, and in part due to a lack of apparent conflicts among water users (MacDonnell, 1986, 1988). Closely following English common law, access to groundwater resources was viewed as a right of land ownership. Landowners enjoyed broad discretion in pumping and using groundwater underlying their lands, and unlike the prior appropriation doctrine for surface water, these groundwater rights were not effectively quantified or limited in any way.

Emergence of Water Supply Controversies

The failure of Colorado law to establish limits or other rules (other than land ownership) regarding groundwater pumping rights was not initially problematic, as the demand for ground water—and perhaps more importantly, the technology of groundwater pumping—was insufficient to support large withdrawals. However, surface waters in the South Platte Basin were fully appropriated by the start of the 20th century, ensuring that demands on groundwater reserves would inevitably climb. That climb began in earnest in the 1930s with the development of high lift submersible pumps and the widespread availability of affordable electricity, and accelerated with the economic boom following the conclusion of World War II. Major droughts in the 1930s and 1950s also contributed to growing demands, which were only partially satisfied by increased transmountain surface water imports (MacDonnell, 1988).

Growing water demands created a host of problems and conflicts, pitting groundwater pumpers against each other, and groundwater pumpers against surface water appropriators. This first type of conflict emerged as escalating pumping levels resulted in declining water tables for all groundwater pumpers in a given region, regardless of their individual levels of use. The second type of conflict emerged, in part, as scientific understanding of the surface water-groundwater connection progressed. In many systems, including the South Platte, tributary groundwater is critical in maintaining the base flow of the surface water system during low flow (and peak use) periods. To the extent that groundwater withdrawals diminish the yield of the underlying aquifer, both groundwater and surface water users were thus impacted by the growing consumption of groundwater in the basin. Given this hydrologic connection, a comprehensive solution to these problems was needed.

Search for Institutional Solutions

A variety of institutional solutions was potentially available to reduce groundwater pumping. For example, a regulatory framework could be installed prohibiting the usage of certain pumping technologies, or perhaps restricting withdrawals in excess of a given standard. Or, the property rights regime currently governing groundwater could be augmented by quantifying groundwater rights associated with land parcels. Still another approach would be to utilize market-based incentive systems to discourage excessive use. The solution first crafted by the Colorado Legislature in 1957 contained elements of both a regulatory and property rights solution by empowering the State Engineer, under

certain circumstances, to establish and implement a permitting system, declaring tributary groundwater subject to the basic rules of appropriation.⁷⁸

This approach, a mixture of regulatory and property rights strategies,⁷⁹ was significantly flawed in two ways. First, the new rules only applied to new wells, an innovation which did nothing to provide pumping limits on those existing wells already causing problems. Regulation of new wells was a wise step, but was clearly an incomplete and politically-motivated solution. Second, new rules calling for the State Engineer to restrict groundwater pumping when senior surface water rights were impaired was of no practical benefit due to long time delays associated with the underground movement of water. The “call” system, which can work quite well for surface water regimes, was not well suited to the conjunctive management situation in the South Platte or in most other parts of the state, prompting the State Engineer to conclude that no groundwater pumping restrictions could be justified during shortage situations. Despite the sound technical basis of this decision, the legislature saw the action of the State Engineer as insubordinate, and ordered the public servant in 1965 to implement the 1957 “solution” by shutting down wells in accordance with a call on the river.⁸⁰ When this was subsequently done in the Arkansas River Valley, it initiated a legal challenge that upheld the original position of the State Engineer: Pumping could not be restricted unless it could be shown to materially benefit senior appropriators.⁸¹

Learning from past mistakes, and from a detailed study authorized in 1967⁸² exploring the surface water-groundwater connection, the legislature in 1969 finally incorporated all nontributary groundwater wells into the prior appropriation system. The Water Right Determination and Administration Act of 1969 established a three-year process during which all undecreed wells would be adjudicated with a priority date of initial diversion.⁸³ Also, new points of diversion for surface water rights, including new wells, were authorized as necessary to avoid injuries to senior rights. Finally, the Act and related legislation provided two strategies groundwater pumpers could utilize to avoid

⁷⁸ Colo. Session Laws, ch 289, § 5; codified at Colo. Rev. Stat., § 148-18-2 (1963).

⁷⁹ Note that prior appropriation, in general, is a mixture of property rights and regulatory elements, since administrators (i.e., State Engineers, water departments, and/or water courts) have a role in program implementation. A pure property rights regime would leave all enforcement actions to civil liability lawsuits.

⁸⁰ Act of May 3, 1965; 1965 Colo. Session Laws, ch 318, § 1.

⁸¹ Falhauer v. People, 167 Colo. 320, 447 P.2d 986 (1968).

⁸² Colo. Rev. Stat. § 148-2-9 (Supp. 1967).

⁸³ Colo. Rev. Stat. § 37-92-101 to -602 (1973), *et seq.*

having their pumping rights curtailed. The first was to adopt and follow a court-approved plan for augmenting water supplies; the second was to provide replacement (or “substitute”) water of sufficient quality, quantity, and timing to forestall injuries to the senior surface water rights holders.

After considering various strategies, draft rules for implementing the Water Right Determination and Administration Act were issued in 1972.⁸⁴ Final rules were issued two years later. As first articulated in the 1969 legislation, groundwater users were required to pursue one of the two strategies for avoiding injury to senior surface rights holders—augmentation or replacement—or face complete loss of groundwater pumping rights within three years. This was a significant regulatory limitation on the property rights of groundwater pumpers. Parties developing a court-approved augmentation plan would be allowed to continue pumping indefinitely; those pursuing a strategy of finding replacement water supplies needed to annually negotiate an acceptable strategy with the State Engineer.

Groundwater Appropriators of the South Platte (GASP)

After publication of these new rules, one group of pumpers deciding to utilize the replacement water supply strategy organized into an association known as Groundwater Appropriators of the South Platte (GASP).⁸⁵ By the 1990s, GASP had grown to include over 1,400 members, operating over 3,000 wells withdrawing over 400,000 acre-feet annually—about 95 percent of the basin’s pumping. GASP functions by collecting funds from pumpers to lease and purchase water rights and reservoir storage rights, to purchase recharge credits, to drill new wells (and extract water from them), and take related actions needed to delivery adequate quantities of replacement water to surface water interests impacted by groundwater pumping. Funds are raised from a tax on water pumped, generally around one dollar per acre-foot—at least 20 times lower than the market value of water in the region.

⁸⁴ Initially, the State Engineer attempted to implement the law by establishing a system of zones, defined in terms of transit time of tributary groundwater to the closest surface water source. Wells in zones with the shortest transit time were to be subject to the most frequent curtailments during surface water shortages, while those farther away would often not be curtailed since these reductions would not benefit surface flows in a timely manner. Although approved by the Colorado Supreme Court, these proposed rules were withdrawn before they could take effect due to concerns over administrative complexity, the likely continuance of some injury to senior rights holders, and to a reluctance to impose the greatest restrictions on wells closest to the river channels—often the most productive lands (Gregg et al., 1991; MacDonnell, 1988). Interestingly, a similar system was adopted in the Gila River Adjudication by Judge Goldfarb.

⁸⁵ GASP operates under rules specified in S.B. 105, 1969 Colo. Sess. Laws 1196 (ch 370, § 8), later codified at Colo. Rev. Stat. § 37-80-120 (1973). Similar organizations exist elsewhere in Colorado (MacDonnell, 1986).

About 100,000 acre-feet of replacement water is annually provided in this way to the State Engineer and eventually to surface water users. Over half of this supply comes from wells operated by GASP.⁸⁶ This level of replacement water required has been increased over time, by order of the State Engineer, in response to learning over the quarter century of operation. Initially, a stipulated decree called for a replacement level of 5 percent (Hillhouse, 1975). However, largely through a process of trial-and-error, this level of replacement was shown to be inadequate, leading to new rules by the 1990s requiring a 25 percent replacement level.⁸⁷ At least for the present, this new set of rules appears to provide a workable institutional framework for conjunctive management in the South Platte.

Case Study Analysis

Review of the Operational Choice Level Problems

As is true for most cases involving complex resources over an entire century, many different types of operational level problems can be identified. This analysis is primarily concerned with that set of problems that emerged in the post-WWII era pertaining to water supply management, and the relationship between surface water and tributary groundwater. With those qualifications, only two major problems—both largely solved—merit a focused analysis:

- (1) *Externality Problem*. The primary problem in this case was the harm (i.e., externality) imposed upon surface water rights holders by junior groundwater pumpers. This problem was not effectively addressed until the early 1970s when Colorado water law finally was modified to reflect the physical reality of the groundwater-surface water connection, and a workable mechanism for conjunctive management was established.
- (2). *Depletion Problem*. The other, and closely related, problem in this case involved the inadequacy of institutional rules to provide any real limits on groundwater pumping, creating burdens for not only surface water users (i.e., the externality problem described above) but also for the community of groundwater users. Burdens borne by particular pumpers included both short-term and potential long-term deficiencies in groundwater supplies, and due to the externality problem, institutional

⁸⁶ To understand how this system works, consider the case of the senior rightsholder (holding a 1873 priority date) far downstream in the basin near Sterling Number 1 ditch. When that party faces a reduction in surface water supplies, a nearby well owned and operated by GASP pumps groundwater directly into the ditch to satisfy the call. This water is provided to replace surface water depletions presumably caused by groundwater pumping throughout the basin.

⁸⁷ This is consistent with the recommendations by Young et al. (1986).

reforms that placed potentially significant restrictions and increased costs on the use of groundwater (i.e., the augmentation and/or replacement requirements). These problems have largely been resolved in the study region through groundwater laws and the GASP mechanism.

Key Attributes of the Problematic Situation

The *externality* and *depletion problems* experienced in the South Platte Basin can largely be thought of as two sides of the same coin, caused by the same deficiency: i.e., the inability of Colorado water law to adequately control groundwater usage. Prior to the institutional reforms beginning in the 1950s and after the technological revolution in pumping technology of the 1930s, groundwater pumping was limited only by the cost of electricity (subsidized in rural areas) and by groundwater availability (which was now declining in some areas). This was a payoff rule encouraging and facilitating groundwater overuse. For many decades, the prior appropriation doctrine had merged private property rights with some regulatory elements to effectively control direct use of surface waters. However, the land ownership requirement of groundwater pumping, a boundary rule, was not married to authority rules capable of similarly controlling total levels of groundwater usage.

While it is the externality problem that is of particular salience in this case, the depletion problem is perhaps more useful in reviewing some of the terms and metaphors that can be used in institutional analysis. For example, the depletion problem here has qualities typical of both *open access* and *common pool resource (CPR)* situations. These terms are typically utilized to describe scenarios in which access to a resource is inadequately controlled, thereby allowing and even encouraging individual actions resulting in overuse of a shared resource. The requirement that groundwater pumpers be landowners is a notable limitation on access; thus, this is not a classic open access situation—a term better reserved for the situation in the first half of the 19th century prior to the formal awarding of public domain lands to individuals and the latter enactment of water law doctrines. However, the community of groundwater pumpers in this case do not readily meet the typical characterization of a CPR either, in that this community was not organized in any sort of distinguishable collective until creation of GASP. Thus, neither metaphor is clearly superior to the other in this case, as both are useful in illustrating the outcomes that can occur when institutional rules (particularly boundary and authority rules) fail to control access and use of finite resources.

The depletion problem in this case is also useful in illustrating how the symmetry concept influences the definition of externalities. As used throughout this report (and most similar discussions), the term externality is normally reserved for asymmetric situations—i.e., those in which one party imposes a burden on another, but not vice versa. That is clearly the case in problem # 1 as

junior groundwater pumpers were allowed for a time to diminish needed surface water flows to which other parties had recognized rights. The second problem (i.e., the depletion problem) also describes a situation where the actions of some parties lead to burdens borne by others. However, since there is considerable overlap between the generators and bearers of these “externalities”—i.e., both belong to the community of groundwater pumpers—the relationship is reciprocal (or symmetric), and features a set of incentives and qualities that distinguishes this situation from the classic externality definition.⁸⁸

The Institutional Solution

The two problems discussed in this case were primarily addressed by that set of innovations bounded by the Underground Water Act of 1957 and the publication of implementing rules in 1974 pertaining to the Water Right Determination and Administration Act of 1969. Rules codified in those efforts finally created a framework for prohibiting, or at least constraining, the problem-creating behaviors seen in the South Platte. The primary contribution of GASP, a collaborative group operating at the collective choice level, has been in providing a workable administrative mechanism for implementing conjunctive management. This is no small accomplishment, given the technical demands of conjunctive management, and the sheer magnitude of the water users involved.

Problem-Solving Prior to GASP

As growing groundwater usage threatened the integrity of the surface water allocation regime, the Colorado legislature became aware of the externality situation and the need for conjunctive management. That body’s 1957 action sought to address this problem by empowering and subsequently requiring the State Engineer to prohibit groundwater pumping in times of surface water shortage. Although these new reforms did provide a seemingly reasonable approach to limiting groundwater rights, they proved to be unworkable due to the poorly understood (by the legislature) time lag between groundwater pumping and surface water depletions. Given this fact, not only would enforcement of this rule not address the underlying externality problem, but if implemented, it threatened to create a new type of externality problem—that of groundwater pumpers needlessly burdened by restrictions on pumping imposed on behalf of senior surface rights holders suffering from low surface water flows. The failure of the 1957 legislation to consider pre-1957 wells was also a huge omission.

Only after the technical nature of the problem had become obvious did the legislature enact the skills of technical experts to help define those rules that

⁸⁸ A related complicating factor not discussed in the case study description is that many surface water users are also groundwater pumpers. These are not entirely separate groups. For the purposes of analysis, however, it is useful to describe surface water and groundwater users as distinct groups (i.e., positions), given that each features a different corresponding set of institutional rules.

eventually became the Water Right Determination and Administration Act. This was an important turning point, as a key feature of this case study is the salience of *cognitive conflict* in collective choice (and constitutional choice) level problem-solving. While *value and interest conflicts* also existed in this case, they were quickly addressed by the state legislature and the judiciary in asserting that the priority tenet of prior appropriation was to be applied between surface water and groundwater. There was some hesitancy about treating new and old groundwater users in similar terms; however, that debate was short-lived, and was consistently overshadowed by the more formidable cognitive conflict rooted in the lack of understanding in the state legislature about the hydrologic connection of surface water and groundwater. Resolution of this cognitive conflict did not occur until the legislature invoked the greater technical knowledge of the State Engineer, along with an ad hoc committee of water engineers and lawyers, in the drafting of rules associated with the Water Right Determination and Administration Act.

Key among the innovations found in that body of law was the requirement that groundwater pumpers had to either devise acceptable plans for augmenting or replacing surface water flows, or face complete loss of groundwater pumping rights. This was a tremendously important modification of the rules associated with groundwater pumping, especially the boundary and authority rules, and created a need for a new position: regional replacement water manager. This position, filled by the creation of GASP, was needed given that the technical demands of implementing a replacement water strategy can be most efficiently addressed through collective action.⁸⁹

GASP serves as a vehicle for implementing solutions to the two operational choice level problems, as well as for addressing lingering collective choice problems of cognitive conflict. GASP, working closely with the State Engineer, contributes to the resolution of the first externality problem by implementing what is known as the “physical solution”—i.e., providing replacement waters in the amount, timing, and location needed to offset surface water declines attributable to the pumping actions of GASP members. As the legislature learned in 1957, it is one thing to require surface and groundwater users to both adhere to the priority system of water allocation, and quite another to successfully implement this concept through conjunctive management. Thanks to the joint actions of the Colorado legislature, the State Engineer, and GASP, no longer can surface water users in the South Platte assert that groundwater pumping impairs their senior rights recognized under prior appropriation.

⁸⁹ While GASP is normally viewed as an innovative creation, some parties have called GASP the “illegitimate son of the State Engineer” in part due to the rules, designed by the State Engineer, that encouraged (some would say coerced) groundwater users to join GASP and similar arrangements or risk forfeiture of pumping rights. (For example, see the comments of Bart Woodward, President of GASP, in MacDonnell, 1986:68.)

GASP contributes to the partial resolution of the depletion problem primarily by linking fees to levels of water withdrawals, providing individual pumpers with an economic incentive for conservation. True, a roughly \$1/acre-foot charge is hardly sufficient to dramatically modify behavior, although increasing aquifer depletion may lead to further raises in the amount of replacement water required (already having risen from 5 to 25 percent), providing further incentives discouraging groundwater depletion. Likely more significant on this front is the fact that GASP membership brings the actions of many individual groundwater users into a framework of collective planning and management, raising many opportunities for GASP and state officials (acting through the State Engineer) to pursue further innovations as needed. At the present time, it is not clear if additional future action will be needed to address issues of tributary groundwater depletion in the South Platte, as agricultural water demands have stabilized or even declined in some areas due to broad economic trends and good weather, interbasin imports to the region have increased, and as environmental mandates and urban water planning programs already provide a strong stimulus for more efficient water use and conservation.

Old Growth Timber Management in the Region of Applegate, Oregon

Case Study Description

Early History

Timber and other forest products have been of extreme value in the development and maturation of many societies, and issues of deforestation have frequently been of great social and economic concern. In the United States, deforestation first emerged as a national issue in the mid to late 1800s, as waves of timber barons moved westward along the expanding American frontier, producing needed timber for a growing nation at the expense of denuded landscapes and modified hydrologic regimes. These practices were not only alarming for their environmental destruction, but due to the huge empires being amassed from the largely unregulated exploitation of the frontier. Both of these issues were of particular concern to the “progressives” who came into power late in the nineteenth century. One of the first products of the “progressive conservation movement” was an initially uncontroversial and obscure amendment to a 1891 timber act that empowered the President to withdraw public lands within states or territories and place them into a system of national forests (Clarke and McCool, 1985; Hays, 1959). By the end of President Cleveland’s presidency in 1897, almost 40 million acres had been withdrawn and a Division of Forestry had been created in the Agriculture Department. In 1905,

these national forests were transferred from the Interior to the Agriculture Department as the Forest Service was born.

From its inception, the Forest Service operated under a mandate to provide a “continuous supply” of wood products. Over the long term, this can only be accomplished by a program of sustained yield management. Sustained yield management—i.e., only cutting timber in amounts equal or less than amount of natural regeneration—evolved into an increasingly formal part of the agency’s mandate in the Sustained Yield Forest Management Act of 1944 and the Multiple Use-Sustained Yield Act of 1960. However, in the post-WWII economic boom, timber harvests grew at unsustainable levels, prompting a host of citizen complaints and lawsuits questioning the agency’s interpretation of its mandate and its increasingly cozy relationship with the timber industry at the expense of other interests, namely recreation and wilderness (Carroll, 1995).⁹⁰ Increasingly, these complaints focused on the practice of “converting” old growth forests (i.e., previously unharvested forests) into stands of secondary growth. Beginning in 1973, the Forest Service responded to pressure by environmentalists by issuing Emergency Directive 16 which called for a special type of “sustained yield” management called “non-declining even flow” (NDEF). The “non-declining” part of this management approach calls for reduced levels of cutting in old growth forests, since the large mature trees in these forests do not grow quickly and consequently can not easily replace the volume of any trees removed.⁹¹

The Spotted Owl Crisis in the Pacific Northwest

Throughout the 1970s and 1980s, the concept of NDEF was a common focal point for the more fundamental debate about appropriate uses of the Pacific Northwest old growth forests. Eventually, the gradual implementation of the Endangered Species Act (1973) brought a shift in focus, as concern grew over the status of the northern spotted owl (*Strix occidentalis caurina*), a species dependent upon the old growth forests along the western slopes of Washington, Oregon, and northern California (Carroll, 1995). In a precursor of larger coming events, an interagency task force of U.S. Forest Service, Bureau of Land Management (BLM), and Fish and Wildlife Service officials in 1978 proposed a management strategy calling for the maintenance of owl habitat primarily on

⁹⁰ Recreation is the dominant use of Forest Service lands in the modern era. In fiscal year 1996, the agency recorded over 859 million visits to Forest Service lands (Forest Service, 1997).

⁹¹ Timber interests responded with the accurate but politically sensitive argument that converting the old growth forests to secondary growth would be more efficient in the long-term, since this would result in faster growing second generation trees. This perspective failed to acknowledge the increasingly high values being placed on the non-timber properties of these old growth forests.

federal lands in Oregon.⁹² This action was viewed by old growth forest activists with great interest, as the spotted owl was quickly emerging as a useful tool for pursuing this broader agenda. Concerns over the spotted owl were used to bring the Endangered Species Act and the National Environmental Policy Act (1969) into the forest planning process specified in the National Forest Management Act (1976). In response to the litigation and delays brought about by these tactics, the Forest Service agreed to prepare a Supplemental Environmental Impact Statement addressing the spotted owl issue. When the document was released in 1988, it pleased few parties involved in the increasingly divisive issue, and sparked greater use of the Endangered Species Act provisions by forest preservation activists—a strategy that was given renewed strength when the Fish and Wildlife Service reluctantly listed the owl as an endangered species in 1990.⁹³

The listing of the spotted owl led to several sweeping court injunctions against timber harvesting in the Pacific Northwest, and resulted in an intense period of conflict, with environmentalists being pitted against loggers, and outsiders against locals.⁹⁴ Of course, the issues involved were much more complex, but the bunker mentality did not provide a welcoming environment to thoughtful dialogue and objective research. Senator Mark Hatfield, Representative Les AuCoin, and Governor Neil Goldschmidt (all of Oregon) brought the feuding parties together for “summit meetings” in 1989, but no compromise position could be reached. The Forest Service responded by drafting the so-called “ISC Report,” authored by wildlife biologist—and future Forest

⁹² The U.S. Bureau of Land Management is a major player in this issue due to its jurisdiction over the so-called O&C Lands. These highly productive timber lands reverted back to the public domain when the Oregon and California railroad land grants were revoked by Congress in 1916 (Kenney et al., 1998).

⁹³ The Fish and Wildlife Service originally determined in 1987 that a listing was not warranted, but this decision was later ruled to be “arbitrary and capricious.” This opinion was reinforced by a GAO (1989) study that concluded that the agency’s decision not to list the owl was determined by political pressure.

⁹⁴ This history of litigation between 1987 and 1991 is tremendously complex, but can be accurately summarized as a series of suits in which the U.S. Forest Service, Fish and Wildlife Service, and to slightly lesser extent, Bureau of Land Management were each routinely found to be in violation of environmental laws and the Administrative Procedures Act in delaying action in the protection of the spotted owl and its habitat. Presumably, these actions were reflective of policy directives from the Administration. (For more information, review the hearings before the Subcommittee on Forests, Family Farms, and Energy of the Committee on Agriculture, U.S. House of Representatives, held May 29th and 30th, 1991; Serial Number 102-33, U.S. Government Printing Office.)

Service chief—Jack Ward Thomas.⁹⁵ The ISC Report called for the establishment of habitat conservation areas to protect owl habitat, at the expense of 30 to 40 percent reductions in regional timber harvests. While this strategy alarmed timber interests and did not result in the acceptable compromise all parties had hoped was possible, the Forest Service reluctantly agreed to follow the majority of the report's recommendations. Subsequent litigation ensured, however, that no management strategies (or timber harvests) would be implemented until a formal recovery plan was in place, and a variety of study efforts were initiated to develop the necessary plan. Planning efforts were soon expanded to include the threatened marbled murrelet in the planning process, due to the similar habitat requirements.

Throughout the summer of 1991, Congress considered a variety of bills aimed at addressing the increasingly intractable conflict.⁹⁶ These efforts drew considerable attention, but were not effective in resolving the underlying conflicts. The same could also be said of the action taken in 1991 by the Endangered Species Committee (more commonly known as the “God Squad”) when asked by the director of the BLM to consider exempting BLM lands from the owl recovery efforts. As was seen in earlier efforts, the Committee reached a compromise decision that pleased no one (and was ultimately abandoned) and sparked further litigation.

While that issue was pending and while the Final Environmental Impact Statement on spotted owl recovery was being circulated in 1992, a new Administration was preparing to take office and a new round of compromise efforts were initiated. Honoring a campaign promise, incoming President Clinton convened a highly publicized “forest summit” in 1993, and established interagency committees to address particular issues. One of these groups, the Forest Ecosystem Management Assessment Team (FEMAT), identified ten management options, of which the administration selected Option 9 (FEMAT, 1993). The option calls for timber harvest levels of approximately 1.2 billion board feet annually, about one-fourth the average of harvests in the 1980s. This strategy, now known as the Northwest Forest Plan, is based on a broad perspective concerned with the needs of owl and marbled murrelet survival, preservation of old growth forests, salmon recovery, and the economic viability of northwest timber-oriented communities.

⁹⁵ The report of the Interagency Scientific Committee (ISC) is listed in the references as Thomas et al., 1990.

⁹⁶ Congress debated several forest management bills in 1991, including The Community Stability Act (H.R. 1309), The Forest and Family Protection Act (H.R. 2463), Ancient Forest Act of 1991 (H.R. 1590), and Ancient Forest Protection Act of 1991 (H.R. 842). None of these bills were able to strike a widely acceptable balance among competing interests, and each was opposed by the Administration in hearings before the Subcommittee on Forests, Family Farms, and Energy of the Committee on Agriculture, U.S. House of Representatives. These hearings were held May 29th and 30th, 1991 (Serial Number 102-33).

The Northwest Forest Plan was officially adopted in 1994, and had since survived judicial review and public scrutiny.⁹⁷ Timber harvesting has resumed in the region on public lands, albeit on a scale significantly lower than historic levels (Kenney et al., 1998). While part of this declining harvest is clearly associated with the owl crisis, broader economic trends and the gradual exhaustion of easily harvested stands are also significant factors contributing to reduced harvest levels. Environmental issues accelerated and exacerbated these larger trends. Estimates of lost jobs in the regional timber industry range considerably, with as many as 30,000 eliminated positions being attributed to owl protection efforts (Carroll, 1995). This larger economic problem is addressed, in part, by the “Northwest Economic Adjustment Initiative” component of the Northwest Forest Plan, which proposes new federal expenditures exceeding \$1 billion over five years for a variety of job training, family assistance, and economic development activities.

Implementation of the Northwest Forest Plan in the Applegate Watershed

An important strategic element of the Northwest Forest Plan is to reserve and manage sufficient quantities of federal forest lands to protect environmental values so that restrictions on timber harvesting on non-federal lands can be eased. Part of this strategy calls for relaxed restrictions on the “incidental taking” of spotted owls on non-federal lands, as long as the management of these areas is done in accordance with habitat conservation plans (HCP’s) approved by the U.S. Fish and Wildlife Service. While this approach offers the potential to limit governmental intervention in private timber operations, it has further burdened timber-based communities located in areas comprised mainly of public lands. One such area is the Applegate watershed, an almost 500,000 acre region in southwest Oregon that is home to about 12,000 residents. Over two-thirds of the Applegate watershed is federal land, located within the Rogue River and Siskiyou National Forests and the Medford District of the BLM.

A History of Collaborative Efforts: Origins of the Applegate Partnership and AMA

Due in large part to the high concentrations of federal lands and spotted owls found in the watershed, timber harvesting activities in the Applegate region have been highly contentious and litigious for many years. Frustrated by the gridlock that surrounded all forest planning and management activities in the

⁹⁷ The plan was formally adopted in the April 13, 1994 Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Spotted Owl (DOI/DOA, 1994). Judge Dwyer of the Federal District Court for Western Washington, the source of most of the timber harvesting injunctions of the early 1990’s, upheld the Plan upon review in December of 1994.

valley, a local logger joined with a local environmentalist in 1992 to form the Applegate Partnership, which describes itself as follows:

The Applegate Partnership is a community-based project involving industry, conservation groups, natural resource agencies, and residents cooperating to encourage and facilitate the use of natural resource principles that promote ecosystem health and diversity. ... Through community involvement and education, this partnership supports management of all land within the watershed in a manner that sustains natural resources and that will, in turn, contribute to economic and community stability within the Applegate Valley.⁹⁸

In addition to promoting thoughtful discussions and building relationships among traditionally adversarial parties, the Partnership has initiated many field-level actions to promote environmentally sensitive land management while, to the extent possible, supporting local timber economies. The Partnership has also pursued an agenda of aquatic habitat restoration through the Applegate River Watershed Council, created by the Partnership in 1994. Participants organized through the largely overlapping memberships of the Partnership and Watershed Council have completed a wide variety of field-level projects, including riparian plantings on private lands, installation of fish screens, fencing of riparian areas, reseeded of timber roads, and wildfire risk reduction programs.

During the drafting of the Northwest Forest Plan, the Applegate Partnership and similar organizations were identified as highly useful and innovative experiments in local collaborative problem-solving, and were largely responsible for the Plan calling for the establishment of ten Adaptive Management Areas (AMA's) in region's with communities with close ties to federal timber lands. These are experimental areas where creative management is encouraged:

The overarching objective for Adaptive Management Areas is to learn how to do ecosystem management in terms of both technical and social challenges. ... It is hoped that localized, idiosyncratic approaches that may achieve the conservation objectives of this plan can be pursued. These approaches rely on the experience and ingenuity of resource managers and communities rather than traditionally derived and tightly prescriptive approaches that are generally applied in the management of forests. (FEMAT, 1993, III-24).

⁹⁸ This statement and other information about the Partnership can be found on the world web wide at <http://id.mind.net/community/app/ghome.htm>.

The second largest of the AMA's, covering 325,000 acres, is found in the Applegate watershed.⁹⁹ The particular focus of the Applegate AMA is to develop and test variations on established forest management practices—including partial cutting, prescribed burning, and low-impact approaches to forest harvest (e.g., aerial systems)—in an effort to provide for a broad range of forest values (DOI/DOA, 1994).

Modern Coordination and Implementation of Regional Problem-Solving Efforts

The establishment of the AMA was an effort to formally encourage more creativity in local problem-solving efforts. The Applegate Partnership and Applegate AMA—as well as the Applegate River Watershed Council and other local groups—are independent and largely informal entities that work together in a cooperative fashion (Shannon, Sturtevant and Trask, 1995; Rolle, 1997). The Applegate Partnership is primarily an organization of local stakeholders (i.e., a “community of place”) concerned with the future of the Applegate region, while the AMA is a governmental entity headed by an interagency group of five federal officials representing the Forest Service and BLM: three District Rangers (Applegate, Ashland, and Galice) from the Rogue River and Siskiyou National Forests, and two Resource Area Managers (Ashland and Grants Pass) from the BLM's Medford District.

The importance of closely coordinating federal land management practices with the efforts of local nongovernmental stakeholders interested in the Applegate is well recognized.¹⁰⁰ Originally, representatives of the Forest Service and Bureau of Land Management served as Board Members on the Partnership, but later resigned these positions when concerns arose regarding possible

⁹⁹ Collectively, the ten AMA's cover 1.5 million acres or about 6 percent of all federal land in the spotted owl range. The AMA's are one of five land classifications given to federal forest lands in the region. The other categories are Late-Successional Reserves, Managed Late-Successional Areas, Riparian Reserves, and Matrix lands. Several “key watersheds” were also identified in the Northwest Forest Plan. These land classifications are primarily based on the habitat needs of spotted owls, the marbled murrelet, and salmon (DOI/DOA, 1994).

¹⁰⁰ While generally applauding efforts to include greater public participation in resource management efforts, some parties have suggested that the Applegate Partnership, and similar collaborative efforts, often fail to adequately involve national groups and other potentially affected parties (e.g., unborn generations) in their efforts, and consequently fall short of true multiparty collaboration (Kenney, 1997). In the case of the Applegate, this concern is most frequently raised with respect to environmental group representation. Several environmental activists participate, but no national environmental group has a formal representative on the Board. The Partnership has made several efforts to secure the involvement of these representatives, however, many of the national groups have been hesitant to abandon a reliance on litigation—a strategy used to great success by many national environmental groups (Rolle, 1997).

violations of the Federal Advisory Committees Act (FACA).¹⁰¹ While this setback temporarily interrupted progress in the region, the Partnership and AMA have since devised several effective mechanisms for interaction and collaboration. As a normal and required “public participation” component of resource planning and management, the AMA coordinates frequent interactions between Forest Service and BLM officials with Partnership members and other local groups regarding a variety of research, planning, and management programs.¹⁰² Additionally, several ad hoc committees organized under the AMA framework and designed in accordance with FACA requirements provide further opportunities for interaction.

The AMA framework does not provide for the formal transfer of authority among agencies or between the public and private sectors, but does encourage the agencies to pursue field-level innovations identified by Forest Service and BLM personnel working together and in cooperation with local stakeholders (USDI et al., 1997). In the Applegate region, these innovations have primarily focused on managing and restoring damaged landscapes, in part through actively involving community members in planning and monitoring. Specifically, strategies have been identified for utilizing thinning cuts to harvest and market small diameter trees in a manner responsive to environmental concerns and economic constraints. Through improved technologies and processes, including aerial harvesting methods (using cables and/or helicopters) and the development of new composite timber products (e.g., laminates), attempts are being made to support local timber economies with selective harvests from stands of thin, but densely packed, trees. This strategy is consistent with the environmental goals of maintaining large old growth forests (and owl habitat) and reducing fire and insect damage on other lands.

Participants in the AMA’s are also encouraged to pursue innovative bureaucratic arrangements, something primarily accomplished in the Applegate AMA through research partnerships.¹⁰³ For example, studies of old growth forest

¹⁰¹ The act outlines a series of specific structural and process requirements that must be satisfied by groups established or utilized by federal agencies in an advisory capacity. In an effort to avoid the requirements of the act, federal agencies in many cases are hesitant to become formerly involved in local collaborative groups, even in those situations that promise mutual benefits (Rieke, 1997).

¹⁰² Only on rare occasions does the Partnership submit a formal position statement or recommendation to the AMA leadership (Rolle, 1997). Generally, efforts are made to encourage an informal dialogue among interested parties, rather than the more formal and adversarial interactions characteristic of past decades of forest management in the region.

¹⁰³ Adaptive management is a learn-as-you-go approach to resource management in the face of uncertainty. In adaptive management, actions are taken and the results are closely monitored with the understanding that the next iteration of management activities will be tailored based on what was learned in the previous iteration (Lee, 1993). Since adaptive management is highly information intensive, research and monitoring are major AMA functions. As of 1997, over 260 research and monitoring projects were underway in the ten

functioning have featured the involvement of researchers from the Forest Service's Pacific Northwest Research Station and Oregon State University, while community and sociological research has been conducted with the participation of researchers from the Rogue Institute of Ecology and Economy, Southern Oregon State College, and Lewis and Clark College. Community involvement is also encouraged in several facets of the AMA's formidable research agenda, a connection illustrated by a two-day "Bringing Science Home to the Applegate" conference held in March, 1996. Significant research accomplishments (as of 1998) include the completion of a regional fire hazard assessment, a demographic assessment, an ecosystem health assessment, and a variety of other site and issue-specific environmental assessments, including those focused on the creation of late successional habitats and the functioning of riparian systems. Also of note is the successful integration of the natural resource databases of the Forest Service, BLM, state agencies, and information from private sources into a unified Geographic Information System (GIS), and the subsequent publication of an Applegate resource atlas.

A New Era in Timber Harvest and Forest Management

Through innovative management programs highly dependent upon collaborative problem-solving efforts, issues of old growth preservation, environmental restoration, and community sustainability are now being addressed in the Applegate region in processes characterized by science and cooperative decision-making.¹⁰⁴ While many parties see this as a welcome change to the preceding eras of litigation and political forestry, several significant problems remain (Rolle, 1997). In part due to comprehensive efforts to protect old growth

AMA's (USDI et al., 1997).

¹⁰⁴ The emergence of the AMA as a vehicle for promoting new patterns of collaborative and scientifically driven resource management was somewhat threatened for a time by the so-called "salvage rider" (Shannon, Sturtevant and Trask, 1995). Originally a small and little known attachment to an appropriations bill (P.L. 104-19), the provision called upon federal land managers to quickly prepare and offer timber sales in areas with a significant amounts of dead, damaged, or disease-infected trees during an approximately seventeen month "emergency period" beginning on July 27, 1995. Approximately 4.6 billion-board-feet (b.b.f.) of timber were offered nationally under the program, about 1.2 b.b.f. more than was planned prior to the enactment of the salvage rider (GAO, 1997). Not only was the program a sore point among environmentalists, but as Shannon, Sturtevant, and Trask (1995:18) observed, it temporarily put the AMA's in an awkward position: "Local agency staff are now compelled to act according to two conflicting policy directives: the President's Forest Plan which relied on analysis to establish appropriate sites and methods for timber harvest and Congress's Emergency Supplemental Appropriations Act ... which required salvage timber sales to be immediately put up for sale relying on past analysis to prepare documents specified in the act." In the Applegate region, resource managers primarily followed the directives found in the Northwest Forest Plan (rather than the salvage rider), not wanting to derail the emerging planning processes heavily reliant on local public input (Rolle, 1998).

forests and spotted owls, the timber industry in the Applegate region remains in decline, with harvests from federal lands having dropped to less than twenty percent (by volume) of those seen prior to the spotted owl listing. For example, in fiscal year 1996, only 42.2 million-board-feet (m.b.f.) were offered for sale in the Applegate AMA, with 29.5 m.b.f. actually sold. Resource managers continue to struggle to offer economically viable timber harvesting opportunities in an era emphasizing old growth protection and a virtual elimination of clearcutting.¹⁰⁵ Other challenges include funding shortages for restoration projects, legal barriers (e.g., those pertaining to stewardship contracting), and fostering adequate collaboration among involved parties. Despite these shortcomings, however, the Applegate region remains a highly regarded pioneer in the resolution of modern forestry conflicts.

Case Study Analysis

Review of the Operational Choice Level Problems

This historic review of timber management in the Applegate region illustrates three types of operational choice level problems: *depletion*, *underinvestment*, and *externality* problems.

- (1). *Depletion Problem*. The first and most chronic problem in the Applegate region involves disagreements over the appropriate level of timber harvesting in the region, and the concern that harvest levels are unsustainable or otherwise inappropriate. This concern has taken on many forms over the past century, becoming particularly heated in the modern era as the focus increasingly shifted to the largely non-renewable component of the resource: the old growth forests. Modern reforms have made this issue largely inseparable from the underinvestment and maldistribution problems described below—problems arising only in recent decades.
- (2). *Underinvestment Problem*. As society began to recognize existence values for the spotted owl and marbled murrelet, and more generally, for old growth forests, a *public good* situation emerged regarding these environmental resources. While each of these resources are of concern to activists, the spotted owl has received the bulk of attention simply due to the formal recognition and protected status afforded that species by the Endangered Species Act.

¹⁰⁵ By 1988, over 55 m.b.f. of timber has been sold in the AMA (Rolle, 1998).

- (3). *Externality Problem.* Closely related to the underinvestment problem is the externality problem, which in this case involves externalities imposed by commodity users of the forest on the non-commodity users. As these forests increasingly become valued for their non-commodity uses, particularly as recreational resources, the commodity orientation (i.e., timber emphasis) of forest management has become increasingly controversial and problematic.

Key Attributes of the Problematic Situation

As is frequently the case, the mix of operational choice level problems in the Applegate region evolved over time in response to a variety of factors, including changing patterns of resource use, evolving societal norms and values, and incremental institutional reforms. Up until the modern environmental movement, the chief concern was one of depletion—i.e., a fear that existing levels of timber harvesting would lead to future timber shortages. Congress first addressed this problem nationally in the late 1800s by creating a series of forest reserves, thereby addressing the *open access* situation that characterized the western frontier. Similarly, Congress later decided to retain federal control over the O&C lands upon foreclosure in 1916, following an emerging 20th century trend favoring land retention over land disposal (Kenney et al., 1998). The creation of federal forest reserves, managed in the Applegate region by both the U.S. Forest Service and Bureau of Land Management, partially addressed the deficient boundary and authority rules characteristic of open access situations by empowering the agencies to establish rules and requirements for timber harvesting. Subsequent legislation—including the Sustained Yield Forest Management Act of 1944, the Multiple Use-Sustained Yield Act of 1960, the National Forest Management Act of 1976, and the Federal Lands Policy and Management Act of 1976—and administrative rules such as the tenet of “non-declining even flow” helped to shape and reshape specific rules regarding harvest levels (Carroll, 1995; Kenney et al., 1998).

These reforms created a system of federal timber marketing that successfully regulated access and harvest levels, however, they did not eliminate all concerns relating to harvesting levels. Many critics maintained that the frequently cozy relationship between the two federal agencies and the timber industry perpetuated high and presumably unsustainable harvesting levels, suggesting that the boundary and authority rules were still largely deficient. Additionally and ultimately of greater salience, however, was the growing feeling that the federal natural resource agencies were still preoccupied with “timber management” in a new era of “forest management,” the latter recognizing a much more diverse set of values and interests in forests than simply commodity production. A complex planning system established through the National Forest Management Act was established to address such concerns, but has satisfied few parties due to the costs and delays in decision-making, and the penchant for encouraging litigation.

The events leading up to and culminating with the adoption of the Northwest Forest Plan were primarily driven by this larger set of issues. No longer were high harvest levels being questioned solely on the grounds of threatened reductions in future harvests (i.e., a concern over depletion), but were challenged due to impacts to public good resources with intrinsic values (e.g., endangered species) and to other non-commodity uses (e.g., recreation). These concerns, described in our terminology as underinvestment and externality problems, were both forcefully articulated by the environmental community, which by the 1980s had accumulated significant strength from public opinion and legal precedents—namely, the Endangered Species Act.

The Institutional Solution

Congress, resource managers, and other concerned parties arguably were making reasonable progress toward solving the underlying depletion problem until the emergence of the environmental philosophy in the 1960s and beyond changed the nature of the debate. At that point in history, the concern for resource “conservation” was joined by a strong desire for resource “preservation,” which significantly altered the context in which timber harvesting decisions could be made.¹⁰⁶ Specifically, this transformation injected a strong element of *value conflict* into resource management decision-making. Generally, value conflicts are difficult (if not impossible) to resolve in processes reliant on bargaining, something perhaps best illustrated by the widespread dissatisfaction with forest planning processes when utilized to address commodity/non-commodity conflicts. Instead, those conflicts are normally resolved, to various degrees, through litigation—a tool well suited to value conflicts.¹⁰⁷ This is the context into which the modern conflict in the Applegate region is best evaluated.

¹⁰⁶ This case study illustrates the historic divergence in environmental thinking between conservationists and preservationists. The original depletion problem, for example, was very much an issue of concern to the conservationists active around the turn of the 20th century, who believed resources should be managed on a sustainable basis to meet human needs. While this belief is not necessarily rejected by the preservationist ideology more characteristic of the modern environmental movement, it is supplemented by the opinion that a certain degree of additional resource preservation—above and beyond that needed to satisfy long-term human consumptive needs—is needed to protect intrinsic and non-commodity values, and to satisfy ethical responsibilities toward the environment.

¹⁰⁷ Litigation, however, is often only a necessary first step, paving the way for other actions establishing an improved framework for articulating and institutionalizing emerging social values.

The set of institutional reforms comprising the Northwest Forest Plan derived from efforts to move beyond the value conflicts. Resolution¹⁰⁸ of the value conflict came slowly, largely through the incremental recognition of environmental values in legislation such as the Endangered Species Act and the multiple-use mandates of the Forest Service and BLM, and later enforced by the timber harvesting injunctions in the late 1980s. This was a contentious period of institutional evolution, resulting in several new rules (particularly scope, position, and boundary rules) ensuring all parties and perspectives a role in collective choice decision-making efforts. That evolution, however, came at a steep yet predictable price: gridlock (i.e., the absence of effective mechanisms and/or forums for collective choice level decision-making).

The establishment of the Applegate Partnership in 1992 was, at the time, a novel response to this problem. It began with the assumption that both commodity and non-commodity uses of the forest lands are valid; i.e., it does not revisit the value conflict about which type of use should prevail. Instead, the Partnership decides to search for the most creative and efficient means of simultaneously achieving both sets of objectives. This type of arrangement, inherently positive-sum in nature, is the only type of bargain that is possible in this setting, as the underlying values of each perspective are largely non-compensatory. Thus, it is no surprise that this model was largely replicated in the Northwest Forest Plan, which formally recognizes the legitimacy of all forest values in an attempt to end the divisive debate over which set of values to protect—that issue is now resolved and taken off the table—and to instead shift the focus to how to best achieve the full spectrum of forest management goals. By bringing some degree of closure to the value conflict, the Plan focuses attention on the remaining *cognitive conflicts* associated with crafting sustainable forest management practices.

As a new century rapidly approaches, the Applegate region still struggles with issues about how much timber to cut, but the context has clearly changed. Now, the desirability of a proposed harvest is not evaluated solely in economic terms or even in terms of the sustainability of the industry, but also in terms of environmental objectives such as fire suppression and habitat improvements. A new set of collective choice level organizations and processes are now in place to seek strategies and technologies that can satisfy these diverse criteria. In theory, the collaborative group approach being taken in the Applegate region seems appropriate for this task; yet, tangible progress under the Partnership/AMA is not readily evident at this time. Clearly, the more significant accomplishment

¹⁰⁸ The term “resolution” is not used to imply that a problem has necessarily been corrected or that controversy has ceased, but only indicates that a set of rules have been imposed that has significantly reduced the magnitude and intensity of conflict. Value conflicts, by their very nature, are not likely to completely dissipate quickly, but rather change slowly in accordance with societal norms.

has been the resolution (perhaps temporary¹⁰⁹) of the value conflict, an achievement more closely associated with national congressional politics and litigation.

Environmental Restoration in the Truckee-Carson River Basins

Case Study Description

The Region and Resource

The Truckee River originates in eastern California, flowing into and through Lake Tahoe on the California-Nevada border in a northeastern direction through the rapidly growing Reno-Sparks metropolis on the way to Pyramid Lake, Nevada. This terminus is the central geographic, cultural, and economic resource of the Pyramid Lake Indian Reservation created in 1859. Following a generally parallel course to the Truckee, both geographically and politically, is the Carson River, which originates to the south of the Truckee and terminates in a complex of wetlands which includes the Carson sink, the Stillwater National Wildlife Refuge, Stillwater National Management Area, Carson Lake and Pasture, and other wetlands in the Lahontan Valley. The Newlands Project, a turn-of-the-century Bureau of Reclamation facility, has connected the two basins into a single plumbing system, with about 172,000 acre-feet/year of the Truckee's flow being diverted in the Carson Basin where it is used for irrigate over 55,000 acres in the Lahontan Valley. This plumbing system is essential for agriculture in the region, which averages only nine inches of rainfall (CCC, 1997).

The key structural elements of the Newlands Project are Derby Dam (below Reno-Sparks) on the Truckee River, which serves as the diversion point through which water is conveyed through the Truckee Canal to the Carson system (WPRS, 1981). Water diverted into the Carson Basin is stored in Lahontan Reservoir, from which irrigation water is withdrawn in accordance with demands. Storage is also provided in a series of federal reservoirs located in the Truckee River headwaters in California. Key storage facilities in the Upper Truckee system include Lake Tahoe, Stampede Reservoir, Boca Reservoir, Prosser Creek Reservoir, and Donner Lake.¹¹⁰

¹⁰⁹ Recent events suggest that the delicate truce embodied in the Northwest Forest Plan may be unraveling, as conflicts regarding harvest levels begin to re-emerge. (For more information, see the November 23, 1998 issue (volume 30, number 22) of High Country News.)

¹¹⁰ These reservoirs are components of the Newlands Project, Truckee Storage Project, and the Washoe Projects.

The major water user in the basin has historically been the Truckee-Carson Irrigation District (TCID), the primary recipient of Newlands Project water. A small amount of irrigation water is also now made available to the Fallon Paiute Shoshone Tribes, although the Fallon Reservation has never been provided with the quantities of irrigation water originally promised. In recent decades, the rapidly expanding metropolis of Reno-Sparks, as well as several smaller communities, have dramatically increased demands for municipal and industrial water. As discussed below, these demands have generally been satisfied at the expense of the environmental resources at Pyramid Lake and the Lahontan Valley.

The Resource Problems

For many years, water demands in this region have outstripped dependable supplies. The result has been water quality and quantity degradation which has caused dramatic declines in fish and wildlife species (and habitat), threatened tribal rights, and raised water supply concerns for many other parties. Pyramid Lake, at the terminus of the Truckee River in Nevada, has been the focus of the most intense controversy (Doermann, 1993; Wilds et al., 1994). Pyramid Lake historically supported large quantities of cui-ui fish and Lahontan cutthroat trout, species of tremendous economic, cultural and spiritual value to the Pyramid Lake Paiutes.¹¹¹ Historically, both species traveled up into the lower Truckee to spawn. Barriers to migration, water quality declines, water quantity reductions, and modifications to flow regimes and riparian vegetation have placed the Lahontan cutthroat trout on the threatened species list (since 1970), and the cui-ui on the endangered species list (since 1967).¹¹² The original strain of the Lahontan cutthroat trout has been extinct since the 1940's, and the current "stocked strain" is entirely dependent on the Pyramid Lake fishery operated by the tribe.

Environmental degradation is also an issue in the complex of wetlands found in the Lahontan Valley, the terminus of the Carson River system and the Newlands Project. Most of the irrigated lands in the valley were originally wetlands. The size of the historic wetlands varied from 100,000 to 300,000 acres, depending on flows from the Carson. Since completion of the Lahontan Dam in 1911, the wetlands have dwindled by 85%, being sustained only by agricultural return flows and spills (Doermann, 1993).¹¹³ Since the Lahontan Valley wetlands are highly dependent upon return flows and spills from irrigation activities, these wetlands actually benefit from inefficient irrigation practices.

¹¹¹ The cui-ui is a large lakesucker found only in Pyramid Lake.

¹¹² The water level in Pyramid Lake has dropped approximately 80 feet, forming a delta where the Truckee River enters the lake. This is the primary physical barrier to migration.

¹¹³ Nonetheless, this wetland complex continues to be an important stopover point for migratory birds along the Pacific Flyway.

When water use efficiency standards for the Newlands Project were tightened beginning in late 1960's, inflows to the wetlands decreased, while concentrations of trace elements (including arsenic, boron, lithium, molybdenum, mercury, and selenium) increased. Ironically, these increases in irrigation efficiency were primarily sought in order to minimize diversions from the Truckee system, thereby increasing flows into Pyramid Lake.¹¹⁴ The more pronounced result, however, has been an accelerated loss of Lahontan Valley wetlands and a build-up of several trace elements to toxic levels, which has led to increased deformities and mortality among migratory waterfowl, fish and wildlife.

Initial Efforts at Environmental Problem-Solving

The Pyramid Lake Tribe has been concerned about the decline of the Pyramid Lake fishery ever since the Newlands Project began to significantly reduce flows on the Lower Truckee. As early as 1913, efforts were initiated to adjudicate Truckee River flows among California, Nevada, the federal government and tribes, and established water users (NRC, 1992). Among the most notable outputs of these efforts was the Orr Ditch Decree of 1944, which established tribal rights to irrigation water, but did not address water needs associated with the fishery and related environmental and cultural resources. In the 1960's, the tribe began to challenge these omissions in the original decree, without success.¹¹⁵ The tribe was successful, however, in convincing a federal judge that the government had a responsibility to try to maintain Pyramid Lake levels by requiring efficient water use in the Newlands Project.¹¹⁶ This was attempted by implementing new “operating criteria and procedures” for the Newlands Project, which only marginally increased inflows to Pyramid Lake while dramatically reducing needed agricultural return flows into the Lahontan Valley wetlands. As early as the 1940's and 1950's, federal and state fish and wildlife agencies and other environmental interests had initiated efforts to ensure that the Lahontan Valley wetlands would continue to receive these return flows; however, formal water rights to specific quantities of return flows were not granted by the office of the Nevada State Engineer (Yardas, 1992, 1997).¹¹⁷ Efforts to address environmental problems in Pyramid Lake brought new urgency

¹¹⁴ Due to the structure of the Newlands Project, environmental activists concerned with Pyramid Lake and those interested in the Lahontan Valley wetlands often found themselves in a situation where proposals to aid one resource had the potential to harm the other.

¹¹⁵ United States of America v. Orr Water Ditch Company, Final Decree, 1944. The tribe challenged the decree on the grounds of a federal conflict of interest (between Reclamation of Indian Affairs), but this argument was rejected in Nevada v. United States, 1983.

¹¹⁶ Pyramid Lake Pauite Tribe of Indians v. Morton, 1973.

¹¹⁷ The State Engineer agreed that return flows (when available) could be used for environmental purposes, but irrigators were not required to provide a specific quantity.

to efforts to protect the Lahontan Valley wetlands, and reiterated the need to view the Truckee and Carson Rivers as a single system.

In the late 1980's, a diverse group of environmental organizations—primarily led by The Nature Conservancy and the Environmental Defense Fund—began to promote a new strategy for addressing Lahontan Valley wetland issues: market-based water transfers from agricultural to environmental purposes. This approach promised to aid the wetlands while not harming Pyramid Lake, a philosophy that was used to mobilize a broad coalition of environmental interests in the Truckee-Carson region into an organization known as the Lahontan Valley Wetlands Coalition (1992, , 1997). The Lahontan Valley Wetlands Coalition quickly became a powerful political force in the region, advocating the creation of a water rights “acquisition program” in the Carson Valley. This effort began to take shape in the late 1980's when Congress appropriated approximately \$2.7 million for this purpose. In 1989, the State of Nevada allocated about \$9 million to settle water rights disputes and to protect natural resources, and in a 1990 bond election, Nevada voters authorized an additional \$8 million for the acquisition of water rights for the wetlands (CCC, 1997). The state also modified its water code in 1989 to recognize environmental protection as a legitimate “beneficial use” of water. An acquisitions program was born.

The Truckee-Carson Pyramid Lake Water Rights Settlement

While political and market mechanisms were being utilized to initiate recovery efforts in the Lahontan Valley wetlands, litigation provided the stimulus for action on Pyramid Lake issues. It was the Endangered Species Act that eventually provided the Pyramid Lake tribe with the needed leverage to encourage a comprehensive problem-solving effort in the basin. Through a complex and bitter series of administrative decisions and lawsuits in the 1970s and early 1980s focusing on the application of the Endangered Species Act to the cui-ui situation, the tribe was able to ensure that Stampede Reservoir (upstream on the Truckee in California), built in the 1960s primarily to supplement and stabilize the Reno-Sparks water supply, had to be managed primarily to promote spawning of the endangered fish. This decision alarmed many parties, including the Sierra Pacific Power Company which provided water and power to the Reno-Sparks area, and to Nevada and California who had been adhering to an unratified interstate water allocation compact on the Truckee since 1970. The compact had never been congressionally ratified due to federal concerns surrounding tribal water rights and the environmental degradation in and around Pyramid Lake. The Stampede Reservoir decision prompted negotiations in the mid-1980's among Nevada and California interests concerned with environmental, tribal, and M&I water issues. These efforts made little progress until Senator Reid of Nevada became an active participant and proponent of the negotiations (Doermann, 1993; Wilds et al., 1994).

Senator Reid realized that solving the many disputes required utilizing a “problemshd” focus (that included both the Truckee and Carson basins),

addressing many issues simultaneously, and getting all the key parties that could veto a settlement involved in the negotiating process. The following parties were identified as the key players: the Pyramid Lake Tribe, Sierra Pacific (representing the interests of Reno-Sparks), the State of Nevada, State of California, TCID (representing irrigation interests and most water rights holders), and the federal government (i.e., Interior Department). The tribe sought increased flows into Pyramid Lake, clear title to the beds and bank of the lake, and funding for fisheries management and habitat restoration. Sierra Pacific was primarily interested in obtaining upriver storage on the Truckee to provide drought protection for Reno-Sparks (something it had originally thought would be provided by Stampede Dam). The states wanted greater certainty in regional water allocation matters, something that could be achieved by congressional ratification of the interstate water allocation compact. Parties associated with TCID generally wanted to maintain the status quo and their senior water rights. The federal government presumably sought to honor all federal obligations and protect all federal rights in an efficient manner.

Almost immediately, the negotiations ran into two problems. First, the Pyramid Lake Tribe and TCID could not find common ground on issues of water rights, and agreed that these issues should be addressed as needed and at a later time through judicial mechanisms or separate negotiations. With this understanding, TCID was not a major player in subsequent negotiations. A second problem was the differences of opinion held by the multiple federal agency representatives at the negotiating table, a problem that was later resolved by appointing one Interior Department spokesman to present a unified federal voice in negotiations. Efforts to address these problems did not slow the negotiations between the Pyramid Lake Tribes and Sierra Pacific concerning the operation of Stampede Dam. These negotiations quickly led to a “preliminary settlement agreement” dealing with the management of the Truckee River facilities, primarily Stampede Dam, in an effort to satisfy both the cui-ui spawning interests of the tribes and the drought water supply issues of Sierra Pacific through integrated reservoir management. Essentially, this agreement allows Sierra Pacific to utilize Stampede Reservoir in drought years as long as adequate releases are provided in normal years to support cui-ui spawning, and as long as Reno-Sparks develops and implements a water conservation plan aimed at minimizing future water supply controversies in the region.

With this key issue resolved, the Pyramid Lake Tribes, Sierra Pacific, and the two states were able to quickly find common ground on the other issues, and prepared a bill (S.1554) to implement the settlement. At this time, however, it became apparent that the scope of the negotiated agreement had failed to adequately consider related resource issues at the end of the Carson system. One issue was the failure of the federal government to provide new irrigation water from the Newlands Project to the Fallon Tribes, as promised in earlier

legislation.¹¹⁸ This issue was linked to the Truckee River issues since any increased irrigation in the Lahontan Valley, either for tribal or non-tribal interests, would potentially require greater diversions from the Truckee system, creating a potential conflict of interest between the Fallon and Pyramid Lake Tribes. The Fallon Tribes' water rights issue was being addressed in a separate negotiation which appeared to enjoy greater political support than the Pyramid Lake negotiations. For this reason, negotiators chose to incorporate S.1554 as part of the proposed water rights settlement for the Fallon Paiute Shoshone Indian Tribes, an action that not only increased the political viability of Pyramid Lake settlement, but which also brought greater regional consistency to the negotiated agreement (Doermann, 1993). The other major omission in the preliminary settlement was the failure to consider the declining health of the Lahontan Valley wetlands. Negotiators concluded that the best way to address the wetlands issues was through the use of improved reservoir operations systemwide, the establishment of funds for habitat and species restoration, and by giving increased support to market-based reallocations through the water rights acquisition program.

The final agreement enacted by Congress in 1990 satisfied the major needs of the negotiating parties (Doermann, 1993).¹¹⁹ The allocation of water between Nevada and California was achieved in a manner consistent with the 1970 compact. The Secretary of Interior was directed to negotiate and develop a new "operating agreement" for the Truckee River reservoirs, in accordance with the preliminary agreement developed by the Pyramid Lake Tribe and Sierra Pacific. The agreement also allows the Secretary to lease storage capacity in these reservoirs for parties with non-project water (e.g., Sierra Pacific), with the aim of improving efficiency and raising funds for environmental restoration. Pyramid Lake funds of \$25 million and \$40 million were established for fisheries management and economic development, respectively, as was a \$43 million fund for expanding irrigation on the Fallon Reservoir through the improvement and expansion of distribution facilities and the purchase of other "active" water rights

¹¹⁸ The dispute involved broken promises from the turn of the century (CCC, 1997). The reservation was divided into 160-acre allotments in the 1890s, as called for under the General Allotment (or Dawes) Act of 1887. When the Newlands Project was authorized in 1902, the tribe entered into an agreement in which most allotment holders agreed to exchange their 160-acre allotments for 10-acre allotments to be serviced, at no charge and in perpetuity, with water from the Newlands Project. This arrangement was to provide the tribes with a water supply, while creating land for non-Indian beneficiaries of the reclamation project. Despite the clear terms of the agreement, no water was ever delivered—although the size of the tribal land holdings was augmented on a few occasions. In 1978, the federal government formally recognized its failure to honor the agreement (P.L. 95-337), but by 1990 no action had been taken to rectify the situation.

¹¹⁹ The Truckee-Carson Pyramid Lake Water Rights Settlement Act is Title II of the Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act of 1990 (P.L. 101-618).

in the region—a strategy that will allow increased tribal irrigation without requiring additional diversions from the Truckee system.¹²⁰ The Secretary is also authorized to acquire water rights from willing sellers in additional and ongoing efforts to further increase flows into Pyramid Lake and the Lahontan Valley wetlands. The Lahontan Valley wetlands water rights acquisition program was given a formal mandate, as the Secretary—primarily working through the U.S. Fish and Wildlife Service and in conjunction with the State of Nevada and other interested parties— was instructed to acquire sufficient water to support 25,000 acres of wetlands.

Implementation of the Settlement Act

The many studies, negotiations, and specific agreements required to implement the overall agreement are generally proceeding on schedule, however, many difficult issues must still be resolved. In 1994-1995, a round of “second generation” negotiations were held to discuss remaining issues. Using a professional facilitator, Senator Reid convened a negotiating group of the key stakeholders—i.e., the Department of Interior, the State of Nevada, the Pyramid Lake Tribe, the Fallon Tribe, Sierra Pacific Power Company, Lahontan Valley farming interests (including TCID), county governments, and the so-called “conservation caucus”—to address issues concerning environmental restoration and the future of agriculture in the region. With the exception of a water quality agreement, these negotiations were only marginally productive (CCC, 1997).

Progress in many other areas, however, has been substantial and dramatic. It appears that the negotiated settlement has provided an effective problem-solving framework which fosters the application of many alternative problem-solving strategies. Two examples are given below.

Lower Truckee River Restoration Steering Committee

One example of the growing role played by collaborative groups in the region is the Lower Truckee River Restoration Steering Committee (Steering Committee), formed in 1993 to help identify and pursue river rehabilitation efforts along the Truckee from Wadsworth, Nevada to Pyramid Lake (Gourley, 1997). This group formed at the urging of The Nature Conservancy, and in response to language in the Settlement Act that called on the U.S. Army Corps of Engineers to develop a program to restore the ecological health of the Lower Truckee River.¹²¹ The Steering Committee is working closely with the Corps to develop a restoration program, and is also active in identifying and implementing other field-level projects designed to promote and accelerate river restoration and cui-ui recovery.

¹²⁰ Total tribal water use is limited to approximately 10,500 acre-feet per year.

¹²¹ The 1990 legislation authorized \$400,000 in expenditures by the Corps on restoration projects.

A wide variety of public and private parties have been involved in the work of the Steering Committee. In addition to the Corps of Engineers, federal participants include the Fish and Wildlife Service, Natural Resources Conservation Service, Bureau of Reclamation, Environmental Protection Agency¹²², and the Bureau of Indian Affairs. The tribes are represented directly by the Pyramid Lake Fisheries Office and the Pyramid Lake Tribe. Among the participating state and local agencies include the Nevada Division of Environmental Protection and the local conservation district. The activities of the committee are primarily directed by a “core group” of representatives from the U.S. Fish and Wildlife Service, the Pyramid Lake Tribe, Washoe County, and The Nature Conservancy. These entities provide the majority of funding and in-kind services utilized by the group, including the support of a watershed coordinator. The Steering Committee is an extremely informal group operating without a formal mandate or procedural rules, capable of action only when participants voluntarily agree to utilize their independently held authorities and resources.

In addition to assisting the Corps in planning efforts, the Steering Committee has investigated and implemented several field-level projects that involve modifying the stream channel, restoring the riparian forest communities, and improving water quality and flow regimes. The work of the Steering Committee to this point has primarily focused on two specific problems: the decline of riparian cottonwood stands, and migration barriers impacting the cui-ui fish (Gourley, 1997). A creative and experimental cottonwood forest regeneration program has been initiated which calls for federal water managers to release water from flood control storage (in wet years only) in a pattern that mimics the natural flood regimes necessary for cottonwood germination. The first test of this voluntary program successfully resulted in the establishment of a new stand of seedlings. Fences have also been erected to aid in cottonwood restoration. The problem of migration barriers to cui-ui fish is being addressed by the Steering Committee through the development and installation of an experimental fish channel. The cui-ui is not a physically strong fish, and cannot effectively utilize fish ladders designed for strong salmonids. The Steering Committee has found that gradual, meandering bypass channels are more effective, as recently shown by a successful demonstration project at the Pyramid Lake delta, which in turn, is now being used to in the design of an new bypass structure at Newmana Dam. The problem of fish passage is also being addressed through other efforts pursued by the Steering Committee and other parties (including the Truckee-Carson Coordination Office) aimed at increasing flows and improving water quality (Zippen, 1997).

¹²² An earlier EPA program known as the Truckee River Strategy helped to create an environment conducive to interagency cooperation.

The Lahontan Valley Water Rights Acquisition Program

Since being formally recognized in Section 206 of the Settlement Act, the acquisition program has grown into a significant regional problem-solving mechanism based on the tenets of voluntary action and market-based decision-making processes.¹²³ Reservoir re-operations and water conservation are also being investigated. The settlement act requires these water acquisitions to comply with relevant federal and state laws, with the notable clarification that wetland protection is acknowledged as a legitimate use of water and that landowners served by the Newlands Project have the right to sell water rights.¹²⁴ A variety of agreements and regulations have been crafted in an effort to ensure that water (and water rights) acquired for wetlands restoration does not result in increased project demands, since increased demands would require additional diversions from the Truckee River system at the expense of the fishery and environmental resources of the lower Truckee and Pyramid Lake. Efforts are also underway to develop strategies for increasingly the long-term certainty of agricultural return flows in the wetlands complex. Flows obtained through the acquisition program are seen as a necessary complement to baseline agricultural return flows, upon which the Lahontan Valley wetlands are still reliant.

Prior to its formal recognition, the program was highly dependent upon the work the Environmental Defense Fund, The Nature Conservancy, the Nevada Waterfowl Association, and many other non-governmental groups to raise funds and to identify and implement water rights purchases. Now, the U.S. Fish and Wildlife Service has established its own Water Rights Acquisition Program, employing realtors, negotiators, and other professionals skilled in the functioning of water markets (Yardas, 1997). The role of non-governmental groups such as the Lahontan Valley Wetlands Coalition—now more commonly known as the Lahontan Valley Coalition—has consequently been significantly reduced, as a publicly financed and implemented acquisition program is now firmly in place.¹²⁵ State agencies, primarily the Nevada Department of Wildlife, are also active in efforts to implement this component of the federal Settlement Act.

Two related issues have been problematic in the implementation of the acquisition program (Yardas, 1997; CCC, 1997). The first is the determination of how much water must be acquired to meet the goal of the Settlement Act, which is to restore and maintain 25,000 acres of Lahontan Valley wetlands.

¹²³ One of the benefits of these strategies is that it allows water to be reallocated away from TCID rights holders in voluntary market transactions, rather than through more contentious, time-consuming, and potentially unsuccessful legal challenges based on environmental laws, federal reserved rights, or tribal obligations.

¹²⁴ The Alpine Decree, which allocates water use on the Carson system in conjunction with the Orr Ditch Decree, asserts that individual Newlands Project landowners have the legal right to those water supplies used beneficially. United States v. Alpine Land and Reservoir Company, 1980.

¹²⁵ Efforts to attract private funding have generally not been successful.

While it is widely assumed that this translates to a water demand of approximately 125,000 acre-feet/year, it is unclear what quantity of water rights must be purchased to achieve this level of inflow. Even in the absence of water rights acquisitions, some return flows, seepage, flood spills, and other discharges are likely to continue reaching the wetlands. This amount can potentially be modified by changes in reservoir operating criteria, efficiency standards, economic incentives, and perhaps most fundamentally, by changes in the magnitude of irrigated acres in the Lahontan Valley. This leads to the second issue of concern, which is the potentially negative third-party impacts to communities in the Lahontan Valley dependent upon declining revenue streams generated by irrigated agriculture.

These issues were featured topics of a recent Environmental Impact Statement, completed in 1996 (DOI, 1996). While the EIS generally finds that community economic interests are being satisfactorily addressed through arrangements such as payments in lieu of taxes and revised operation and maintenance reimbursement agreements, the study does support the Fish and Wildlife Service's self-imposed purchase limit of 75,000 acre-feet, and calls for periodic assessments of socioeconomic impacts as the level of acquired water rights increases. By the end of 1996, approximately 20,000 acre-feet of water rights have been acquired, with purchase prices generally falling in the range of \$435 to \$812 per acre-foot (CCC, 1997). There is some interest, particularly among Lahontan Valley farmers, to enter into lease agreements rather than to sell rights; although this raises many issues concerning the viability and dependability of long-term funding sources. Funding mechanisms for environmental restoration will likely remain a key element of future negotiations, as basic issues of authorities and problem-solving strategies have now largely been resolved.

Case Study Analysis

Review of the Operational Choice Level Problems

This case features a complex mixture of problems and rules deficiencies. For purposes of analysis, it is useful to identify five related operational level problems that have evolved in the Truckee and Carson River valleys since the early days of this century. Three of those problems are of the asymmetric *maldistribution* type and two are symmetric *underinvestment* problems characteristic of *public goods* situations.

- Maldistribution Problems:
 - (1). The diversion of Truckee River water into the Carson Basin and Lahontan Reservoir by the Newlands Irrigation Project created a maldistribution—specifically, an externality—in that water use by the Truckee-Carson Irrigation District (TCID) denied adequate inflows into Pyramid Lake. As a result, the water

level fell by eighty feet, drastically reducing populations of cutthroat trout and cui-ui upon which the Pyramid Lake Paiutes depend.

- (2). Along similar lines, the second maldistribution problem involves damages imposed on the Lahontan Valley wetlands as a consequence of irrigation expansion by the TCID. Over time, the loss of wetland area and water supplies was compounded by the introduction of pollutants in return flows into the remaining wetlands, most of which were by then incorporated in the Stillwater National Wildlife Refuge and the Carson Lake Wildlife Management Area. Thus, federal interests in wetlands bore the externality of Lahontan Valley irrigation.¹²⁶
- (3). The third maldistribution problem arose when federal operators of the Newlands Project failed to deliver irrigation water to the Fallon Paiute Shoshones as promised in earlier agreements. Instead, limited irrigation supplies were provided to non-Indian irrigators and municipalities, all of whom had water rights junior to those of the tribe.¹²⁷
- Underinvestment Problems:
 - (4) The first of two public goods situations derives from the first externality described above; namely, the diversion of water out of the Truckee and into the Carson Basin. With the passage of the Endangered Species Act and the subsequent listing of the cutthroat trout and cui-ui, the federal government asserted a national interest in protecting these species that went beyond their value to the Pyramid Lake Paiutes.¹²⁸ In pursuit of that national interest, it has changed the allocation of storage in Stampede Reservoir and taken other steps at public expense to protect these

¹²⁶ It could be argued that the wetlands also bear a “positive” externality in that they benefit from return flows from agricultural activities. This situation was illustrated by efforts to impose greater conservation requirements on irrigators. Undermining the positive externality argument, however, is the observation that the cessation of consumptive uses of water by irrigators would provide a greater benefit.

¹²⁷ Note that this situation was as much a problem of law enforcement as it was of institutional deficiency. It is listed here as an institutional problem in order to highlight the fact that enforcement of the agreement was, in large part, due to the failure of institutional arrangements to provide adequate position and boundary rules regarding the Fallon tribe.

¹²⁸ Thus, the “public good” component of this problem relates to the “existence value” granted all species by the Endangered Species Act.

two fish species.

- (5). The other underinvestment problem arose as a consequence of the second externality problem (loss of Lahontan Valley wetlands) and the adverse effects upon the migratory waterfowl which depend in part upon those wetlands during their seasonal migrations. The federal government, in the creation of the national wildlife refuge system, assumed the costs of acquiring water rights and otherwise protecting remaining waterfowl habitat, recognized the national interest in protecting waterfowl (a public good).¹²⁹

Key Attributes of the Problematic Situation

While this scheme of five related problems may seem somewhat awkward at first glance, it is highly useful in discussing the evolution of the problematic situation over time. For example, the western states' water law doctrine of prior appropriation, as it existed at the turn of the century, can be shown to have led directly to the maldistribution problems later addressed in this case. Of particular concern are authority, position and boundary rules that recognized only a limited subset of interests in western water. At the time of initial water development and allocation in the region, water rights could be acquired only by diverting water from its natural course to support a narrow range of consumptive, or off-stream, uses. Water rights could not be acquired to maintain streamflows or lake levels for fishery purposes. Similarly, water rights could not be acquired for the purpose of maintaining wetlands or other forms of wildlife habitat. Finally, the diversion and seniority principles of the doctrine effectively excluded most Indian tribes from acquiring water rights. Eventually, federal law did recognize Indian water rights (beginning in the Winters decision, 1908), but few such rights were successfully adjudicated or enforced for several decades.

In similar fashion, natural resource laws in the region did not initially recognize a national interest in endangered species or migratory waterfowl protection. Only later were these public goods given formal recognition by virtue of federal laws such as the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act of 1934, respectively.¹³⁰ In this case and elsewhere, it is these federal statutes regarding species protection that have been utilized to address many of the problems associated with antiquated state rules for water

¹²⁹ The migratory waterfowl resource is a public good in this situation in that it is a resource from which many benefit freely and without possibility of exclusion, and for which the benefit to an additional beneficiary is costless.

¹³⁰ See, 16 U.S.C.A. §§ 1531-1543 and 661-667, respectively.

allocation and management. Federal statutes (and court decisions) regarding tribal water rights were also particularly salient in this case, helping to eventually level the playing field and create incentives for a negotiated settlement.

By the late 1980s, the institutional environment was conducive to the pursuit of a comprehensive solution to the five problems. Not only had new federal rules regarding tribal rights, wetland resources, and endangered species modified the balance of power in the region, but initial and uncoordinated attempts at problem-solving had quickly illustrated the folly of pursuing incremental solutions to a multifaceted problematic situation. This was perhaps best illustrated by efforts to address those problems associated with decreased inflows into Pyramid Lake. These efforts had been greatly aided by passage of the Endangered Species Act, and the subsequent court decision requiring Stampede Dam to be managed to support cui-ui spawning. However, as is often the case with narrowly focused problem-solving efforts, this judicial “solution” had the effect of creating a new externality situation for Reno-Sparks and Sierra Pacific Power, in that the decision took away a key component of their water supply system to resolve a problem that was primarily attributable to the action of irrigators (with federal assistance) in the Carson Basin. The situation also disrupted the unratified interstate water allocation compact scheme in use by Nevada and California. A similar externality phenomenon occurred when the Lahontan Valley wetlands lost part of their water supply when the new irrigation efficiency requirements were imposed to increase flows into Pyramid Lake. By the late 1980s, these problems, when combined with pre-existing institutional deficiencies, created an institutional environment problematic (in widely varying ways and magnitudes) to almost all key parties. One notable exception was TCID irrigators, who predictably chose not to participate in the subsequent negotiations and instead advocated a protection of the status quo.

The Institutional Solution

The Settlement Act

The 1990 Settlement Act (P.L. 101-618) provided a partial solution to the five underlying problems in the region, and opened the door for subsequent problem-solving efforts reliant heavily on alternative problem-solving strategies. For example, the first maldistribution (externality) problem concerning inflows to Pyramid Lake and the consequences of the Stampede Dam decision were addressed through new reservoir operating rules requiring water releases to support cui-ui spawning in normal hydrologic years, but suspending such releases in drought years to protect Reno-Sparks water supply needs assuming municipal water conservation programs are implemented. Federal funding for improved fishery management and tribal economic development were also provided. The second maldistribution (externality) problem concerning the health of Lahontan Valley wetlands has been (and is being) addressed through a host of federally-funded measures, including improved reservoir operations, water rights

acquisitions, retirement of land, water transfers, water banking, and the establishment of funds for habitat and species restoration. The third maldistribution problem associated with the unfilled rights of the Fallon Paiute Shoshone tribe is addressed in the Settlement Act by again recognizing those rights, establishing a federal fund of \$43 million for purchasing TCID water rights for conveyance to the tribe, and authorizing a federal program to improve water distribution facilities to the tribe's benefit.

These reforms also address the two underinvestment problems. New rules for reservoir operations and water allocation/use promise to aid the Pyramid Lake fishery, as do increased federal financial commitments for improved resource management. Similarly, Lahontan Valley wetlands are likely to benefit from a variety of new management programs, particularly the establishment and implementation of the federal water rights acquisition program with the goal of securing sufficient water to support 25,000 wetland acres. This program promises to supplement and largely overtake initial water rights acquisition efforts undertaken by state and private interests working through the Lahontan Valley Wetlands Coalition.

Remaining Efforts in Alternative Problem-Solving

The new rules imposed as part of the Settlement Act only partially address the underlying problems in the institution. Many important issues still remain to be resolved—e.g., the legislation left the allocation of Truckee River water rights between TCID and the Pyramid Lake tribe for future adjudication. Additionally, many other solutions, such as the acquisition of sufficient water rights to support 25,000 acres of Lahontan Valley wetlands, have not been fully implemented. However, to the extent that these goals remain unfulfilled by the Settlement Act, the legislation does provide support for processes to eventually achieve these objectives. As described earlier, prominent strategies currently being employed are highly “alternative” in nature: i.e., stakeholder negotiations, market exchanges, and collaborative efforts.

While market-based tools are the most prominent element of the framework established for resolving long-term problems in water maldistribution, the collaborative efforts underway do merit some attention. Collaborative groups such as the Lower Truckee River Restoration Steering Committee can potentially make a significant contribution to future problem-solving in the region in several ways. One way is to address the cognitive conflicts that undoubtedly surround complex issues in ecosystem restoration. By bringing together a host of expert opinions, and by strategically employing pilot projects and other experimental management techniques, many technical fixes can potentially be realized. The cottonwood reforestation and fish channel experiments of the Steering Committee are illustrative. Along similar lines, collaborative groups hold the promise of promoting greater integration and coordination among (and between) resource managers and stakeholders, a usual need in problematic situations involving multijurisdictional resources. To the extent that positive-sum strategies

for problem-solving can be identified and implemented, the contribution of collaborative groups in the region should continue and potentially increase.

More readily tangible results are likely to emerge from the market-based elements of the problem-solving framework—particularly, the acquisition of water rights from TCID to support wetlands and endangered fisheries. In addition to addressing the underlying problem of insufficient water rights for environmental interests, this strategy is notable in two ways. First, it brings the TCID irrigators into the problem-solving effort, and in a way which is more politically viable than other potential strategies (given the voluntary nature of the program). This approach appears to be equitable, in that it does not penalize irrigators for those outcomes more appropriately attributed to deficient and antiquated institutional arrangements. Second, it transforms the zero-sum nature of water reallocation efforts into a positive-sum activity by relying heavily on federal dollars to finance water acquisitions for the environment. Providing federal investments is a classic strategy in western water politics for resolving interest conflicts. In many historic cases, however, federal dollars were used to subsidize financial ventures of specific interest groups, an inefficient and inequitable practice routinely chastised as pork barrel politics. In this case, however, taxpayers are being asked to fund programs aimed at restoring public goods (i.e., endangered species and migratory waterfowl), an appropriate way of addressing those largely unmalleable boundary and payoff rules that lead to underinvestments in these resources. Other funds provided in the Settlement Act to serve tribal interests also appear appropriate and reasonable—given the historic role of the federal government in creating those problems borne largely by the tribes—and undoubtedly contributed to the viability of the problem-solving effort.

Ultimately, however, the recent problem-solving progress in the region is perhaps most closely tied to the resolution of two long-term value conflicts coloring all decision-making efforts at the collective choice level of the institution: the status of tribes in American law, and the worth of environmental resources (namely, endangered species) to society. Formal recognition of tribal water rights was primarily achieved through litigation, while the recognition of environmental rights emerged from a broad social movement (i.e., the environmental movement of the 1960s and 1970s), hard-fought legislative gains during that period, and a host of subsequent litigation. These efforts were highly confrontational in nature, and were essential to establishing the context of the Settlement Act and subsequent ongoing problem-solving efforts which are well-suited to alternative problem-solving strategies, given their emphasis on interest conflicts. These observations reinforce the assertion that institutional problem-solving and innovation often occurs in several distinct stages at multiple levels of action, and that different types of problem-solving tools are likely needed over time as dictated by the nature of problem types and action situations.

SECTION V: THE NEXT STEP FORWARD: ANALYSIS AT A MACRO SCALE

Introduction

The preceding discussion of institutional problem-solving case studies illustrates a formal way of thinking about natural resource and environmental problems and their solutions, and as such, promises greater analytical utility than a more unstructured presentation. Admittedly, the language and metaphors utilized in analysis are abstract and general in nature and are not always easily applied to complex real world situations. This is largely due to the fact that natural resource concerns often involve operational choice level problems of several kinds and derivations, and the corresponding collective choice level (and higher) problem-solving efforts usually feature a complex and evolving mixture of conflict types. However, applying metaphors to the analysis of specific cases is a difficult challenge in virtually all fields of scholarly inquiry; institutional analysis is no exception.

These observations certainly do not invalidate the framework presented, but rather help to describe the context within which this methodological tool is best applied. While the conceptual framework can be productively applied to specific case studies, as done in Section IV, ultimately the best use of the framework may come in the analysis of large groupings of case study data, identifying broad trends and “truths” in natural resources and environmental problem-solving. This type of “macro scale” analysis is the logical next step in the development of tools for institutional analysis. The three case studies presented in Section IV hardly constitute a large grouping of data, but they are representative of a much broader set of cases that, in various ways and magnitudes, fall under the heading of alternative problem-solving—a particularly salient “macro-level” trend in natural resources and environmental institutions.

In the remaining pages below, some of the issues associated with applying the conceptual framework to the analysis of larger trends are briefly reviewed. In accordance with the problem-solving orientation of this study, this discussion focuses first on problems, then on solutions. Some general conclusions regarding the merits of alternative problem-solving are also provided, highlighting the types of issues and concerns that should be featured in future research.

Institutional Problems

Some Causal Factors of Natural Resource and Environmental Problems

It is difficult to say anything very meaningful about trends in institutional innovation in the natural resources and environmental realm without giving some thought to those factors encouraging institutional change in the modern era. On a case by case basis, it is sufficient to say that institutional change is motivated by the existence of problematic situations, defined broadly herein to include those situations in which one or more parties is dissatisfied with the existing flow of goods and/or services associated with a resource.¹³¹ While this is a convenient convention at the micro (case study specific) scale focused tightly on a distinct geographic region and point in time, it is not terribly illuminating at a larger, macro scale of analysis, where the scope of the analysis may be to identify broad regional trends and causal factors underlying the emergence of natural resource and environmental problems. This macro perspective, often the focus of parties involved in the planning of resource management regimes, takes on particular importance when a long-term goal is to anticipate and thus minimize future sources of problems—the best of all problem-solving strategies. Some of these “causal factors” can be identified by reviewing the case studies from Section IV.

At least four types of frequently-related causal factors can be found underlying the operational choice level problems reviewed in the three case studies: (1) growing demands on resources, (2) technological change, (3) changing social values, and (4) previous rule-making exercises.¹³² These factors, in various ways, modified the interaction of those element comprising the action situations of the three case studies reviewed, leading to perceived problems and, in turn, calls for rules changes.

The first of these factors, growth, is seen in all of the cases, as the West evolved from a sparsely populated frontier region to a modern industrialized component of the United States. The salience of growth is perhaps best illustrated by considering the open access situations characteristic of the frontier West, situations that became problematic only after economic and population growth led to increased demands on resources—as shown by dwindling timber resources in the Applegate region and inadequate water supplies in the South Platte and Truckee-Carson regions. These concerns were first addressed in the 19th century with innovations establishing forest reserves and the prior

¹³¹ Some authors use the term “gap” to refer to the unmet need attributed to an institutional deficiency (Gregg et al., 1991).

¹³² This list is not intended to be comprehensive or to have particular analytical value, but is simply a general list generated from the preceding case study data. Developing a more exhaustive list is beyond the scope of this report.

appropriation doctrine, respectively, still key elements of the modern institutional rules. Of course, these innovations were insufficient to completely manage all concerns over access, allocation and use of finite resources, ensuring a need for future institutional reforms as growth pressures continued.

Technological change is also a frequent stimulus for institutional change. This is perhaps best shown herein by the South Platte case, when the development of high-lift submersible electric pumps greatly accelerated water withdrawals in the 1930s. The impact of technology in contributing to natural resource problems is well established in many other contexts, such as the environmental consequences of industrialized agriculture and the depletion of ocean fisheries due to the development of improved harvesting techniques. Just as frequently, however, technology is a featured element of solution strategies. Technologies such as seawater desalinization, genetic engineering, and renewable energy development are among a vast and rapidly growing arsenal of tools dramatically modifying the interface of human societies and the natural environment. As the pace of scientific learning and invention continues to accelerate, controlling technology—rather than being controlled by technology—has become an increasingly pervasive challenge in many types of modern institutions.¹³³

Perhaps the most salient causal factor of institutional problems in the Applegate and Truckee-Carson cases, and in natural resource and environmental conflicts generally, is changing social values. Of particular note is the modern environmental movement of the 1960s and 1970s, a time of great social change. During that turbulent era in American history, the philosophy of environmentalism, combined with somewhat related concerns over civil rights—including tribal rights—and antiwar activism, achieved widespread acceptance, finding expression in a variety of formal and informal institutional rules (Paehlke, 1989). To a large extent, many modern environmental conflicts are simply an attempt to reconcile the ideas legitimized in that era of social change with institutional arrangements that evolved in a radically different era. It is this observation that leads to the characterization of natural resource and environmental institutions as “antiquated,” designed to satisfy a set of social objectives that has largely been abandoned. As described by Charles Wilkinson (1992:17) in *Crossing the Next Meridian*, “westwide, natural resource policy is dominated by the *lords of yesterday*, a battery of nineteenth-century laws, policies, and ideas that arose under wholly different social and economic

¹³³ One of the most fascinating cases of this nature involves efforts to protect ocean fisheries from depletion, given that modern fishing technologies can produce huge harvests. One of the primary strategies utilized to date has been regulations prohibiting the use of certain technologies that make fishing “too easy,” an option that is often more politically viable—although less economically efficient—than imposing restrictions on access or enforcing harvest quotas (Steelman, 1998).

conditions but that remain in effect due to inertia, powerful lobbying forces, and lack of public awareness” (emphasis added).

Changing social values in the West not only influence our selection of desired outputs of institutional regimes for natural resource management, but also shape our ideas about appropriate procedural elements expressed in collective choice level and other arrangements (Kenney, 1999). As discussed in Section III in the context of alternative problem-solving strategies, current normative ideas in the West call for arrangements featuring bottom-up and non-adversarial decision-making mechanisms, stressing voluntary action and efficient, often market-driven, tools of goal achievement. This was not always the case. For example, many of the most salient features of western natural resource institutions evolved in an era featuring a strong distrust of market processes, and a correspondingly high faith in independent agency decision-making (Hays, 1959). These Progressive Era (1890-1920) ideas have not navigated the 20th century unscathed.

Along a closely related line is the fourth and most universal causal factor contributing to the observed problems: previous rule-making exercises. All current natural resource and environmental issues are shaped, in part, by that baseline of rules and arrangements established in earlier problem-solving efforts. Often, this set of rules may be stable for decades, becoming problematic only after factors such as growth, technology, social movements, and other factors modify the action situation within which institutional arrangements reside. In those cases it is difficult to be critical of previous rule-makers, as they likely crafted rules appropriate for the circumstances at that time. In other cases, however, rules are enacted that almost immediately prove problematic. For example, in the South Platte case, rules enacted in 1957 to remedy the externality situation were poorly designed, requiring significant and immediate modifications before a workable solution emerged. Poor judgement—from an institutional design standpoint—was also shown in the Truckee-Carson Basin in the 1960s when new “operating criteria and guidelines” regarding the Newlands Project were enacted to aid environmental resources in Pyramid Lake, exacerbating similar problems in the Lahontan Valley wetlands.

Relevance of the IAD Framework

The analyst concerned with issues at this macro level of institutional change faces many more challenges than the scholar concerned with only one isolated case study. Nonetheless, many of the principles of case study analysis are still relevant at the macro scale. Of particular note is the continued salience of the IAD Framework, especially the action situation construct, and the non-substantive definition of problems types.

The Salience of the Action Situation

Whether looking at a specific case study at a discrete moment in time, or evaluating the general contours of a subject area from a more geographically and

temporally broad perspective, it is critical to appreciate the context of the observed institutional rules. At both the micro and macro scales, this is best done by referring to the action situation concept. Usually of particular concern to the analyst are that set of rules and levels, described herein as the institutional component of the action situation, which forms the canvas upon which any potential new institutional solutions must be painted. While activities such as genetic engineering occasionally raise problems for which no well-developed set of applicable rules already exist, most natural resource and environmental problems in the West are layered upon a formidable body of rules accumulated over time. It is worthwhile for the analyst to not only be familiar with this body of rules, but to have some understanding about how these rules came into existence.

An appreciation of the changing nature of the other two elements of the action situation is also essential. In assessing the actor/behavioral component of the action situation, it is important to identify the presence of new parties over time. For this set of actors, it is likely safe to assume that bounded individual self-interest will remain a dominant and constant force in influencing behavior. However, the expression of self-interest will change over time, as individual preferences, values, and circumstances change, as do the ideological composition of involved participants and the incentive structures provided by evolving rule sets. Behavior assumptions may be relatively constant, but behavior is always changing. Similarly, the third element of the action situation, the physical environment, is also constantly changing, as the human imprint on natural landscapes continues. An understanding of this physical transformation can be highly valuable, especially since the management objective in the modern era frequently features restoration of modified landscapes.

To fully appreciate evolving trends in each of these action situation components requires a highly interdisciplinary perspective, perhaps drawing upon the skills of lawyers and historians to describe rules and rules changes; sociologists, political scientists, and economists to interpret and predict behavioral patterns; and biologists, engineers, and geographers to assess the changing qualities of the physical environment.

Problem Definition

As aptly demonstrated in Section IV, operational choice level problems can only be precisely identified in the context of a specific moment in time. The underinvestment problems in the Applegate and Truckee-Carson cases, for example, arguably did not exist until society developed an interest in recognizing and preserving intrinsic environmental values.¹³⁴ While this is a partial limitation on the use of the problem typology for a so-called “macro” institutional analysis,

¹³⁴ Admittedly, this is a highly anthropocentric perspective, but institutional arrangements are human constructs, something that should be reflected in methodological tools for institutional analysis.

the more analytically useful quality of the problem typology is readily transferrable: namely, the non-substantive nature of problem definition. This quality is demonstrated in the aforementioned underinvestment problems in the Applegate and Truckee-Carson regions, which were shown to be highly similar from an analytical standpoint, even though the substantive focus in the Applegate region is on forest resources while the Truckee-Carson basin primarily involves water resources.¹³⁵

These seemingly distinct cases are, in reality, close siblings, something best captured by the public good metaphor. As suggested earlier in the discussion examining the role of changing social values in creating operational choice level problems, public good situations appear to be an increasingly common element of the natural resources and environmental agenda of the latter 20th century, just as open access situations predominated a century earlier. Of course, all problem types can be found in all eras; yet, if the relative mix of problem types does, in fact, change over time in a given area of concern (such as natural resources in the West), then this has dramatic implications regarding the appropriate mix of solution strategies used by problem-solvers. This is the sort of practical insight potentially obtainable through a macro analysis.

Solution Strategies

A Typology of Solution Strategies: An Unmet Need

At the micro (case study) scale, it is typically sufficient to describe solution strategies simply as all sets of rules changes potentially sufficient to address the particular institutional deficiencies identified as part of problem definition. This broad definition encourages the analyst to cast a wide net in the search for solutions, and recognizes that solutions, like problems, are highly context specific. As the focus of analysis shifts to the macro level, however, it is important to note that certain problems tend to lend themselves to specific solution strategies. For example as discussed in Section III, solving depletion problems typically requires changing boundary and/or authority rules; addressing underinvestment problems is usually best achieved by reforming information rules; and maldistribution problems, including the special case of externalities, typically are solved by modifying position, authority, and/or boundary rules. These types of reforms can, collectively, modify the payoff rules characteristic of the institution, either easing or eliminating the concerns giving rise to the

¹³⁵ Identified problems are, of course, “substantive” in that they are based on the specific interaction of the three elements contained within the action situation construct, and defined by the scope rule of the institution. But the typology itself is not substantive in the classic sense in that the terms used do not describe familiar “substantive” classes of resources, such as water, forests, range, minerals, and fish and wildlife. Those terms, as argued throughout this report, lack useful analytical qualities.

problematic situation. Trends of this nature, if properly identified and analyzed, have the potential to evolve into useful metaphors.

Developing metaphors that link problems to solutions is an important research objective of a macro nature, in that it will require the coordinated review of a large number of representative cases. One obstacle impeding progress in this area is the absence of an analytically useful solution typology. This report is only a preliminary step in that direction. While solution strategies are discussed in many contexts in this report, no explicit typology is offered. Development of an analytically useful solution typology—i.e., one that can be linked to our problem typology—is exceedingly difficult, in part because the ideal scheme (or schemes) would need, at a minimum, to integrate two types of data: (1) variations in problem-solving approaches used at the collective choice level to make operational choice level rules, and (2) recurring patterns of operational choice level rules enacted to successfully address the problems identified (i.e., the “solutions” themselves). While these are distinct elements, they are closely related in that the process of collective choice decision-making often influences the types of operational choice level rule changes possible.

In this report, both of these elements of an ideal solution typology are addressed in some detail, although it is the former (i.e., the focus on collective choice level processes) that is of particular interest. Many scholars have examined collective choice decision-making processes, often organizing these data using categories based on either the locus of decision-making (i.e., who makes decisions, typically a function of position, boundary and authority rules) or the mechanism of decision-making (i.e., how decisions are made, largely a function of aggregation, information and payoff rules).¹³⁶ Such approaches have led to distinctions such as *hierarchical/non-hierarchical* and *compulsory/non-compulsory* arrangements, admittedly awkward terms (introduced in Section III), but potentially of more analytical value than more familiar descriptive schemes distinguishing between regulatory, property rights, and market-based regimes. The term *alternative problem-solving* is also primarily descriptive in nature, employed herein simply to draw attention to a fairly coherent grouping of problem-solving strategies that is currently enjoying widespread support. Much like the terms used by other authors, the solution strategies falling within the category of *alternative problem-solving* are primarily distinguished in terms of the “who” and “how” of decision-making.¹³⁷

¹³⁶ For example, see Gregg et al. (1991) and Dahl and Lindblom (1957).

¹³⁷ The “who” in the alternative problem-solving strategies are typically involved stakeholders (often defined primarily in terms of local interests), operating with a level of decision-making autonomy not normally seen in approaches based on regulation, litigation, or legislative approaches; while the “how” is voluntary, consensus processes, dependent on positive-sum transactions.

General Findings Related to Alternative Problem-Solving

The case studies reviewed in Section IV do provide some insights into the nature of alternative problem-solving and, more specifically, the type of environment within which this class of solution strategies can best flourish. Two factors appear to be most salient in creating an environment conducive to success: (1) the earlier resolution of fundamental value conflicts, and (2) the existence of symmetrical problem-solving incentives. These observations are offered as tentative working hypotheses, deserving of further macro-level investigations in institutional analysis.

Resolution of Value Conflicts

Unlike interest and cognitive conflicts, value conflicts are noted for being unsuitable to a negotiated solution, given that the values are non-compensatory. Thus, given the emphasis of the alternative problem-solving strategies on consensus processes, it is not surprising that these strategies did not take center stage in the case studies until resolution of the underlying value conflicts occurred through other collective choice processes. This was most clearly seen in the Applegate and Truckee-Carson cases by the conflict between preservation and development/use interests. In both cases, a key step in the resolution of the conflict came with congressional passage of the Endangered Species Act, and then later followed in each case by environmental litigation based on this legislation. Only after the courts upheld the validity of environmental rights was the fundamental value conflict resolved, prompting action to address the remaining interest and cognitive conflicts.

The resolution of value conflicts is something for which the judiciary is ideally suited, given that litigation is designed to function in those situations where agreement cannot be reached. Value conflicts can also be resolved in a legislative setting, in large part due to an aggregation rule of majority-rule rather than consensus. However, legislatures are historically hesitant to address value conflicts, since any decision is likely to alienate a large percentage of the voting public. Much more profitable, from a political standpoint, is so-called *distributive* politics, a term used to describe policies that promise clear benefits but largely hidden costs (Lowi, 1964). Why then, did Congress enact the Endangered Species Act, the most controversial and influential piece of environmental legislation in dozens of natural resource and environmental conflicts in the West today? The answer probably lies in the fact that the true impact of the legislation was not appreciated by the Congress at the time (1973), and that a strong social movement in favor of environmental legislation was at its zenith. Today, when the significance of the legislation is fully realized, and when environmentalism is not such a potent political force, Congress is struggling with the ongoing and seemingly endless challenge of revisiting the legislation, something mandated by the need for periodic re-authorization. Failure to continue the program will likely bring the preservation/development value conflict back to the surface, providing a strong impediment to the further

proliferation of alternative problem-solving strategies. This is ironic given that many of the proponents of alternative problem-solving see these strategies as the preferred alternative to the regulation/litigation model embodied by the Endangered Species Act and similar value-oriented environmental legislation.

As environmental legislation has evolved to quiet value-oriented debates about whether we, as a nation, should protect environmental resources, the focus of activists, resource managers, and policy-makers has gradually shifted toward the implementation of these environmental goals. In the modern era, natural resource and environmental policy debates are increasingly about the “means” of policy implementation, rather than the “ends.” This is significant in many ways, not the least of which is that the modern era prominently features interest and cognitive conflicts that are suited to alternative problem-solving, given that both are amenable to negotiation and experimentation. The importance of institutional arrangements in promoting efficient goal achievement is widely recognized. Where environmental activists of past decades turned to the highly philosophical writings of Muir or Leopold for inspiration, the bookshelf of today’s army of environmentalists also include works such as Reinventing Government by Osborne and Gaebler (1992) and The Death of Common Sense (1994) by Howard. There is now a premium on institutional knowledge and a preference in favor of creative institutional problem-solving strategies, salient modern legacies of an earlier social movement and the rise to prominence of environmental litigation.

The Importance of Incentives

To the extent that value conflicts can be resolved or at least tabled, an opportunity then exists to utilize alternative problem-solving strategies.¹³⁸ The first step in such efforts is often to identify incentives to bring all key parties into the problem-solving effort. Broadly dispersed incentives are needed given that each of the mechanisms lumped under the heading of alternative problem-solving strategies are highly dependent upon achieving agreement among all key participants. The aggregation rule in market transactions is unanimity (between buyers and sellers), and in most ADR and collaborative groups, a decision-rule

¹³⁸ This is not to imply that alternative problem-solving approaches have no role in situations involving value conflicts. The discussion and education that occurs in collaborative settings can encourage parties to change their value structures, thus eliminating the value conflict. This, however, is not likely to happen over short time periods if at all, and it is difficult to maintain a collaborative effort over time if the dominant issue is a value conflict. Work on a more manageable problem will likely be needed to sustain the group while the value conflict is slowly and cautiously addressed. More commonly, the group discussion and education may lead some parties to realize that the perceived value conflict is, in fact, really an interest or cognitive conflict, or some actions may be found that serve the interests of both competing factions without forcing a direct resolution of the value conflict. In those situations, the group effort is actually working around the value conflict, a significant, but different, type of resolution.

of either unanimity or “consensus” (usually defined to mean a super-majority with no forceful dissents) is employed. Generally, the way to encourage agreement in rule-making settings is by providing incentives to agree (or disincentives to disagree). Thus, a preliminary step in problem-solving is often identifying potential benefits of the problem-solving effort (i.e., incentives), and devising a means for distributing those benefits among all the key players. This is often best done through discussion, debate and bargaining processes.

Much of the modern literature of institutional reform focuses primarily on the value of providing incentives to problem-solvers (Osborne and Gaebler, 1992). As shown by the three case studies, both negative and positive incentives can be productively employed. Negative incentives were utilized in the South Platte by the legislature—largely at the behest of the State Engineer—to urge development of a market-oriented collaborative group (GASP) by ordering groundwater pumpers to replace or augment surface water supplies or forfeit pumping rights. The threat of losing rights was a significant incentive to act, and the economy of scale of providing replacement water was sufficient to encourage the group, market-driven approach. Similarly, the impact of environmental regulations in the Applegate and Truckee-Carson regions, illustrated in part by the timber injunctions and the Stampede Dam re-operation respectively, provided strong stimuli for the eventual (and ongoing) problem-solving efforts. Positive incentives in these two cases were also prominently featured, through federal funding provided through the Northwest Forest Plan and the Settlement Act.

Ultimately, however, the most obvious incentive driving problem-solving efforts is the resolution of the operational choice level problem. By definition, operational choice level problems involve situations in which one or more parties view the current situation as problematic. Those parties, therefore, have an obvious built-in incentive for problem resolution. This simple observation takes on significance when considered with the *symmetry* concept introduced earlier. In the symmetrical situations typical of depletion and underinvestment problems, for example, all parties can be expected to perceive a personal benefit to problem resolution. However, in the asymmetrical situation of maldistribution (including externalities), some parties are benefitted from the status quo. Thus, they perceive no problem, and have no incentive for institutional change—to the contrary, they have an incentive to discourage institutional change. It is expected, therefore, that alternative problem-solving strategies will not emerge in the asymmetrical situations unless additional incentives (either positive or negative) are provided, but may independently emerge in the symmetrical situations.

This is exactly the pattern shown in the case studies. Groundwater pumpers did not voluntarily organize into GASP and cease impacting surface water rights holders; they were forced. Similarly, water rights holders in the Truckee-Carson Basin did not step forward to voluntarily address the maldistribution problems, but are now currently participating in the market-based reallocation since outside public funding has been provided. The other alternative problem-solving efforts in the Basin are primarily focused on the

restoration of public goods, a situation with symmetrical incentives. Alternative problem-solving efforts in the Applegate region are also primarily concerned with solving the symmetrical problems. As mentioned above and discussed in Section IV, in both the Truckee-Carson and Applegate cases, widely-felt burdens associated with ongoing problem-solving efforts augmented the intrinsic incentive structure provided by the symmetrical problems, prompting the initiation of the alternative problem-solving efforts.

Concluding Thoughts

This report reflects a growing desire among many parties in the natural resources community to bring a greater level of scientific scrutiny to the description, analysis and, ultimately, the design of institutional arrangements. The conceptual framework described herein, while far from perfect, is an initial step in that direction. However, while not minimizing the potential contribution of institutional analysis to improved resource management, it must be acknowledged that even the most informed and academically rigorous processes of institutional design will not be sufficient to craft arrangements stable over long time periods—especially at the operational choice level. The operational choice level problem causal factors identified in the case studies (and presumably many other considerations not highlighted herein) are not easily controlled, and to the extent that their ramifications can be managed, this activity must be viewed as an ongoing challenge—much as we accept government to be a permanent fixture of modern civilization.

Increasingly, a diverse coalition of policy-makers and advocates are encouraging the use of so-called *alternative problem-solving* approaches to address natural resource and environmental problems. There is reason to be optimistic about these approaches emphasizing voluntary, incentive-based decision-making, often occurring in collaborative or market settings. In many geographic and substantive areas, these approaches are making a positive contribution to management regimes, providing problem-solvers with a bigger and better toolbox. The enthusiasm for alternative problem-solving strategies, however, is somewhat disconcerting. The three case studies reviewed in this report were sufficient to illustrate two major limitations on the use of these tools: first, when significant value conflicts are unresolved; and secondly, in situations primarily featuring problems with asymmetrical incentive structures. Further analyses, especially those focused at a macro scale, will likely identify additional insights into the proper, and improper, application of these approaches. The discipline of institutional analysis is the proper setting for these investigations, utilizing concepts and methodologies drawn from a wide variety of academic pursuits.

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