Acceptance of Scientific Management by Natural Resource Dependent Communities

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Abstract: *We explore the reaction of two resource dependent communities, west Texas ranchers and Gulf Coast oyster fishers, to scientific resource management. We examine the criteria these two social groups use to judge scientific claims, and by extension, scientific resource management. Although scientists rely on factors internal to the scientific enterprise (e.g., methodological rigor), natural resource dependent communities such as ranchers and fishers may rely on factors external to the scientific process. Such factors include the historical relationship the community has had with the managing agency, the extent to which scientific explanations match local experience, the conceptual fit between managers' and communities' views of the appropriate relationship between humans and nature, and the resources available to the community to argue against regulation. We conclude that (1) agencies should explore the possibility of including the experiential knowledge of natural resource users where applicable and (2) agencies should recognize that communication skills can be as important as scientific skills in reaching management goals.*

Aceptación del Manejo Científico por Comunidades Dependientes de Recursos Naturales

Resumen: *Exploramos las reacciones de dos comunidades dependientes de recursos naturales (rancheros de la region oeste de Texas y pescadores de ostras de la Costa del Golfo) al manejo científico de los recursos. Examinamos el criterio utilizado por estos dos grupos sociales pare juzgar los reclamos científicos y por extensión, el manejo científico de los recursos. Aunque los científicos se apoyan en factores internos relacionados con la actividad científica (por ejemplo el rigor metodológico), las comunidades dependientes de recursos naturales tales como rancheros o pescadores pueden apoyarse en factores externos al proceso científico. Tales factores incluyen la relación histórica que la comunidad ha tenido con la agencia de manejo, la magnitud con que las explicaciones científicas coinciden con la experiencia local, la adecuación conceptual entre los enfoques de los manejadores y las comunidades con respecto a las relaciones entre el ser humano y la naturaleza y los recursos disponibles a la comunidad para argumentar en contra de alguna regulación. Concluímos que: (1) las agencias deben explorar la posibilidad de incluir el conocimiento resultante de la experiencia de los manejadores de recursos naturales cuando se considere aplicable y (2) las agencias deben reconocer que las habilidades de comunicación pueden ser tan importantes como las habilidades científicas para alcan-zar las metas de manejo.*

Introduction

Natural resource managers are subject to diverse and even conflicting demands that require balancing the needs of species, ecosystems, and the interested public. This balancing act should be performed within the context of the best available scientific information, and management decisions should represent the application of available science. In reality, many management decisions have to be made without sufficient scientific information, using the process of adaptive management (Williams & Johnson 1995). It is not surprising, therefore, that agency personnel are frustrated when influences, which many of them perceive as extraneous to their job

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(e.g. political, economic, social factors), interfere with the process of scientific management (Clark 1992).

Many agency personnel with whom we have worked believe they have good data, capable of speaking for itself, and often cannot understand why scientific management is challenged or discounted. In our experience the rhetoric of scientists generally implies that user-groups are scientifically illiterate (an understanding "deficit") and/or apply special interests in lieu of rational, scientifically based decision-making in the interest of a common resource. We address the understanding and acceptance of scientific information in the context of natural resource management.

We argue that (1) a complex constellation of factors determines whether and to what extent the public accepts the scientific arguments of agencies about what constitutes appropriate management, not just a deficit of scientific information and (2) implicit use of the "deficit model" by managers may be based on a misunderstanding of how non-scientists incorporate scientific information into their daily lives. Using West Texas ranchers and Gulf Coast oyster fishers as examples, we demonstrate that, far from being a blank slate, resource users often employ their own criteria to judge the validity of scientific information on which policy is based.

Social Studies of Science

The assumption that natural resource communities do not have a sound understanding of scientific management is an example of what Ziman (1991:101) calls the deficit model. According to this model, the public is more or less a blank-slate scientifically and the transfer of scientific knowledge will make them scientifically literate. Editorials and essays in natural resource journals reveal the perceived relationship between management difficulties and the public's misunderstanding of scientific management (e.g., Noss & Murphy 1995). The proposed solution is usually public education.

Although the public's lack of scientific understanding is a well-documented problem, the rejection of scientific management is more complex than the deficit model suggests. Public acceptance of scientific knowledge may be affected by non-scientific phenomena. Social and psychological factors affect the various ways non-scientists understand, use, or reject scientific models (Nelkin 1979,1982; Trachtman 1981; Yankelovich 1982; Wynne 1989, 1991, 1992; Kempton 1991; Ziman 1991; Silverstone 1991; Hess 1992). Resource users may not judge scientific evidence the way scientists do (i.e., academic qualifications of the scientist and soundness of scientific methodology). One problem with implicit use of the deficit model by resource managers may be underestimation of the amount of distrust generated by the history of interactions between some resource users and resource regulators. The deficit model assumes that the message is more important than the messenger and that it will be heard even if the messenger is not trusted. This ignores a basic element in human communication, the social context.

Also relevant to the cases we discuss is the relationship between local and scientific knowledge. Local knowledge systems are parallel to scientific knowledge systems in that they are not the product of the scientific method and do not necessarily rely on even a vague understanding of scientific concepts (Johannes 1981; Dyer & Leard 1994). Local knowledge may inform the public's understanding of scientific models (Kempton 1991), but local knowledge is not dependent on scientific knowledge. Scientific knowledge is not always "privileged" over local knowledge; therefore, it takes more than just the transfer of scientific information to make the public scientifically literate in the way scientists consider necessary to meet management goals.

In contrast to a scientific illiteracy (deficit) model, we assert that acceptance of scientific management depends on the combination of (1) the availability of other resources that communities can mobilize (science is but one resource; others include political pressure, money, and moral arguments); (2) the social relationships between the resource users and resource managers; (3) the extent to which resource users' cognitive models of "how the resource works" fits scientific models; and (4) the conceptual fit between managers' and resource users' perspectives regarding the appropriate relationship between humans and nature. Our two examples, West Texas ranchers and Gulf Coast oyster fishers, illustrate these somewhat vague and general assertions (Table 1).

Strategy

The comparisons we make between fishers and ranchers suggest valid dimensions for further analysis; however, we emphasize that the information we present has been condensed from projects conducted by researchers of different disciplinary backgrounds and that were designed to address different issues. An understanding of the perspectives of fishers was derived from personal interviews conducted in a systematic manner by the senior author, using the long-interview technique (McCracken 1988). An understanding of the perspectives of ranchers was derived from a participatory approach by the junior author, including informal conversations, attendance at public forums, and rhetorical analysis of publications (membership bulletin and books).

We offer this essay in the spirit of a dialogue between disciplines, an exploration of the ways that the social studies of science can inform the work of biologists working in the area of natural resource management. The focus is on identifying and understanding underly-

Table 1. Dimensions for comparing attitudes of social groups on natural resource management.

Dimension	*Ranchers*	*Fishers*
Access to scientific, political, economic resources	landedness and social networks provide access to political and economic power; use organization to lobby legislators	weakly organized, only certain individuals have political access; access system through non-agency scientists
User group's relationship with resource managers	historical miscommunication generated mistrust	history of conflict with managers
Cognitive models of how resource works	generally valued local knowledge over scientific knowledge	alternated between "privileging" local knowledge and scientific knowledge
Conceptual fit between cognitive models of managers and user group	ranchers relationship to land primarily utilitarian; managers perceived humans as part of ecological whole	fishers relationship to bay primarily utilitarian; managers stressed bay as ecological system

ing dimensions, an initial step in formulating grounded theory. We do not claim that our rhetoric actually represents a majority of individuals in the user-groups we described; we simply report our experiences with these groups.

Understanding the strategies that natural-resource-dependent communities use in either supporting or rejecting scientific management requires some background knowledge about each community so that its response to management can be put in a social and ecological context. We offer brief descriptions of the major players in the communities of ranchers and fishers, as well as of the scientists with whom they come in contact.

Scientists

The agencies that make decisions about natural resources affecting the lifestyles of ranchers and fishers include scientists in both state and federal government. Federal agencies that interact with ranchers include the U.S. Fish and Wildlife Service, the U.S. National Park Service, and the Environmental Protection Agency.

The Texas Parks and Wildlife Department (TPWD) is the state agency responsible for resource management. Agency staff interact with ranchers regarding endangered species, harvest of game species and predators, and management of state lands. Oyster resources are managed by the Coastal Fisheries Branch of TPWD, located in field offices near the major bay systems and in the state capital. Overseeing the Texas Parks and Wildlife Department, and responsible for regulatory decisions, is the Texas Parks and Wildlife Commission comprised of political appointees.

Private, non-governmental organizations that interface with government agencies are perceived by some ranchers as part of the social group regulating ranchers' actions and are often participants in meetings addressing conflict. The non-governmental organizations with which ranchers have had contact include Sierra Club, The Nature Conservancy, and the Texas Organization for Endangered Species. For example, Sierra Club petitioned TPWD to have the Texas population of the mountain lion (*Felis concolor*) listed as an endangered species. Locally, The Nature Conservancy helped mediate the purchase of the ranch which became the Big Bend Ranch State Natural Area. These environmental organizations use lobbying, lawsuits, and research to influence the regulatory process.

Generally, scientific staff of governmental and non-governmental organizations have training in the natural sciences or resource management. A predominant viewpoint is that scientific information is more salient to resource management than economic or social information. A few agency scientists commented on the need to consider potential economic and social costs of regulations; however, they felt squeezed between the institutional mandate to act in the best interests of the resource and the political realities affecting program funding and personnel.

Scientists varied in their evaluation of local knowledge. Some expressed the view that resource users only know how to extract the resource (utilitarian approach), whereas others stated that some resource users know a lot about the local area and about cycles of abundance and decline (ecological approach). Most referred to Hardin's "tragedy of the commons" (Hardin 1968) to describe what they considered resource users' relationship to the resource.

Although a majority of personnel in upper management in natural resource agencies are scientists, our discussion of scientific staff refers only to those scientists assigned to regional and local offices. We recognize that agency staff assigned to central offices deal with a different cluster of constituents including national and state level organizational leaders and elected officials and are subject to different pressures (e.g., Clarke & McCool 1985; Yaffee 1994). Field staff and agency management do not always agree on management strategies and agency policy and upper management has the final say about both resource management and public involvement. Intra-agency dynamics are thus important in the generation of trust between the agency and user groups.

Unfortunately, an in-depth exploration of such intra-organizational dynamics is beyond the scope of this essay.

Big Bend Ranchers

Although ranching occurs throughout Texas, we have chosen to focus on one group that has provided a public forum for discussion of natural resource issues in the arid Big Bend region. The word *rancher,* therefore, only refers to spokespersons of this group, the Davis Mountains Trans-Pecos Heritage Association (here after referred to as the association). The association was founded in 1989 to block action on a feasibility study to purchase private lands for a proposed national park in the Davis Mountains. It expanded into the statewide Trans-Texas Heritage Association in 1992.

Relations of ranchers with scientists are formal and informal. In Alpine, Sul Ross State University provides bachelors and masters degree programs. Researchers from a variety of universities work in and around Big Bend National Park. A relatively high number of scientifically trained individuals, including government employees, retirees, nature guides, and providers of hospitality services for tourists, live in non-ranching communities in the area.

Primary accounts have documented the historical experiences and attitudes of local residents in the Big Bend region (Newsome 1975; Casey 1981; Stillwell 1991). The natural resources in the region include primarily grazing lands and minerals (Maxwell 1985). Mining no longer constitutes a major economic activity in the region, therefore, natural resource issues focus primarily on regulation that affects the use and sale of private ranch lands. In a sense, the land itself has become a resource.

In the early 1940s the U.S. government used a combined strategy of buying and condemning private lands to create Big Bend National Park (Maxwell 1985). Although the descendants of these dispossessed ranchers claim to bear no grudge against the government and have not lobbied for removal of the park they still tell stories of the emotional and economic burden the takings levied on their forebears (Carroll 1989).

Government miscommunication relating to land acquisition precipitated the coordinated effort by ranchers to fight natural resource regulations. For example, after being assured that the National Park Service had no intention of acquiring his ranch for inclusion in the Rio Grande Wild and Scenic River corridor, a prominent rancher discovered a planning document that depicted a visitor center on his land (Carroll 1989). The mistake was made at a regional rather than local level; however, as an institution, the National Park Service's credibility was questioned. One rancher stated that he had confidence in certain individuals within the Park Service, but the turnover of personnel was so rapid it was no longer worth his time to educate and build confidence with each new person. In essence, he saw even rational decision-making processes based on scientific information as representing a "social agenda" of the scientists and environmentalists involved. Another rancher, who had cooperated with scientists in providing access to an airstrip convenient for radio-telemetry activities, revoked access permission when his property (an inholding) was incorrectly depicted in a public newsletter as belonging to the national park.

After communication mistakes such as these, area residents felt government agencies were not to be trusted. Ranchers now view each new piece of natural resource legislation and each new government land acquisition as a potential threat to their property rights. Regardless of the confidence level between local residents and local institutional representatives, decisions were potentially being made by other individuals in the institution without access to local knowledge.

Ranchers also worry about cooperation between agency scientists and environmental groups. For example, they were concerned that about 70–80% of the membership of the Texas Organization for Endangered Species consisted of government biologists. Generally, they viewed legislation such as the U.S. Endangered Species Act and regulations for wetlands protection as tools in a larger scheme to impede economic development and convert private lands into public lands (a social agenda).

Many association members consider themselves land stewards, promoting conservation through the wise use of private property. Conservation in this context has both social and biological meanings, including (1) conservation of property rights guaranteed under the 5th Amendment of the U.S. Constitution; (2) conservation of a way of life (heritage); (3) conservation of natural resources in the form of soil and ranch resources; and (4) conservation of productive uses of the land.

Ranchers' views of individual scientists and scientific models appeared related to both community ethics and ranchers' cognitive models of proper conservation. Many ranchers contrasted their own notion of conservation (based on the utilitarian ethic of production) with what they perceived to be the preservationist notions of environmentalists and some agency scientists. Embedded in the association's portrayal of preservation is rhetoric invoking an anti-progress, anti-private property, and anti-individual-rights orientation that favors big government.

In addition to being anti-private property, the government was portrayed as being a bad neighbor, violating social norms of reciprocity. In particular, ranchers pointed to a declining tax base due to government land acquisition and to agency policies about predators. Although local communities received compensation for public lands, the association conducted an analysis demonstrating that public ownership does not contribute as

much as private ownership to the local tax base supporting schools and hospitals. Parks and preserves were viewed by ranchers as breeding grounds and safe havens for predators viewed as harmful to the livestock industry.

The predator issue is a good example of differences in the perceived value of local versus scientific knowledge. Ranchers claimed that mountain lions were currently abundant in the area and refuted the notion that there was any need to regulate their taking outside of park boundaries (Frank & Frank 1992). Proposals to study mountain lion abundance met with opposition, partly because it might lead to further incursions on property rights, but also because it was felt that it would "only duplicate existing information on lions that indicates a growing and thriving population . . . the landowners with first hand knowledge believe that there have been enough studies conducted already" (Frank 1991*b*).

Three broad strategies were employed to further the goals of the association: legal/political, educational, and scientific. The Legal and Legislative Committee's lobbying efforts have helped to derail several pieces of legislation at the state level such as a proposal to use the cigarette tax to purchase land for parks, several wildlife protection bills, and a bill affecting the tax burden of The Nature Conservancy (Frank 1992*a*). In addition, the association advised ranchers to file Freedom of Information requests against all research to be conducted in the Trans-Pecos area and against government agencies and to prohibit access to their land by environmental groups and scientists.

By portraying the conflict as one over rights, ranchers were invoking moral, legal, and economic arguments (in contrast to scientific discourse) to substantiate their position that natural resource regulations were not necessary. Claiming that environmental restrictions were onerous and prohibited them from using their land productively, ranchers invoked the notion of freedom. In this equation, property rights were established so people could be free, and the Constitution guaranteed this freedom. Ranchers also appealed to heritage and community, contrasting urban-based environmental groups with rural communities. This illustrates how, in resource-user communities, scientific discourse may not have the "privileged" status it has within communities of natural resource regulators.

The credibility gap between agency and environmental scientists and the ranchers presents a dilemma for ranchers: how to present a credible case to influence decision-makers against regulations, when regulations are to be based on the best available science? One of the guest speakers at the 1991 symposium answered this question. He told society members to "find scientists you can trust and use them; fight agency science with your own science" (Davis Mountain Trans-Pecos Heritage Association 1991). The word *trust* is important. The criteria for good science and credible scientists was social, and to a lesser extent related to academic discipline. The two members of the Scientific Committee, highlighted in the newsletter, (Frank 1992*b*; Frank 1991*a*) had both attended the local university and had studied sciences perceived as utilitarian. One scientist held patents on a predator control collar and the other was an employee of the Soil Conservation Service. Despite his government position, the latter was accepted by the ranching community because of his local degree and his "common sense" approach to soil conservation—viewed by ranchers as markers of his political inclinations.

In summary, the following constellation of factors plays a role in a natural resource community's (in this case the ranchers') acceptance of scientific management (Table 1).

(1) *Access to resources*: Ranchers appeared to rely more on a political than a scientific strategy. They had access to state government through their organization and were very sophisticated in their lobbying techniques. On the other hand, their criteria for trustworthy scientists limited the number of scientists on whom they could rely.
(2) *Relationship with resource managers*: A history of miscommunication between ranchers and government agencies generated mistrust of agency scientists. This predisposed ranchers to discount scientific management as suggested by the agencies, viewing the science as driven by a non-utilitarian agenda. Reciprocity was a prevailing positive ethic in the ranching community and scientists and/or the agencies they represented were not perceived as abiding with the social norm of reciprocity.
(3) *Cognitive models of how the resource functions*: Ranchers considered local knowledge about predators to be more accurate than scientific models and therefore disagreed with agency scientists about the threat to private enterprise and value to ecosystem function.
(4) *Perceived appropriate relationship of humans and nature*: Ranchers' relationship to the land was primarily utilitarian, defining their view of conservation and aesthetics, in contrast to resource-managers who perceived humans as one part of an ecological whole.

Galveston Area Fishers

The oyster fishery in Texas is concentrated in the Galveston Bay system, parts of which are within an hour's drive of the city of Houston. The area is home to the petrochemical industry, numerous defense and aerospace firms, and Johnson Space Center. The fishing villages and vacation cottages that used to dot the shore are giving way to expensive suburbs and yacht clubs.

The immediate area is served by three universities and several junior colleges. Locals claim that the area has more petrochemical companies, engineers, and sailboats than any other place in the country.

Commercial fishing was important to the settlement of the area, but has been overshadowed by the petrochemical, aerospace, and tourism industries. At the time this study was conducted, the oyster fishery was valued at $7 million (calculated using ex-vessel value) in contrast to $171 million (calculated using expenditures) for recreational fishing and billions for the industrialized sector (Ditton et al. 1989).

Although oyster fishers attend open hearings, comment on proposed regulations, and travel to the state capital to lobby the department and occasionally legislators, they primarily take action individually, not as a group. In contrast to the ranchers, it was generally felt that oyster fishers band together only temporarily in the face of an immediate and acute crisis and then disband. Neither of two industry organizations that had formed in response to specific issues, PISCES and the Texas Oyster Association, was active during the time of this research. Two related and reinforcing factors contribute to the failure of the industry to sustain an organization: industry structure and a self-described independence.

The oyster industry is differentiated according to the nature of the activity (e.g., boat owner/operator; crew; leaseholder). This differentiation leads to economic stratification and social fragmentation. A recurrent theme found in interviews with both industry members and regulators was intra-industry conflict. Several interviewees expressed the opinion that the oyster fishery was too fractured socially to sustain an organization. Additionally, fishers claimed to be highly individualistic, a trait they felt contributed to success in a hunting mode of production.

Another difference between fishers and ranchers is their relationship to legislators. Oyster fishers do not have an organized lobbying strategy. If an issue of interest arises, one or two individuals will contact their representatives and ask for intervention.

Like ranchers, fishers have a history of conflicts with the agency that regulates them. Also like ranchers, fishers' mistrust of agency science is related to mistrust of agency intentions and notions of power and property rights. Unlike ranchers, fishers rely on state, not private resources. When fishers invoke the notion of property rights, they alternate between conceptions of the bay as open access (saying that bay resources belong to everyone equally and claiming that regulations are unfair because they restrict the access of the commercial subgroup and grant access to the recreational subgroup) and the conception of the bay as common property as technically defined (i.e., belonging primarily to the communities that surround it).

Oyster fishers are not as concerned as ranchers about the relationship between environmentalists and agency scientists. Fishers focus on the relationship between recreational fishers, the oil products industry, and agency scientists. Fishers point to the composition of the politically appointed Texas Parks and Wildlife Commission as proof that there is an agency/oil industry/recreational fishery alliance. Some Commissioners are members of the Gulf Coast Conservation Association (GCCA), a wealthy and powerful recreational fishing group begun by a prominent member of the oil industry. Likewise, some Commissioners own or work for oil, gas, or petrochemical industries. Recreational fishers are faulted because of their relationship with the oil industry and because of the recreational fishing lobby's role in closing several commercial fisheries that competed with recreational fishing. The closure of these fisheries hurt some members of the oyster industry who fished for other species when oyster season was over. Fishers are also concerned about GCCA's programmatic ties to the department. The GCCA has donated several hatcheries and operates a hotline to report illegal fishing. When departmental action is perceived to be a threat to the oyster industry, the industry describes the situation as one in which the lackeys of big business are bullying the common man.

Although fishers do construct arguments based on rights, in contrast to ranchers, those individuals who are most active in lobbying the state rely heavily on scientific models and individual scientists. They differentiate between what they claim to be credible versus non-credible science and scientists, using research conducted by university researchers to challenge regulations based on the work of government scientists. In this way, fishers have been very sophisticated in appropriating one of the scientific establishment's own informal systems for distinguishing "good" from "bad" science. They have tapped into the differential prestige between basic and applied science and the hierarchy of degrees (virtually all university scientists have Ph.D.s, whereas relatively few Coastal Fisheries Division scientists in the agency have Ph.D.s).

Some fishers have good access to university scientists. In a sense, they act as patrons of university scientists, offering docking facilities (often gratis), the use of boats and crew, access to estuaries and canals that are under their riparian rights, and writing letters of support to granting agencies for proposed research. In exchange, scientists share information with fishers.

Fishers use two types of information to challenge management strategies they feel are inappropriate: local knowledge and scientific knowledge. Both are used to criticize the department's scientific activities. For example, oyster fishers use their local knowledge of reef distribution combined with their knowledge of dredging techniques to criticize TPWD's sampling program. They argue that the department should only sample known reefs instead of relying on a random sampling technique

designed to identify new reefs as well as reefs in decline. Also criticized is the technique TPWD uses to harvest the oysters sampled because it does not mimic industry methods. In effect, fishers are arguing for a grounded approach, based in local knowledge, to assess oyster abundance.

The TPWD's sampling program has also been criticized by fishers using a more scientific approach. The trend data gathered from the sampling program was represented in the source book for the proposed Oyster Management Plan as indicating a decline in oyster abundance. Comments from oyster fishers at the open hearing on the plan (1) pointed out that it was problematic to compare 1984 data with earlier data that were gathered under a different sampling regime; (2) claimed the population models that informed the interpretation of monitoring data were more suitable to dove or deer than to oysters; and (3) referred to the cyclical nature of oyster abundance, which was not captured in the linear graphs the department included in the plan's source book.

Fishers are acutely aware that their livelihoods depend on a healthy bay system. However, the relative worth of the various components of the bay differ from that of scientists. This is because of the utilitarian view of the bay held by fishers. The bay is a unit of production in which a product, the term fishers use to refer to oysters, is grown. Natural systems are thus commodified and the focus is on the parts of the ecosystem they feel are relative to the production of commercial species. For example, water quality is very important, reefs are important, but "trash" fish, other non-targeted species, and sea grasses are not. Oyster fishers see themselves as stewards, but they do not care for all parts of the ecosystem equally.

In summary, the oyster fishers differed from the ranchers in their approach to scientific management in the following ways:

(1) *Access to resources*: Although better-off individuals did have access to state government, fishers as a group were weakly organized. They did have access to scientists in the universities and allied themselves to scientists.
(2) *Relationship with resource managers*: Like ranchers, fishers had a history of conflict with resource managers, which predisposed them to discount the scientific models managers used to justify regulation. They viewed TPWD as being captured by powerful forces that desired the closure of the bay to commercial fishing.
(3) *Cognitive models of how the resource functions*: Fishers alternated between local knowledge and models offered by university scientists.
(4) *Perceived appropriate relationship between human beings and nature*: Fisher's relationships to the bay were utilitarian in contrast to the ecological perspectives of scientists.

Discussion

Comparison of these two examples reinforces our argument that a constellation of factors plays a role in resource communities' acceptance of scientific models, not just a "deficit" of information. The two non-scientific groups we described had their own criteria for accepting or rejecting certain scientific models relating to natural resource regulation, and hence for accepting or rejecting regulations themselves. For both groups a particular scientific position was considered legitimate if the scientist taking that position seemed to be sympathetic to the interests of natural resource communities. This model of scientific authority makes "trust" an important element of an individual scientist's credentials. Credentials were perceived somewhat differently in the two communities. Ranchers focused on the social context of individual scientists. They seemed to prefer local scientists, the term *local* referring to either long-time residence or training at the local university. Although fishers evoked the notion of "locality" when trying to deny the state's right to regulate (they did mention the many years one particular scientist worked on the bay), locality was not an important attribute of scientists. Fishers focused on the scientific models themselves, whether these models agreed or disagreed with their own models. This attitude extended to social science. For example, P. Weeks was asked several times for references to any social scientific work, not necessarily her own, that might illustrate how regulation can cause social dislocation.

Therefore, in contrast to a model that depicts these resource-users as lacking something (scientific knowledge), we propose that fishers and ranchers were adding something to their understanding of science, namely their own understanding of the social context of scientific practice. When resource-dependent communities listen to scientific arguments for certain management regimes, they reconstruct the information in relation to their livelihood and the views they hold of the speakers (Wynne 1989). Fishers and ranchers assert that science is not neutral, but a product of individuals working within a scientific network that has its own norms and career paths and within organizations that have their own interests. Their critique of scientific models of resource depletion focuses on the relationship between scientists and certain powerful actors they perceive as being antagonistic to the goals and values of resource-dependent communities.

Fishers and ranchers exhibited an ambivalence about science and scientists, alternating between a general belief in the validity of local knowledge and a preference

for moral discourse (that denies scientific knowledge and discourse) and the appropriation of scientific discourse and individual scientists because certain individual scientists were associated with political power and others with rational power. These two strategies, appropriating and denying, were employed by both groups although the fishers appeared much more willing than the ranchers to appropriate scientific models from scientists outside the local community.

It is important for natural resource agencies to understand the social context in which scientific information is received because the use of the deficit model of the public's understanding of scientific concepts potentially increases, rather than reduces conflict over the use of natural resources. It allows regulators to ignore problems of trust, claiming that natural resource dependent communities' disagreement with management policies is primarily a function of their lack of scientific understanding. It is important for policy makers to understand what perceptual filters their constituents use when deciding whether to accept a scientific construct. While scientists may primarily rely on factors internal to the scientific enterprise (i.e., the rigor of the methodology or the status of the scientist or lab in which the study was conducted), various lay publics may rely on factors external to the scientific process. Such factors include the historical relationship the resource dependent community has had with the regulatory agency, whether the scientist offering the scientific information is known to the community, and the extent to which the scientific explanation matches local experience. Understanding the criteria natural resource communities use to interpret the scientific basis for regulations is a necessary precursor to effective communication between regulators and the regulated community. By understanding the worldview of the user group, a scientist or regulator will be more effective at presenting new information within the context of the user's value system (Peterson & Horton 1995).

Recommendations

What are the practical implications of understanding the social context of science related to management of natural resources? We recommend explicit recognition of and careful evaluation of decisions that may be implicitly informed by the deficit model. This would apply to decisions regarding personnel, communication between field and central offices within organizations, and interorganizational communication. The following actions may aid scientists in responding adaptively to their constituents.

First, our analysis points to the need for agencies to provide incentives for good communication between scientists and user groups. Often agency scientists have been chosen primarily for their scientific background, despite their expected roles in managing human impacts on resources. Some may choose to participate in continuing education programs to enhance an understanding of communication (e.g., Pearce 1989), conflict resolution (Gray 1989), cooperative decision making (McCay 1988; Pinkerton 1988, 1989) and the interfaces among scientific, political and organizational knowledge (Clark 1993). We suggest the criteria for hiring new recruits, as well as promotions, be based on the skills anticipated as characterizing the "reflective scientist" of the future (Schon 1983; Thomashow 1995; Clark et al. 1994).

Second, our work points to a possible reconsideration of desirable career trajectories. Currently, some agencies encourage relocation for career advancement. This ignores the importance of trust with user-groups, which may develop over a long time. Underlying this strategy is the assumption that a manager's knowledge of the resource is always more important than knowledge of the user community and locality. However, trust is a form of "social capital," hence a resource itself (Putnam 1993). Although agencies can risk intellectual stagnation and agency capture if the majority of their personnel stay in the same assignment for a long period of time (Clarke & McCool 1985), advancing in one's career should not be based on moving to a new assignment. Possible strategies for avoiding capture of individuals in long-term assignments include mid-career training and sabbaticals in other content and geographical areas (Yaffee 1994).

Third, these results point to the need for an exploration of the appropriate relationship between local and scientific knowledge, and by extension, the appropriate role of resource-dependent communities in management. The deficit model assumes that scientific models always describe the world more accurately than local models, but a growing body of literature illustrates the value of local knowledge in the context of a cooperative decision making model for management. For example, Kloppenburg (1991), Ruddle (1994), and Chambers (1983) point to the dynamic nature of local knowledge and its value to state management. Local knowledge is not static and tradition-bound, but experiential and changing (Johnson 1972). Another area of investigation has been the accuracy of local knowledge. Local ecology is often cited as an example of a cognitive domain with a high degree of scientific validity (Horton 1967; Brokensha et al. 1980; Johannes 1981; Pinkerton 1989; Wynne 1989). Maritime anthropology, in particular, has focused on self-regulation based on local knowledge (Acheson 1975; McCay 1980; Anderson 1994; Berkes & Pocock 1987). Self-regulation is based on rules of access that can be expressed through systems of property rights (Acheson 1975; Schlager & Ostrum 1992), seasonal, species, and size restrictions (Johannes 1981), and ritual and taboo (Anderson 1994). The integration of local knowledge into a cooperative management framework

cannot guarantee regulatory success. However, management by a cadre of scientific experts has suffered from both a series of management failures and resistance from user groups (Dryzek 1987; Paehlke & Torgerson 1990).

We conclude with two caveats. First, although our recommendations focus on the duties of professional managers to cooperate with their constituents in the management of natural resources, we recognize that as consumers and stewards of public resources, user groups also have duties. These have been cogently summarized by Pinkerton and Weinstein (1995) as the duty to (1) engage in long-range planning; (2) educate the larger community regarding problems; (3) protect, enhance, and restore habitat; (4) enforce rules; (5) communicate problems and resolve disputes. Fulfillment of these management duties/functions by user groups would enhance their credibility as stewards in the eyes of resource managers and would be a significant factor in gaining the trust of managers.

The second caveat concerns reflexive practice. Academics also need to be reflexive and in this spirit, we recognize that as academics we are in the enviable (compared to agency staff) position of being free to make recommendations we do not have to execute. We have recommended measures designed to democratize resource management which probably seem naive to some of our agency colleagues. They might protest that legal mandates, institutional norms and structures, and user-group conflict impede cooperation in management. Successful management depends on a cluster of factors, open communication being only one of them. It is, however, a key factor and we stress that it is one over which the individual, rather than the institution, has a large measure of control.

We have illustrated how a complex set of factors may influence the manner in which user groups actively appropriate or reject scientific evidence, in direct contrast to the deficit model of communication between scientists and non-scientists. We have outlined four dimensions on which user groups may differ in ways that influence how scientific information is accepted and touched on a larger body of social science literature that identifies other factors. We would like to encourage more quantitative approaches to examining the validity of some of the relationships among factors identified in this qualitative analysis. We suggest agency scientists and their organizations incorporate knowledge of the social context of science into their decisions influencing user groups and the scientists that interface with them.

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