Williams, E. S., E. T. Thorne, M.J.G. Appel, and D. W. Belitch. 1988. Canine distemper in black-footed ferrets (*Mustela nigripes*) from Wyoming. *Journal of Wildlife Diseases* 24:387–398.

Wilson, J. Q. 1980. *The Politics of Regulation*. New York: Harper.

Yaffee, S. L. 1982. *Prohibitive Policy*. Cambridge: MIT Press.

5

The Yellowstone Grizzly Bear Recovery Program

Uncertain Information, Uncertain Policy

David J. Mattson and John J. Craighead

Management of Yellowstone's threatened grizzly bear population (*Ursus arctos horribilis*, Figure 5-1) has a long history of often reported but poorly understood controversy. This history, though troubled, is a rich source of lessons about the management of a threatened species. Perhaps in no other arena is there so much need for adaptive organizational learning—given that the room for management error is so small and the consequences irreversible. By legal as well as biological definitions, endangered and threatened species are at great risk of extinction and require high-performance management to ensure their survival.

Here we examine individual and organizational behavior associated with grizzly bear conservation and offer some lessons that, if applied, could enhance the prospects for the bear's survival. Consequently we emphasize the performance of key figures and government agencies holding responsibility for research and management and will not dwell on the natural history of the population. Clearly, our analysis is bounded by our experiences and vantage point. Different experiences would highlight different factors. Accordingly, the views we express are not those of any organization or agency. Our experience with research and management of Yellowstone's grizzly bear population spans thirty-five years (1959–1993) and two major research projects that have involved us at the heart of the bear's recovery process. Thus we offer our informed perspectives with the hope that, through wise application of the Endangered Species Act, Yellowstone's grizzly bears will survive in perpetuity.

FIGURE 5-1. The grizzly bear. (Photo by Bart O. Schleyer, Interagency Grizzly Bear Study Team.)

Some History and Context

To understand the present manifestations of grizzly bear research, management, and the recovery program in the Greater Yellowstone area, it is essential to understand some of the biology and history that has structured management programs and shaped risks and benefits for researchers and managers. In this section we review some relevant history and identify key players and processes.

Grizzly Bears and Humans

Grizzly bears are large-bodied, wide-ranging omnivores (Craighead 1976; Craighead and Mitchell 1982; Blanchard 1987; Blanchard and Knight 1991a), and, because of their size and feeding habits, they are direct and often physically threatening competitors for virtually all foods valued by humans (Mattson 1990; Craighead et al. 1994). Although the grizzly rarely causes human death or injury, the bear's size, claws, dentition, and demeanor make it at times, and under certain conditions, a threat to human safety (Herrero 1985).

Almost universally the cause of grizzly bear population declines and extinctions has been direct human-caused mortality and associated habitat usurpation by European settlers (Craighead and Mitchell

1982). Habitat modification is usually only a peripheral factor (Mattson 1990). Even though conflict between humans and grizzlies did intensify after European settlement, grizzly bears and aboriginal North Americans were dissociated even under primeval conditions (see Driver 1969), plausibly due to competition. The documented decline of grizzly bears started shortly after contact with European settlers (Storer and Tevis 1955; Brown 1985), and by the 1920s grizzly bears were extinct in over 95 percent of their former range in the conterminous United States. At that time they existed in only small isolated populations in remote areas (Servheen 1989).

Although habitat relationships of grizzly bears are complex, in general their survival is a function of a simple negative relationship with humans. This pattern is evident worldwide, regionally, and within occupied grizzly bear habitat (Craighead 1980; Mattson 1990). Today grizzly bears survive only in extensive wilderness areas—in the conterminous United States principally as four "populations" in the northern Rocky Mountains (Craighead and Mitchell 1982, Servheen 1989). Yellowstone's grizzly bears are one of the two largest remaining populations and comprise a significant portion of the estimated remaining seven to nine hundred bears (Servheen 1989).

Recent History

The first intensive field study of Yellowstone grizzly bears was conducted by Dr. John Craighead and Dr. Frank Craighead, Jr., from 1959 through 1970. (For an overview see Craighead et al. 1974, 1994; Craighead and Mitchell 1982.) During this study, grizzly bears concentrated at open-pit refuse dumps and used human-origin foods, both inside and outside the park. Late in the Craighead study (1967–1970), Yellowstone National Park (YNP) instituted a policy of "natural regulation" based on the agency's interpretation of a paper by Starker Leopold and his colleagues (Leopold et al. 1963) that called for national parks to preserve "the primitive scene." This policy included the termination of herd reduction programs for elk (*Cervus canadensis*) and bison (*Bison bison*) in the park and, more important for the bears, abrupt closure of the open-pit refuse dumps.

Later two conflicting hypotheses were posed—one by the Craighead research team based on analysis and interpretation of their extensive data base and one by Glen Cole, a research biologist for YNP, based on tenuous and typically anecdotal information. According to the Craigheads, abrupt dump closures would have substantial negative effects on the grizzly bear population by lowering the stability,

quality, and abundance of food. This would cause wider-ranging movements into unprotected areas as well as increases in human/bear conflicts. As a consequence, they postulated catastrophic effects, one of which would be greatly increased bear mortality. Alternatively, Cole postulated that dump closures would not have catastrophic consequences to the grizzly bear population because additional bears, not accounted for in the Craigheads' research, did not use the dumps. These unaccounted bears, as well as declines in density-dependent mortality, would buffer negative population effects from dump closures.

Research over the last twenty years provides no conclusive basis for rejecting either hypothesis regarding the ultimate effects of the dump closures on population viability—due partly to the long life span of grizzly bears and the correspondingly long time required for reliable determination of demographic effects. In all other respects, however, the Craigheads' hypothesis was confirmed. Food supplies declined; population structure destabilized; and movements and conflicts with humans increased (Mattson et al. 1991, 1992; Craighead et al. 1994; Craighead and Craighead 1971). More important, of the 222 to 350 grizzlies estimated to have existed in 1967 (Cole 1973; Craighead et al. 1974), at least 127 were killed over a three-year period (1969–1972) during and immediately after dump closures, primarily by legal hunters and management agencies (Craighead et al. 1974, 1988). After 1970, YNP administrators prohibited further research by the Craighead team in the park and no other research program was in place until 1974 to monitor the effects of dump closures. This lapse in data collection (1971–1973) greatly complicated the interpretation of demographic data in the years that followed.

The Interagency Grizzly Bear Study Team (IGBST) was created in 1973 as a result of the controversy over dump closures. The team is administered by the National Park Service (NPS) and initially consisted of three members, one each from the NPS, U.S. Fish and Wildlife Service (FWS), and U.S. Forest Service, plus cooperating members from the states of Montana, Idaho, and Wyoming (Committee on the Yellowstone Grizzlies 1974). Since its inception, the IGBST has been the primary source of information on Yellowstone's grizzly bear population and has borne primary responsibility for research. The IGBST's formal membership now consists entirely of two NPS personnel, however, although research conducted by the Wyoming Game and Fish Department and Idaho Cooperative Park Studies Unit is informally included in the IGBST program. Not only

does the team's current composition no longer reflect the diversity specified in its initial charter but, more important, it does not reflect the original recommendation of the National Academy of Sciences (NAS) committee that reviewed research needs in 1974 (Committee on the Yellowstone Grizzlies 1974)—that most research be conducted by nonagency scientists. Although the history of this attrition in personnel and inattention to NAS recommendations is obscure, it has resulted in a research team with less technical breadth and depth and subject to control by a single agency.

The Yellowstone grizzly bear population was listed as threatened under provisions of the Endangered Species Act (ESA) in 1975. Ecosystem-wide coordination of grizzly bear research and management was at first exercised by the Interagency Steering Committee, a group of research administrators and midlevel managers instituted in 1975 (Committee on the Yellowstone Grizzlies 1974). Among its other tasks, the Steering Committee provided general review and direction for the IGBST research program. The ESA also specified management oversight by the FWS that has been amplified since 1979 by the activities of a Grizzly Bear Recovery Coordinator, whose tasks include writing and revising a recovery plan for grizzly bears in the conterminous United States. Initially little was done after listing to modify existing management practices, although efforts to reduce availability of human-related foods, especially in YNP, were continued (Primm 1993).

In 1982 the IGBST and the Interagency Steering Committee recognized a crisis—based on two years of high bear mortality (1981 and 1982) and a draft demographic analysis suggesting that the population was still in decline. This high mortality was human-induced and attributed to continuing availability of human foods in communities surrounding YNP and on Forest Service lands. In response to this crisis, the Steering Committee dissolved itself and recommended the formation of a replacement committee comprised of high-level managers with decision-making authority to deal more effectively with the problems facing Yellowstone's grizzly bears. The Interagency Grizzly Bear Committee (IGBC), which embodied the recommendations of the Steering Committee, was subsequently formed in 1983 by an interagency memorandum of agreement (Primm 1993). More restrictive management of human-related foods and more consistent protocols for management were instituted under the auspices of the IGBC and elaborated in the most recent (1986) Interagency Grizzly Bear Guidelines (Mealey 1986). Subsequent to implementation of

these guidelines, grizzly bear mortality is believed to have declined substantially.

In 1988 wildfires burned a large percentage of Yellowstone's occupied grizzly bear habitat—the most substantial restructuring of habitat and food resources in the Yellowstone area since closure of the open-pit dumps. Again, as with the dump closures, the ultimate effects of these fires on the population are likely to be revealed only after a long period of time, some twenty to thirty years. Although positive or neutral effects have been postulated (Greater Yellowstone Coordinating Committee 1989; Blanchard and Knight 1991b), there is a strong basis for hypothesizing long-term negative effects that derive from potential redistribution of bears to unburned areas on the ecosystem's less protected periphery and reduction in abundance of high-quality foods such as whitebark pine (*Pinus albicaulis*; Mattson and Reinhart 1994).

Current management of Yellowstone's grizzly bears is directly shaped by just a few key figures and documents. The 1993 recovery plan, individual National Forest Management Act forest plans, the Interagency Grizzly Bear Guidelines, and ESA Section 7 consultations with the FWS provide the primary guidance for grizzly bear management in the Yellowstone area. Because Section 7 consultation draws heavily on the recovery plan and was used in formulating forest plans and the guidelines, the recovery plan has served as the key document guiding grizzly bear management in the Yellowstone ecosystem (Primm 1993). The strategic direction of management, therefore, is largely dependent on the FWS recovery coordinator, who is the sole author of the recovery plan. There has been no formal recovery team or fixed program for formal consultation to guide the recovery effort or the development of the recovery plan.

The current political climate of the Yellowstone ecosystem is relatively conservative. Seven of the nine current congressional delegates from the states of Idaho, Montana, and Wyoming with districts that include Greater Yellowstone are conservatives with a history of favoring extractive, consumptive uses of public lands and limited government regulation on private land (Primm 1993). There are also currently a number of local industries—timber, livestock, mining, tourism—reliant on public lands for resources and income. In addition, the regional real estate industry has a stake in the transfer of private lands from commercial agriculture to smaller residential or recreational holdings. These political and economic interests have a direct stake in defining the problems associated with managing Yellowstone's grizzly bears and favor continuing land uses that have historically caused human/bear conflicts and grizzly bear mortality (Primm 1993).

When Are Grizzly Bears "Recovered?"

As we will see, there are two major definitions of the current grizzly bear situation. Most of the debate surrounding these competing definitions has been mired in technical rationalization and has not addressed the associated policy and organizational issues. We argue that uncertainty in scientific information and in ESA policy design, deference to current economic interests, different scientific conceptualizations, and discretion in agency implementation are at the heart of divergence between these two definitions. Consequently in this section we elucidate these normative issues and show how they have shaped perceptions and management of the Yellowstone grizzly bear population's status. Clearly, there is no single way of seeing the plight of Yellowstone's grizzly bears (see Clark 1993). Nevertheless, some perceptions are shaped more by biological information—that is, reliable information—than others.

From the outset, ESA policy design has introduced uncertainty into grizzly bear management by not specifying vital normative criteria. In particular, ESA policy prescription does not specify:

1. Timeframes for management (whether we are managing for persistence of species over 100, 200, or 1000 years)
2. Levels of confidence at which we want to manage (whether we want 70, 90, or 99 percent confidence of having a species persist for the specified time)
3. A protocol for managing uncertainty or allocating burden of proof
4. Explicit biological goals at the population level (whether we are managing demographically, genetically, or both)

Although biologists have something to contribute, all of these issues are fundamentally valuational and need to be clarified in future ESA legislative design. Furthermore, all of these issues are absolutely critical to providing a clear direction for management. Without legislative specificity, ESA implementation is left up to agency discretion and hence to political and economic influences.

The importance of uncertainty to management cannot be overstated (Panem 1983; Committee on Applications of Ecological Theory to Environmental Problems 1986; Walters 1986). The available scientific information is virtually never so definitive and explicit that only one course of management action is obvious. Yet only one management choice and implicit hypothesis will be the most biologically defensible at any one time, recognizing that as the amount of reliable knowledge increases, the biologically most defensible management choices may change. Although the ESA calls for use of "the best available data," it does not clearly require that threatened and endangered species management be based on the biologically most defensible data or hypotheses. Nor does it require that, in the face of scientific uncertainty, deference should be given to the postulated needs of species at risk.

Management of Yellowstone's grizzly bears over the last twenty years has been further complicated by considerable scientific uncertainty over the status, trend, and distribution of the population—primarily as a consequence of long-duration research projects that have yielded relatively small data sets. From the outset, sampling problems were severe because grizzly bears exist at low densities and are hard to observe in Yellowstone's primarily forested environment. Biases and incompatibilities among data attributable to different methods are not trivial if for no other reasons than the 35-year span of research involving two different studies and the study area's large size (about 23,000 km^2 according to Blanchard et al. 1992). But these inherent problems have been compounded by the behavior of agency managers and biologists—particularly during the transition between the Craigheads' and IGBST research programs. Most bears marked during the 1960s were either killed or had their individual markers removed, while research within the park was limited to indirect techniques based on visual observations. Not until 1974 was the IGBST allowed to radio-mark bears and collect the data necessary to develop individual life histories comparable to those obtained by the Craighead team. Thus, despite the duration and intensity of grizzly bear research in the Yellowstone ecosystem, it has been difficult to obtain reliable and precise estimates of population and habitat status and trends. Despite three decades of intensive research and several million dollars' expense, we remain plagued by considerable scientific uncertainty. Ironically, a significant part of this uncertainty has resulted from the decisions of agency managers and biologists themselves—especially

during the critical transition years following dump closures—and despite the recommendations of the NAS review committee.

As might be expected, this uncertainty in science and ESA's design sets the stage for ambiguous and contradictory definitions of problems facing Yellowstone's grizzly bears. It fosters disputation of management goals and appropriate methods for monitoring and managing the population and its habitat. It shifts much of the burden of making or reshaping ESA policy onto the shoulders of agencies and civil servants. As a result, the real ESA policy is made by those who implement it (Mazmanian and Sabatier 1983; Houck 1993; Chapter 17). This broad agency discretion in policy implementation, rather than bridging conflicting interests, more often contributes to polarization of constituencies and issues. More important, this combination of limited information and agency prerogative fosters management that is detrimental to the grizzly bear population's long-term survival—especially in cases where an agency has its own interests at stake or is captive to the interests of consumptive resource users (Yaffee 1982; Primm 1993).

Agencies often view uncertainty as license for preserving the status quo or promoting politically expedient ideologies (Pfeffer et al. 1984; Primm 1993). For many years the Forest Service underestimated the importance of information suggesting that road access associated with timber harvest harms bears; indeed, the service even used tenuous assessments to argue the benefits of clearcutting to Yellowstone grizzlies. More recently, because the FWS does not address the potential effects of scientific uncertainty in its 1992 recovery plan revision, criteria for recovery are, not surprisingly, compatible with existing consumptive land uses. Similarly, the definition and designation of prioritized management situation areas within the grizzly bear recovery zone (Mealey 1986) are also strikingly compatible with preexisting human activities and land uses. Not only have these designations failed to reflect the intent of Congress when it called for critical habitat designations (U.S. Congress 1977), but they are not based on any substantive biological evaluation of the habitat (Mattson and Reid 1991). This kind of rationalized agency management is a predictable consequence of the marked incompatibility between grizzly bears and humans and the opportunities to exploit uncertainty in order to provide services, jobs, and access for humans.

Thus it is not surprising that there are two major competing views of the status and future prospects of the Yellowstone grizzly bear

population. One view is implicit to the most recent recovery plan (U.S. Fish and Wildlife Service 1993); the other is described in publications by Mattson and Reid (1991), Shaffer (1992), and Craighead et al. (1994). The FWS definition given in the 1993 recovery plan postulates that the Yellowstone grizzly bear population will be recovered within thirty to forty years. Furthermore, the plan assumes that population sizes derived from an analysis done in 1978 (Shaffer 1983)—assuming 95 percent probability of persistence for one hundred years—are appropriate standards for assessing long-term population viability. Furthermore, the draft FWS recovery plan assumes that potential catastrophic and long-term habitat changes are not explicitly relevant to assessing population viability or setting recovery goals. Finally, it assumes that indices with indeterminate or unexamined biases are adequate for monitoring population size, trend, and distribution in a way that produces reliable knowledge.

The alternative definition is that long-term viability should be assessed according to more recent advances in conservation biology that invoke longer time frames—especially for long-lived animals like grizzly bears—and that much larger populations and new management concepts are needed to ensure long-term persistence (Chapter 12). This definition asserts that potentially catastrophic or long-term habitat changes are important to assessing long-term population viability and setting recovery goals (see Pimm et al. 1988; Thomas 1990). Finally, proponents of this definition argue that status and trends of the grizzly bear population and its habitat should be monitored using direct estimates of critical parameters or by using indices with few (and controllable) biases.

These two definitions are in direct conflict. In practical terms, the FWS definition implies that the Yellowstone grizzly bear population has recovered—given that the population currently satisfies most if not all of the recovery criteria written into the most recent draft recovery plan (Craighead et al. 1994). Conversely, the alternative definition implies that the population is not recovered or that its status cannot be determined with sufficient reliability to allow any confident conclusions and, as a consequence, the Yellowstone population is still in need of full ESA protection.

These two definitions require substantially different management responses. The FWS definition clearly accommodates the status quo and seems to accommodate further human development. For this reason, the FWS definition is likely to be favored by local industries and hence garner the greatest local political support. In contrast, the

alternative definition at most accommodates the status quo but implies reduction of current levels of human activity. This definition assumes that successful conservation of Yellowstone's grizzlies will require new economic concepts (Rees and Wackernagel 1992; Wackernagel and Rees 1992) and the adoption of less exploitative natural resource management (Craighead et al. 1994).

Differences in these two definitions are obviously a result of different values and perceptions. A bear population with the same characteristics could be considered "recovered" or "not recovered" depending on the time frame and level of confidence used for the evaluation and whether future catastrophes or uncertainties in habitat conditions were considered. In other words, the clash of definitions is rooted at least partly in divergent values focused on questions of how long we want grizzly bears in the Yellowstone ecosystem and how confident we want to be that a viable population will exist at the end of that time. From this perspective, it is likely that formal adoption of one or the other definition will ultimately be determined by the political clout of the opposing parties, including interests inside and outside the management agencies. If these political interests prevail, rather than the interests promoting conservation science, there is little reason to think that the Yellowstone grizzly bear population will survive.

Other differences in these two definitions relate to substantive scientific and biological issues that could well be addressed in the technical arena—such as the capacity of present analyses to provide reliable estimates of relevant population parameters and the adequacy of indices proposed for monitoring the population. But to date there has been very little scientific discussion of these issues. Not only has access to relevant data been limited by the government, but there has not been sufficient time to fully evaluate proposed uses of indices that were revealed in the recently revised recovery plan.

Thus, ESA policy design allows competing constituencies (such as the commodity extraction industries) to exploit scientific uncertainty in order to define the problems facing Yellowstone's grizzly bears in terms of their own perceptions of the situation. This reality has often been clouded by ad hoc technical rationalization. Because pro-consumption industries have historically held the greatest political clout and have consequently been able to shape agency behavior in favor of their agendas, grizzly bear management in the Yellowstone ecosystem has typically favored definitions that make the least imposition on resource extraction (Primm 1993). Under this arrangement,

recovery will continue to be defined in the politically and economically most expedient ways—so long as ESA policy does not deal with critical normative issues (such as the parameters of population viability) and so long as the collection of critical technical information remains solely the domain of management agencies.

Implementing the Recovery Program

Formal endangered species policy is written in the ESA, but the real policy is made by the ESA's implementers. This section describes the reality of policy implementation as we have experienced and understood it. It obviously reflects our values, expectations, and perspectives, which are not shared by everyone involved in grizzly bear conservation. As mentioned earlier, several factors play themselves out in implementation of grizzly bear recovery: ESA policy prescriptions, science, agency discretion, and various political and economic interests. Lindblom (1980) calls this the "play of power." The interaction of these forces—not only through problem definition but in more specific aspects of the grizzly bear recovery program—are illustrated here by examining information flows, information feedback loops, monitoring of implementation, and professional behavior (see Morgan 1986 and Clark et al. 1989).

We have two reasons for taking this approach to examining implementation. First, there have been successes in managing Yellowstone's grizzly bears, such as the cleanup of human facilities and the adoption of a uniform standard for management. Yet it is also clear, as is usually the case in complex programs, that the program could have done significantly better. This, in part, speaks to our expectations. By examining both the strengths and weaknesses of past efforts, we may arrive at a better guide to future action. Second, it is also likely that a new era of more difficult management lies ahead (Mattson and Reid 1991). If this is true, then it is vital to review and discuss how information is collected, used, and legitimized in the grizzly bear recovery program as a basis for meeting foreseeable as well as unforeseeable management challenges.

Information Flows

The information used by key decision makers responsible for the recovery of Yellowstone's grizzly bears originates from a variety of sources including science, law, agency culture, and society at large

(Clark 1993). Information is typically distilled (reduced in detail and biased) as it is passed into agencies and transmitted through the hierarchy from technical specialists to top-level decision makers (Ingram 1973; Sabatier 1978). Some distillation is necessary, of course. Researchers and lower-echelon specialists need to reduce the information's volume and detail to accommodate the limited time and technical expertise of higher-level managers. Even so, most analysts agree that substantial distortion of information impedes effective management and can even put resources at risk (Ingram 1973; Sabatier 1978; O'Reilly 1980; Clark 1993). This is an especially apt concern in the case of Yellowstone's grizzly bears. Our experience suggests that biological information suffers great distortion—unlike the information received directly from elected politicians or that which is rooted in agency culture (see Primm 1993).

Ultimately, we found that most of the distortion was attributable to four factors: insufficient time and resources to locate and integrate available information, both theoretical and specific; insufficient training to provide the necessary theoretical and conceptual context; the agency's resistance to outside collaboration; and subtle but real coercion of lower echelons to meet the expectations of supervisors (Ingram 1973; Sabatier 1978; Pfeffer et al. 1984). When all four factors were at work, gross distortion of basic biological knowledge was virtually guaranteed.

Lack of adequate time and training clearly takes its toll on information collected by agency specialists. Many technical specialists have a short tenure but are required to become experts on numerous highly complex issues. An agency biologist in the Yellowstone ecosystem, for example, may have to deal with issues relating not only to grizzly bears but also to great gray owls (*Strix nebulosa*), boreal owls (*Aegolius funereus*), migratory birds, American marten (*Martes americana*), elk, black bears (*Ursus americanus*), moose (*Alces alces*), bison, and others. This predicament is sometimes exacerbated by both official and unofficial impediments to soliciting assistance or information from outside the agency, often asserted in terms of agency pride ("We can take care of the job ourselves"). Occasionally outside consultation is viewed as a constraint to established agendas. This is particularly true when these agendas emphasize consumptive resource uses potentially at odds with management actions favoring grizzly bears. Regardless, these factors hamper both the collection of reliable and timely information by agency specialists and the incorporation of new techniques and research findings into the management process.

Coercion is probably responsible for most distortion of biological information. Typically this coercion is a result of budget allocations, job performance standards, and agency cultures. Nonetheless it results in highly selective transmittal or reconfiguration of information (see Bacharach and Lawler 1980). Within the Forest Service, for example, there are often direct and quantifiable performance standards that pertain to timber production goals. These standards are often at odds with standards pertaining to grizzly bear conservation, which are much more ambiguous and more easily circumvented. Similarly, in most ranger districts far more budget dollars are tied to timber programs than to grizzly bear management. Thus endowment of a position and potential for career advancement are more closely tied to facilitating timber production than to conserving grizzly bears. Supporting these observations, Twight and Lyden (1989) found that the Forest Service was captive to timber interests, although Brown and Harris (1992) report encouraging evidence that this bias is slowly changing. In the same way, NPS career opportunities and budgets are more closely tied to providing visitor services, protection, and law enforcement than to enhancing conditions for grizzly bears. This allocation of emphasis by both the Forest Service and NPS can be fundamentally at odds with the ESA's directives for ranking the conservation of grizzly bears over other resource uses on public lands within the Yellowstone recovery area (Keiter 1991; Kuehl 1993).

On some occasions, coercion is more direct—particularly when the technical expertise and information compiled by a grizzly bear specialist conflicts with existing or proposed management programs. (See Bacharach and Lawler 1980; Twight and Lyden 1988; Brown and Harris 1992.) Direct coercion is often couched in terms of "being a team player" and typically involves slander, threats to career advancement, and curtailment of travel and professional responsibility. We personally observed at least eight instances of such coercion related to grizzly bear management. Coercion directed at people outside of agencies is not uncommon. It occurs through public news releases and interviews, and involves attacks on the person's character and motivations as well as misrepresentation of professional work. The cases of Adolf Murie after publication of *Ecology of the Coyote in the Yellowstone* (1940) and the Craigheads after submission of their grizzly bear management report (*Management of Bears in Yellowstone National Park*, 1967; Frome 1984) are two noteworthy examples.

Self-justification is a typical reflexive response for most organizations when threatened (Yaffee 1982; Mazmanian and Sabatier 1983).

In the case of Yellowstone's bears, for example, NPS newsletters and news releases in the 1970s frequently referred to a recovered backcountry population of three hundred grizzlies, with little or no reference to the source or reliability of the information. Similarly, NPS news releases and information papers until recently stated that black bears were numerous in Yellowstone's backcountry when, in fact, no substantive data support this statement and approximately 340 black bears were known to have been killed during the 1960s. When these public-management tactics are employed, both the public and resource administrators are done a great disservice.

Sometimes grizzly bear researchers and technical specialists, perhaps in common with researchers in any politically heated situation (Westrum 1986), produced and passed on distorted or incomplete information to managers. Most notably, we observed inclusion of unreliable or misleading information in key management efforts or documents such as the 1993 FWS recovery plan and official cumulative-effects analysis (Mattson and Knight 1991). We could only partly attribute these deficiencies to coercion or inadequate time and resources.

Other causes of technical failure, especially among grizzly bear specialists and researchers, were internal in nature: an unwillingness to consult and collaborate with other (especially nonagency) experts and scientists and an inability or unwillingness to incorporate recent advances in population and habitat analyses and conservation biology into their work. For example, long-term viability of the Yellowstone grizzly bear population has been only cursorily addressed in formal management. Little of the technical expertise or conceptual advances in population viability modeling have been used; instead, point population estimates have been the main criterion for judging future population prospects. Consequently, management issues related to long-term population viability have not been adequately communicated to managers; instead, short-term considerations have been emphasized (Mattson and Reid 1991). Similarly, agency researchers and biologists have failed to directly address the importance of uncertainty to long-term management and some have even displayed outright hostility to the idea.

This unwillingness to incorporate the work of nonagency scientists has also been evident in approaches to evaluating grizzly bear habitat. Although a variety of techniques are applicable, depending on the specific management or study area conditions (Mattson and Knight 1989), supervised satellite mapping is perhaps the best approach to

evaluating extensive nonroaded areas (Craighead and Craighead 1991; Craighead et al. 1982). Although the technology for this approach has been available for over a decade, agencies have either ignored it, or, when embracing it, have reinvented the wheel. The pioneering work by nonagency scientists using LandSat data to evaluate grizzly bear habitat in the northern Rocky Mountains of Montana (Craighead et al. 1982) has neither been used nor credited in subsequent Forest Service efforts. The most plausible explanations for this behavior are shortcomings in technical training, job insecurity, influence from high-level administrators, or simply an attempt to take undeserved credit.

Management is only as good as the information it gets—and uses. Our experience suggests that much of the information reaching grizzly bear managers in the Yellowstone area has not been reliable or complete. This problem is rooted in distortion arising from inadequate time, resources, and training, but also, more importantly, from coercion of agency technical specialists by upper echelons. Thus much of this problem can be ascribed to the actions of key decision makers and scientists, whether by design or not.

Information Feedback Loops

The speed at which feedback travels to key decision makers from politicians, from other organizations, and from the biological system itself in response to management actions varies according to a predictable pattern (Ingram 1973; Sabatier 1978). Virtually all managers and researchers involved with Yellowstone's grizzly bears seem to receive faster—and more forceful—feedback from their parent or government agencies, from various interest groups, and from elected political agents concerning the implications of their actions than they do from their own investigations of biological systems. As a result, managers appear to respond almost wholly to the social process rather than to biological knowledge when making decisions. This is inevitable and not necessarily harmful. But problems sometimes arise that thwart biological solutions to the problems. For example, most nongovernmental organizations and political agents have partisan agendas that may or may not coincide with ESA or reflect the most reliable biological knowledge. Consequently, the ability of managers to implement ESA with fidelity depends on how influenced they are by such feedback versus how well ESA's prescriptions are formally and informally supported by the agency's culture and structure. Our experience tells us that many grizzly bear managers and their administrators are highly responsive to local interests, because agency feedback

emphasizes natural resource consumption, job continuity, and commodity interests over conservation.

Feedback concerning the impact of management decisions on Yellowstone's grizzly bears often carries little weight simply because of the long time lags involved. Until the recent completion of a thorough assessment by Craighead et al. (1994), for example, there had been insufficient information to assess conclusively the impacts of the late 1960s open-pit dump closures. Thus the clear consequences of an agency's management actions to Yellowstone's grizzly bears are rarely revealed to decision makers during their tenure, while the political consequences are immediate and forcefully manifest. This asymmetry suggests that managers and researchers responsible for threatened and endangered species should be shielded from local, short-term interests. Instead they should operate in an environment where reliable biological knowledge is given more weight, including an explicit mechanism for dealing with scientific uncertainty.

But even when management agencies are set up to use biological information, their response is still only as good as the information they receive. In the case of the Yellowstone grizzlies, feedback on population and habitat status has come largely from "unconfirmed" demographic indices. The current draft FWS recovery plan proposes to set targets and monitor population status based on annual counts of "unduplicated" females accompanied by cubs-of-the-year, the distribution of females with young within the recovery area, and known annual grizzly bear mortality—with the proviso that these indices are treated as running means (U.S. Fish and Wildlife Service 1993). As indicated earlier, all of these indices are severely biased and not yet subject to widespread critical review by the scientific community (Craighead et al. 1994). The FWS recovery plan also fails to set goals and provide a means for maintaining or monitoring habitat. This shortcoming could be catastrophic for the bears. Without some indication of habitat status and trend, untenable habitat conditions could go undetected by demographic indices until it is too late for remedial action. Furthermore, this shortcoming is at odds with the ESA prescription. Thus it appears that Yellowstone grizzly bear management will continue to be limited by unreliable and inadequate feedback from the biological system itself—the bear population and its habitat.

Monitoring Implementation

The FWS, which has monitored grizzly bear management since the Yellowstone population was listed under the ESA in 1975, has manifested all the shortcomings described above. This behavior, in

turn, has led to highly variable performance (arguably a result of dif ferences in state-level supervision) at higher administrative level and resulted in the politicized context. Yaffee (1982) and Houck (1993) view the behavior of the FWS as the means by which a pro hibitive law has been transformed into a discretionary permit system. As Houck (1993:358) states: "The risk is, of course, that the compro mises arrived at through agency interpretation of the [ESA] will only prolong the process of species decline."

The inability of the FWS to provide consistent monitoring has been manifest in several ways. Virtually all research results to date suggest a profound incompatibility between grizzly bears and humans (Craighead 1980; Mattson 1990), for example, and timber harvesting, road building, human visitation, and development of private lands have all increased substantially over the last three decades. Yet the FWS issued only two Section 7 jeopardy opinions in twenty-one consultations on projects for one state's portion of the Yellowstone area between 1977 and 1992. Section 7 consultation apparently gave priority to reducing agency conflict and as a consequence primarily supported the status quo or nominal mitigation (Houck 1993). The FWS also failed to take the lead in defining issues, estimating problems, and providing or accepting reliable methods to monitor the population and its habitat. This shortcoming has been especially clear in formulation of the most recent revision of the FWS's grizzly bear recovery plan.

The 1974 NAS committee also provided review and nonbinding oversight as part of an investigation into the controversy surrounding the late 1960s closures of open-pit dumps. Such a committee is ostensibly a good idea—especially if it can provide a truly independent review focusing on scientific issues and using reliable information. Yet we observed that such a committee can also be subject to personal and partisan influences—especially when the agency that solicits the committee's input is the financial sponsor and the members are selected by an active participant in the controversy. This bias can influence the committee's schedule, its composition, its scope of investigation, and, ultimately, its final recommendations. Indeed, in this instance we observed that the NAS committee did not provide unbiased scientific input or professional scientific follow-up, showing that this approach to independent review is not always successful and that the NAS should establish better guidelines for nonbinding reviews in which a person is pitted against his government or employer.

Management of Yellowstone's grizzly bears under ESA clearly lacks

adequate monitoring. This shortcoming can largely be attributed to the same basic mechanisms in the FWS that have made the Forest Service and NPS vulnerable to outside pressure, agency culture, and political bias. Again, remedial action will require restructuring of the agency's internal system of rewards and punishment and reconfiguration of feedback to emphasize biological information. Adequate monitoring may also require periodic intervention or review by some independent nonagency panel—given the resistance to conservation that inevitably arises when traditional economic activities are threatened (Heinen and Low 1992).

Professional Behavior

Although there is considerable debate on the appropriate roles of professionals in policy implementation (Clark 1986, 1988; Lindblom 1980; Mazmanian and Sabatier 1983; Harmon 1989), the requirements of professionalism are relatively clear—especially with regard to management of Yellowstone's grizzly bear population. Not everyone involved in grizzly bear research or management shares our views, but most people would concur that our society expresses its priorities through laws passed by the legislative branch, approved and executed by the executive branch, and upheld by the judiciary. We recognize that the process is not always clear. Nevertheless, we believe that it is incumbent upon government employees to execute these laws as fully and consistently as possible, according to the stated or apparent statutory intent, however this is interpreted in light of a sincere analysis. When this is prevented by higher authority, then it becomes the employee's duty to place professional ethics above loyalty to an agency. Admittedly, the employee then runs great risk of an official reprimand or even more severe reprisals should he or she persist. Faced with a highly bureaucratic agency backed by a closed culture and a substantial budget, the employee has little chance of winning.

Civil servants inevitably create the real policy while implementing laws (Lindblom 1980; Mazmanian and Sabatier 1983; Chapter 17), and real grizzly bear conservation policy in the Yellowstone area has been largely shaped by the nature of government bureaucracy and the influence of conservative, pro-consumption, local constituencies, all to the detriment of grizzly bears. Ironically, our society has given preservation of Yellowstone's grizzlies relatively clear priority through the ESA. Thus, unlike the ambiguous and sometimes conflicting laws governing other resources (such as multiple-use laws), managers have a message direct from Congress regarding their management of

Yellowstone's grizzly bears. The discrepancy between the ESA's prescription and the implemented policy suggests that some involved in management or research of Yellowstone's grizzly bears may not have exhibited the highest professional behavior.

It is also incumbent on public employees to use all available information to develop effective research and management programs as a means of fulfilling the ESA. This means that agency researchers and managers should solicit input and assistance from as many sources as possible. Any civil servant who uses data or position for self-aggrandizement or to secure a career breaches the public trust. In this light, we suggest that professionals are obligated to speed the flow of reliable knowledge into and out of agencies, to incorporate the best available information into management, and to update actions as new information becomes available. The agency's structure and culture must not only allow but promote this kind of professional behavior.

Our experiences suggest that too many employees in government agencies involved with Yellowstone grizzly bear research and management have been motivated by careerist goals rather than the primacy of law and information. Similarly, agencies have been resistant to adaptive problem solving: people who exposed problems were removed, silenced, or at best stonewalled; responsibility was ignored or compartmentalized; free, open communication within or among organizations was discouraged or, at most, grudgingly allowed; faulty technical performance was covered up; new ideas were crushed or, at best, perceived as problematic. Westrum (1988) calls such an organization "pathological" or "calculative," depending on the severity of the characteristics. Advocating the use of biological information in either organization is a decidedly risky professional proposition. It is not surprising, then, that a number of employees did not exhibit the professional ideal outlined above in grizzly bear research and management.

What are the prospects for changing the performance of pathological or calculative agencies by appealing to some professional ideal? The chances are poor to nil, for people's behavior has generally evolved to favor short-term self-interest over long-term benefits to society (Heinen and Low 1992). We observed that many people holding professional ideals who entered the agencies responsible for grizzly bear management were either forced out, retained permanently in a lower echelon, or obliged to abandon their idealism (see Westrum 1988). Conversely, many of those who "succeeded" seemed to be the careerists and pragmatists—the ones who were highly responsive to the expectations and agendas of superiors or influential partisans. The agency's selection for these opportunists created self-reinforcing feedback, which in turn created substantial conformity of thought (Twight and Lyden 1988, 1989; Brown and Harris 1992). This groupthink typically favored natural resource consumption over conservation and inculcated pathological or calculative behavior. We also observed professional "goal displacement"—that is, the pursuit of nontask goals, such as personal gain or agency control, over the goal of grizzly bear recovery.

Although one can profess high ideals of professional behavior, this is clearly not enough to change the way that agencies implement the ESA and manage grizzly bears in the Yellowstone area. People's natural risk aversion often combines with an agency's calculative and pathological structure and culture to select for individuals in key management and research positions who are responsive to agency values. Resolution of this problem lies in changing the agencies and creating systemic risks and benefits such that managers are naturally led to pursue fulfillment of the ESA. Resolution also entails transferring more research responsibility to outside researchers.

Lessons

Most of the lessons from our experiences researching and managing Yellowstone's grizzly bear population relate to the distortion and withholding of information, the system of rewards and punishment for action advocates and key decision makers, the allocation of research responsibilities, and the allocation of implementation or normative responsibilities. The eleven recommendations that follow address these four issues and are arranged more or less in order of importance. Some of these lessons are more likely to be the focus of action than others, given the political climate at local and national levels. Although this chapter is not the ideal forum for explicating the details of implementation improvements, we nonetheless offer these lessons in the hope that they can contribute to improved management of endangered species.

First, a thorough analysis of relevant statutes is necessary so that ESA policy prescription is made explicit—with subsequent hierarchical ranking of ecosystem-wide resource goals and then the development of spatially and temporally explicit management objectives. This step is critical because of the overlap and contradiction among

the many laws governing natural resource management in the Yellowstone area and the need to put the ESA in a clear legal and social context. This analysis should be part of regional resource and forest planning and would involve ongoing assessment and updating by specialists. Although the strategic "vision" process carried out by the Greater Yellowstone Coordinating Committee in 1990 is a theoretical example of this type of effort, most analyses conclude that it did not address statutory obligations adequately or explicate an ongoing adaptive process (Clark and Minta 1994; Lichtman and Clark in press).

Second, a rigorous analysis of agency job performance standards and budget allocations is needed to ensure concordance with priorities and objectives derived from the analysis of governing statutes discussed above. Without this step, there will be continued differences in management goals and government agencies will continue to be vulnerable to capture by local partisans. Most likely, a semiautonomous board or panel is needed to perform this function.

Third, increased emphasis and new avenues are needed for soliciting information and expertise from outside the management or research agencies involved in grizzly bear recovery, as well as from nontraditional internal sources. This step could be facilitated by making pertinent changes in job descriptions and job performance standards and by making time and funds available. This end would also be served by diversification of grizzly bear research to include nonagency scientists as recommended by the Committee on the Yellowstone Grizzlies (1974). Research functions are currently concentrated in one federal agency and, consequently, are vulnerable. In this regard, the current research program should be subject to a periodic, critical, and wide-ranging review of its goals, methods, and performance.

Fourth, the flow of newsworthy scientific findings and resource information through agency channels must be upgraded. To accomplish this, public relations writers and staff journalists should adhere to the highest ethical code and undergo thorough review. Again, reports and books treating scientific subjects should also be submitted to outside peer review.

Fifth, better personnel training is needed—both at higher academic levels and on the job—with an emphasis on professionalism, a good knowledge of the law, and an understanding of public policy processes (Clark 1992). Discussions are especially needed in the areas of fulfilling laws, taking personal risks, and emphasizing the completion of tasks when pursuing career advancement. Accordingly, desired behavior should be rewarded by higher job performance ratings or other incentives. Although we recognize that substantive change in agency structure and culture will not be achieved simply by appealing to selfless idealism, our experience suggests that if given the opportunity most people are motivated by appeals to higher ideals. Other things being equal, they will act with greater integrity if such behavior is expected.

Sixth, an explicit protocol is needed that incorporates scientific uncertainty into the estimation of biological parameters (including future population prospects) and into management practices. Given the need for responsive and effective management of threatened and endangered species, this would entail an adaptive (Walters 1986) and an open learning approach (Clark et al. 1989) in which management actions are treated as hypotheses that require testing. Hypotheses selected as a basis for management action should also be the most defensible in light of the most current and reliable knowledge.

Seventh, improved methods of monitoring both the grizzly bear population and its habitat are required. Ideally the population should be monitored by direct estimates of relevant parameters when possible and acceptable indices when not. This would clarify the reliability of population monitoring data and their application to management.

Eighth, any revision of the ESA should include a clear statement of what the act is intended to achieve and why. Moreover, it should explicitly address the normative issues of time frame, level of confidence, and burden of proof. In other words, over what time frame and at what level of confidence are we managing for species or population survival? Should the burden of proof lie with demonstrating that proposed actions *will* harm grizzly bears or *will not* harm grizzly bears? The answers to these questions have paramount implications to management and ultimately species survival. Consequently, we think these issues should not be left solely to the discretion of civil servants but should be addressed by a forum of conservation biologists and high-level policymakers.

Ninth, a recovery team rather than a single recovery coordinator should guide recovery efforts. A single person in such a key position is likely to deal with partisan pressures less successfully than a team and could cause considerable damage to the recovery process if he or she falls prey to venal considerations. Moreover, a team offers a wider range of knowledge, insights, and ideas and would be correspondingly

more successful at dealing with the overall complexities of the recovery process (Clark and Westrum 1989; Chapter 14).

Tenth, a permanent oversight committee should be established to address problems in all threatened or endangered species cases. This committee could examine the progress of recovery and the performance of key figures and organizations. Ideally, the committee would consist of highly qualified specialists, well versed in biological, organizational, and policy issues, who had a reputation for fairness.

Eleventh, interagency management groups like the Interagency Grizzly Bear Committee (IGBC) should be given a monetary stake in management of the Yellowstone grizzly bear population that is independent of individual agency budgets. While we recognize that this would necessitate some administrative restructuring and could lead to management that is related more to empowerment of competing agencies or individuals than to grizzly bear recovery, some incentive is needed to replace the IGBC's current approach.

Recovery of threatened and endangered species requires high-performance management. There is little room for error. With the irretrievable loss of biological diversity at stake, government agencies must strive to perform effectively in the face of uncertainty, complexity, and political pressure. The future of Yellowstone's grizzly bear population is contingent upon the ability of research organizations to collect reliable biological knowledge and the ability of management to incorporate this information expeditiously into decisions and actions. We contend that biological knowledge, rather than political knowledge, should exert the greatest influence on management. There have been many calls for greater sensitivity to the human dimension in threatened and endangered species management in this country. We agree with this need—but only insofar as this receptiveness to human issues supports the ESA mandate for species or population viability. In other words, we are deeply concerned about calls for further compromise and accommodation. Yellowstone's grizzly bears may have already been compromised to the brink of extinction.

The people and agencies responsible for the future of Yellowstone's grizzly bears require the support and the opportunity to make difficult decisions without fear of political or agency reprisal. If society does not wish to incur the costs implicit to these arrangements, it should reexamine its values and its laws. Meanwhile our experience suggests that permitting high-level government administrators and political appointees to reinterpret laws in implementation often creates a no-win situation and thwarts the intent of Congress and the ESA. So long

as this state of affairs continues, grizzly bear populations in the United States will remain in jeopardy.

Acknowledgments

We would like to thank Michael Frome, Maurice Hornocker, Craig Pease, and Roland Wauer for the opportunities, insights, and help they have provided and Steve Primm and Gerald Wright for critically reviewing the chapter. We would also like to pay tribute to Frank C. Craighead, Jr., for the battles he has fought and to all the other dedicated and idealistic people involved in recovery of Yellowstone's grizzly bear population who have taken risks, lived by their ideals, and often incurred substantial personal costs. People as well as grizzly bears have paid a price.

References

Bacharach, S. B., and E. J. Lawler. 1980. *Power and Politics in Organizations.* San Francisco: Jossey-Bass.

Blanchard, B. M. 1987. Size and growth patterns of the Yellowstone grizzly bear. *International Conference on Bear Research and Management* 7:99–107.

Blanchard, B. M., and R. R. Knight. 1991a. Movements of Yellowstone grizzly bears, 1975–87. *Biological Conservation* 58:41–67.

———. 1991b. Reactions of grizzly bears to wildfire in Yellowstone National Park, Wyoming. *Canadian Field Naturalist* 104:592–594.

Blanchard, B. M., R. R. Knight, and D. J. Mattson. 1992. Distribution of Yellowstone grizzly bears during the 1980s. *American Midland Naturalist* 128:332–338.

Brown, D. E. 1985. *The Grizzly Bear in the Southwest.* Norman: University of Oklahoma Press.

Brown, G., and C. C. Harris. 1992. The United States Forest Service: Changing of the guard. *Natural Resources Journal* 32:449–466.

Clark, T. W. 1986. Professional excellence in wildlife and natural resource organizations. *Renewable Resources Journal* 4:8–13.

———. 1988. The identity and images of wildlife professionals. *Renewable Resources Journal* 6:12–16.

———. 1992. Practicing natural resource management with a policy orientation. *Environmental Management* 16:423–433.

———. 1993. Creating and using knowledge for species and ecosystem conservation: Science, organizations, and policy. *Perspectives in Biology and Medicine* 36:497–525.

Clark, T. W., and S. C. Minta. 1994. *Greater Yellowstone Ecosystem: Prospects for Ecosystem Science, Management and Policy.* Moose, Wyo.: Homestead Press.

Clark, T. W., and R. Westrum. 1989. High-performance teams in wildlife conservation: A species reintroduction and recovery example. *Environmental Management* 13:663–670.

Clark, T. W., R. Crete, and J. Cada. 1989. Designing and managing successful endangered species recovery programs. *Environmental Management* 13:159–170.

Cole, G. F. 1973. *Management Involving Grizzly Bears in Yellowstone National Park, 1970–72.* U.S. Department of Interior, National Park Service, Natural Resource Report no. 7.

Committee on Applications of Ecological Theory to Environmental Problems. 1986. *Ecological Knowledge and Environmental Problem Solving: Concepts and Case Studies.* Washington, DC: National Academy Press.

Committee on the Yellowstone Grizzlies. 1974. *Report of Committee on the Yellowstone Grizzlies.* Washington, DC: National Academy of Sciences.

Craighead, F. C., Jr. 1976. Grizzly bear ranges and movements as determined by radio-tracking. In *Bears—Their Biology and Management,* M. Pelton, J. Lentfer, and G. Folk (eds.). New Series 40. Morges, Switzerland: IUCN.

Craighead, J. J. 1980. A proposed delineation of critical grizzly bear habitat in the Yellowstone region. *International Conference on Bear Research and Management Monograph Series* 1:1–20.

Craighead, J. J., and D. J. Craighead. 1991. New system-techniques for ecosystem management and an application to the Yellowstone ecosystem. *Western Wildlands* 17:30–39.

Craighead, J. J., and F. C. Craighead, Jr. 1967. *Management of Bears in Yellowstone National Park.* Mimeo report. Missoula: University of Montana, Montana Cooperative Wildlife Research Unit.

———. 1971. Grizzly bear–man relationships in Yellowstone National Park. *BioScience* 21:845–857.

Craighead, J. J., and J. A. Mitchell. 1982. Grizzly bear. In *Wild Mammals of North America,* J. A. Chapman and G. A. Feldhamer (eds.). Baltimore: Johns Hopkins University Press.

Craighead, J. J., K. R. Greer, R. R. Knight, and H. I. Pac. 1988. *Grizzly Bear Mortalities in the Yellowstone Ecosystem 1959–1987.* Bozeman, MT: Montana Fish, Wildlife, and Parks, Interagency Grizzly Bear Study Team, Craighead Wildlife-Wildlands Institute, National Fish and Wildlife Foundation.

Craighead, J. J., J. S. Sumner, J. A. Mitchell, and J. T. Hogg. 1994. *The Grizzly Bears of Yellowstone: Their Ecology in the Yellowstone Ecosystem, 1959–1992.* Unpublished manuscript.

Craighead, J. J., J. S. Sumner, and G. B. Scaggs. 1982. *A Definitive System for Analysis of Grizzly Bear Habitat and Other Wilderness Resources.* Wildlife–Wildlands Institute Monograph 1. Missoula: University of Montana Foundation.

Craighead, J. J., J. R. Varney, and F. C. Craighead, Jr. 1974. A population analysis of the Yellowstone grizzly bear, Montana Forestry and Conservation Experiment Station, School of Forestry. *University of Montana Bulletin* 40:1–20.

Driver, H. E. 1969. *Indians of North America.* Chicago: University of Chicago Press.

Frome, M. 1984. Are biologists afraid to speak out? *Defenders* 59:40–41.

Greater Yellowstone Coordinating Committee. 1989. *The Greater Yellowstone Postfire Assessment.* Washington, DC: U.S. Department of Interior.

Harmon, M. M. 1989. The responsible actor as "tortured soul": The case of Horatio Hornblower. *Administration and Society* 21:283–312.

Heinen, J. T., and B. S. Low. 1992. Human behavioral ecology and environmental conservation. *Environmental Conservation* 19:105–116.

Herrero, S. 1985. *Bear Attacks—Their Causes and Avoidance.* New York: Nick Lyons Books.

Houck, O. A. 1993. The Endangered Species Act and its implementation by the U.S. Departments of Interior and Commerce. *University of Colorado Law Review* 64:277–370.

Ingram, H. M. 1973. Information channels and environmental decision making. *Natural Resources Journal* 13:150–169.

Keiter, R. B. 1991. Observations on the future debate over "delisting" the grizzly bear in the greater Yellowstone ecosystem. *Environmental Professionalism* 13:248–253.

Kuehl, B. L. 1993. Conservation obligations under the Endangered Species Act: A case study of the Yellowstone grizzly bear. *University of Colorado Law Review* 64:607–643.

Leopold, A. S., S. A. Cain, C. M. Cottam, I. N. Gabrielson, and T. L. Kimball. 1963. Wildlife management in the national parks. *American Forests* 69:32–35, 61–63.

Lichtman, P., and T. W. Clark. In press. Improving strategic coordination for management of the Greater Yellowstone Ecosystem: Learning from the "vision" exercise. Society and Natural Resources.

Lindblom, C. E. 1980. *The Policy-Making Process.* Englewood Cliffs, N.J.: Prentice-Hall.

Mattson, D. J. 1990. Human impacts on bear habitat use. *International Conference on Bear Research and Management* 8:35–56.

Mattson, D. J., and R. R. Knight. 1989. Evaluation of grizzly bear habitat using habitat and cover type classifications. In *Proceedings—Land Classifications Based on Vegetation: Applications for Resource Management,* D. E. Ferguson, P. Morgan and F. D. Johnson (eds.). U.S. Forest Service General Technical Report INT-257. Washington, DC: Government Printing Office.

———. 1991. *Application of Cumulative Effects Analysis to the Yellowstone Grizzly Bear Population.* Interagency Grizzly Bear Study Team Report 1991C. Washington, DC: U.S. Department of Interior, National Park Service.

Mattson, D. J., and M. M. Reid. 1991. Conservation of the Yellowstone grizzly bear. *Conservation Biology* 5:364–372.

Mattson, D. J., and D. P. Reinhart. 1993. Bear use of whitebark pine seeds in North America. In *Proceedings—International Workshop on Subalpine Stone Pines and Their Environments: The Status of Our Knowledge*, W. C. Schmidt and F.-K. Holtmeier (eds.). U.S. Forest Service General Technical Report INT. Ogden, UT: Intermountain Research Station.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1991. Food habits of Yellowstone grizzly bears, 1977–1987. *Canadian Journal of Zoology* 69:1619–1629.

———. 1992. Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. *Journal of Wildlife Management* 56:432–442.

Mazmanian, D. A., and P. A. Sabatier. 1983. *Implementation and Public Policy*. Glenview, Ill.: Scott, Foresman.

Mealey, S. P. (ed.). 1986. *Interagency Grizzly Bear Guidelines*. Denver, Colo.: Interagency Grizzly Bear Committee.

Morgan, G. 1986. *Images of Organization*. Beverly Hills: Sage.

Murie, A. 1940. *Ecology of the Coyote in the Yellowstone*. Fauna of the National Parks of the United States, Bulletin 4. Washington, DC: U.S. Department of the Interior, National Park Service.

O'Reilly III, C. A. 1980. The intentional distortion of information in organizational communication: A laboratory and field investigation. In *The Study of Organizations*, D. Katz, R. L. Kahn, and J. S. Adams (eds.). San Francisco: Jossey-Bass.

Panem, S. (ed). 1983. *Public Policy, Science, and Environmental Risk: Brookings Dialogues in Public Policy*. Washington, DC: Brookings Institution.

Pfeffer, J., G. R. Salancik, and H. Leblebici. 1984. Uncertainty and social influence in organizational decision making. In *Environments and Organizations*, M. W. Meyer, et al. (eds.). San Francisco: Jossey-Bass.

Pimm, S. L., H. L. Jones, and J. Diamond. 1988. On the risk of extinction. *American Naturalist* 132:757–785.

Primm, S. A. 1993. Grizzly conservation in Greater Yellowstone. MA thesis, University of Colorado.

Rees, W. E., and M. Wackernagel. 1992. Appropriated carrying capacity: Measuring the natural capital requirements of the human economy. Paper presented at the Second Meeting of the International Society of Ecology and Economics, Vancouver, British Columbia.

Sabatier, P. 1978. The acquisition and utilization of technical information by administrative agencies. *Administrative Science Quarterly* 23:396–417.

Servheen, C. 1989. The status and conservation of the bears of the world. *International Conference on Bear Research and Management Monograph Series* 2:1–32.

Shaffer, M. L. 1983. Determining minimum viable population sizes for the grizzly bear. *International Conference on Bear Research and Management* 5:133–139.

———. 1992. *Keeping the Grizzly Bear in The American West: A Strategy for Real Recovery*. Washington, DC: The Wilderness Society.

Storer, T. I., and L. P. Tevis, Jr. 1955. *California Grizzly*. Berkeley: University of California Press.

Thomas, C. D. 1990. What do real population dynamics tell us about minimum viable population sizes? *Conservation Biology* 4:324–327.

Twight, B. W. and F. J. Lyden. 1988. Multiple use vs. organizational commitment. *Forest Science* 34:474–486.

———. 1989. Measuring Forest Service bias. *Journal of Forestry* 87:35–41.

U.S. Congress. 1977. Endangered species act oversight: hearings before the Subcommittee on Resource Protection of the Committee on Environment and Public Works, U.S. Senate, 95th Congress, First Session. Washington, DC: Government Printing Office.

U.S. Fish and Wildlife Service. 1993. *Grizzly Bear Recovery Plan*. Missoula, MT: U.S. Fish and Wildlife Service.

Wackernagel, M., and W. Rees. 1992. Perceptual and structural barriers to investing in natural capital. Paper presented at the Second Meeting of the International Society of Ecology and Economics, Vancouver, British Columbia.

Walters, C. 1986. *Adaptive Management of Renewable Resources*. New York: Macmillan.

Westrum, R. 1986. Management strategies and information failure. Paper presented at the NATO Advanced Research Workshop on Failure Analysis of Information Systems, Bad Winsheim, Germany, August 1986.

———. 1988. Organizational and inter-organizational thought. Paper presented at the World Bank Conference on Safety Control and Risk Management, Washington, DC: October 1988.

Yaffee, S. L. 1982. *Prohibitive Policy: Implementing the Federal Endangered Species Act*. Cambridge: MIT Press.

Endangered Species Recovery

Finding the Lessons, Improving the Process

Edited by
Tim W. Clark,
Richard P. Reading,
Alice L. Clarke

ISLAND PRESS

Washington, D.C. • Covelo, California

Library of Congress Cataloging-in-Publication Data

Endangered species recovery: finding the lessons, improving the process / edited by Tim W. Clark, Richard P. Reading, and Alice L. Clarke.
p. cm.
Outgrowth of a conference held at the University of Michigan, Jan. 8–9, 1993.
Includes bibliographical references and index.
ISBN 1-55963-271-2 (cloth). — ISBN 1-55963-272-0 (paper)
1. Endangered species—United States. 2. Wildlife conservation—United States. 3. Wildlife conservation—United States—Case studies. I. Clark, Tim W. II. Reading, Richard P. III. Clarke, Alice L.
QL84.2.E55 1994 94-18097
591.52'9'0973—dc20 CIP

Printed on recycled, acid-free paper

Manufactured in the United States of America
10 9 8 7 6 5 4 3 2 1

Contents