Research in Endangered Species Conservation: An Introduction to Multiple Methods

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Abstract
Diverse methods may be required to understand and solve conservation problems in species recovery. These problems are usually multi-faceted. Endangered species recovery is a biological challenge, but it also requires that professionals and the public support an organized recovery effort in a timely, rational, and effective way. Biological, social, and interdisciplinary methods all lend themselves to aid the multi-dimensional task of species recovery. Social science and interdisciplinary methods, however, are little used currently. These three kinds of approaches are briefly examined. We conclude with a call for increased interdisciplinary approaches, as we believe they promise greater effectiveness in species conservation.

Introduction
Endangered species conservation is usually a complex, multi-dimensional challenge. As such, endangered species recovery programs require the use of diverse methods to determine which processes threaten a species and how best to achieve recovery. Interdisciplinary approaches that incorporate multiple methods in biology and the social sciences promise to improve species restoration efforts. Biological methods focus on the species and its ecosystem. Social science methods examine the decision and social processes, including how the values and perspectives of participants and the situation affect recovery efforts. Interdisciplinary methods systematically integrate biological and social research into a unified recovery program.

Many universities offer programs in biological and social methods, and a few even offer interdisciplinary programs that address the full challenge posed by endangered species conservation. The established, but separate, disciplines (e.g., wildlife biology, sociology, policy analysis) train professionals to be knowledgeable in different methods. Seldom does university training fully prepare practitioners for the policy-related, professional, organizational, and personal demands of the work world. Despite the obvious need for professionals skilled in integrative approaches, there are few jobs in endangered species recovery that explicitly utilize interdisciplinary problem solvers. Fortunately, the situation is changing. Conservation and related professions, university training programs, and the organizational contexts of practice (both internal and external environments of organizations) are in flux today and prospects for using fully integrative methods in the future is improving. We expect that interdisciplinary approaches using multiple methods and inclusive participation will significantly improve recovery plan success rates over more narrow approaches that rely on a limited set of methods, a single discipline, or domination by single (or just a few), self-interested people or organizations.

In this paper, we (1) offer a brief overview of multiple methods in endangered species recovery, (2) look briefly at available biological and social science methods, and (3) introduce an interdisciplinary approach we believe best uses and integrates knowledge obtained from the diverse biological and social methods currently employed to restore endangered species.

Multiple methods: A strategy in species recovery
Using multiple methods in endangered species recovery is like triangulation wherein a radio collared Florida panther's (*Felis concolor*) location is located, or 'fixed,' using three receiver readings from different angles. As conservationists, we can best get a 'fix' on a conservation problem by using different methods, ideally a combination of biological and social science meth-

ods. In our case, triangulation means using and integrating data from diverse sources about a problem and its context. It means using different investigators, ideally working in close collaboration. Different theories should guide work and interpretation of data. Multiple methods should be used to investigate a problem from different perspectives in order to develop the fullest possible picture of the conservation problem and alternatives to address it. Just as using multiple methods to address a specific research interest increases the reliability of results (e.g., independent measures of population size from an aerial survey, a ground survey, and capture-resighting data), so too do multiple methods increase the reliability of problem definitions. Using multiple methods to analyze a problem can improve the reliability, richness, and diversity of data available to researchers, decision makers, and managers (Clark 1993; Janesick 1994).

Increasingly, researchers are being called upon to address complexity (and risk)—a key theme of endangered species conservation. Usually, the more unknowns there are in a recovery program, the more complex it is and the more risks it involves. Perhaps it is not surprising therefore that some of the most interesting technical innovations in conservation were developed to cope with complexity, and the long-term, exploratory, and creative dimensions of protecting and recovering endangered species (e.g., population viability analysis). The task is not to deny or try to minimize complexity in species conservation, but to instead emphasize the complexity, and search for ways to understand and address it. To this end, being knowledgeable and skilled in using and integrating multiple methods is key to successful recovery programs.

Studying endangered species using multiple methods is different from studying more abundant wildlife for several reasons. First, the species under study usually persists in low numbers (and density) and occurs in limited or shrinking habitat. As researchers, we must take great care to ensure that our work does not put the species or even individuals at risk. The species' status may limit the kinds of methods that can be used; therefore, methods should be developed to minimize harassment and, worse, mortality. Second, controlled experiments such as manipulating individuals, populations, or habitats, may be impossible for these same reasons. Third, the human context or social process that is often the root cause of endangerment may be unrelated to biological or other technical considerations and may require immediate attention. This means researching human values, perspectives, and practices and working to understand and perhaps alter those that adversely affect the species or habitat in question. Finally, there are few chances in species conservation. Given the frailty of endangered systems, researchers do not have the luxury of testing multiple approaches over a significant period of time. It is often necessary to get it right the first time.

Often the contexts of species endangerment and recovery efforts continually change in a highly complicated way. Researching conservation problems implies studying and interpreting the past to clarify current circumstances and needs of participants and to project future trends. If methods are not carefully considered, the very effort of studying a species, its habitat, and its context may adversely affect conservation efforts, especially if major variables (e.g., human social process [see Clark and Wallace 1998]) are overlooked, misconstrued, or misunderstood. Multiple methods help ensure a more complete and accurate understanding of a conservation problem's context.

Black-footed ferret (*Mustela nigripes*) recovery is a good example that illustrates how biological, social, and interdisciplinary research have been carried out in a conservation effort. The general characteristics of the program may be typical of how endangered species recovery is conducted. A ferret conservation program has been ongoing for almost two decades (also see Clark 1989, 1997; Miller et al. 1996). In brief, biological methods have dominated ferret recovery efforts. There has been very limited utilization of social science and interdisciplinary methods, although there have been calls for greater use of both. This pattern of neglecting available methods directly reflects the biological disciplinary training of most professionals in species recovery efforts.

Biological and social science methods

Relying on only a few methods from a biological discipline can result in a distorted picture of the conservation challenge, similar to the story of the three blind men trying to describe an elephant. Each blind man touched only one part of the animal—the trunk, leg, or tail—so each had a different notion of what it looked like, and all were wrong. Using a single discipline or limited methods can produce the same result: an incomplete and possibly distorted picture of the endangered species conservation challenge. This is why a skillfully used mix of biological, and social science, and interdisciplinary methods can yield the best, most realistic picture of the problem and possible solutions (see Barrett 1978).

Biological methods

Methods used in biological study of endangered species and other wildlife are detailed by Beveridge (1950), National Research Council (1986), Brookhout (1996), Scott et al. (1996), Baydack et al. (1999), and others. These methods set the standards for research and management, will always be essential to endangered species recovery, and require upgrading as needed.

Because our society is technologically driven, it is not necessary to detail the positivistic (experimental) concept of the scientific method for constructing theories, designing and carrying out experiments, and determining cause and effect (see Beveridge 1950; McCain and Segal 1977; Ratti and Garton 1996). In short, biological researchers seek accurate predictions and strive to conduct experimental science using quantifiable methods (such as modeling). Naturalistic studies, however, which are largely descriptive and qualitative, are also used in conservation. Overall, the positivistic approach is invaluable, but it can be misused when researchers or managers insist that all knowledge be obtained by this method. Positivism is coming under increasing criticism because of its inability to address highly complex, unique problems (e.g., Dryzek 1990).

Multiple methods were used, at least in part, in the black-footed ferret recovery effort. For example, researchers determined the free ranging ferret population's size from directly counting animals in spotlight surveys, snow tracking, litter counts, and mark-recapture methods (see Clark 1986; Miller et al. 1996). These four methods were used to "triangulate" and support one another, increasing confidence in the estimates. The ferret recovery effort involved methods from many fields, including plant taxonomy, plant ecology, wildlife biology, conservation biology, ethology, population biology, genetics, physiology, community ecology, wildlife management, physiology, captive breeding, and zoo biology. Many good biological methods were used (Clark 1986, 1997; Miller et al. 1996; Reading et al. 1996; Lockhart et al. 1998), as well as some that were suspect (see Reading and Miller 1994; Miller et al. 1996).

Biological methods constitute only part of the full set of methods available to save species. Still, some biological researchers use a positivistic approach to species conservation that relies solely on biological methods to the exclusion of approaches that address the human dimensions of recovery (e.g., social, political, organizational, and policy issues). A more complete approach to conservation includes social and interdisciplinary methods.

Social methods

Methods in the social sciences used for endangered species conservation or other problems are discussed by Dominowski (1980), Barzun and Graff (1985), Miller (1991), Dey (1993), Rosaldo (1993), Denzin and Lincoln (1994), Strauss and Corbin (1994), Isaac and Michael (1995), and others. As the importance of social, economic, and organizational factors to endangered species recovery becomes clearer to wildlife and ecosystem managers, standards and approaches to modern social science research should grow in importance and use in endangered species recovery.

Social methods focus on the human element in endangered species conservation, range from positivistic approaches similar to those used in the biophysical sciences to descriptive approaches similar to naturalistic methods used in ecology. Positivistic studies were described above. Descriptive studies employ qualitative methods to "investigate human behavior in its natural and unique contexts and settings by avoiding the artificial constraints of control and manipulation" (Isaac and Michael 1995:218). This approach examines human behavior in real situations, relies on observational techniques, adapts itself to multiple circumstances, and recognizes both intuitive and explicit knowledge (Scott 1998). Because this kind of research studies human perception and multiple realities, often for applied purposes, it is little concerned with creating a final, unified system of knowledge or grand theory. It approaches in a grounded, emergent way (i.e., induction), as opposed to approaching it with a preset explanatory theory (i.e., the scientific method). The study's boundaries emerge in the course of the research, rather than being pre-established prior to the investigation. This approach often uses a case study format because it better captures the multiple realities at play in complex human interactions (Yin 1989).

To analyze a human social situation means to break it down. Often questions in social methods include who is involved, what happened, why, when, and where (Marius 1995). Each question can be posed in several different ways. The question of 'who' forces us to identify the individuals and groups involved in the social process affecting endangered species. The question of 'what' forces us to sift through competing opinions, views, and misunderstandings to find out what really happened. Even if researchers determine what happened, why did it happen? This is a conditioning or cause and effect question. Things happen because

of precipitating causes, but background causes may be important too. Causation is complex and usually there are multiple causes for, and outcomes that result from, human behavior. Therefore, factors must be considered in their context. Understanding the temporal and spatial context of events is essential to answer the other questions. In thinking contextually, researchers carefully try to sort through and evaluate the relative importance of various causes. Lastly, it is important to know when and where the situation under study came about or the event happened.

Qualitative methods are used to describe, classify, and analyze social phenomena and their interconnections. In carrying out data manipulations, information may "lose its original shape, but we gain by organizing it in ways which are more useful" for generating insight about human behavior (Dey 1993:42). Making inferences from data is an important function of research. The aim of inference is coherence. Most people assume an ability to make correct inferences. In our daily lives we make many inferences by recollecting past experiences and using them to interpret a present situation or event (Marius 1995). Without inference, we would have to reinvent life anew each day. Social scientists, as well as biological scientists, infer some answers to scientific questions. In doing so we strive to make sense of a behavior or situation, trying to decide what it is and whether our interpretation is reliable. Researchers use inference to fill in gaps to round out or complete a picture of a situation or event. Statistics can be a valuable quantitative method in this regard. But statistics require interpretation. By themselves, statistics tell use little, but what we infer from them can tell us a great deal. Inferring correctly is key.

The black-footed ferret case employed some social science methods. Initially these focused on socioeconomic and organizational dimensions (Clark 1989), and consisted of formal and informal interviews with many residents in ferret habitat and an economic tradeoff analysis (Clark 1989). Increasingly, researchers recognized that many human factors were critical determinants of both short and long-term success in the ferret program and additional social science work was undertaken. Other social science methods included the use of decision analyses, interviews with local people and key stakeholders, a formal survey of values and attitudes, organizational and professional analyses, and policy assessments (see Clark and Harvey 1988; Clark and Westrum 1989; Clark et al. 1989; Maguire 1989; Clark and Cragun 1991; Reading 1993; Reading and Kellert 1993; Reading and Miller 1994). Efforts were made on the part of some researchers to integrate the diverse biological and social science data into a comprehensive picture of the whole conservation challenge in order to make practical, constructive interventions (Clark 1989, 1997; Reading 1993; Miller et al. 1996). Overall though, there was little interest in social science or intellectual or political support for it in the ferret program, and the results of most social science analyses had little influence on program direction. This remains the case today.

The use of social science methods in endangered species recovery is increasing, but they have yet to be applied in ways that demonstrate their potential. The next major leap in research for endangered species recovery should be to apply multiple social science methods to the full context of recovery, including by researchers, decision-makers, and managers.

Interdisciplinary methods

The most comprehensive approach to problem solving utilizes interdisciplinary methods. Interdisciplinary problem solving draws on all methods typically used in the biological and social sciences. It differs from multidisciplinary approaches in that diverse methods are integrated, rather than conducted in isolation. The first requirement of interdisciplinary problem solving is a conceptual and practical framework that can accommodate diverse data, epistemologies, and disciplines (Clark 1998). The analytic framework of Lasswell (1971a) is comprehensive and helps users find, analyze, store, recall, and relate important information for use in creating realistic problem solving alternatives. A complete description of interdisciplinary problem solving methods is provided by Lasswell and McDougal (1992).

Conservationists must take multiple vantage points to best see and understand the complex factors affecting social process and decision making in endangered species recovery. Interdisciplinary problem-solving will hopefully grow in importance as the requirements of actual species conservation become more fully appreciated. The response calls for contextuality and problem orientation. Interdisciplinary problem solving does just that, tending "toward *contextuality* in place of *fragmentation* and toward *problem-oriented* not *problem-blind* perspectives" (Lasswell 1971a:8, italics in original). This in turn requires the use of multiple methods. In very general terms, interdisciplinary problem solving involves four elements: problem orientation, social process mapping, decision process mapping, and standpoint clarification. These elements must be integrated.

Problem orientation is a strategy to analyze problems and invent

solutions in a rational manner (Wallace and Clark 1999). To permit more complete identification and definition of problems, goals that people seek should be laid out relative to the problems under study. Historic trends must be described to see if events are moving toward or away from goals, and the factors or conditions that have influenced trends must be determined. Projections of future trends are possible if past trends and conditions are known adequately. Last, potential solutions must be invented, evaluated, and selected (assuming projections are viewed as harmful). If these five tasks are carried out comprehensively, yet selectively and realistically, a practical solution will likely be found.

Social process mapping is an effort to understand the social context in which all problems are embedded (Clark and Wallace 1998). Social process focuses on the political and moral components of problem solving. Every problem setting, regardless of its subject matter, is composed of participants with interacting perspectives. Participants employ whatever values, or assets, they have through different strategies to obtain desired outcomes. The outcomes have additional effects (e.g., power, well-being, respect, affection). Values are both the things for which people strive (outcomes) and the assets they use to get them (e.g., wealth, enlightenment, skill, rectitude). They are the medium of exchange; values are used, exchanged, shaped, or shared to gain more values. In any social and decision process, participants both indulge in and are deprived of values. Eight value categories are recognized by Lasswell (1971a): power, wealth, enlightenment, skill, well-being, affection, respect, and rectitude.

Decision process mapping is an analysis of the decision-making process involved in problem solving (Clark and Brunner 1996). Decision process involves the rational (i.e., is it reasonable?), political (i.e., is it possible?), and moral (i.e., is it justifiable?) dimensions of problem solving. Decision processes consist of six interrelated functions, or activities. (1) Intelligence must be gathered about a problem and its context. (2) In turn, information obtained through intelligence must be debated and discussed, and solutions must be recommended, advanced, and promoted. (3) Rules or guidelines must then be established to address the problem. (4) Subsequently, the rules must be specified and enforced, and resulting disputes must be resolved. (5) All of the functions of the decision process must be appraised. (6) Finally, the process must be terminated, often as a result of the problem being redefined. Lasswell (1971a) recommends performance standards and preferred outcomes for each function. In actual practice, not all of these functions are always carried out.

Observational/participant standpoints consist of a person's value orientations and biases, and stem from personality, disciplinary training, parochial/universal experiences, epistemological assumptions, organizational allegiances, reference groups, and other sources. All people have standpoints, including those who engage in endangered species conservation (Clark and Wallace 1999). People should seek to clarify their own standpoints and understand the perspectives of other people involved or concerned. Often practitioners are not explicit about or do not recognize their own standpoints, risking incomplete and biased analyses.

Empirical study can yield data on problem orientation, social and decision process variables, and standpoint. These categories must be considered repeatedly in interdisciplinary problem solving because information is cumulative. Multiple methods—qualitative and quantitative, observational and experimental, intensive and extensive, contemplative and manipulative—are required to obtain empirical data. This overall process should function as a disciplined, self-corrective framework, the utility of which can best be appreciated by applying it to actual problems.

In species recovery, reasonable explanations of the causes and consequences of endangerment are needed as the basis for practical action and cooperation. Multiple methods provide the only reliable approach for obtaining comprehensive answers to key questions about a recovery challenge. Multiple methods are required to address biological and social problems and fully map the context of the problems. Endangered species professionals should therefore use appropriate disciplines and methods to understand problems and find solutions. All methods have both strengths and limitations. By focusing attention on certain areas of inquiry, single methods create blind spots. By using multiple methods, researchers can minimize blind spots and avoid the fragmented views, knowledge, and actions that rise from single methods. Integrating multiple methods requires that professionals use an interdisciplinary framework for understanding the problem.

Two types of information are recognized in endangered species recovery: ideological and technical. Ideological information includes "facts about the thoughts, feelings, and conduct of human beings. Other facts are technical" (Lasswell 1966:123). Because ideological information is about words and deeds (actions), which may be contradictory in a single person or group, both forms of information should be studied using multiple methods to gain insight.

Qualitative methods are often used to triangulate on problems because people often are not capable of rationally explaining their intentions (Dey 1993). So, training programs are necessary to expose students to contextual concepts, problem orientation, and methods of obtaining, processing, and utilizing data.

Little interdisciplinary problem solving has been carried out to date in black-footed ferret recovery, although it has been called for, as well as described repeatedly, by a few participants (Clark 1989, 1997; Reading 1993; Miller et al. 1996). The official ferret program as carried out by government agencies has begun to consider social science considerations (Hutchins et al. 1996), but these remain under-appreciated, poorly addressed, and little integrated with the biological aspects of the recovery challenge (Reading et al. 1997). As such, the official recovery program has made little progress toward utilizing interdisciplinary approaches (see Clark et al. In press). By addressing the biological and social science aspects of the recovery challenge separately (i.e., a multi-disciplinary approach), practitioners risk devising fragmented, possibly contradictory solutions.

Perhaps the best interdisciplinary approach to endangered species recovery is the decision seminar (see Clark 1997). This group effort explicitly calls for problem-solving by addressing all of the dimensions of species conservation—problem orientation, social process mapping, decision process mapping, and standpoint clarification. It further requires that multiple methods be used, including both biological and social research. The entire effort is guided by an integrated analytic framework described by Lasswell (1971b), Brewer (1974, 1986), Burgess and Slonaker (1978), Willard and Norchi (1993), and Clark (1997). We recommend using this approach in species recovery.

Conclusions

Endangered species conservation is a complex and diverse undertaking. The scope of species recovery is variously interpreted. Often it is viewed as largely or solely a biological task, but when analyzed more comprehensively, species recovery is seen to encompass social science and interdisciplinary considerations as well. As a result, multiple methods are increasingly being used and additional methods will be invented and adapted to meet the multi-faceted challenges of species recovery. Over time, the self-correcting impact of experience will hopefully modify and integrate these diverse methods and move endangered species recovery towards an explicit interdisciplinary approach. An interdisciplinary approach; that is, a contextual, problem-oriented, and a multi-method approach to endangered species conservation, can be expected to improve our knowledge both of and in decision processes and thus make us more effective in solving conservation problems. Interdisciplinary approaches can also contribute to the development of expertise in the formulation of endangered species policy and management in terms of realizable objectives and strategies.

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