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Process Components in Developing Habitat Conservation Plans

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Abstract

According to the U.S. Fish and Wildlife Service, more than 230 habitat conservation plans (HCPs) have been developed since 1992, encompassing nearly 12 million acres of endangered species habitat. Relatively little has been produced that describes the actual steps or processes that have been utilized in the development of HCPs and associated conservation plans. In 1998, the National Center for Environmental Decision-making Research conducted 124 interviews of conservation planning participants and produced summaries of the processes used in the development of 31 plans. While analysis of these summaries and interviews is ongoing, we present here five initial process components: type of permit applicant, role of the administering federal agencies, participation in planning, decision-making process design, and management and review of technical data. Our discussion of these components raises a number of questions that must be addressed in order to improve the effectiveness and efficiency of individual planning processes, endangered species policy, and other efforts to balance private economic interests with conservation of the environment.

Introduction

The genesis of Habitat Conservation Plans (HCPs) was the addition of Section 10(a)(1)(b) to the Endangered Species Act (ESA) in 1982. Section 10 allows the Secretary of Interior to issue a permit for the "incidental take" of endangered and threatened species by non-federal entities if the application for the permit is accompanied by an approved conservation plan. Although the initial number of HCPs developed was modest, the current Secretary of Interior, Bruce Babbitt, has embraced and created greater incentives for this approach to endangered species management. Since 1992 more than 230 HCPs have been developed, encompassing nearly 12 million acres (USFWS 1999). Accompanying this explosion in the number of plans has been a rapid evolution of how the Section 10 provision is utilized, leading to the development of safe harbor and candidate conservation agreements. (Safe harbor agreements offer land managers an incentive of regulatory assurance if activities on a property draws new populations of endangered species to their land. Candidate conservation agreements, which result in plans for species not yet listed under the ESA, are not actually Section 10 agreements, but have many similarities to HCPs.) These HCPs and associated conservation plans have become incredibly diverse. Several cover properties of less than one acre of golden-cheeked warbler habitat in Texas, while, at the other end of a continuum, a red-cockaded woodpecker safe harbor plan was recently approved for approximately five million acres of private timberlands in the southeastern U.S.

In 1996, the U.S. Fish and Wildlife Service (FWS)—which along with the National Marine Fisheries Service (NMFS) administers the HCP approval process and issues incidental take permits (ITPs)—produced a draft *HCP Handbook* that provides potential permit applicants guidelines for developing an HCP. This handbook, however, is primarily concerned with questions of "what" must be done regarding HCP development, not "how" it should be done. Likewise, the draft "Five-Point" directive issued for comment in March 1999 (USFWS 1999), recommends increasing or adding some process elements to HCP planning, but provides no guidance on how to achieve those changes. Barring a study on public participation performed by a group of graduate students at The University of Michigan (Anderson et al. 1998), relatively little has been produced that describes the actual steps or processes that have been utilized in the development of HCPs and associated conservation planning.

This in mind, in January 1998 the

National Center for Environmental Decision-making Research (NCEDR) embarked on a research project to provide an objective understanding of HCP decision making. NCEDR was established by the National Science Foundation in 1995 to analyze and improve environmental decision making, particularly at the subnational (state, regional, and local) level. As a newly developing mechanism that directly involves non-Federal participants in endangered species management, the world of HCP decision-making represented a living laboratory to pursue NCEDR's mandate.

Unlike other studies of HCPs that analyze the adequacy of conservation planning as a policy and practice (see Aengst et al. 1998; Hood 1998; Karieva et al. 1998), this study sought to provide an objective overview of the range of participant experiences in HCP development. It is argued here and elsewhere (Wilcove et al. 1996; Thornton 1997) that in spite of praise and ridicule (and perhaps because of both praise and ridicule), HCPs or similar mechanisms are politically inevitable and necessary if endangered species and biodiversity interests are to be integrated with economic development and into landscape-level planning. As such, NCEDR considered this descriptive study to be of value to other researchers, policy makers, and practitioners.

During the summer of 1998, NCEDR researchers conducted semi-structured, confidential interviews with 124 conservation planning participants. These participants were chosen from a sample of thirty-one plans, selected to capture a broad range of characteristics that included the type of permittee (public or private), scope of participation (limited or multi-stakeholder), type of "habitat take," FWS region, and status of the permit. Two to six individuals were identified through a snowballing technique, with the first contact generally coming through FWS field offices. The substance of these interview responses was used to write case summaries, which follow the same format as the interview protocol. Each summary also includes an introductory section containing brief background information about the case and characteristics of the plan.[3] Draft case summaries were distributed to the respective case participants, who provided comments and corrections. The complete, final text of all thirty-one case summaries was entered into a QSR NUD*IST database to facilitate analysis.

Although the plans studied are diverse, one trend regarding their development stands out above all others: there is a notable absence of a consistent framework for the HCP planning process. Limited *up-front* attention appears to have been given to a framework for establishing and clarifying roles of participants, setting guidelines and rules for decision making, and establishing timeline targets. Exceptions to this existed, and in at least four of the thirty-one cases some guidelines were agreed upon early in the process. For the most part, however, decision frameworks seemed to evolve, with an emphasis on "deciding as we go." Previous work by NCEDR and others have illustrated that attention to decision processes is important (Sexton et al. 1999; Tonn and Petrich 1997). As such, we offer five components of a habitat conservation planning process as starting points for considering what improvements can be made to the practice and policy of conservation planning. They are (1) type of applicant, (2) role of the Services, (3) participation in planning, (4) decision-making process design, and (5) management and review of technical data.

Type of applicant

Because Section 10 addresses the otherwise legal actions of any *non-Fed-*

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Cover: Two adult male Cuban iguanas (*Cyclura nubila*) in combat.
Photo by J. Lemm.

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eral land manager, there is considerable variation in who acts as the applicant for the ITP. While private landowners and private corporations are often perceived as the typical ITP applicant, public entities including municipalities, counties, and states, have also submitted HCPs. Some of these public plans are *programmatic*, in which the permittee is vested with the authority to extend assurances to individual landowners or land managers, creating a set of "sub-applicants."

In this study, private applicants tended to be concerned with localized development of residential properties or management of private resources (e.g., timber, mining, or agriculture). Public plans were focused on regional-level resource management (e.g., timber or agriculture), regional development planning (e.g., county-wide master planning), or recreation management (e.g., beach use). Our research indicates that whether an applicant is private or public has notable impacts on the process.

Participants in private plans often mentioned involving only those interests that they saw as being "relevant," while among plans with public permittees, interviewees indicated more of a concern to have "representative" participation. This disparity in participation levels may lead to marked differences in the duration and efficiency of the planning process. Plans in our sample that had public permittees averaged nearly twice the time needed to complete the plan as those with private permittees. While this disparity in process duration was not absolute—some private planning processes took more time to develop than some public plans—it does support the notion that the more highly participative processes of public plans require more time to complete.

Role of the Services

Only two participants are guaranteed in every HCP: an applicant and the Services (FWS and NMFS). Although the Services are required only to review the plan, prepare the appropriate National Environmental Policy Act (NEPA) and ESA documentation, and issue or deny an ITP, we found Service personnel to have been involved in the process in a number of ways. These include guidance for plan development, participation in decision-making advisory committees, facilitation of multi-party processes, and the provision and review of technical information. Perception of the Services' role varied widely among the participants we interviewed, and comments included both praise and criticism of the role the Services played.

Many participants expected the Services to provide guidance throughout the process. In several plans, participants described FWS guidance as valuable, supportive, constructive, and as "the key to making this plan a good one." Guidance, however, was also the topic that most often resulted in negative comments. The most common criticism involved what some participants referred to as a "hands-off" approach to guidance. These participants became frustrated working in a process they perceived as operating in a vacuum, having little or no indication from the Services about what options might be selected to assure that approval could be secured. Although the *HCP Handbook* was developed too late to have been used in many of the plans included in our study, it seems to have been only partly successful, with critiques ranging from "very helpful" to "useless."

The second most frequently occurring negative comment involved the roles and action of various levels of Service participants. Specifically, participants expressed frustration at dealing with the multiple levels of Service personnel. Some HCP participants found that FWS personnel at different levels of the organization seemed to have undefined responsibilities, making unclear the appropriate level of contact. A frequent complaint was a perceived lack of decision authority among FWS negotiators. Specific comments described a "systemic disconnect" between Service field staff and Department of Interior lawyers assigned to HCP cases and the involvement of "too many layers of FWS bureaucracy," particularly in the review process.

Participation in planning

As mentioned previously, there are only two interests guaranteed to be present in any conservation planning process—the applicant and the Services. Because, however, the Services' obligations are actually limited to reviewing the plan and issuing or denying a permit, the applicant is the sole decision maker required in the development of the plan. Even a cursory examination of a few planning processes, however, reveals that decision-making often, but not always, involves diverse interests. These interests have included other federal, state, and tribal agencies, municipalities, land owners, industry groups, agricultural interests, user groups, conservation groups, consultants, lawyers, and independent scientists.

To facilitate analysis, we designated each of this study's thirty-one plans as belonging to one of three categories of participation. "Required" participation met legal requirements and involved the applicant and/or consultants hired by the applicant and the appropriate Service. "Expanded" participation involved one or more decision makers beyond that required, sometimes through the inclusion of a state agency or local non-profit organization in the process. Plans with "representative" participation are those in which the intent was to involve representatives of all interests. Of thirteen plans with private applicants, six had expanded partici-

pation and seven involved only required interests; none exhibited representative participation. In some of these cases, the applicant and the Service representatives noted that the scope of the plan did not warrant other participants. In other cases, decision makers were concerned about the perceived tradeoffs between process efficiency and involving multiple participants. For public plans, fifteen of eighteen exhibited either representative or expanded participation. Participants in public plans also indicated a struggle between the need to reap the benefits of involving multiple parties and the perceived efficiency assumed with smaller groups. The struggle was apparently worthwhile to some participants, however, with several interviewees from representative planning processes indicating that the benefits of representative participation outweighed their associated problems.

Participants acknowledged that certain groups or interests felt left out or underrepresented in the planning process. One participant in Maine's Atlantic Salmon Conservation Plan said, "In any public process there's always someone who doesn't feel they got a fair shake." This was sometimes due to the intentional exclusion of some groups that were perceived as unwilling to work together cooperatively. Sometimes, however, exclusion was due to oversight or an inability to adequately represent an interest. For instance, in Texas' Balcones Canyonlands Conservation Plan, participants expressed frustration with not knowing how to involve large numbers of unorganized landowners or individual citizens in the process.

HCP processes also include opportunities for non-decision-making interests to participate, at some level, in the process. Because the approval of an ITP is a federal action, it is regulated by the National Environmental Policy Act (NEPA). As such, public comment periods are required as part of the process for submitting an environmental assessment (EA) or environmental impact statement (EIS). (There has been a recent movement to designate some HCP processes as "low effect," which would mean no EA or EIS would be required. None of the plans in this study were considered "low effect.") Section 10 of the ESA also requires a thirty-day comment period on final HCP drafts, which are to be announced in the *Federal Register*. Generally, a single comment period is used for both the draft HCP and NEPA documentation. There was, however, evidence in twenty of the plans studied that those outside the decision-making process had been involved in ways that exceeded the minimal NEPA or ESA requirements. Methods for involving these interests included one-way communication (e.g., decision-making meetings were open to the public, newsletters were distributed to mailing lists, or information was routinely distributed to the press) and more interactive means of communication (e.g., public meetings and hearings, meetings with interest groups, or soliciting comments on early drafts of plans). There was a range of opinions concerning this involvement of outside interests, including those who felt that it was handled in a token way or was superfluous to the decision to be made. Others believed that a front-end investment in participation could decrease conflicts with the public later in the process. In a case where the input of outside interests had been relatively limited, participants expressed fears that the plan had been left open to future criticism.

Decision-making process design

Also reflecting the diversity of conservation plans are the methods in which decisions were made. This study's analysis distinguished two distinct facets of the decision-making process—how options for species or land management were identified and how agreements were reached.

Options and alternatives were identified in a number of ways. In some cases, the development of options fell entirely under the responsibility of one participating interest. In these "black box" plans, it was common for the applicant to draft portions of the plan in the absence of input from other interests and then submit the plans to the Services for comment. Generation of alternatives was also sometimes assumed by the Services and presented to the applicant as a set of guidelines or requirements. In other plans, alternatives were generated through the integration of multiple interests, either through open discussion (informal and formal) or through a tiered approach. In tiered approaches, issue-specific subcommittees debated ideas in informal discussions and presented recommendations to a larger decision-making committee. None of the methods used for developing options were necessarily exclusive of the other methods, and in fact, a number of planning efforts employed different decision processes at different phases of the project or to address specific issues.

In many conservation planning processes, reaching agreement on which options to include in the final plan was handled through the same mechanism used to generate alternatives. Participants in two private plans said that decisions were facilitated by modeling their plan after other plans that existed for the same species. For larger, multiple-interest planning efforts, consensus was a common choice for making decisions. The largest obstacle to decision-making was when individuals discussing the alternatives did not have decision-making authority but had to defer decisions to managers higher up in their organizational hierarchy.

Management and review of technical data

One of the most contentious issues surrounding HCPs is the quality and quantity of data used to make decisions; however, like other aspects of conservation planning, the process of managing and reviewing technical information has not been described adequately.

This study identified four technical roles played by conservation planning participants: setting parameters, providing information, managing information, and reviewing technical components of the plan. Setting parameters refers to determining what kinds of data will be included in the plan and what methods will be used for acquiring and managing the data. Actually providing that information may consist of conducting new research, identifying and acquiring existing research data, or creating reports and databases of available research. Some entity must be responsible for managing (collecting and compiling) all of the incoming data and information. The final role is that of reviewing the data in order to determine its adequacy.

The management of technical information was unique for each plan examined through this study. Applicants, the Services, steering committees, non-Service governmental agencies, academics, environmentalists, and public volunteers were all involved in some technical aspect of plan development. In twenty of the thirty-one plans included in this study, private consultants filled some technical role, commonly collecting and managing information. Prevalent among plans with public permittees was the use of technical advisory committees that were comprised of diverse interests (and were sometimes, but not always, decision makers).

Although the adequacy of data included in conservation plans has come under fire in HCP literature (e.g. Kareiva et al. 1998), in general the participants to which we spoke believed that the technical data included in their plans were adequate for the decisions that had to be made. This does not imply that the participants felt the data was perfect, but that given limitations in the availability of some data, they had developed the best plan possible. Conflicts over the adequacy of data were sometimes resolved by dropping controversial provisions or by incorporating adaptive management into the plan.

Because it has received so much criticism, it is important to say a few words about the technical review process. Many options for technical review were exemplified in the plans we studied, including review by interests from within or outside the plan development process, ad-hoc reviews throughout the planning process, and formal reviews of early and final drafts. In some cases, no review occurred other than during the Services' permitting process and the public comment periods. According to interviewees, external review might diffuse the potential for later conflict regarding a plan; most public plans, however, were reviewed by interests that were otherwise involved in the plan development (generally as part of a technical advisory group). For only one of the cases we studied was there mention of a more academic-style "peer review," and the independence of the reviewers in this case was disputed by some interviewees. During the public comment period for one large-scale private plan, however, independent environmental organizations convened scientific review panels and the permittee extended the comment period to allow for submission of comments.

Conclusion

Before we can intelligently steer the future evolution of conservation policy and its implementation, we must strive to understand current conditions and available options. This research is an important building block in understanding habitat conservation planning. We hope the questions raised through this research become an impetus for further dialogue within and among communities interested in producing HCPs or improving endangered species policy. While analysis on our database is ongoing, the process components presented in this article raise some basic questions:

1. Is it necessary or appropriate to accommodate the current diversity in decision making or establish standard practices that all planning processes should follow?
2. How can policy and practice best accommodate the needs of both public and private permittees?
3. What are the appropriate roles for the Services in the HCP planning process, and what are the obstacles to the Services filling these roles?
4. Who should be involved in the development of the HCP, to what extent, and what are legitimate methods for involving them?
5. Are there more effective and efficient methods for developing viable management options and reaching decisions regarding those options?
6. How should the technical needs of conservation planning be met? For instance, who should review the technical components of a plan and at what points in the process?

We also recognize that the HCP processes described through this research are just one facet of a larger national movement towards natural resource and environmental management that integrates multiple interests into decision making. All of the questions coming from and to be answered by this research are relevant to other areas of policy and collaboration. We

have only begun to tap the knowledge of those most involved with these processes in order to determine the most effective and efficient ways to balance private economic interests with conservation of the environment.

Literature cited

Aengst, P., J. Anderson, J. Chamberlin, C. Grunewald, S. Loucks, E. Wheatley, and S. Yaffee. 1997. Introduction to Habitat Conservation Planning. Endangered Species UPDATE **14**(7&8):5-9.

Anderson, J. and S. Yaffee. 1998. Balancing Public Trust & Private Interest. University of Michigan School of Natural Resources & Environment. Ann Arbor, MI. 48109-1115. 40pp.

Hood, L. 1998. Frayed Safety Nets: Conservation Planning under the Endangered Species Act. Defenders of Wildlife, Washington, D.C. 115pp.

Kareiva, P.M., S.J. Andelman, D.F. Doak, B. Eldard, M. Groom, J. Hoekstra, L. Hood, F. James, J. Lamoreux, C. McCullough, J. Regetz, L. Savage, M. Ruckelshaus, D. Skelly, H. Wilbur, and K. Zamudio. 1998. Using Science in Habitat Conservation Plans. American Institute of Biological Sciences, Washington, D.C. 50pp plus appendices.

Sexton, K., A.A. Marcus, K.W. Easter, and T.D. Burkhardt. 1999. Better Environmental Decisions: Strategies for Governments, Businesses, and Communities. Island Press, Washington D.C. 450pp.

Thorton, R.D. 1997. The No Surprises Policy is Essential to Attract Private Dollars for the Protection of Biodiversity. Endangered Species UPDATE **14**(7&8):65-66.

Tonn, B.E. and C. Petrich. 1997. Environmental citizenship: Problems and prospects. National Center for Environmental Decision-Making Research Technical Report, NCEDR/97-16. NCEDR, 600 Henley Street, Suite 314, Knoxville, TN. 37996-4138. 123pp.

US Fish & Wildlife Service, Division of Endangered Species. 1999. Habitat Conservation Plans/Incidental Take Permit. <http://www.fws.gov/r9endspp/hcp/hcptable.pdf.> (5 March 1999).

Wilcove, D.S., M.J. Bean, R. Bonnie, and M. McMillan. 1996. Rebuilding the ark: Toward a more effective Endangered Species Act for private land. <http://www.edf.org/pubs/Reports/help-esa/index.htm> (5 December 1996).

Legislative News

Sea Lions in Jeopardy

Environmental organizations are asking U.S. District Judge Thomas Zilly to block pollock trawling in critical sea lion habitat in the Bering Sea and Gulf of Alaska, according to the *Christian Science Monitor* 8/9. In the last two decades alone, the endangered Steller's sea lion population has plummeted from 120,000 to 20,000, an 80 percent decline. Pollock, a major food source for the sea lion, also supports a $700 million a year fishing industry. Environmentalists contend that the National Marine Fisheries Service quotas maximize the harvest with little regard for the impact on the sea lions. (GREENLines, 11 August 1999)

Grizzly Protection Plan Flawed

AP 8/9 reports that environmental groups are calling the habitat criteria in the FWS Yellowstone grizzly bear recovery plan flawed and "the beginning of the end for bear recovery." Environmental groups contend that grizzly mortality indicates that the existing recovery area is inadequate and needs to be expanded to provide corridors to other grizzly populations and to compensate for continued development within the recovery area. (GREENLines, 16 August 1999)

Local Zoning for Endangered Species

AP reports 8/16 that the city of Medford, OR is proposing a 50-foot riparian buffer zone along fish-bearing streams. Construction and the use of fertilizers and pesticides would be banned and native vegetation protected in the buffer zone. This innovative use of local zoning laws was specifically designed to meet statewide planning goals for protecting wetlands and riparian areas and to comply with the Endangered Species Act. (GREENLines, 19 August 1999)

Court Orders Critical Habitat

The San Diego North County Times reports 8/12 that a federal court has ordered the Fish and Wildlife Service (FWS) "to prepare a plan that will protect the California gnatcatcher's habitat in Riverside, San Diego, Los Angeles and Orange counties." While conservation groups hail the order to designate critical habitat as an important step forward, FWS says it will only further "tax limited resources" strained by a lack of congressional funding. As the agency charged with enforcing the ESA, FWS's $802 million 1999 budget had less than $1 million "set aside for critical habitat efforts nationwide." (GREENLines, 1 September 1999)

ESA Reauthorization No.1 Priority

The Western Governors Association led by Montana Governor Marc Racicot has made reauthorization of the Endangered Species Act its number one priority, according to the *Billings Gazette* 9/10. The governors are pushing "three separate bills to change the act that they say will make it stronger and more workable." Their strategy advocates a three-part approach focusing on species recovery, more money for recovery efforts and "conservation agreements or habitat protection plans before they are listed and local control is lost." (GREENLines, 15 September 1999)

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 trade-off 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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Literature cited

Barrett, W. 1978. The Illusion of Technique: A Search for Meaning in a Technological Civilization. Anchor Books, Garden City, New York.

Barzun, J. and H.F. Graff. 1985. The Modern Researchers. Harcourt Brace Jovanovich, Publishers, New York.

Baydack, R.K., H. Campa III, J.B. Haufler, eds. 1999. Practical Approaches to the Conservation of Biological Diversity. Island Press, Washington, D.C.

Berk, R.A. and P.H. Rossi. 1990. Key concepts in evaluation research. Pp. 12-32 in R. A. Berk and P. H. Rossi, eds. Thinking about program evaluation. Sage Publications, London.

Beveridge, W.I.B. 1950. The Art of Scientific Investigation. Vintage Book, New York.

Bookhout, T.A., ed. 1996. Research and Management Techniques for Wildlife and Habitats. The Wildlife Society, Bethesda, Maryland.

Brewer, G.D. 1974. Dealing with complex social problems: the potential of the "decision seminar." Pp. 439-461 in G.D. Brewer and R.D. Brunner, eds. Political Development and Change: A Policy Approach. Free Press, New Jersey.

Brewer, G.D. 1986. Methods for synthesis: policy exercise. Pp. 455-475 in W.C. Clark and R.E. Munn, eds. Sustainable Development of the Biosphere. Cambridge University Press, Massachusetts.

Burgess, P.M. and L.L. Slonaker. 1978. The Decision Seminar: A Strategy for Problem-solving. Merschon Center of the Ohio State University, Columbus, Ohio. Paper No. 1:1-22.

Clark, T.W., ed. 1986. The Black-footed Ferret. Great Basin Naturalist Memoirs **8**:1-208.

Clark, T.W. 1989. Conservation Biology of the Black-footed Ferret *Mustela nigripes*. Wildlife Preservation Trust Special Scientific Report No. 3.

Clark. T.W. 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. 1996. Appraising threatened species recovery efforts: Practical recommendations. Pp. 1-22 in S. Stephens and S. Maxwell, eds. Back from the Brink: Refining the Threatened Species Recovery Process. Australian Nature Conservation Agency in Transactions of the Royal Zoological Society of New South Wales, Australia.

Clark, T.W. 1997. Averting Extinction: Reconstructing Endangered Species Recovery. Yale University Press, New Haven, Connecticut.

Clark, T.W. In Press. Interdisciplinary problem-solving: Next steps in the Greater Yellowstone Ecosystem. Paper presented at a Conference on the Theory and Practice of Interdisciplinary Work, June, 1998. The Swedish Foundation for Strategic Environmental Research and The Council for Planning and Coordination of Research, Stockholm, Sweden. Policy Sciences.

Clark, T.W., A.R. Willard, and C.M. Cromley, eds. In Press. Foundations of Natural Resources Policy and Management. Yale University Press, New Haven, Connecticut.

Clark, T.W. and R.D. Brunner. 1996. Making partnerships work: Introduction to decision process. Endangered Species UPDATE **13**(9):1-5.

Clark, T.W. and J.R. Cragun. 1991. Organization and management of endangered species programs. Endangered Species UPDATE **8**(8):1-4.

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

Clark, T.W. and A.H. Harvey. 1988. Implementing endangered species recovery policy: Learning as we go? Endangered Species UPDATE **5**(10):35-42.

Clark, T.W. and R.L. Wallace. 1998. Understanding the human factor in endangered species recovery: An introduction to human social process. Endangered Species UPDATE **15**(1):2-9.

Clark, T.W. and R.L. Wallace. 1999. The professional in endangered species conservation: An introduction to standpoint clarification. Endangered Species UPDATE **16**(1):9-13.

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

Denzin, N.K. and Y.S. Lincoln, eds. 1994. Handbook of Qualitative Research. Sage Publications, Thousand Oaks, California.

Dey, I. 1993. Qualitative Data Analysis: A User-friendly Guide for Social Scientists. Routledge, New York.

Dominowski, R.L. 1980. Research Methods. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Dryzek, J. 1990. Discursive Democracy: Politics, Policy, and Political Science. Cambridge University Press, New York.

Hutchins, M., R.J. Wiese, and J. Bowdoin. 1996. Black-footed ferret recovery program analysis and action plan. American Zoo and Aquarium Association, Bethesda, MD.

Isaac, S. and W.B. Michael. 1995. Handbook in research and evaluation: A collection of principles, methods, and strategies useful in the planning, design, and evaluation of studies in education and behavioral sciences. EdiTS/Educational and Industrial Testing Services, San Diego, California.

Janesick, V.J. 1994. The dance of qualitative research design: Metaphor, methodology, and meaning. Pp. 209-219 in N.K. Denzin and Y.S. Lincoln, eds. Handbook of Qualitative Research. Sage Publications, Thousand Oaks, California.

Kellert, S.R. 1985. Social and perceptual factors in endangered species management. Journal of Wildlife Management **49**:528-536.

Lasswell, H.D. 1966. The Analysis of Political Behavior: An Empirical Approach. Archon Books, Hamden, Connecticut.

Lasswell, H.D 1971a. A Pre-view of Policy Sciences. American Elsevier Publishing Company, New York.

Lasswell, H.D. 1971b. The Continuing Decision Seminar as a Technique of Instruction. Policy Sciences **2**:43-57.

Lasswell, H.D. and M.S. McDougal. 1992. Jurisprudence for a Free Society. Kluwer Law International, The Hague, Netherlands.

Lockhart, M., A. Vargas, P. Marinari, and P. Gober. 1998. Black-footed ferret (*Mustela nigripes*) recovery update. Endangered Species UPDATE **15**:92-93.

Maguire, L.A. 1989. Managing black-footed ferret populations under uncertainty: Capture and release decisions. Pp. 268-292, in U. S. Seal, E. T. Thorne, M. A. Bogan, S. H. Anderson, eds. Conservation Biology of the Black-footed Ferret. Yale University Press, New Haven, Connecticut.

Majone, G. 1989. Evidence, Argument, and Persuasion in the Policy Process. Yale University Press, New Haven, Connecticut.

Marius, R. 1995. A Short Guide to Writing about History. HarperCollins, New York.

McCain, G. and E.M. Segal. 1977. The Game of Science. Brooks/Cole Publishing, Company, Monterey, California.

Miller, B.J., R.P. Reading, and S.C. Forrest. 1996. Prairie Night: Black-footed Ferrets and the Recovery of Endangered Species. Smithsonian Institution Press, Washington, D.C.

Miller, D.C. 1991. Handbook of Research Design and Social Measurement. Sage Publications, Thousand Oaks, California.

National Research Council. 1986. Ecological Knowledge for Environmental Problem Solving. National Academy Press, Washington.

Reading, R.P. 1993. Toward an Endangered Species Reintroduction Paradigm: A Case Study of the Black-footed Ferret. Ph.D. Dissertation, Yale University, New Haven, Connecticut.

Reading, R.P., T.W. Clark, A. Vargus, L.R. Hanebury, B.J. Miller, and D. Biggins. 1996. Recent directions in black-footed ferret recovery. Endangered Species UPDATE **13**(10&11):1-6.

Reading, R.P. and S.R. Kellert. 1993. Attitudes toward a proposed black-footed ferret (*Mustela nigripes*) reintroduction. Conservation Biology **7**:569-580.

Reading, R.P. and B.J. Miller. 1994. The black-footed ferret recovery program: Unmasking professional and organizational weaknesses. Pp. 73-100 in T.W. Clark, R.P. Reading, A.L. Clarke, eds. Endangered Species Recovery: Finding the Lessons, Improving the Process. Island Press, Washington, D.C.

Rosaldo, R. 1993. Culture and Truth: The Remaking of Social Analysis. Beacon Press, Boston.

Ratti, J.T. and E.O. Garaton. 1996. Research and experimental design. Pp. 1-23 in T.A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. The Wildlife Society, Bethesda, Maryland.

Scott, J. 1998. Seeing Like a State. Yale University Press, New Haven, Connecticut.

Scott, J.M., S.A. Temple, D.L. Harlow, and M.L. Shaffer. 1996. Restoration and management of endangered species. Pp. 531-539 in T.A. Bookhout, ed. Research and Management Techniques for Wildlife and Habitats. The Wildlife Society, Bethesda, Maryland.

Strauss, A. and J. Corbin. 1994. Grounded theory. Pp. 273-285 in N. K. Denzin, Y. S. Lincoln, eds. Handbook of Qualitative Research. Sage Publications, Thousand Oaks, California.

Wallace, R.L. and T.W. Clark. 1999. Solving problems in endangered species conservation: An introduction to problem orientation. Endangered Species UPDATE **16**(2):28-34.

Willard, A.R. and C.H. Norchi. 1993. The Decision Seminar as an Instrument of Power and Enlightenment. Political Psychology **14**(4):575-606.

Yin, R.K. 1989. Case study research: Design and methods. Applied Social Research Methods, v. 5. Sage Publications, London.

Marine Matters

The Hawaiian Islands Humpback Whale National Marine Sanctuary Advisory Council: Expanding Protection through Community Involvement

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Abstract

*This is the final article of a three part series on the endangered humpback whale (*Megaptera novaeangliae*) and the Hawaiian Islands Humpback Whale National Marine Sanctuary. This article focuses on the role of the Hawaiian Islands Humpback Whale National Marine Sanctuary's Advisory Council. The Council is a 25-member volunteer advisory group established by the National Oceanic and Atmospheric Administration's Marine Sanctuaries Division to assist in the continued development and management of the Hawaii Sanctuary Program. The Council maintains a strong advisory role in matters relating to the Hawaii Sanctuary. Members represent Sanctuary-related constituent interests in education, research, conservation, ocean recreation, native Hawaiian communities, and government agencies. This broad representation ensures that advice provided to Sanctuary management is comprehensive, well-informed, and diverse. In addition, meetings of the Council provide an opportunity for the local community to participate in discussions about issues affecting the Sanctuary. It allows for the concerns of various constituencies to be heard and enables the Sanctuary program to develop a more responsive and balanced approach to managing the Sanctuary's marine resources.*

Introduction

The Hawaiian Islands Humpback Whale National Marine Sanctuary is a unique opportunity for the National Oceanic and Atmospheric Administration (NOAA) to develop a community partnership with the people of Hawaii. Through the establishment of the Hawaii Sanctuary Advisory Council (SAC), citizens of Hawaii can provide input into the development and ongoing management of the Sanctuary. The Hawaiian Islands Humpback Whale National Marine Sanctuary Advisory Council is comprised of a group of volunteers, including representatives from adjacent counties, local user groups, representatives of native Hawaiian groups, conservation, scientific and educational organizations, and members of the general public. Members are appointed by the Sanctuary Manager in consultation with the Director of NOAA's Ocean and Coastal Resource Management Office and the State of Hawaii. To be included in SAC, members must be willing to commit their expertise to providing sound advice to enhance the effectiveness of the Sanctuary's management efforts. SAC is an integral part of the Sanctuary's management and their involvement translates into greater local stewardship of the marine environment in Hawaii. SAC is instrumental in reaching people who may not have heard about Sanctuary issues and activities. SAC also has two working groups, for education and research and a subcommittee for conservation. These additional groups of SAC are chaired by local experts who coordinate activities and assist Sanctuary staff in addressing priority education, research and conservation issues.

Establishment of the Hawaii Sanctuary Advisory Council

Sanctuary Advisory Councils are established under Section 315, (16 U.S.C. Sec. 1445a) of the National Marine Sanctuaries Act. The Secretary of Commerce is authorized to establish sanctuary advisory councils to provide assistance to the Secretary regarding the designation and management of national marine sanctuaries. The primary purpose of a sanctuary advisory council is to provide advice and recommendations to the sanctuary manager and the Marine Sanctuaries Division (MSD) relating to the continued development and management of a sanctuary. A sanctuary ad-

visory council functions in an advisory capacity to the Sanctuary Manager and is instrumental in helping produce annual operating plans and reports by identifying education, outreach, research, long-term monitoring, resource protection and revenue enhancement priorities.

In March 1996, the MSD, established the Hawaii sanctuary advisory council to ensure that local concerns were addressed in the ongoing development and management of the Hawaii Sanctuary. SAC consists of 25 members in a balanced representation of those groups affected by Sanctuary designation in Hawaii. Members include four federal and six state agency representatives, and 15 non-governmental representatives. Government entities designate one individual to serve on the SAC to represent the agency and provide a specific area of expertise to the SAC. Federal agencies represented with area of expertise identified in parenthesis include: Army Corps of Engineers (water quality, dredge disposal, and alteration of the seabed), U.S. Coast Guard (oil spills and enforcement), National Marine Fisheries Service (protected species and enforcement), and the Western Pacific Regional Fisheries Management Council (fisheries management). State agencies (area of expertise identified in parenthesis) include: the Office of Planning (marine and coastal coordination and planning), Department of Health (water quality management and monitoring), Department of Business, Economic Development, and Tourism (marine recreation, development, and tourism), Department of Land and Natural Resources (aquatic resources, marine conservation areas, boating, and enforcement), Office of Hawaiian Affairs (native Hawaiian issues), and the Department of Transportation (shipping, harbors, and harbor expansion). Non-government groups represented include: native Hawaiian communities, fishing, whale-watching, ocean recreation, business/commerce, shipping, tourism, conservation, research, and education interests, a citizen at large, and a representative for each of the four counties (Kauai, Honolulu, Maui, and Hawaii).

Appointment terms for all non-government members is set at two years. Initially, the terms for non-government members were staggered to establish continuity within the Council. At that time, the Sanctuary manager selected one-half of the non-governmental members to serve a two-year appointment with the other half to serve a three year term.

SAC has an elected Chair, Vice Chair, and Secretary. Officers are elected to serve for one year and can be elected to serve a total of three consecutive one year terms. Captain James (Jim) Coon is currently serving his second term as Chair of SAC. Jim has spent his entire life centered on or around the ocean. He began his career as a commercial fisherman and is currently the owner/operator of Maui's oldest sail boat company. Jim currently serves on the Executive Board of Directors for the Hawaii Visitors Bureau. He is an appointed member of the State's Marine and Coastal Zone Management Advisory Group, and the Governor's Small Business Regulatory Review Board. He is also a member of the Maui County Boat Owners Association and the Ma`alaea Boat and Fishing Club.

Since its establishment, the SAC has met fourteen times. The majority of SAC meetings are held on the island of Oahu. SAC has also met on the islands of Maui and Hawaii. All SAC meetings are open to the public. The Council meets regularly averaging six times per year and more often in subcommittees and working groups. Meetings provide an opportunity for the community to learn and participate in discussions about issues affecting the Sanctuary. Presentations and discussion topics at past meetings include the Sanctuary's management plan, research and education priorities, and presentations on issues and activities within the Sanctuary.

SAC works in concert with the Sanctuary manager by keeping him informed about issues of concern throughout the Sanctuary, offering recommendations on specific issues and aiding the manager in achieving the goals of the Sanctuary program within the context of Hawaii's marine programs and policies. Members play an active role in the Santuary's management and provide a link between the Sanctuary and state and federal management agencies, native Hawaiians, user groups, researchers, educators, policy makers, and others in the community. More importantly, this link helps to focus efforts and attention on the humpback whale and its habitat. In this capacity, SAC is a critical part of the Sanctuary's identity. It provides a forum through which Sanctuary management issues can be raised and addressed in an ongoing and relatively informal manner, enhancing the efforts of the Sanctuary in managing and protecting the humpback whale and its habitat.

In addition, to increase its efficiency and advisory capacity to incorporate the different concerns from all the main Hawaiian Islands, SAC has formed subcommittees and working groups. These subcommittees and working groups focus on the three SAC management priorities of education, research, and resource conservation.

Role and responsibilities

From March 1996 through June 1997, SAC's primary role was to provide advice and recommendations to NOAA and the State on responding to public comments received on the draft management plan for the Hawaii Sanctuary. In June 1997, members

of SAC were invited to meet with Governor Benjamin Cayetano to express both their support and their concerns regarding NOAA's proposals for the Hawaii Sanctuary. The collective voice of SAC during this visit may have been a factor in the Governor's decision to approve the Sanctuary's management plan.

Since the Governor's approval of the Sanctuary in June 1997, SAC continues to work on defining its role within the management regime of the Hawaii Sanctuary.

SAC is governed by a Charter established by the National Oceanic and Atmospheric Administration (NOAA), Office of Coastal and Resource Management, Marine Sanctuaries Division. The Charter provides general guidance to SAC on its role in relation to the management of the Hawaii Sanctuary. It covers a variety of issues including a general framework of SAC's capacity to provide advice and recommendations.

In this capacity, SAC may advise the Sanctuary Manager on resource protection, research, education, and site administration.

In relation to the Sanctuary's resource protection program, SAC may advise the Sanctuary manager on the effectiveness of interagency agreements, permit review and coordination, and on the effectiveness of the Sanctuary regulations in providing adequate resource protection. For research, SAC may advise the Sanctuary Manager on priority research and monitoring needs, proposals, and reports. For education, SAC may advise the Sanctuary Manager on enhancing public awareness, understanding, and sustainable use of the marine environment and on the development of an informed constituency. SAC may also be asked by the Sanctuary manager to advise on proposals for activities within the Sanctuary, and on proposals for activities outside of, but affecting, the Sanctuary. The Sanctuary manager may also request advise on planning for the use, development, and maintenance of Sanctuary lands and buildings and equipment. In addition, the Council's advice can be sought in the process to identify other resources of national significance that may be considered for future inclusion in the Sanctuary; the review of any new regulations or modification of existing regulations developed pursuant to or for any other purpose based on new findings or future needs; and for necessary modifications to the management plan.

SAC in action

SAC has two working groups and a subcommittee focused on the areas of education, research, and conservation.

Education

The SAC Education Working Group formed in May 1998. During the last year, the group has met several times to prioritize sanctuary and environmental education needs and to assist staff in developing Sanctuary education initiatives for enhancing public awareness and improving sustainable use of the marine environment. This group assists Sanctuary staff in identifying current activities in the education community, increases opportunities for cooperative efforts, provides direction in the development of the Sanctuary's education program, prevents duplicative efforts, and helps to establish guidelines and standards for the production of sanctuary education materials.

In a recent endeavor, Chair Patty Miller coordinated an impressive island-wide effort to gather valuable information from various sectors of the community in Hawaii. Meetings were conducted on the islands of Maui, Kauai, Hawaii, and Oahu. These meetings provided valuable input from local environmental educators and interested public on priority environmental education needs within these communities. Guided by this input, members of the education working group have chosen to actively support and assist in the development of a new Hawaii Sanctuary website and a interpretive sanctuary poster.

The focus of the Education Working Group during the next year will be to support education and outreach efforts for the Sustainable Seas Expeditions (SSE). SSE is a five-year ocean exploration and conservation project focused on NOAA's national marine sanctuaries. It is administered by the National Geographic Society in partnership with NOAA's National Marine Sanctuaries and made possible by a grant from the Richard and Rhoda Goldman Fund. Currently, the SAC Education Working Group is coordinating education efforts for SSE Teacher Workshops scheduled for this fall.

Research

The SAC Research Working Group has been actively meeting since September 1998. The input provided by the SAC Research Working Group has helped the Sanctuary to prioritize research and monitoring needs. The group has also been effective in helping Sanctuary staff in identifying, selecting, and sponsoring research projects that are responsive to the Sanctuary's research and management needs.

A list of priority research topics identified by the SAC Research Working Group will be used to guide the Sanctuary in selecting research topics for the next humpback whale season in 2000.

A goal of the research working group is to support and promote research on, and monitoring of Sanctuary resources to improve management decision-making in the Sanctuary. Research working group Chair, Dr. Paul Nachtigall believes that the Sanctuary Advisory Council is help-

ful for a number of reasons, primarily because it represents constituencies of people effected by the Sanctuary. He explains that, "as research chair I am particularly mindful of the effects that issues brought before the Sanctuary might have on the excellent scientific projects that are possible within the Humpback Whale Sanctuary. People preserve what they understand and understanding is developed through scientific research".

Conservation

The SAC's Conservation Subcommittee was inaugurated in November 1998 when a total of 12 SAC members and alternates joined the group. Meetings of the Subcommittee provide an important forum to discuss various issues concerning the humpback whale and its habitat. Recently, the Subcommittee met to discuss the continuation of the Scripps Institution of Oceanography's Acoustic Thermometry Ocean Climate Project in waters north of the island of Kauai and the U.S. Navy's Hawaiian Shallow Water Training Range in waters off Maui and Draft Overseas Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active Sonar Projects. The group is coordinated by group Chair, Dr. Louis Herman, who continues to work with group members to further define the role of the Conservation Subcommittee in addressing relevant issues that directly protect and conserve the humpback whale within the Hawaii Sanctuary.

Conclusion

SAC and its working groups maintain a strong advisory role in Sanctuary-related matters and policy direction. As a result, the Sanctuary benefits greatly from the energy and enthusiastic commitment of individual SAC members. In return, Sanctuary related efforts help to maintain the richness, diversity, and quality of life within the Hawaiian Islands for this and future generations.

The Sanctuary staff in Hawaii have a daunting task, monitoring and protecting over 1,218 square nautical miles of coastline in the Hawaiian Islands. For the Sanctuary to be successful, a tremendous effort must be made by all who have a vested interest in Hawaii's marine environment to address tough policy issues and seek win-win solutions to ensure the vitality and well-being of Hawaii's marine sanctuary.

In 2002, NOAA and the State of Hawaii will conduct a five year review of the Hawaiian Islands Humpback Whale National Marine Sanctuary's Management Plan to evaluate the progress made toward implementing the goals and objectives of the plan in protecting the humpback whale and its habitat in Hawaii. The accomplishments during these beginning years of the Hawaii Sanctuary will be a measure of achievement of those who were willing to commit to the challenge of protecting Hawaii's ocean resources.

Literature cited

Hawaiian Islands Humpback Whale National Marine Sanctuary Advisory Council Charter. 1996 (amended 1998).

National Marine Sanctuaries Act (NMSA). 16 U.S.C. 1431, Section 315.

Sanctuaries and Reserves Division. 1997. Hawaiian Islands Humpback Whale National Marine Sanctuary Final Environmental Impact Statement/Management Plan. Prepared by: NOAA's Sanctuaries and Reserves Division, Silver Spring, MD.

Conservation Spotlight

Developing Recovery Strategies for West Indian Rock Iguanas

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Abstract

As a result of habitat degradation and the negative effects of invasive species, the rock iguanas of the West Indies are among the most endangered lizards in the world. Before recovery plans are instituted for critically endangered species, it is important to gather as much information as possible to assess whether or not these programs are likely to succeed. Given that relatively healthy populations still exist in the wild, the Cuban iguana (Cyclura nubila) *can serve as a valuable model for developing conservation strategies for other endangered rock iguanas. Since 1993, we have been studying Cuban iguanas on the U.S. Naval Base at Guantanamo Bay. To investigate management options for small populations, we carried out a long-term field experiment in which dominant males were temporarily relocated in an effort to provide a greater percentage of males the opportunity to contribute to the gene pool. We also conducted an experimental reintroduction to examine how hatchlings retained in captivity prior to release fare in the wild. Our results to date indicate that released juveniles have adapted well in terms of growth, thermoregulation, predator avoidance, and social interactions. As a group, rock iguanas appear to be excellent candidates for headstart/release programs.*

Introduction

West Indian rock iguanas (genus *Cyclura*) form a unique group of eight species inhabiting tropical dry forests in the Greater Antilles and the Bahamas (Figure 1). As a group they are highly endangered, primarily because much of their fragile island habitat has been eliminated by human development or severely degraded by invasive species (Table 1). Mongooses, dogs, feral cats, and black rats prey heavily on juvenile iguanas, and in many areas introduced livestock have destroyed the native vegetation on which iguanas feed (Alberts 1999). Because rock iguanas are potentially important seed dispersers for many native plants, their loss has serious consequences for the ecosystems to which they belong.

Since its inception in 1990, the American Zoo and Aquarium Association (AZA) Lizard Taxon Advisory Group has designated West Indian rock iguanas as one of their highest priorities, and many AZA member institutions have actively contributed to iguana conservation, research, and education programs in the region. The Rock Iguana Species Survival Program® (SSP), initiated in 1996, seeks to manage captive populations of these lizards as a safeguard against extinction in the wild and generate support for *in situ* conservation and recovery programs (Hudson 1996). Because relatively healthy populations of Cuban iguanas (*Cyclura nubila*) still exist in the wild, the SSP has identified this species as an ideal research model for developing conservation strategies that can be applied to other, more highly endangered West Indian iguanas.

Research on wild populations

In 1993, the Ecology Division of the San Diego Zoo's Center for Reproduction of Endangered Species initiated a field study of Cuban rock iguanas inhabiting the U.S. Naval Base at Guantanamo Bay. Our intentions were to gain an understanding of the basic biology of these iguanas, as well as to develop practical methodologies for population recovery. Our first field season was devoted to studying hormone/behavior interactions in a group of 60 iguanas inhabiting a section of rocky coastline on the windward side of the base.

Using hand nets, we captured all adult iguanas at the site once per month. At the time of capture, we made a series of morphological measurements and collected blood samples for hormonal analysis. Our behavioral observations revealed that approximately 80 percent of adult males engaged in aggressive interactions with other males. Dominant

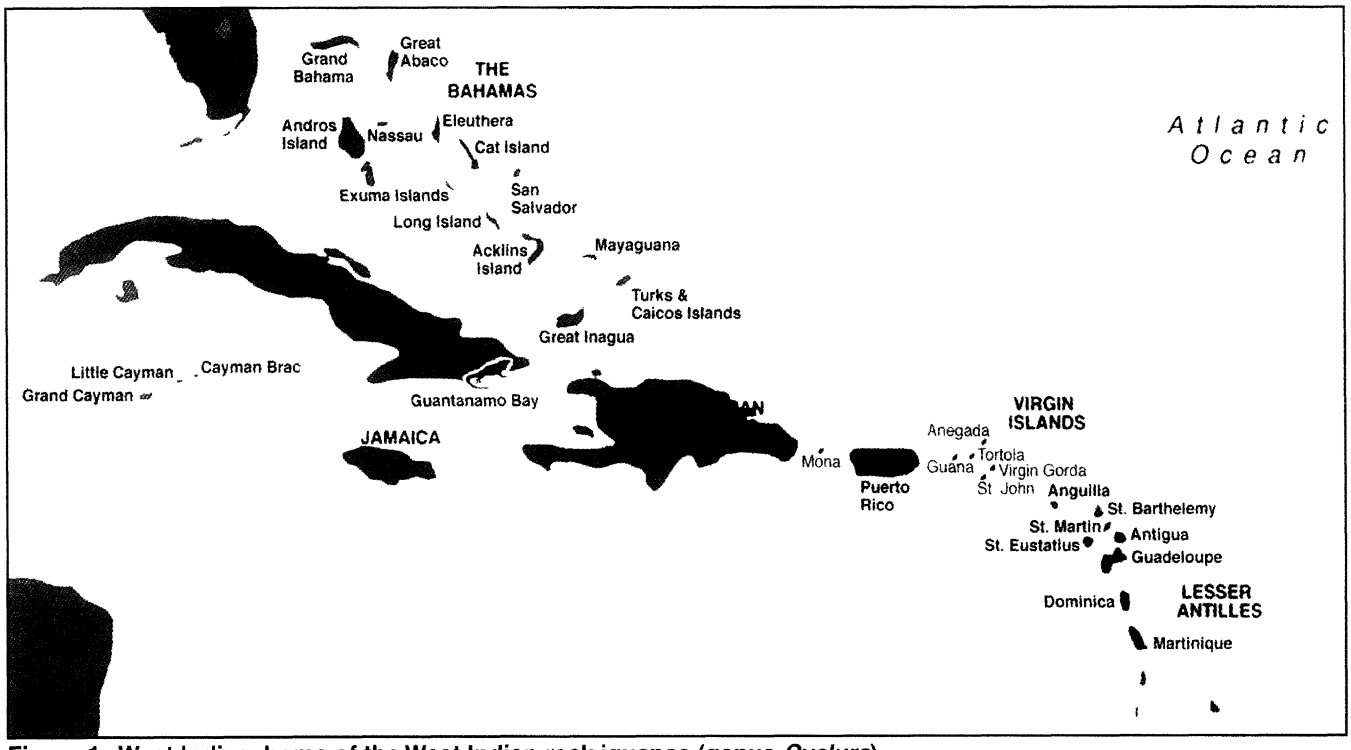

Figure 1. West Indies: home of the West Indian rock iguanas (genus *Cyclura*).

males had higher testosterone levels and were larger than lower ranking males. Headbob displays, chases, and mouth gaping, behaviors usually performed in the context of territorial defense, were exhibited by higher ranking males more often than by other males. Additionally, there was a trend for courtship to be performed more often by dominant males. Smaller, low-ranking males occupied large poorly defined home ranges, while high ranking males defended small territories which overlapped the ranges of one to four different females.

Our results suggest that high-ranking males, through their more robust body morphology and behavioral dominance, had better access to potential mates than lower ranking males. Only about 30 percent of all males were classified as high-ranking. If these males contribute disproportionately to the gene pool, then the variability in male social behavior we observed has important implications for genetic structuring of local populations.

Experimental manipulation of local social structure

During the subsequent breeding season, we conducted an experiment to determine if temporary alteration of local social structure would increase the probability that sexually mature but genetically under represented male iguanas would have the opportunity to mate. This type of manipulation represents a unique approach to lizard conservation, and has the potential to serve as an important management tool for endangered populations.

For the duration of the breeding season, we temporarily relocated the five highest-ranked males from the study site. Removal of high-ranking males produced immediate and dramatic changes in male social structure. Within a few days, the five largest previously low-ranking males showed increased rates of headbob display, began to defend territories spatially similar to those vacated by dominant males, and exhibited testosterone levels typical of high-ranking males during the breeding season. Vigorous courting of females occurred, indicating that lower ranking males attempted to attract mates in the absence of the previously dominant individuals.

At the close of the breeding season, we returned four of the five previously dominant males to the study site. Unfortunately, one individual escaped from the enclosure during the holding period and could not be retrieved. The other four males each regained their previous territories within two days, although the aggressive interactions required for these males to reestablish themselves were among the longest and most intense observed during the entire study. Behavioral observations and home range mapping for five weeks following the return of the dominant males indicated no long term disruption of behavior or social relationships. Our results indicate that temporary alteration of local social structure may represent a valuable management tool for small or otherwise genetically compromised populations by potentially allowing a greater percentage of males to contribute to the gene pool.

Captive propagation

In addition to research on adult iguanas, we also sought to understand how environmental factors affect egg incubation and the subsequent growth and viability of hatchlings (Alberts et al. 1997). During the breeding season, we captured gravid female iguanas at several different locations on the base and placed them in a large outdoor enclosure containing artificial nest sites. Upon laying their eggs, we released the females at their site of capture. We assigned eggs to one of three incubators maintained at 28, 29.5 or 31°C. Within each incubator, we combined water with vermiculite to create wet (-150 kPa), moist (-550 kPa), or dry (-1100 kPa) incubation conditions.

Eggs hatched after 89 to 136 days of incubation, with those incubated at higher temperatures hatching sooner. Whereas moisture level had little influence of size of animals at hatching or their subsequent growth, we found a significant effect of incubation temperature on these variables. Although slightly smaller at hatching, as a result of their faster growth rates, iguanas from eggs incubated at higher temperatures were larger in mass, length, and head size than those incubated at lower temperatures by three months of age. These higher growth rates persisted through the first year, resulting in significantly larger body sizes for hatchlings incubated at higher temperatures.

Experimental release of headstarted juveniles

Studies on reptiles indicate that larger juveniles may survive better than smaller ones because they are more successful at avoiding predation and competing for food. This has led to proposals for headstarting programs, in which animals are raised in captivity until they reach a less vulnerable body size, as a conservation strategy for increasing survivorship of released individuals. Headstarting programs have not been without criticism, however. In sea turtles, headstarting does not address the fundamental causes of population decline and may disrupt key links in the marine food chain (Frazer 1992). Even when captive-bred individuals are used in headstarting programs, danger remains that they will lose their fear of predators, have difficulty adapting to natural food sources, or expose the wild population to infectious disease.

Most rock iguana populations are depressed due to heavy predation on hatchlings by introduced species rather than increased adult mortality or a lack of suitable habitat (Alberts 1999). This indicates that headstarting, while it may not be appropriate or successful for all reptilian species (Congdon et al. 1993), may still prove to be a valuable conservation strategy for rock iguanas. Headstarting has the potential to directly address the problem of reduced juvenile recruitment in wild populations, and can be accomplished without exceeding the natural carrying capacity of the habitat.

In 1995, we released two groups of juvenile Cuban iguanas at Guantanamo Bay, one of which had been headstarted for 18 months. Prior to release, we monitored growth of the headstarted juveniles, and carried out a series of experiments to assess how well they might be expected to adapt to life in the wild. To determine whether headstarting alters the response of hatchlings to potential predators, we conducted monthly anti-predator experiments in which we measured the distance individual hatchlings would allow a human to approach before fleeing. While mean flushing distances in captivity were only about 60 percent of those measured in the wild, flushing distances in the captive group increased throughout the first year, indicating that captivity had not resulted in a significant decrease in fear of humans over time.

A second experiment investigated whether headstarted hatchlings would be willing to accept natural food sources after several months on an artificial diet. At ten months of age, we offered captive hatchlings a simultaneous choice between the freshly-collected leaves of a consumed but not highly palatable food plant in their native habitat, or several foods that they had been routinely fed in captivity. Responses of the hatchlings to the various choices showed that although the native plant was not a favored food item, the majority of hatchlings were willing to try the unfamiliar food source. Thus it appeared unlikely that headstarted hatchlings would experience difficulty in adapting to natural food sources once released into the wild.

In collaboration with the zoo's Veterinary, Pathology, and Virology Departments, we completed an extensive health screening examination of all juveniles prior to release, including physical examinations, analyses of fecal samples, complete blood counts, and serum chemistry panels (Alberts et al. 1998). Light microscopic evaluation of red blood cells followed by electron microscopy revealed the presence of the piroplasm *Sauroplasma*, a red blood cell parasite, in a high percentage of captive hatchlings. To insure that a new parasite would not be introduced into the wild population, we made an additional trip to Guantanamo Bay to collect blood from free-ranging iguanas. Electron microscopy confirmed the widespread presence of *Sauroplasma* in the wild population. In diverse families of lizards worldwide, this organism appears self-limiting and is not associated with any type of pathology or disease. All other test results indicated that the juvenile Cuban iguanas were in excellent health

Table 1. Present status of West Indian rock iguana populations (Alberts 1999).

Taxon	Estimated Population	IUCN Threat Category
Turks and Caicos iguana *Cyclura carinata carinata**	30,000	Critically Endangered
Bartsch's iguana *Cyclura carinata bartschi*	200-300	Critically Endangered
Jamaican iguana *Cyclura collei*	100	Critically Endangered
Rhinoceros iguana *Cyclura cornuta cornuta*	10,000-17,000	Vulnerable
Mona Island iguana *Cyclura cornuta stejnegeri*	1,500-2,000	Endangered
Andros Island iguana *Cyclura cychlura cychlura*	2,500-5,000	Vulnerable
Exuma Island iguana *Cyclura cychlura figginsi*	1,000-1,200	Endangered
Allen's Cay iguana *Cyclura cychlura inornata*	400-500	Endangered
Cuban iguana *Cyclura nubila nubila*	40,000-60,000	Vulnerable
Lesser Caymans iguana *Cyclura nubila caymanensis*	1,000	Critically Endangered
Grand Cayman iguana *Cyclura nubila lewisi*	100-175	Critically Endangered
Anegada Island iguana *Cyclura pinguis*	200	Critically Endangered
Ricord's iguana *Cyclura ricordi*	2,000-4,000	Critically Endangered
San Salvador iguana *Cyclura rileyi rileyi*	500-1,000	Endangered
White Cay iguana *Cyclura rileyi cristata*	150-200	Critically Endangered
Acklin's iguana *Cyclura rileyi nuchalis*	15,000	Vulnerable

*Although the population of this taxon is relatively large, its range continues to contract at an alarming rate.

and could safely be released.

At six month intervals, we have returned to evaluate the health and status of the released juveniles. To date, we have relocated 10% of the headstarted and 7% of the non-headstarted individuals. Their growth, thermoregulation, and behavior, particularly with regard to predator avoidance, closely parallels their wild counterparts. We will continue to carry out surveys at regular intervals in an attempt to relocate enough marked juveniles to permit comparisons of survival and growth in headstarted and non-headstarted individuals to be made. In addition, we will note any potential predators encountered during the census surveys. Feral cats are abundant at Guantanamo Bay, and if scat samples can be obtained, they will be examined for any iguana remains that might provide details about the size classes of iguanas most vulnerable to cat predation. This information will be very useful in designing future headstarting programs, especially in determining an appropriate length for the headstarting period.

Acknowledgements

We are grateful to the U.S. military and civilian personnel at the Guantanamo Bay Naval Base for logistical support and continued hospitality. Our research was supported by the National Science Foundation Conservation and Restoration Biology Program and the Zoological Society of San Diego Conservation and Research Fund.

Literature cited

Alberts, A.C. 1999. West Indian Iguanas: Status Survey and Conservation Action Plan. IUCN - The World Conservation Union, Gland, Switzerland.

Alberts, A.C., A.M. Perry, J.M. Lemm, and J.A. Phillips. 1997. Effects of incubation temperature and water potential on growth and thermoregulatory behavior of hatchling rock iguanas (*Cyclura nubila*). Copeia **1997**:766-776.

Alberts, A.C., M.L. Oliva, M.B. Worley, S.R. Telford, Jr., P.J. Morris, and D.L. Janssen. 1998. The need for pre-release health screening in animal translocations: A case study of the Cuban iguana (*Cyclura nubila*). Animal Conservation **1**:165-172.

Congdon, J.D., A.E. Dunham, and R.C. Van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): Implications for conservation and management of long-lived organisms. Conservation Biology **7**:826-833.

Frazer, N.B. 1992. Sea turtle conservation and halfway technology. Conservation Biology **6**:179-184.

Hudson, R. 1996. AZA Species Survival Plan profile: West Indian rock iguanas. Endangered Species UPDATE **13**(7&8):9-10, 14.

News From Zoos

Giant Panda Birth at San Diego Zoo

On 21 August, a Giant Panda was born at the Pacific Bell Giant Panda Research Station at the San Diego Zoo. The parents are currently on long term loan from the People's Republic of China (PRC) as part of a joint research and conservation effort between the PRC, the San Diego Zoo, and the U.S. Fish & Wildlife Service.

The female was artificially inseminated, after studies found deficiencies that prevented the male from knowing when she was in estrus. A variety of behavioral and hormonal factors were used to time the insemination, and daily urine samples were collected, enabling the zoo to monitor patterns of estrogen secretions and pinpoint the period of maximum fertility.

The panda's post-partum maternal behavior has also helped shore up the case for pandas as members of the bear (Ursid) family. Studies on molecular genetics have suggested that pandas are bears, and the San Diego Zoo, in collaboration with Professor Pan Wenshi (Peking University), has analyzed data from wild females to help guide them through the post-partum phase. In the first eight days after the birth, the female left the maternity den for only two drinks of water, and did not show any interest in food, which is very bear-like behavior.

New Species of Striped Rabbit Discovered in Asia

A new species of rabbit is hopping around the forests of Southeast Asia. Discovered by biologists from the Bronx Zoo-based Wildlife Conservation Society (WCS), the rabbit lives in the rugged Annamite Mountains of Laos, an extremely isolated region that has yielded several new species of mammals in recent years. The rabbit, which has distinct, dark brown stripes running down both its face and back, a reddish rump, and short ears, was first seen by a WCS researcher, who found three freshly killed specimens in a food market in Ben Lak, Laos. According to researchers, the rabbit's closest relative is a critically endangered species found in Sumatra - about a thousand miles away; genetic data suggest that the two species may have diverged about eight million years ago. Nothing is yet known about the biology of either variety. Since the discovery, the rabbit has been photographed in a nature reserve in Vietnam.

Students Help Save Rhinos

One of the most important functions of moderns zoos and aquariums is to excite the public about wildlife conservation and get them directly involved. A great example is occurring in Cincinnati where students at Mason Intermediate and Western Row Elementary raised more than $11,000 for rhinoceros conservation programs through the International Rhino Foundation (IRF). It was a two-year "Critter Campaign" developed by gifted-education teacher Becky Howard Miller.

After the Cincinnati Zoo's Education Department visited the school and explained how the rhino is endangered because of habitat loss and illegal poaching, about 900 students collected more than four tons of aluminum cans, sponsored pie tosses, and organized a silent auction to raise money. Half the money went to the Cincinnati Zoo and Botanical Garden's ADOPT (Animals Depend on People Too) Program and half went to the IRF.

Through the International Rhino Foundation, the students adopted a 10-year-old Sumatran rhino (about 400 left in the wild) at an Indonesian preserve. The IRF Web site, complete with pictures of students, teachers, and Minah, is at <www.rhinos-irf.org/support/community.html>.

Information for News From Zoos *is provided by the American Zoo and Aquarium Association.*

Bulletin Board

Help Save Birds from Extinction

Birdlife International is currently working to make available up-to-date information on the over 1,200 bird species considered to be in danger of extinction globally. This information will be published in the form of a book to be completed next year entitled *Threatened Birds of the World.* In order for this book to be made available to help governments, policy makers and communities take necessary steps to ensure the survival of these species, Birdlife International is looking for individuals, organizations, and commercial companies to sponsor their favorite species of bird. For more information, please contact Naomi Hawkins at Birdlife International (tel.: +44 1223 277318, fax: +44 1223 277200, e-mail: naomi.hawkins @birdlife.org.uk).

Awards for Student Conservation Research

Student teams from around the world are invited to enter the 2000 BP Conservation Programme Awards to secure funding, training, and support for the field research projects that they are planning, which tackle conservation issues of international importance. The closing date for applications is November 16, 1999. For an entry form, contact Programme Manager Katherine Gotto (tel.: +44 1223 277318, e-mail: katherine.gotto @birdlife.org.uk).

Building Bridges with Traditional Knowledge II Conference

A landmark conference on conservation, development, traditional knowledge and the sustainable use of the earth's cultural and biological resources will be sponsored by The University of Hawaii and The Juliflora Foundation May 28-June 3, 2001 in Honolulu, Hawaii. For information, visit their website at <www.traditionalknowledge.com>.

EcoSummit 2000: Integrating the Sciences

The aim of the second EcoSummit is to encourage integration of both the natural and social sciences with the policy and decision-making community, for the purpose of developing a deeper understanding of complex systems. The EcoSummit 2000 Secretariat has made the first announcement and call for posters. For more information and to register for the second announcement, visit their website at <www.elsevier.com/locate/ecosummit>.

Announcements for the Bulletin Board are welcomed.

Endangered Species UPDATE

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