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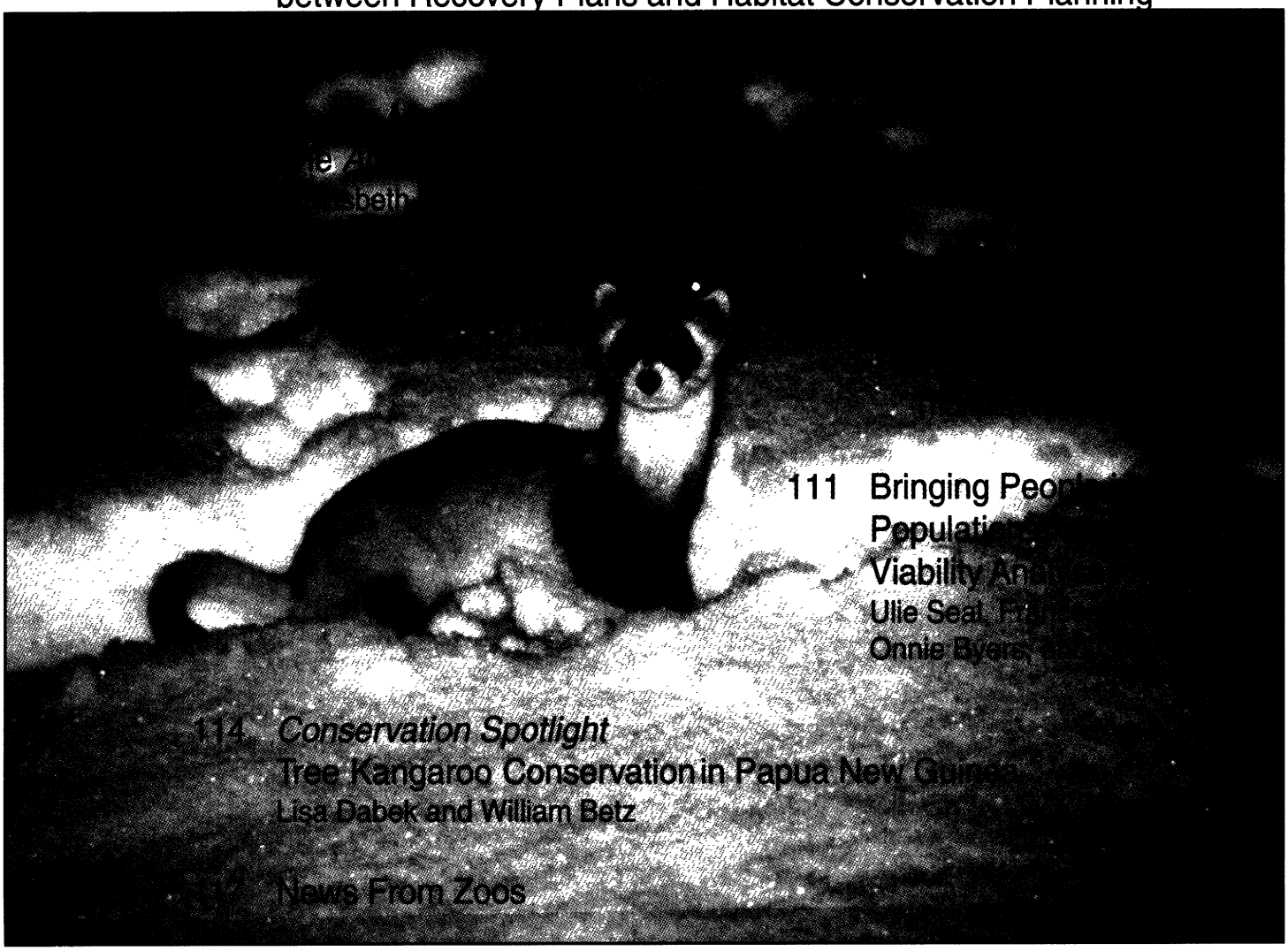

Black-Footed Ferret (*Mustela nigripes*) Recovery Update

Mike Lockhart
Astrid Vargas
Paul Marinari
Pete Gober
National Black-footed Ferret Conservation Center, 410 Grand Ave., Suite 315, Laramie, WY 82070

In 1998, the number of black-footed ferrets (ferrets; *Mustela nigripes)* produced from Species Survival Plan (SSP) captive breeding facilities (six zoos and one government breeding center) far surpassed all previous years with a total of 425 born and 321 ferret kits surviving to weaning. The largest contribution of ferrets came from the U.S. Fish and Wildlife Service's (FWS), National Black-footed Ferret Conservation Center (NBFFCC) where 249 kits were born and 191 survived. Record production was also achieved at the Phoenix Zoo and the Toronto Zoo. Higher birth rates resulted, in large part, from the discovery of a principal cause of false pregnancy in ferrets by the National Zoo's Conservation Research Center; a problem that has long affected captive breeding efforts (Howard et al. 1998; Wolf et al. 1997). Because female ferrets are induced ovulators, pairings with males that lack viable sperm result in false pregnancies. It was discovered through electroejaculation techniques that many juvenile males that display physical signs of breeding readiness (by standard testes measurements) are aspermic until later in the season. By utilizing only males with demonstrated sperm quality (via electroejaculation), the number of pseudopregnant females at the NBFFCC dropped by 20 percent. The FWS has recommended that this monitoring technique be implemented as a program-wide management tool at SSP facilities in 1999.

A total of 217 kits were allocated for reintroduction and field breeding programs in 1998. Ninety-four (59.35; i.e., 59 male and 35 female) ferret kits were provided to the Conata Basin/Badlands National Park reintroduction area in South Dakota. Seventy-seven ferret kits were allocated to two separate release sites on a Montana experimental reintroduction area; 55 kits (35.20) to the Ft. Belknap Indian Reservation and 22 kits (11.11) to the Charles M. Russell National Wildlife Refuge. Finally, 29 kits (18.11) were sent to Arizona, some of which will be released while some will be retained for on-site breeding efforts in 1999. Ferrets are also being provided to two new field breeding projects: Seven kits (4.3) will be transferred to a New Mexico breeding facility constructed by the Turner Endangered Species Fund; and 10 kits (5.5) will be sent to a breeding project on an experimental reintroduction area in northwestern Colorado and eastern Utah.

Black-footed ferret (*Mustela nigripes*).

As was the case last year, all ferret kits destined for release in the wild in 1998 were "preconditioned." Preconditioning consisted of extended exposure to outdoor pens that have naturalistic prairie dog burrows, and in which developing kits are exposed to prairie dog prey (Vargas et al.

1996). Preconditioning significantly enhances the survival of ferrets released to the wild (Biggins et al. 1998). With construction of 24 on-site preconditioning pens by the U. S. Forest Service in South Dakota in 1997, the national program now has sufficient capacity to precondition all ferrets targeted for release.

News regarding ferret production in the wild in 1998 is also highly encouraging. Of 56 adult ferrets (25.26, 5 sex undetermined) found during spring surveys in South Dakota, more than 70 kits have been observed. Of 25 adults (5.20) located last spring in Montana, at least 31 different kits have been detected. So far, it appears that litter sizes are also larger than past years. Between both South Dakota and Montana over 34 litters and more than 100 wild born young have been produced in 1998.

Significant progress in the area of on-site breeding was also achieved this past spring in Arizona. The Arizona Game and Fish Department produced 26 kits (of which 18 survived) in 1998. This marks the first time that ferrets were produced in on-site pens at an existing reintroduction area. A portion of the kits will be released from their pens directly to the wild while others will be retained for future breeding efforts.

Although field surveys and reintroduction efforts are still ongoing at the time of this report, 1998 can be considered to be the most successful year in the history of the ferret recovery program. Given the number of ferrets that persisted from previous reintroductions, the number of kits produced in the wild, and the number of ferrets released in 1998, it is likely that more ferrets will exist in the wild during the fall of 1998 than are in captivity—an important program milestone. Captive breeding and reintroduction capabilities continue to steadily improve. Little progress, however, has been made in the conservation of prairie dog habitats upon which black-footed ferrets depend. A recent evaluation by the FWS indicated that only ten sites exist in all of North America that have prairie dog complexes of sufficient size and density to potentially support viable ferret populations (which include all current reintroduction sites). The most formidable challenge now facing ferret recovery is whether suitable prairie dog habitat can be secured to achieve the objectives of establishing multiple, self-sustaining ferret populations in the wild.

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Endangered Species UPDATE
School of Natural Resources and Environment
The University of Michigan
Ann Arbor, MI 48109-1115
(734) 763-324; fax (734) 936-2195
E-mail: esupdate@umich.edu
http://www.umich.edu/~esupdate

Cover: Black-footed ferret (*Mustela nigripes*). Photograph by Ron Stoneberg.

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Opinion

Four Sure Ways to Undermine a Good Idea... and Hurt Endangered Species

Michael J. Bean
Environmental Defense Fund, 1875 Connecticut Avenue, NW, Suite 1016, Washington, DC, 20009; mb@edf.org

If Murphy's Law has variants, one of them must surely be that given the opportunity to screw up a good idea, people will. Evidence for the existence of this fact is abundant, but here the focus is on endangered species "safe harbor agreements" and a variety of ideas that, if pursued, will surely rob this new conservation tool of much of its potential value.

What are endangered species "safe harbor agreements" and what is their potential value? Essentially, they are agreements between a nonfederal landowner and the US Fish and Wildlife Service (FWS) or National Marine Fisheries Service in which the landowner agrees to restore or enhance the habitat of an endangered or threatened species and FWS agrees that it will not impose added restrictions on the landowner as a result of the species being attracted to, or increasing in, the area where the restoration was done. In simpler terms, instead of blindly following the maxim, "No good deed goes unpunished," a safe harbor agreement commits a landowner to do a good deed, and commits the government not to punish him or her for doing it.

The "good deeds" that landowners might do under safe harbor agreements can take a variety of forms. Typically, they will include creating, restoring, or enhancing habitat, managing habitat so as to replicate the effects of natural disturbance regimes that no longer operate effectively, extending forest rotation cycles, reintroducing an endangered species into an area from which it has been extirpated, and controlling exotics or other competing or predatory species. There are two simple reasons why it is a good idea to induce such practices through safe harbor agreements. First, for many endangered species, unless these practices are done, the fate of the species is sealed: without prescribed fire or practices mimicking the effects of fire, species dependent upon fire adapted ecosystems will inexorably disappear; so will species that today persist in small, nonviable populations on highly fragmented landscapes, where each small population is now effectively isolated from the others and at high risk of loss through chance events; so will many species whose habitats are being overrun by exotics. Taken together, the preceding describes a majority of today's endangered species. Second, nothing in the Endangered Species Act (ESA) requires such practices to be undertaken and, absent the sort of assurances that safe harbor agreements provide, few landowners will voluntarily undertake them if they understand that a likely consequence of doing so will be to encumber their property with restrictions that would not otherwise exist. Hence, relieving landowners of those encumbrances in order to secure their willingness to implement essential conservation practices is the central idea of a safe harbor agreement.

The safe harbor idea is thus simple and straightforward. People have managed, however, to suggest a variety of ways to complicate this simple idea and negate much of its useful potential. Four of those ways follow:

Combine safe harbor agreements with traditional HCPs.

Safe harbor agreements can take the form of "habitat conservation plans" or HCPs. Indeed, most safe harbor agreements approved to date have done so. They are not, however, "traditional" HCPs. In traditional HCPs, landowners seek immediate authority to harm an endangered species (usually by destroying its habitat) and propose to mitigate that harm through conservation actions that may or may not leave the species as well off as it was before. In sharp contrast, in safe harbor agreements, landowners have no immediate intention to do anything harmful to an endangered species or its habitat; indeed, their intent is exactly the opposite. They seek to improve the situation for endangered species on their property and may have no specific intent ever to do anything that will negate that improvement. They do, however, want to preserve the right to change their minds in the future and to undo the improvements they have implemented if they so wish. For as long as the improvement is maintained, the species is better off; when the improvement is eliminated, the species is no worse off than it was before the safe harbor agreement.

Combining these two fundamen-

tally different tools is the first, and most likely, way to damage the safe harbor idea. A number of landowners who need traditional HCPs (i.e., they have an immediate intent to carry out an activity harmful to an endangered species) have concluded that they would be well served by combining that traditional HCP with a safe harbor agreement. The traditional HCP gives them the right to harm currently occurring individuals on their property; the safe harbor agreement gives them a similar assurance with respect to those that may occur there in the future. Such a combined measure was approved for a North Carolina landowner, Ben Cone (See 61 Fed. Reg. 36390, July 10, 1996). Cone sought permission to take all the endangered red-cockaded woodpeckers (*Picoides borealis*) on his property; if that were granted, he then proposed to manage his land thereafter so as to benefit the woodpecker, provided that he be given safe harbor assurances with respect to those that might later occur on his property. FWS agreed.

It may not be immediately apparent why the approach taken in the Cone example is necessarily a bad idea. If landowners agree to as much mitigation for the incidental taking of currently occurring individuals on their property as the law requires, yet are willing to make some additional, voluntary commitments that may result in endangered species using their property yet again in the future, why not let them do so in a combined traditional HCP and safe harbor agreement? There isn't a strong theoretical answer to this question, but there is a very compelling practical one. The practical concern is that the amount of mitigation required by law for any proposed incidental taking is never known at the outset. It is not derived through a mathematical formula. It is rather the product of a negotiation, heavily influenced by what is "practicable" in light of the unique circumstances of the particular landowner. Thus, there is a danger that the safe harbor component of this package will be perceived—by the landowner, by FWS, or by the public—as part of the mitigation for the immediate incidental take. It isn't, and it shouldn't be, but it will never be possible to eliminate the perception that it is. That perception will have a corrosive effect upon the value of, and support for, safe harbor agreements. Landowners will demand that FWS reduce the amount of mitigation they must do, citing their virtuous agreement to enter into a post-hoc safe harbor agreement; FWS will be tempted to do so to avoid a nasty conflict with the landowner; environmentalists will become suspicious of safe harbor agreements because they no longer assure that "baseline" condition will be maintained, and endangered species will be worse off. Better to not go down this road at all.

Combining traditional HCPs and safe harbor agreements will have one other detrimental effect: it will destroy the important concept that under safe harbor agreements the current situation for an endangered species gets no worse. This concept is embodied in the description of an endangered species "baseline" that exists at the time the agreement is negotiated. The baseline represents the landowner's existing (i.e., pre-agreement) obligations under the ESA, if any. A safe harbor agreement grants a landowner a future right to take endangered species incidental to lawful activities, provided that incidental taking not reduce the status of the species or its habitat on the land in question below its baseline conditions. As the Ben Cone example illustrates, the combination of a traditional HCP and a safe harbor agreement severely undermines the baseline concept. The effect of that agreement was to allow Cone to eliminate all present red-cockaded woodpeckers on his property and all future woodpeckers. Thus, the "baseline" was rendered meaningless.

Give safe harbor assurances for activities that are legally required.

A key feature of safe harbor agreements is that they commit a landowner to undertake activities they are not otherwise lawfully required to undertake and are not likely to undertake absent such an agreement. A pending HCP illustrates that this important requirement that safe harbor assurances be extended only for voluntary actions may not be adequately understood, at least by regulated interests and possibly by FWS itself. That HCP concerned a beach resort development in the Commonwealth of the Northern Mariana Islands (see 63 Fed Reg. 31226, June 8, 1998). The development was likely to result in the incidental taking of nightingale reed-warblers (*Acrocephalus luscinia*), an endangered species. The HCP was offered in support of an application for a permit to take the reed-warblers.

Another endangered species on the island, one not found on the site, is the Mariana common moorhen (*Gallinula chloropus guami*). Because it did not occur on the project site, no permit to take it incidentally was sought by the developers. The Commonwealth government, however, had imposed a number of requirements on the project under local environmental legislation unrelated to endangered species concerns. Among these was a requirement to construct several "mitigation ponds." The HCP rather casually noted that the required mitigation ponds might in the future attract moorhens. If so, it said, the resort developer would

address that issue through a safe harbor agreement. Implicit in this assertion is the apparent belief that safe harbor agreements are a vehicle for relieving landowners from any responsibilities toward endangered species, even those that become established on the land prior to the agreement as a result of legally required activities. A more profound misunderstanding of safe harbor agreements can hardly be imagined.

Deny safe harbor assurances to landowners receiving federal funds.

Regrettably, ill-conceived ideas are not the exclusive province of the regulated community or the government. Among the more self-defeating ideas embraced by at least some environmental groups is that landowners who receive public cost-sharing assistance to carry out habitat improvements should not be allowed to enter into safe harbor agreements with respect to those improvements. Thus, FWS's Partners for Fish and Wildlife Program, USDA's Wildlife Habitat Improvement Program, and other similar cost-sharing programs would, under this suggestion, be off-limits to landowners seeking to enter into safe harbor agreements. It is certainly true that at present a small number of private landowners are participating in those programs and carrying out activities likely to benefit endangered species, all without any safe harbor assurances, either because they are unaware of the potential encumbrances upon their property, or because they don't care about those encumbrances. It is also true, however, that participants in these programs typically sign agreements giving them a contractual right to return their land to its prior condition and use, with nothing said about the presence of endangered species qualifying that right. If landowners who wish to exercise that contractual right discovers that they cannot do so, the consequence is not likely to be beneficial to the program. Their experience, if widely known, will make it even more difficult to persuade others to take part in such programs if their participation has the potential to cause endangered species to occupy their lands. Such a result would be extraordinarily counterproductive.

More fundamentally, the objection to providing cost-sharing assistance to safe harbor participants means that only those landowners with the financial ability to pay for habitat improvements out of their own pockets will be able to secure safe harbor agreements. Wholly apart from considerations of fairness, such a result can hardly be said to further the purposes of endangered species conservation. By extending safe harbor agreements to participants in cost-share programs, the universe of landowners potentially interested in those programs will be expanded. That increased demand for participation may or may not result in increased expenditures for these modest programs, but it surely won't justify decreasing those expenditures.

Ignore the Shaker Hymn "'Tis a Gift to Be Simple."

Safe harbor agreements commit landowners to do things they don't have to do. Furthermore, they do them either entirely at their own expense or with only partial reimbursement from cost-sharing programs. The surest way to kill a private landowner's interest in this idea is to make it complicated. If a non-industrial forest landowner with a few thousand acres of mixed longleaf pine and hardwood forest in the Southeast is willing to commit to a program of hardwood reduction followed by regular prescribed burning, and the installation of artificial cavities in suitable sized trees—all to benefit the highly endangered red-cockaded woodpecker—get out of his or her way. Imposing requirements for frequent written reports, intensive monitoring of results, and similar things are likely only to cause landowners to lose interest in the whole endeavor. Corporate landowners may be more likely to accept such requirements, but even then one has to ask whether the money spent on compliance would be better spent on on-the-ground conservation.

This doesn't mean that reports, monitoring, and other requirements should never be imposed on safe harbor agreements, but rather that the temptation to go overboard with such requirements may only drive away the very landowners whose cooperation would most benefit endangered species. In considering this point, it is important to consider the consequences of driving landowners away. A system so complex that it deters landowners from participating means that conservation of endangered species on private lands must be accomplished primarily through enforcement of the taking prohibition. That prohibition, however, doesn't even reach many of the most serious threats to species survival, including the loss of natural disturbance regimes, the presence of exotic species, the inevitable downward spiral of small, isolated populations in already fragmented habitats, and so on. Furthermore, effective enforcement of the taking prohibition presupposes that enforcement officials know where protected species occur and when landowner activities have taken them; for many listed species, that is clearly not the case. Safe harbor agreements offer the potential to improve both our knowledge of where endangered species occur and our ability to conserve them by enlisting the willing cooperation of private landowners. That is why it is so important not to ruin them.

Strange Bedfellows: Observations on the Current Relationship between Recovery Plans and Habitat Conservation Planning

Christopher R. Pyke
Department of Geography, Biogeography Lab, University of California, Santa Barbara, California 93106;
pyke@geog.ucsb.edu
Britta Bierwagen
Donald Bren School of Environmental Science and Management, University of California, Santa Barbara
Noah Goldstein
Department of Geography, Biogeography Lab, University of California, Santa Barbara

Abstract

The U.S. Endangered Species Act (ESA) mandates the formation of recovery plans to define the steps and approaches needed to remove species from threatened or endangered status. A 1982 amendment to the act added Section 10(a) allowing for the "incidental take" of listed species under an innovative and controversial program known as Habitat Conservation Planning. While the goal of recovery planning is the eventual delisting of a species, Habitat Conservation Plans (HCPs) are only required to cause no further jeopardy, while mitigating impacts to the maximum extent practicable. This study focused on the interaction between these ESA provisions in 44 approved HCPs. We participated in an interdisciplinary working group organized by the National Center for Ecological Analysis and Synthesis (NCEAS) and the American Institute for Biological Sciences (AIBS) during Fall 1997. The working group integrated the resources of 13 faculty ecologists, and 106 graduate students at 8 universities to conduct an in-depth review of a cross section of existing HCPs. The scientific basis of the plans was evaluated in terms of the amount and type of data and the appropriateness of subsequent analyses in five areas: (1) take, (2) effects of implementation, (3) current biological status, (4) monitoring, and (5) mitigation. We found that species without recovery plans received more favorable ratings for adequacy of mitigation, monitoring procedures, and assessment of take. The existence of recovery plans had no impact on scores for the adequacy of the assessment of current status or the effects of HCP implementation. The existence of a recovery plan does not directly translate into improvements in species-specific planning in HCPs. The findings from the AIBS/NCEAS workshop were also compared to an extensive survey of recovery plans conducted by Foin et al. (1998). Our findings suggest several ways in which mutually beneficial improvements in HCPs and recovery planning could assist in the management of threatened and endangered species.

Introduction

In recent years there have been many studies concerning recovery plans and the performance of the Endangered Species Act (ESA). These reviews have either been case studies or a sampling of completed plans (e.g., Tear et al. 1993; Stafford 1995; Foin et al. 1997, 1998). The debate over threatened and endangered species conservation has consistently identified the need for natural habitat protection and restoration (e.g., Safford 1995; Foin et al. 1998). Although designating and protecting critical habitat in recovery plans is mandated by the ESA, it has been a difficult political and economic reality. The lack of success in delisting threatened and endangered species has prompted critics to ask whether the ESA is fundamentally flawed or if just the recovery planning process is failing (Tear et al. 1993). Amidst this debate the ESA has also come under fire for permitting incidental take by establishing habitat conservation plans (HCPs) under Section 10 (a) (Shilling 1997). One common perception holds that HCPs further imperil the tenuous state of threatened and endangered species through their authorization of take, while not adequately mitigating or minimizing impacts (Sher and Weiner 1997; Jackson 1997). In this context, the term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect

a threatened or endangered species (Section 3 (18), U.S. Endangered Species Act of 1973). Published studies have evaluated either single HCPs or a sample of available plans (e.g., Sher and Weiner 1997; Kareiva et al. 1998; Hood 1998). This paper looks for synthesis between current research on HCPs and recovery planning by specifically integrating data collected by an interdisciplinary working group organized by the National Center for Ecological Analysis and Synthesis (NCEAS) and the American Institute for Biological Sciences (AIBS) with a comprehensive survey of recovery plans conducted by Foin et al. (1998). We compared the types of threats identified in HCPs to those found by Foin et al. (1998) in recovery plans. Our work permits an initial analysis of the relationship between management options recommended in recovery plans and those actually permitted for use in approved Habitat Conservation Plans.

Our goal was to address five key research questions concerning the functional relationship between guidelines suggested in recovery plans and management practices embodied in HCPs:

(1) Are recovery plans utilized in the preparation of HCPs?

(2) Does the existence of a recovery plan correspond to the preparation of higher quality HCPs?

(3) Are some taxa disproportionately represented in HCPs when compared to the complete set of Federally listed threatened and endangered species? (For example, mammals make up 5.9% of all Federally listed species, but they comprise 21.1% of all species covered under approved HCPs.)

(4) How do threats to species identified in HCPs correspond to those threats identified by recovery plans (Foin et al. 1998)?

(5) Foin et al. (1998) have subdivided recovery plans into three classes of recommended management: preservation, restoration, and active management. How does the distribution of actual management regimes for approved HCPs reflect these recommendations?

Methods

We utilized a dataset collected during the Fall of 1997 by an AIBS/NCEAS working group composed of 13 faculty and 106 graduate students from 8 universities. The working group selected 44 plans representing a range of approved HCPs. The AIBS/NCEAS set of HCPs mirrored the distribution of taxa covered by all 207 approved HCPs. Graduate student evaluators reviewed the suite of documents that comprise the core of each HCP: the Incidental Take Permit (ITP), Implementing Agreement (IA), US Fish and Wildlife Service Biological Opinion, associated environmental review documentation (EA/EIR/EIS), and the HCP document itself.

Based on a thorough review of this material, students answered specific questions for two questionnaires; one pertaining to the plan itself and the other focusing on individual species covered by the HCP. Some questions were quantitative or factual in nature, while others required subjective, qualitative evalu-

Table 1. The conversions used to correlate threat categories between Foin et al. (1998) and the AIBS/NCEAS working group. The comparison categories are presented along the x-axis in Figure 4.

Comparison Category	Recovery (Foin et al. 1998)	HCP (AIBS/NCEAS)
Habitat loss	Habitat reduction	Habitat loss
Habitat modification	Habitat modification	Habitat degradation, fragmentation, pollution, water diversion and dams
Direct mortality	Population reduction	Direct mortality, harvest
Invasive species	Exotic species	Invasive species
Rarity	Specialized and relict habitat	Natural rarity
Biotic Interaction	Succession and disturbance, biotic interactions, hybridization, and coevolution	Change in food species, change in predator/prey relationships
Other	Other threats	Another threat not specifically listed on the AIBS/NCEAS questionnaire

Table 2. The conversion of the AIBS/NCEAS data into the management categories of Foin et al. (1998). AIBS/NCEAS categories are indicated in column one, and management classes from Foin et al. are indicated in bold across the first row.

AIBS/NCEAS Category	Habitat Preservation	Habitat Restoration	Active Management	No Equivalent
Land acquisition	22			
Conservation easement	18			
Safe Harbor	12			
Habitat restoration		27		
Habitat banks		13		
Maintain disturbance regimes			16	
Captive breeding			2	
Direct manipulation			20	
Rotating management			5	
Money for research				13
HCP Total	52	40	43	13
Percentage of HCP management events	**35**	**27**	**30**	**9**

ations of plan attributes. Each reviewer carefully documented their decision-making procedure with appropriate citations and justifications. The broad categories of evaluation included: assessment of current status, affects of implementation, evaluation of expected take, procedures planned for mitigation and minimization, and project monitoring. These criteria were evaluated for species in each HCP. One type of qualitative analysis was a synthetic ranking of plan adequacy. This subjective measure drew on the experience of the

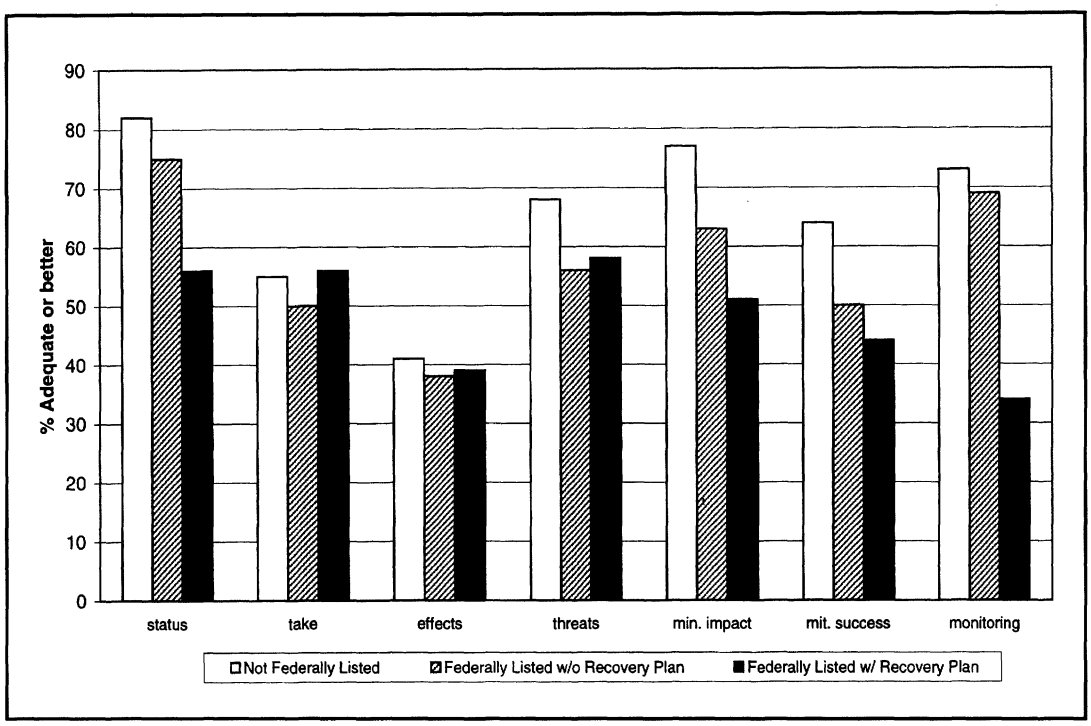

Figure 1. Data for research question 2. The bars illustrate the percentage of species in each category that received adequate or better rankings by the AIBS/NCEAS working group. Many non-Federally listed species are included in the Natural Community Conservation Plan (NCCP) in San Diego and the Multiple Species Conservation Plan (MSCP) in Orange County, California.

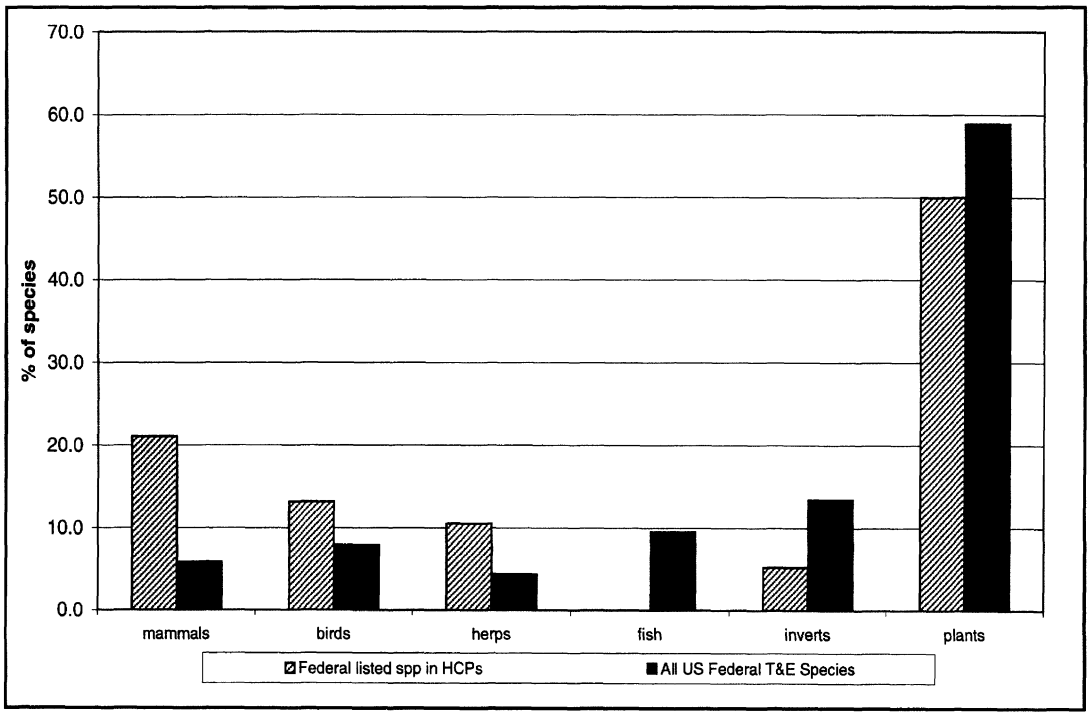

Figure 2. Relative to all Federally listed threatened and endangered species, HCPs overrepresent mammals, birds, amphibians, and reptiles, while underrepresenting fish, invertebrates, and plants. The HCP species include only those represented in the 44 plans surveyed by the AIBS/NCEAS working group; however, the distribution of taxa in the AIBS/NCEAS study is not significantly different from the distribution of taxa across all HCPs.

individual evaluators to summarize the information and determine if the plan and its components used scientific methods in an adequate and appropriate manner.

The resulting dataset contained 176 responses for each plan and 789 answers for each species. A more comprehensive review of the AIBS/NCEAS methods can be found in the AIBS/NCEAS working group report (Kareiva et al. 1998). It is important to note that the AIBS/NCEAS working group found that the distribution of species in taxonomic groups in their sample of HCPs was not statistically significantly different from the distribution of taxonomic groups across all HCPs. This relationship facilitated comparisons between the distribution of taxa for Federally listed species with and without recovery plans.

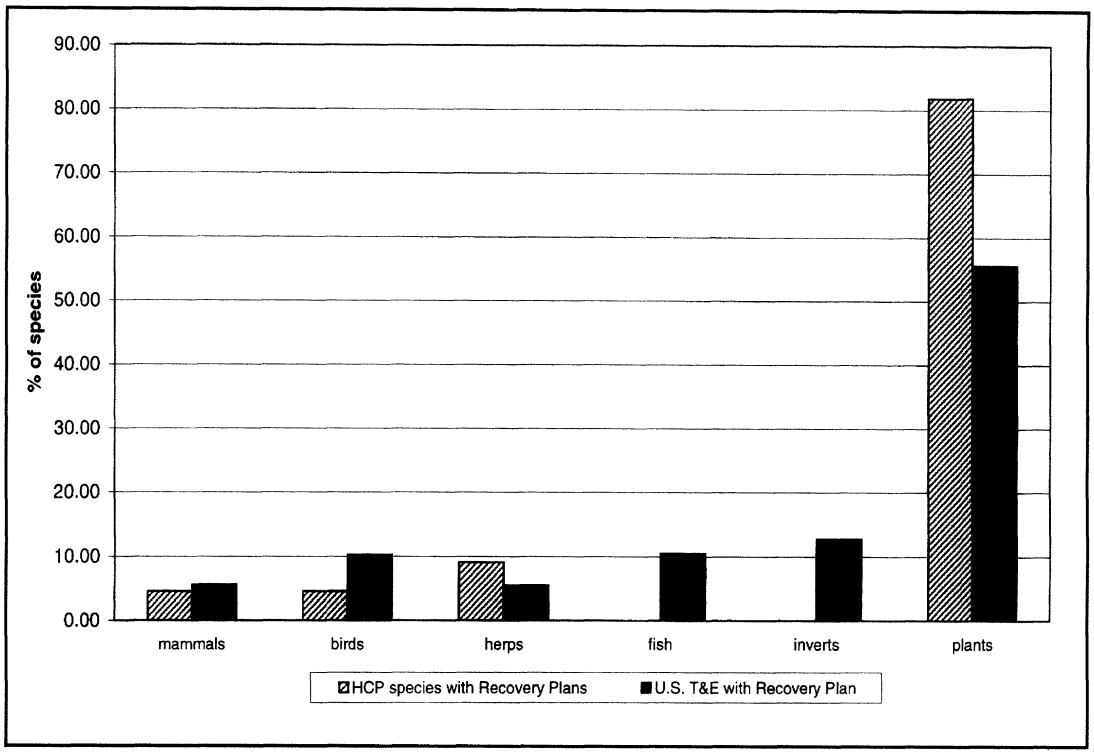

Figure 3. The hashed bars represent the percentage of species in the AIBS/NCEAS HCP sample from each taxa with completed recovery plans. The solid bars indicate the distribution of taxa for all US threatened and endangered species as listed in the May 31, 1998 FWS "Box Score" (US Fish and Wildlife 1998).

We linked the AIBS/NCEAS information with recovery data recently published by Foin et al. (1998). We developed conversion tables to translate between the different categorical ranking systems used in each study. Tables 1 and 2 illustrate our conventions for the threats to species and management regime categories respectively.

Results

Are recovery plans utilized in the preparation of HCPs?

Our investigation indicates that when recovery plans exist they are used extensively during HCP preparation. HCPs in our study often repeatedly reference recovery documents, and many HCPs use management or monitoring recommendations developed during recovery planning (e.g., the Sweetwater HCP for the Least Bell's Vireo (*Vireo bellii pusillus*)). Beatley (1994) notes that recovery plans have served as explicit biological foundations for several plans (e.g., the USFWS recovery team for the threatened Coachella Valley fringe-toed lizard (*Uma inornata*) provided significant input in planning the minimum size and configuration of habitat preserves). The resulting HCPs often reflect the positive and negative aspects of available recovery plans. Two examples illustrate the spectrum of results. First, a positive outcome resulted in plans covering the red cockaded woodpecker (*Picoides borealis*) (Costa 1997). The woodpecker's recovery plan draws on a wide range of scientific studies to recommend the design and placement of artificial nesting cavities (e.g., Copeyon 1990; Taylor and Hooper 1991). This exchange of peer reviewed information has resulted in direct benefits for both managers and woodpeckers. Conversely, some HCPs covering prairie dogs (*Cynomys parvidens*) may have caused direct harm to managed populations. The approved recovery plan for the species recommends the translocation and release of prairie dogs away from development sites to government land. More recent research suggests that only 3% of translocated prairie dogs survive (Utah prairie dog conservation plan 1996). When a recovery plan is lacking, well intentioned developers may conduct ad hoc local research to meet their needs (e.g., Ocean Trails HCP 1996). Such research may provide site specific benefits, but the landowner may be cut off from broader resources and expertise available from academics and federal agencies.

We also noted that some developers have looked to HCPs as a tool to circumvent the recovery planning

process. In California, a special type of habitat-based HCP called Natural Community Conservation Planning (NCCP) has resulted in multiple species protection under the umbrella of the Federally threatened California gnatcatcher (*Polioptila californica calfornica*) (listed March 30, 1993) (Silver 1997). The gnatcatcher resides almost exclusively within coastal sage scrub habitat, and consequently has suffered dramatic losses in territory during the booming development of Southern California. Under the provisions of the ESA, a species in conflict with economic interests, such as the gnatcatcher, should receive high priority during the recovery planning process. However, despite the fact that the biological needs of this so-called umbrella species have guided much of the design of the reserve system underlying the NCCP, this Federally threatened species does not have a recovery plan or designated critical habitat (US Fish and Wildlife Service 1998). The NCCP process will make decisions influencing the majority of the gnatcatcher's remaining range within the United States, and the NCCP will effectually act as a de facto recovery planning document without the benefit of the usual set of recovery objectives or scientific reviews (Silver 1997).

Does the existence of a recovery plan correspond to the preparation of higher quality HCPs?

The AIBS/NCEAS data indicate that the existence of a recovery plan does not demonstrably increase the quality of related HCPs as rated by the AIBS/NCEAS criteria. We divided the species in the AIBS/NCEAS HCP sample into three categories: (1) not Federally listed, (2) Federally listed without a recovery plan, and (3) Federally listed with a recovery plan. We then assessed the percentage of species with scores of "adequate" or better in seven categories (Figure 1). In the categories of status, minimization of impacts, mitigation success, and monitoring, those species without Federal recovery plans received a greater percentage of adequate scores. Scores for take, the effects of implementation, and evaluation of threats indicate little effect from the presence or absence of a recovery plan.

Are some taxa disproportionately represented in HCPs when compared to the complete set of Federally listed threatened and endangered species?

The distribution of taxa in the AIBS/NCEAS study is not significantly different from the distribution of taxa across all HCPs (AIBS/NCEAS 1998). Given this relationship, we compared the distribution of taxa in approved recovery plans with those of species covered by HCPs. In comparison to all Federally listed threatened and endangered species, HCPs over-represent mammals, birds, amphibians, and reptiles, while under-representing fish, invertebrates, and plants (Figure 2). Birds and invertebrates included in HCPs have a lower percentage of recovery plans than would be expected based on the distribution of all Federally threatened and endangered species (Figure 3). The same data suggest that for those species with recovery plans (i.e., Federally listed species), plants make up the overwhelming majority of species.

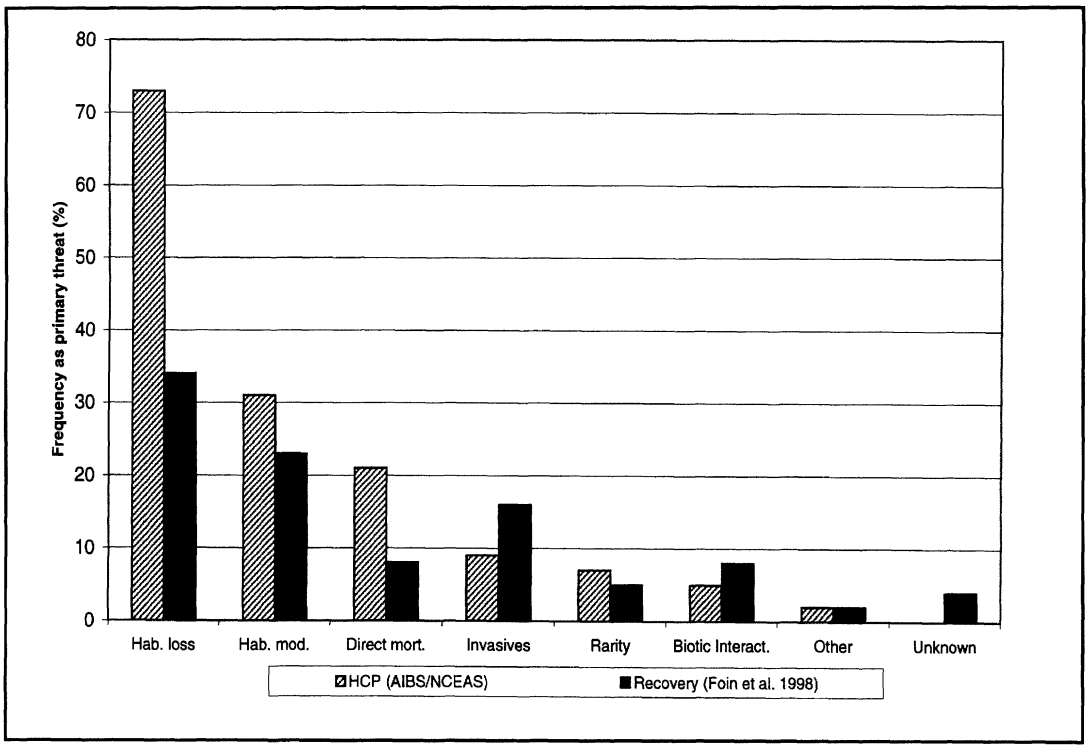

Figure 4. Foin et al. (1998) indicated one primary threat for each completed recovery plan, and the results below reflect the distribution of threats with regard to the composite threat categories detailed in Table 1. The AIBS/NCEAS working group ranked threats to species from a suite of choices. Data in the chart above reflect only those threats rated "primary" threats to species; however, individual plans may address multiple primary threats for a given species (i.e., several threats may pose equal challenges for species management). The results above reflect the contribution of each threat category as a fraction of the total number of primary threats identified.

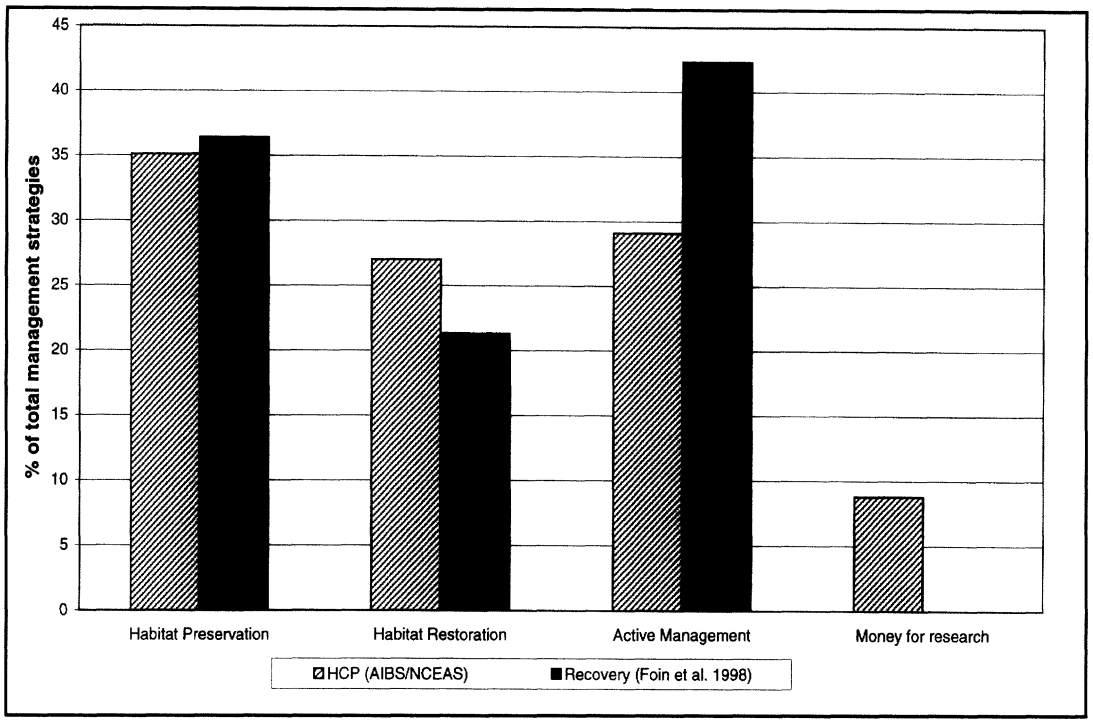

Figure 5. Foin et al. (1998) classified the type of management recommended by each recovery plan. Above, the AIBS/NCEAS data have been resampled (see Table 2) into the categories of Foin et al. (1998). The AIBS/NCEAS criteria of "money for research" has no direct equivalent in the Foin et al. (1998) scheme. The hashed HCP bars indicate the percentage of the total management decisions made for all 44 HCPs in the sample.

How do the threats to species identified in HCPs correspond to those threats identified by recovery plans (Foin et al. 1998)?

Figure 4 illustrates the distribution of primary threats as identified in recovery plans by Foin et al. (1998) and AIBS/NCEAS HCPs. Habitat loss and habitat modification are indicated as the primary threats in the majority of both recovery plans and HCPs. The threat groups are based on the interpretations detailed in Table 1. In comparison to Foin et al. (1998), habitat loss, habitat modification, and direct mortality are cited more frequently in HCPs as the primary threats to species. Recovery plans cite invasive species more frequently as a primary threat compared to HCPs.

How does the distribution of management regimes for approved HCPs reflect recommendations in recovery plans?

Foin et al. (1998) evaluated each approved recovery plan and classified the type of management recommended for each species. The AIBS/NCEAS working group evaluated the type of management actually approved for implementation under HCPs. These two data-sets provide an opportunity to compare both the type of management indicated by the recovery planning process and that chosen by HCPs. Foin et al. (1998) assigned each recovery plan to a management category: low intensity (habitat preservation), intermediate effort (habitat restoration), and high intensity (active management). The AIBS/NCEAS working group noted which of 11 mitigation/minimization measures were included in an HCP: avoidance of impacts, minimization of impacts, land acquisitions, conservation easements, habitat banks, translocations, restoration of total habitat areas, maintain/restore disturbance regimes, removal of exotics, money for research, or other. Table 2 summarizes the relationship between the conventions used in each study.

The AIBS/NCEAS data indicate that recovery plans recommend and HCP implement habitat preservation for similar proportions of covered species (Figure 5). The two differ dramatically, however, with regard to Foin et al.'s (1998) category of "active management". For this group, HCPs under-prescribe active management when compared to the distribution of management in recovery plans. HCPs sometimes specifically allocate money for research; however, this category has no equivalent in recovery plans. The recovery plans offer site specific recommendations, but they do not indicate that money ear-marked for conservation research will yield direct benefits to species equivalent to actual management measures such as conservation easements or captive breeding. Habitat restoration is implemented more frequently in HCPs than it is recommended in recovery plans.

Discussion

The Endangered Species Act is the centerpiece for legislation addressing threatened and endangered

species in the United States. The provisions of the ESA outline a sequence of activities that ideally provide a structure for the protection and eventual recovery of threatened and endangered species. However, recent amendments to the ESA have created a conflicting mandate for those charged with implementing these provisions. Section 4(f)(1) of the ESA requires the Secretary of the Interior to develop and implement plans for the conservation and survival of endangered species. Some authors have suggested that recovery is the "ultimate purpose" of the ESA program (Clark 1996), and this section has spawned the complex process often referred to as recovery planning (see reviews Tear et al. 1995; Foin et al. 1998). The goal of the recovery process is straightforward: return a species to a condition in which it can be removed from the endangered species list.

Section 10(a)(1)(B) of the ESA presents the Secretary of Interior with the opportunity to issue permits for the "incidental take" of listed species. This section provides the legislative underpinnings beneath the rapidly growing area of habitat conservation planning. The idea is to provide an exemption to the prohibitions of the ESA that may be issued if an applicant intends an otherwise legal action that will result in the take of a Federally listed endangered or threatened species as a by-product of that activity. To obtain such a permit, the applicant must prepare a document known as a Habitat Conservation Plan (HCP). According to the ESA, such plans should stipulate the impact resulting from take, steps the applicant will take to minimize and mitigate impacts, and provisions for funding the activities in the plan. A permit may not be issued if the proposed activity will appreciably reduce the likelihood of survival and recovery of the species in the wild.

These provisions create a tension, if not an outright conflict, within the ESA. On one hand, the Secretary is tasked with promoting the recovery and delisiting of species. Conversely, Federal agencies are also under pressure to craft HCPs that balance the mandate of recovery with economic concerns. It is our contention that HCPs and recovery plans are not diametrically opposing forces. Rather, a small redirection in philosophy and effort could promote a high degree of cooperation and synergy between these important tasks.

Our results present the initially puzzling conclusion that species without recovery plans receive more adequate treatment by HCPs than those with approved recovery plans. It may be the case that plan preparers are held to a lower standard when agency personnel believe that an existing recovery plan already contains sufficient information for the assessment of a proposed HCP. Another logical explanation for this pattern suggests that species with recovery plans contain less information in HCP documentation and thus receive less favorable ratings by reviewers. At the very least, this situation makes the scientific rationalizations behind HCPs less tractable to outside observers.

The data presented in this paper indicate a disconnection between the types of threats and management regimes indicated by recovery plans and those actually permitted for implementation under existing HCPs. Our results confirm the observations of other authors (Sher and Weiner 1997) that HCPs emphasize mitigation at the expense of project minimization. Participants in the AIBS/NCEAS working group often commented about the abundance of active habitat relocation and restoration measures (mitigation) and the relative lack of serious alternatives to the size and scope of the proposed impacts (minimization).

Rigorous updating and investigation of recovery plans seems the key to unifying these currently disparate processes. The original ESA mandate for recovery planning provides clarification for the required course of action. Section 4(f)(1)(A) of the ESA stipulates:

The Secretary, in development and implementing recovery plans, shall, to the maximum extent practicable- (A) give priority to those endangered species or threatened species, without regard to taxonomic classification, that are most likely to benefit from such plans, particularly those species that are, or may be, in conflict with construction or other development projects or other forms of economic activity. . .

All the species currently affected by existing or proposed HCPs meet this definition and should consequently receive top priority for recovery planning. If the recovery planning process rises to the challenge, it could provide a means to infuse related HCPs with scientifically based management options at no cost to the individual HCP applicant. The process would gain efficiency if recovery planning efforts anticipated future planning needs and were prepared with information that would be directly relevant to landowners preparing HCPs. Intensifying the effort to provide quality recovery plans for all species in conflict with economic interests would simultaneously provide several benefits: (1) it would meet ESA requirements for the preparation of recovery plans, (2) expedite the HCP process, and (3) reduce the direct costs for each permit applicant. Current examples of the political bartering of HCP agreements against recovery plan approval provide cause for concern (e.g., coastal California gnatcatcher and the San Diego NCCP). It

is possible that such arrangements could drive negative feedback loops with developers offering HCPs in exchange for the indefinite delay of recovery plan approval. Ultimately, threatened and endangered species may suffer since managers and developers will lack the consistent guidance and scientific information normally available in recovery plans.

Conclusions

Ideally, HCPs should be positive tools for the implementation of the priorities outlined in a species' recovery plan in light of site-specific concerns stemming from economic or development interests. HCPs and recovery plans are two sides of the same coin for species conservation, and the emerging trend toward larger, regional multispecies conservation plans indicates further blurring of boundaries in the future. As mandated by the ESA, recovery plans should be provided for those species in conflict with economic interests so that HCPs can be developed around a coherent framework of management options. The interface between recovery planning and HCPs holds great promise for both streamlining conflict resolution and providing coordinated protection for threatened and endangered species.

Acknowledgments

The efforts of the entire AIBS/NCEAS Habitat Conservation Planning working group developed the data-set that facilitated our work. Sandy Andelman deserves special recognition for her support and advice with regard to this manuscript. Cory Craig, Peter Kareiva and Dan Doak provided valuable comments and encouragement.

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Marine Matters

The *Audubon* Guide to Seafood Revisited

M. Elsbeth McPhee
Managing Editor, *Endangered Species UPDATE*, University of Michigan, 430 East University, Ann Arbor, Michigan

In the May-June 1998 issue of *Audubon* magazine, Carl Safina, Director of the National Audubon Society's Living Oceans Program, published a seminal study that quantified the damage of commercial fisheries to various marine organisms. With this information, he compiled a list to help consumers make wise food choices.

The information compiled by Safina is thorough, sound, and exceedingly important. Below, we quote his suggestions relating to the more imperiled animals—providing readers with guidelines to their own seafood consumption choices (Safina 1998).

Species	Background	Status	Management	Bycatch and Habitat Concerns
Sharks 400 species worldwide, including mako, thresher, dogfish, a.k.a. cape shark	Sharks mature late, and produce few offspring. Thus, their populations require decades to recover from intensive fishing. Sharks are often caught for shark-fin soup and shark cartilage is now being exploited for "miracle" drugs.	Many populations are declining. Most species on the East Coast are overfished and depleted.	Poor in the Pacific Ocean. Management is fair to good in U.S. Atlantic waters. Almost no management elsewhere.	Moderate to high. Most shark fisheries use longlines or gill nets, which also catch unwanted fishes and creatures such as turtles and marine mammals. Many sharks are killed just for their fins, then dumped.
Swordfish, marlins one species of swordfish; several marlin species, in tropical to temperate seas	The popularity as pricey steaks is depleting the spectacular species.	Overfished and depleted in the Atlantic. Their status is unknown in most of the Pacific.	Ineffective in the Atlantic. Virtually nonexistent in the Pacific. Atlantic marlins may not legally be sold in the U.S., although that has not stopped their decline.	High. Most swordfish and marlins are caught with longlines, which bear thousands of hooks, or in drift nets. Both methods take high numbers of juveniles, sharks, turtles, and some marine mammals.
Shrimps	A wide variety of shrimps come from all over the world, from the tropics to temperate climes. About half are farmed, mostly in the tropics. Shrimp farms pollute and destroy habitat.	Plentiful in some regions, depleted in others (such as Mexico's Gulf of California). Their status is not well known elsewhere.	Generally poor in the U.S., and even worse in many other countries. Regulation of farming, the effects of bottom-trawl nets, and bycatch are the main issues.	The highest of any fishery in the world. For every pound of shrimp you buy, and average of seven pounds of other sea life was killed and shoveled overboard. West Coast spot

Species	Background	Status	Management	Bycatch and Habitat Concerns
				prawns are an exception.
Orange roughy	Most orange roughies come from deep waters off New Zealand and Australia. They grow very slowly, taking 20 years to reach spawning age.	Many populations were severely overfished when the mild-tasting species' popularity soared, in the 1980s.	Poor in New Zealand, where successive populations are being completely fished out. Good in Australia. Nonexistent in international waters.	Significant. The trawls used to catch orange roughies cause serious damage to ocean-floor habitat.
Groupers	Overfishing of this predominantly tropical species in some spawning areas has depleted many populations. Groupers change sex with age, so heavy fishing—which takes most of the old fish—can wipe out an entire sex.	The Nassau grouper is one of the few ocean fishes ever proposed for listing in the U.S. as an endangered species. Many other species are overfished and depleted.	Poor. Many groupers, especially in the tropics are taken in unregulated fisheries. Management in the southeastern U.S. is improving.	High. Groupers are frequently caught with wire traps, which keep killing even if lost at sea. Bycatch is also high from hook and line. Juvenile groupers tossed back in to the sea don't necessarily survive, because pressure changes cause injury when they are hauled up form deep water.
Atlantic groundfish Atlantic cod, haddock, pollack, "scrod," yellowtail flounder, monkfish	These species are mainly caught off Newfoundland, New England, and Europe. After several decades of overfishing and mismanagement, their collapse probably ranks as the world's greatest fishery-management disaster.	Overfished and depleted, to the point of disrupting fishing communities in New England and Canada.	Poor. Mortality rates are high in many areas, such as the Gulf of Maine. In large areas that have recently been closed to fishing, depleted populations are slowly increasing.	High. The bottom-trawl nets used for these species sometimes entail the highest rates of bycatch of any fishery, except shrimping. The nets also scour the seabed, which degrades the habitat, lowering the potential for recovery in vast areas.
Scallops	Two varieties are usually sold: sea scallops and bay scallops. Some scallops are farmed.	Atlantic sea scallops are overfished. Bay scallops are having trouble with harmful algal blooms.	Generally poor. Varies on a regional basis.	High. Dredging takes many other species and disrupts ocean bottom habitat. The exception is farmed scallops.

Species	Background	Status	Management	Bycatch and Habitat Concerns
Salmons one Atlantic species, six Pacific species	Salmon are native only to the Northern Hemisphere. Nearly half of all salmon sold is farmed.	Healthy in Alaska; elsewhere, several salmon populations are listed as endangered, and many are extinct.	Good in Alaska; poor elsewhere. Salmon are most at risk not from fishers but from logging, agriculture, and dams.	Low bycatch. But salmon farming pollutes, displaces wild fish, and prompts the shooting of predatory seals near farms.
Tunas five major species: bluefin, bigeye, yellowfin, albacore, skipjack	Almost all large bluefins are shipped to Japan for sushi. Canned "white tuna" is albacore; "chunk light" is yellowfin or skipjack.	Bluefins are severely overfished. Bigeyes, yellowfins, and albacores are declining in some regions. Skipjack populations are still large.	Poor in the Atlantic, where populations are most depleted. Current management in the Pacific is not adequate to prevent future depletion.	Moderate. Many dolphin-safe netting methods catch juvenile tunas and unwanted species. Troll-caught tuna is OK.
Pacific rockfishes more than 50 species	Pacific rockfishes are a valuable commodity on the West Coast. Often marketed as Pacific red snapper.	Poorly known for many species. Pacific rockfishes are especially vulnerable to overfishing.	Fair to poor. But overfishing of a number of key species is now forcing managers to sharply reduce the catch.	Moderate. Caught with either nets or longlines—which also take a number of other sea creatures.
Snappers	Most snappers live in the tropics or subtropics.	Red snapper is depleted. The status of yellowtail snapper is unknown, but it is probably in fair shape.	Fisheries are unmonitored in most countries. Red snapper is overfished in the U.S., primarily because shrimp nets kill billions of juveniles.	High. Fishing for snappers entails significant bycatch of juveniles and nontargeted species.

Impact on other species \ ***Status***	**low**	**stable**	**high**
low		lobsters bluefish	mackerels squid striped bass
medium	salmons Pacific rockfishes	tuna summer flounder halibut	dolphinfish crab
high	sharks swordfishes orange roughy groupers Atlantic groundfish scallops snappers	shrimps clams/oysters	

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Conservation of Native Freshwater Mussels: An Overview

Thomas Hayes
Member, AZA Aquatic Invertebrates Taxonomy Advisory Group, Pittsburgh Zoo, One Wild Place, Pittsburg, PA 15206

Abstract

There are approximately 300 recognized species of native freshwater mussels (Unionids) *in the United States. The survival of native mussels is at risk for several reasons. Little concern, however, has been generated due to lack of knowledge and public appeal. Freshwater mussels serve many purposes, including indicators of water quality. The importance of native freshwater mussels is gradually being recognized through education, research, and conservation. Recent conservation efforts focus on the restoration of mussel habitats and the controversial reintroduction of native species.*

Introduction

When examining the number of species that are now listed as extinct and extirpated, it is easy to see why freshwater mussels (*Unionids*) are of special concern. Particularly profound is the loss of freshwater mussel life from major drainage systems, where once thriving commercial freshwater mussel harvests took place. As a result, many freshwater mussels have been recognized as threatened and federally protected.

Life history

Life for the freshwater bivalve begins with the adult male mussel releasing sperm. The female siphons up the sperm to fertilize her eggs, which develop into glochidia, or larva. The larva are released and survive only if picked up by a species-specific host fish. Mechanisms of attachment vary with mussels and their host fish. Some mussel species glochidia encyst on the host fish fin while others attach to the gills of species-specific fish. The parasitic larva then develop into juvenile mussels where they drop off and settle into the lake, river, or stream substratum. At this point, the mussel develops into the adult stage and lives a relatively sedentary life style.

Freshwater mussels are filter feeders, drawing large volumes of water through the incurrent siphon and filtering out copious amounts of particulates, bacteria, plankton as well as chemicals, herbicides, pesticides, heavy metals, silt and other properties that are found in the water. Freshwater mussels are long-lived with some living longer than 100 years.

Historically, freshwater mussels were a substantial food source for wildlife. In addition, they once played a significant role in early Native American diet and culture, e.g, shells were used for making tools and jewelry.

Ecological threats

Two hundred years ago, the assemblage of freshwater mussels in the Pennsylvania region was probably much different from today. Historically, the Ohio River was a shallow fast-moving body of water with some areas only a foot deep. In 1825, the United States Army Corps of Engineers began dredging and damming the Ohio River to make it more suitable for commercial navigation. By 1929, 50 low-rise lock-and-dams had been constructed. Eventually, those were replace by 20 high-rise lock-and-dams, channeling the river to depths of 50 feet in some sections. The once fast-moving, well-oxygenated water that was filtered through gravel and rock became a deep, stagnant body of water. Mussels are able to travel short distances to remain submerged during temporary times of drought. Generally occurring in less than forty feet of water, mussels cannot, however, avoid the habitat changes of deep water created by locks and dams.

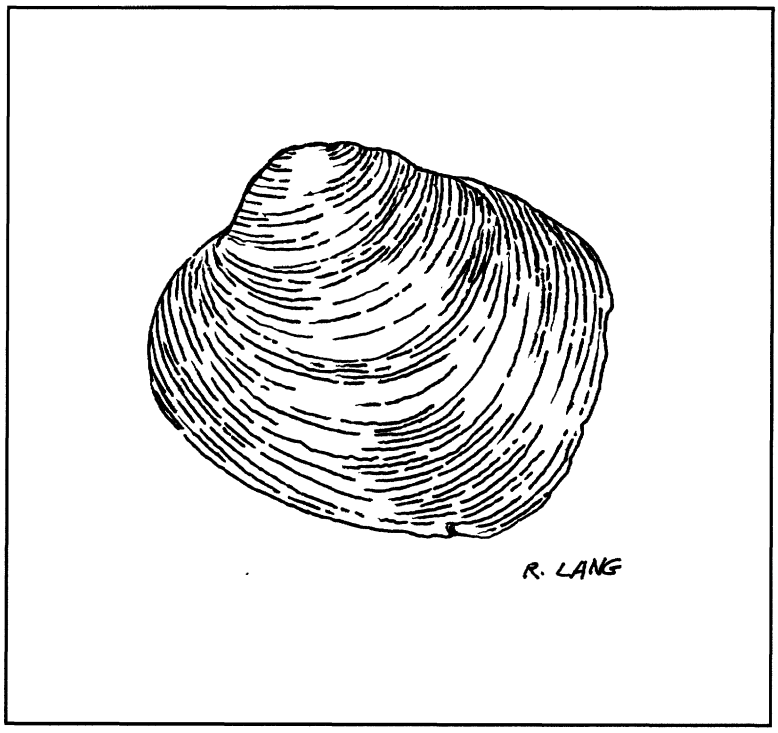
These changes drastically altered the ecology of the Ohio River and associated drainage basins, which subsequently impacted the region's freshwater mussel populations (Ohio River Fisheries Management Team 1995). Similar ecological changes occurred on other reconstructed rivers throughout the United States.

A more recent threat to native freshwater mussel populations is the invasion and spread of the European zebra mussel, *Dreissena polymorpha*. *Dreissena*, which was accidentally brought over on boat hulls in the early 1980's, is a

voracious feeder and prolific breeder with few predators in North America. These circumstances have enabled it to outcompete indigenous mussel species in many areas. Zebra mussels have the ability to attach to hard objects with byssal threads and are also able to detach and move with the foot (Prevant and Chalermwat 1992). At first the introduced zebra mussel was thought be cleaning polluted waters of Lake Erie. With time, because of its successful reproductive rate and short life span, it was soon realized that thousands of dead animals could quickly foul the water. Zebra mussels do not require host fish to reproduce and free swimming animals have been known to survive for long periods in water carried in boats and bait buckets to other lakes and rivers. Native freshwater mussels have been found to be completely covered by zebra mussels to the point that the native mussel could no longer effectively filter feed.

Because mussels are filter feeders, they absorb toxins and waste, including heavy metals, sewage, agricultural runoff, industrial waste, and pesticides. Mussels are able to shut down during times of direct insult from pollution but during long term conditions the mussels have no control over resuming regular body functions. The effects are evident when trees and vegetation are cleared and erosion takes place clogging the streams with tons of topsoil. The muddy waters clog the gills of mussels and bury the animals in silt. Cattle grazing along the shoreline denude areas of grass, causing further erosion. Direct deposition of cattle urine and manure from animals in the streamed adds to the stream's bioload.

Additional non-point pollution from pesticides, farm runoff, and leaking sewage all comes to rest at the bottom of streams, lakes and rivers where the freshwater mussels eke out a living. Point pollution from industry effluent in the riverine system is diluted in volume with heavy metals and other compounds, settling to the bottom of the river where it is filtered, absorbed and stored in the tissues of mussels. Toxic effects are not limited to the incidence of mussel mortality; wildlife that feed on mussels are at risk as well, and the toxins can increase exponentially up the food chain of consumers, which can include humans.



Female Higgins' Eye (*Lampsilis higginsi*) Lea. Once widespread and common, this species is now listed as endangered. Illustration by Russ Lang.

Habitat changes have also indirectly affected mussel populations. Freshwater mussels need specific host fish to complete their life cycle. Parasitic mussel glochidia attach to a host fish where they develop into juveniles, then drop from the fish into the substrate. The loss of species-specific host fish due to altered habitats or over-fishing interrupts the life cycle of mussels, causing an even greater decline in populations. The Pennsylvania native Brook Trout (*Salvelinus fontinalis*) and many non-game species of fish like the dace (*Rhinichthys*), sculpin (*Cottidae*), minnow (*Notropis*), and darters (*Ammocrypta*, *Etheostoma*, and *Percina*) have been displaced by introduced game fish. Biodiversity has been offset by monocultures limiting reproductive opportunities of mussels. To the purist, introduction of any fish, including bait fish, to waters in which they do not naturally occur increases the possibilities of introducing new mussel species as these fish may be infected with glochidia.

Freshwater mussel conservation

A biological survey of mussel species presents many difficulties, and may not accurately represent actual population dynamics. Current classifications are confusing, and survey results are contingent on the various methods used and the prevailing environmental conditions. Participation in field sur-

veys is limited to those who have the technical skills for identification, because the same species of mussels may greatly vary in morphology within a region, or even within the same mussel bed. Other confusing factors include sexual dimorphism, phenotypic differences between juveniles and adults, and look-alike species that may be found in a mixed-species mussel bed.

The Columbus Zoo, in partnership with the University of Maryland, Ohio Division of Wildlife, and the United States Fish and Wildlife Service, sponsored the 1998 Freshwater Mussel Symposium in Columbus, Ohio. Although research was presented on topics such as distribution, abundance, habitat requirements, ecology, life history, taxonomy, captive management, and propagation of freshwater bivalves, it barely scratched the surface. In addition, historical data on species distribution and numbers are not well documented, sparking debate on the release or restocking of selected mussel species into new or formerly inhabited areas.

Progress has been made in the area of long-term maintenance of captive adult mussels. Collaborative efforts between government agencies, zoos, aquaria, museums, universities, conservancies, fisheries and private landowners are crucial to the improvement of conditions for the freshwater mussel. Public zoos and aquariums have the potential resources for the propagation of fish and freshwater mussels. Multispecies exhibits and education programs at zoos provide learning experiences that can be far reaching to the general audience.

Conclusion

Why do we need freshwater mussels? Freshwater mussels are valuable food sources for wildlife. They contribute to making our rivers, lakes, and streams clean and clear by filtering out micro algae (green water), bacteria and other microscopic matter. As indicators of our water quality they are early warning devices when the water becomes contaminated or polluted. Because they are sensitive to water pollution, native freshwater mussel beds that yield high animal densities and multiple species are indicative of a healthy ecosystem.

In sum, we need to pay attention and recognize the value of biodiversity in understanding the complete ecosystem and how it works. Underappreciated or misunderstood animals can be a crucial part of this system and need to be recognized as such.

Acknowledgments

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Bringing People into Population and Habitat Viability Analyses

Ulie Seal
Conservation Breeding Specialist Group, 12101 Johnny Cake Ridge Road, Apple Valley, Minnesota 55124-8151, USA; (612) 432 2757 (fax); cbsg@mtn.org
Frances Westley
Faculty of Management, McGill University, Montreal, P.Q., Canada; (514) 486 5885 (fax); Westley@management.mcgill.ca
Onnie Byers
IUCN/SSC, Conservation Breeding Specialist Group, Apple Valley, Minnesota
Gayl Ness
University of Michigan, Ann Arbor, Michigan

Abstract

The Conservation Breeding Specialist Group (CBSG), part of IUCN's Species Survival Commission, has developed a powerful workshop process to assist environmental managers to protect endangered species in specific habitats. The Population Habitat Viability Analysis (PHVA) brings together a variety of scientists and wildlife managers to examine the condition of a specific species and habitat and to help plan for their effective management. To date, over 150 of these workshops have been organized in more than 50 countries. An important gap in the process, however, lies in the lack of good demographic and social science input. This is now being addressed by a new global biodiversity network, a collaboration between the CBSG and Professor Frances Westley of McGill University's School of Management. The network includes biological and social scientists. It is now conducting a series of experiments to bring human demography and other social sciences more fully into the PHVA process.

Introduction

The Conservation Breeding Specialist Group (CBSG), a subcommittee of the IUCN, World Conservation Union, Species Survival Commission, has pioneered new strategies to allow practical and effective conservation actions around endangered species all over the world. A small, scientifically based organization, CBSG has developed a set of workshops that facilitate planning meetings both to identify species and habitats deserving conservation and, more importantly, to assist stakeholders in producing practical research and management recommendations. Among these workshops is the Population and Habitat Viability Assessment (PHVA), which brings together biologists, wildlife managers, captive breeding specialists and government officials to develop a set of conservation objectives and management plans for the particular species in particular habitats. The workshop uses a variety of tools, including a computer simulation called VORTEX (Lacy et al. 1995), to model extinction scenarios and align stakeholders' research and action agendas around a common direction and plan. Conducting or participating in 125 such workshops in 50 countries over the last five years, CBSG has been described as "an endangered species fire brigade which goes from crisis to crisis with state-of-the-science advice on the emergency moves best calculated to avert calamity...without the CBSG, there would (often) be no movement at all" (Alvarez 1993).

The PHVA process

The PHVA process provides an objective environment, expert knowledge, and a neutral facilitation process that supports sharing of available information across institutions and stakeholder groups. The process allows groups to reach agreement on issues and available information, and then make useful and practical management recommendations for the taxon and habitat system under consideration. The CBSG PHVA Workshop process is based upon biological and sociological science. Effective conservation action is best built upon a synthesis of available biological information, but is dependent on actions of humans living within the range of the threatened species as well as established national and international interests. There are characteristic patterns of human behavior that cross disciplinary and cultural boundaries

and affect the processes of communication, problem-solving, and collaboration in: 1) the acquisition, sharing, and analysis of information; 2) the perception and characterization of risk; 3) the development of trust among individuals; and, 4) 'territoriality' (personal, institutional, local, national). Each of these has strong emotional components that shape our interactions. Recognition of these patterns has been essential in the development of processes to assist people in working groups to reach agreement on needed conservation actions, collaboration needed, and to establish new working relationships.

As yet, however, the workshops have been limited in terms of the inclusion of social science data (e.g. demographic, land use, or cultural and economic data) either in the modeling or planning process. The powerful tools of demographic projections and socio-economic analyses have not yet been brought to bear on the PHV Assessments. Moreover, CBSG also recognizes that preservation and protection of natural resources cannot be done by biologists, social scientists and agency people alone. While the workshops have been successful in building collaboration between scientists and wildlife managers, non-scientific groups such as local landowners or tribes, grass roots organizations and industrial actors need to be at the table. Workshop designs are urgently needed to provide such inclusion, without compromising the sound science which is CBSG's signature.

Into this hiatus has come a new partnership with CBSG. Under a grant from the Canadian Social Sciences and Humanities Research Council, Frances Westley of McGill University has developed a Global Diversity Network in collaboration with CBSG. The network includes social and biological scientists from Canada and the U.S. One of the first issues to be confronted is that of systematically incorporating human population dynamics into the PHVA process.

The human population: Numbers and behavior[1]

The human impact on species and habitats is a function of both numbers and behavior. Numbers have become particularly important with the recent rapid growth of population, especially in the less developed regions. In these areas, rapidly growing populations with low levels of income and weak government structures imply heavy pressures of people on all species and their habitats. In the more developed regions, the growth of numbers may be less important than behavior, in part because greater government capacities can provide more effective protection of designated habitats and species.

The numbers

Demographic theory and methods provide us with some powerful tools for projecting population numbers into the future. Projections for the next 10-20 years are often quite accurate, largely because birth and death rates tend not to change very rapidly and the people who will give birth are already here and their numbers and reproductive habits are fairly well-known. In addition, there is solid experience assessing the current and future impacts of diseases, famines, and various forms of health care support (like family planning). Death rates can be reduced rapidly with modern medical and public health technologies and even fertility can decline rapidly when modern family planning services are available. Projections can thus be made of near term movements of populations under a variety of social and economic conditions.

The numbers are important, especially because our tools have allow us to project not only totals but age-sex composition as well. This is perhaps where demographic projections are most useful. Rapid population growth will give us a younger population, lots of new babies and infants. That means increased demands of nurturance capacities: MCH services, schools, various forms of infant care. We can also project the growth of the "young male" population (ages 15-19), a highly volatile group and rapidly growing group in most poor countries. Young males are high in energy, testosterone, and low in judgment, and a sense of the future. Some environmentalists have called them a predatory species. They will act with great energy and daring. They are often found at the center of urban or ethnic violence, and in frontier areas of extreme environmental degradation. But what these young males actually do depends on the opportunities open to them, which in turn depend on government policies and leadership, and on national wealth.

Behavior

Although numbers are important, what people actually do is far more important, and, unfortunately, less easily assessed. There are, however, three major dimensions of behavior that can be tracked with relative ease, and translated into probabilities of population encroachment on the habitat and species. These include education, employment and urbanization. Three simple generalizations can illustrate some of what is known. First, educational levels are a product of government policies and national wealth. Low levels of education usually exacerbate the pressures produced by young males. Second, high levels of unemployment, and poverty, usually signal

heavy population pressures on habitat and species as people clear new land for planting and harvest animals for food. Third, urbanization is a mixed condition, in than it draws on natural resources and concentrates human environmental impacts, but it also signals a decline of rural areas, which can reduce the pressure of people on species and habitats.

Two experiments: The biodiversity network in PHVAs

Currently the CBSG-Biodiversity Network is planning a series of combined PHVAs, which will attempt to integrate socio-metric data into VORTEX modeling and PHVS processes. To date, there have been combined exercises concerning the mountain gorilla in Uganda, and the muriqui in Brazil. These experiences illustrate the great diversity of human impacts and the problems of integrating the two sets of disciplines.

Uganda

Two sites in Uganda show both the general impact of population growth and radically different human impacts on a species in two protected areas: Biwindi National Park in the west central part of the country, and Virunga National Park in the southwest, on the border with Rwanda and Congo. Like most of Africa, Uganda's population is growing very rapidly. From just under five million in 1950 the population will have reached 22 million in 2000, and with a total fertility rate of 7.0 or more, it continues to grow at more than 3.3 percent. Around Bwindi the pressure of human population growth on the habitat and gorilla has been attenuated by effective park protection and a resource sharing scheme with local inhabitants that has reduced poaching and sabotage. Around Virunga the bloody ethnic wars have taken a heavy toll on the animals and habitat as thousands have crowded into refugee camps that have virtually destroyed the habitat. Modeling the more gradual impact around Biwindi will require making local estimates of population movements, but also raises the question of the conditions under which growing populations may be triggered into heavier impact by unstable political conditions, or loss of effective park protection, which depends heavily on international support. Modeling the catastrophic uprisings around Virunga may imply building equations for a catastrophic scenario, with a probability derived from past history.

Brazil

The Brazilian experience shows one important demographic experience, with two sites showing different patterns of human impact. Overall, Brazil's population growth has declined substantially as the demographic transition has been completed and the country is now at about replacement fertility. Urbanization has also proceeded very rapidly, with rural populations showing an absolute decline since about 1975. In neither of the two areas examined, Caratinga in Minas Gerais and Carlos Botello State Park in the state of Sao Paulo, was human population growth an issue. In both, people were leaving the rural areas for the city. Nonetheless, around Caratinga natural woodlands had been drastically reduced from logging and clearing for coffee and pasture. In Carlos Botello State Park, muriquis were being harvested illegally but persistently. This was the result of illegal palm heart harvesting in the park, where the harvesting crews killed monkeys for food. From information of local residents and past experience, we could estimate a habitat destruction around Caratinga of about 400 hectares per year. A much more delicate data gathering exercise will be needed in the State Park to estimate the number of monkeys killed per year. The workshop did come up with an intriguing idea, however, for protecting the monkeys. If the state of Sao Paulo would legalize harvesting of palm hearts under plantation agriculture, it could eliminate the illegal harvesting in the state park.

Both exercises provided useful insights into habitat and species pressures and protection possibilities. But in neither case were we really successful in obtaining the appropriate demographic or socio-economic data to provide useful inputs into VORTEX modeling. A major problem lies in the specialization of scientific disciplines and environmental or developmental organizations. The CBSG-Biodiversity Network collaboration is now planning two additional exercises, in Chile and Papua New Guinea with slightly different strategies to draw human data into the PHVA processes.

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Notes

[1]IUCN recently published a guide book for integrating population with national sustainable development strategies, Ness and Golay, 1997. This contains extended discussions of the materials presented in this section.

Conservation Spotlight

Tree Kangaroo Conservation in Papua New Guinea

Lisa Dabek
Conservation and Research Department, Roger Williams Park Zoo, 1000 Elmwood Ave., Providence, Rhode Island 02907, (401) 785-3510 x335; (401) 941-3988 (fax); LDabek@worldnet.att.net
William Betz
Southampton University, United Kingdom; c/o Conservation and Research Department, Roger Williams Park Zoo, 1000 Elmwood Ave., Providence, Rhode Island 02907

Abstract

*The Tree Kangaroo Conservation Project in Papua New Guinea (PNG) is part of the American Zoo and Aquarium Association's (AZA) Tree Kangaroo Species Survival Plan (TK-SSP). The primary goal of the project is to determine the wild status of tree kangaroos (*Dendrolagus *spp.) through research efforts of the project's own scientists and by training, encouraging and collaborating with other researchers and students in PNG. Additional goals of this long-term project are to increase knowledge about the natural history of tree kangaroos, to develop conservation education programs, to record traditional stories/beliefs about tree kangaroos, and to encourage conservation awareness among landowners. Two methods are being used to collect information about tree kangaroo populations. The first involves censusing at field sites using Distance Sampling, which should help determine what levels of population given areas can support. The second includes interviews with landowners. By providing landowners with necessary population census information about tree kangaroos, they can make informed decisions about creating Wildlife Management Areas.*

Papua New Guinea (PNG) has some of the last major rainforest habitats in the world. These rainforests contain thousands of unique plants and animals, including the greatest number of tree kangaroo species (*Dendrolagus* spp.). Tree kangaroos are the only arboreal member of the Macropodidae family. Primarily folivores, they depend on rainforest habitats that are threatened by destruction from mining, logging and development; encroachment of human populations; and overhunting. For most species, however, there is still time for conservation efforts to be successful.

The Tree Kangaroo Conservation Project in Papua New Guinea is part of the American Zoo and Aquarium Association's (AZA) Tree Kangaroo Species Survival Plan® (TK-SSP). The project is led by Dr. Lisa Dabek, Director of Conservation and Research at the Roger Williams Park Zoo and Research Coordinator of the TK-SSP, with the assistance of William Betz, graduate student at Southampton University (UK). The primary goal of the project is to determine the wild status of tree kangaroos through the research efforts of the project's own scientists and by training, encouraging and collaborating with other researchers and students in Papua New Guinea (PNG). Additional goals of the project include increasing knowledge about the natural history of tree kangaroos, developing new conservation education programs while supporting existing local projects, recording traditional stories/beliefs about tree kangaroos, and encouraging conservation awareness among landowners.

Landowners in PNG are in a unique position because, unlike most developing countries, the PNG government and constitution recognizes traditional lands. Ninety-seven percent of the country's land remains in customary ownership. There are no national forests and very few national parks. With expanding agriculture, caused mainly due to increasing human populations, and opportunities to sell logging and mining rights, it is crucial that landowners be encouraged to manage their resources for the long term. Conservation therefore depends on convincing landowners, not just governments, of the need to use sustainable development practices; and for conservation to succeed landowners must recognize their role as stewards. Because tree kangaroos are a part of the diet and culture of the local people, landowners are encouraged to manage their own landholdings by setting aside no-hunting zones. The no-hunting zone has been presented as a "bank" for wild-

Conservation Spotlight *is produced in collaboration with the American Zoo and Aquarium Association.*

life—an area in which people will always have wildlife resources and the "interest," young animals dispersing, will help to maintain stocks in sustainable hunting areas.

This project is in the third year of a long-term study to census selected wild tree kangaroo populations in PNG. The baseline data gathered during these censuses will provide information for further collaborative conservation work by PNG's Department of Environment and Conservation (DEC), local villagers, local NGOs, the University of Papua New Guinea (UPNG), and the TK-SSP.

In its first two years the project focused mainly on the Matschie's tree kangaroo (*Dendrolagus matschiei*) which is endemic to the Huon Peninsula in northeastern PNG. The field site is located in the forest belonging to a landowner from the Keiwing Village. In 1998 project researchers also started to census Doria's (*D. dorianus*) and Goodfellow's tree kangaroos (*D. goodfellowi*) in the Eastern Highlands. This field site is near the village of Maimafu in the Crater Mountain Wildlife Management Area (WMA) south of Goroka. Crater Mountain, which is probably the best known conservation project in Papua New Guinea, is managed by a local NGO, the Research and Conservation Foundation (RCF). With the assistance of RCF, landowners from neighboring villages have established a formal association in which they cooperatively establish guidelines for land use. By choosing to work in the Crater Mountain area, the tree kangaroo project has utilized an existing infrastructure for research, and has supported the conservation aims of RCF (for more information on the RCF, contact them at rcf@dg.com.pg). The tree kangaroo project is committed to supporting local students throughout the study by training UPNG students and hiring them as research assistants.

Wild Matschie's tree kangaroo (*Dendrolagus matschiei*) in Papau New Guinea. Photograph © William Betz.

Two methods are being used to collect information about tree kangaroo populations. The first involves censusing at field sites using distance sampling, a statistical technique designed to accurately estimate populations of hard-to-observe animals (Buckland et al. 1993). This method should help determine what levels of population given areas can support. In addition, individual animals are being documented by remotely-triggered cameras. These data collected from distance sampling and photo-documentation will be supplemented by information derived from interviews with landowners. The interviews, conducted by UPNG students, will provide invaluable accounts of historical and current regional tree kangaroo abundance as well as information about tree kangaroo natural history. The use of landowner interviews should give a general picture of tree kangaroo abundance over relatively large areas, while the distance sampling work and photo-documentation will give more detailed results for smaller areas and also serve as a means of confirming landowner statements of tree kangaroo status.

Due to the elusive nature of tree kangaroos, dung proved to be the best indicator of animal presence. A network of over 300 survey points have been established at each of the two study sites. Each point is surveyed for dung by teams of researchers. Results are encouraging, with enough dung being observed to allow for the use of distance sampling techniques. The data will be analyzed during 1998-1999 and shared with the local landowners. Fresh dung is also collected for DNA analysis. DNA extracted from dung can be identified to the species level to confirm that the dung was produced by tree kangaroos.

Tree kangaroo food plants are also being studied. Research on Australian tree kangaroo species suggests that they are dietary generalists, eating a wide variety of plants. The results from the project's inquiries indicate that these findings are also true for New Guinea tree kangaroo species. Over 80 specimens of plants and fungi said to be eaten by Matschie's tree kangaroos have been collected and the local names have been matched with the samples. Identifications to genus or species level are being conducted by botanists at the National Herbarium in PNG and at Kew Gardens in London.

The landowners suggest that the animals are particularly attracted to ferns (both ground and tree), a variety of ground and tree dwelling orchids, *Impatiens* spp., gingers and other succulent herbs, various vines, and the leaves and shoots of several tree species. Betz has questioned landowners in several areas of PNG and has been encouraged by the fact that they have identified many of the same food plants. This suggests that local knowledge could ultimately be an accurate guide for determining tree kangaroo diet. The reliability of the information will be confirmed by collaborating with Dr. David Christophel (University of Adelaide, South Australia) who has developed a method of plant identification that involves matching leaf stomata patterns with the patterns on undigested leaf cuticle remnants in dung. The collection of dung samples and food plants can determine exactly what the animals eat, and potentially corraborate the findings with traditional knowledge.

Conservation education is another essential component of this project. In order to increase public and student awareness of tree kangaroo conservation, the project staff have distributed Conservation International's tree kangaroo posters to villages and schools. Curricula that focus on tree kangaroo biology, rainforest ecology, and local conservation needs are being developed for community schools and teacher training workshops. In 1999 survey questions and educational coloring books will be distributed to the schools to gather more data on local tree kangaroo populations. Sister-school exchanges between the US and PNG also have been proposed.

Villagers have been very receptive to the conservation ideas that the project has presented. The Keiwing landowner mentioned above has demarcated permanent no-hunting zones on his land. He has also persuaded other landowners in the region to do the same. In 1998 he had the opportunity to meet with landowners from the Crater Mountain region to learn about landowner management of that region. A long- term goal of the project is for landowners on the Huon Peninsula to create a similar landowner association to cooperatively manage their land with Wildlife Management Areas. This approach of landowner resource management appears to be the most effective course of action for the conservation and sustainable use of PNG's forests and wildlife.

In addition to the existing program, the project is planning the following conservation, research, and educational efforts for the future: 1) Satellite radio-tracking, to determine home ranges and behavioral ecology of the tree kangaroo; 2) DNA fingerprinting (distinguishing among individuals) from fecal samples as a census technique and for determining home ranges; and 3) Participation in local village teacher training in collaboration with the Wildlife Conservation Society and the Rainforest Habitat in Lae.

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NEWS FROM ZOOS

News from National Aquarium in Baltimore

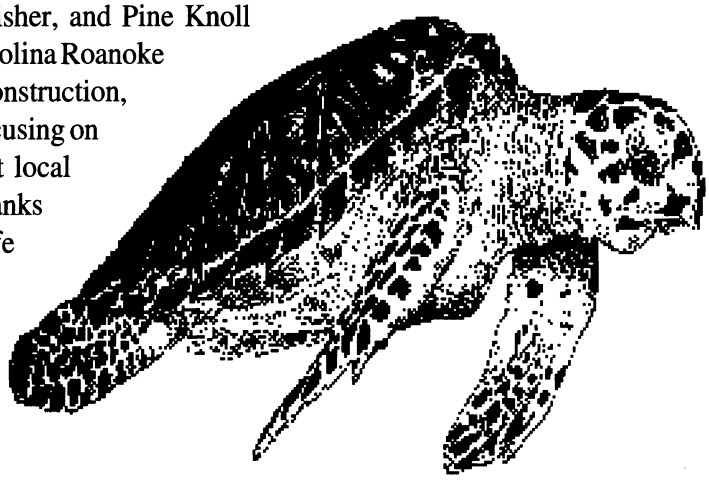
In the South American rain forest at the National Aquarium in Baltimore, nine splashbacked poison dart frogs have metamorphosed in a backup area. This is significant because to the knowledge of Aquarium herpetologists, this is a first in this country. Black with a splash of orange, they will be in the Amazon River Forest exhibit, now in the planning stage. Twenty-five species of poison dart frogs have been successfully bred at this Aquarium.

A gray seal that has been rehabilitated by Marine Animal Rescue Program personnel will be released this fall from Nahant, near Boston. This is the first gray seal released by the Aquarium. It will be transported to the area in a Coast Guard plane, first class accommodations, and fitted with a satellite tag so that its movements can be tracked.

A recently released hooded seal has been tracked to the Newfoundland area. It is doing well and diving to depths of 1,000 feet—the length of more than three football fields. Its satellite tag is providing new information about the diving patterns of hooded seals.

North Carolina Aquariums Plan Expansion

The three North Carolina aquariums will double their size and offer more educational opportunities to visitors, thanks to a $32 million appropriation included in the budget approved last week by the NC General Assembly. Each aquarium (Roanoke Island, Fort Fisher, and Pine Knoll Shores) will focus on a theme unique to its region. The North Carolina Roanoke Island Aquarium, which will close for 14 months to facilitate construction, will include a newly renovated, 70,000 square-foot aquarium focusing on the "Waters of the Outer Banks." This exhibit will highlight local freshwater, brackish, and ocean environments. New and larger tanks will house sharks, barracuda, sea turtles, and other marine life found in the aquatic habitats at the Outer Banks. The focal point of the aquarium, an 180,000-gallon ocean tank, will feature a variety of reef fishes and invertebrates swimming among the skeletal remains of the recreated USS Monitor shipwreck.



Hawksbill sea turtle (*Eretmochelys imbricata*). Drawing by Robert Savannah, U.S. Fish and Wildlife Service.

The Fort Fisher Aquarium, situated at the mouth of the Cape Fear River, will center its expansion plans on the "Waters of Cape Fear River System." Tanks and exhibits will highlight the aquatic life found in freshwater rivers and swamps to estuaries, reefs, and the open ocean. Five aquatic zones of North Carolina will be interpreted in the renovated aquarium at Pine Knoll Shores. "Aquatic Life from the Mountains to the Sea" will focus on mountain streams, piedmont rivers and lakes, waters of the coastal plain, swamps and marshes, and the open ocean.

Jacksonville Zoo Launches International Effort to Save Endangered Jaguar Population

The Jacksonville Zoo has teamed with Venezuelan wildlife and zoological officials in the unprecedented import of three wild-born jaguars. Once found from the southern United States through Central America and most of South America, the jaguar (*Panthera onca*) is now classified as "highly endangered" by international wildlife authorities, and survives mainly in the rain forests of Central and South America. The zoo has three of the only four non-sibling, genetically traceable jaguars in North America. If their male and two females reproduce, the potential founder population for long-term captive management will increase by 300 percent.

The unique American-Venezuelan agreement was signed in March of this year among the Jacksonville Zoo; FUNZPA, and Venezuelan zoo authority; and PROFAUNA, the Venezuelan wildlife agency. The two parties plan cooperative activities to benefit Venezuelan wildlife programs as well as promote education and research at the Jacksonville Zoo. Additional information is available at the Zoo's website (www.jaxzoo.org).

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

Bulletin Board

Third Edition of *The Evolution of National Wildlife Law* Published

The third edition of *The Evolution of National Wildlife Law* is now available. In this new edition, Michael J. Bean and co-author Melanie J. Rowland provide a comprehensive revision and updating of Bean's previous (1983) edition. The new edition includes a greatly expanded discussion of wildlife conservation legal issues on federal multiple use lands, new chapters on wildlife and water resource development, and wildlife on private lands, plus an 84-page chapter examining the Endangered Species Act.

The book is available from Greenwood Publishing Group, 88 Post Road West, PO Box 5007, Greenwich, CT 06881-5007, $32.50 paperbound or $79.50 clothbound.

The Society for Conservation Biology's 1999 Annual Meeting

The 1999 annual meeting of the Society will be co-hosted by the University of Maryland's graduate program in Sustainable Development and Conservation Biology, and the Smithsonian Institution's Institute of Conservation Biology. The meeting will be held on the University's campus in College Park, MD, 17-21 June. The meeting web site is www.inform.umd.edu/SCB. For additional information contact David Inouye, di5@umail.umd.edu; fax 301-314-9358; phone 301-405-6946.

Proceedings Available

The proceedings for the Third International Conference on Environmental Enrichment are now available (60+ papers; 400+ pages). Each volume costs $35 ($45 overseas addresses); make checks payable to *The Shape of Enrichment* and mail to 1650 Minden Drive, San Diego, CA 92111 (payment must accompany order). For more information, contact *Shape* at shape@enrichment.org or www.enrichment.org.

1999 Albert Schweitzer Environmental Youth Award

The Albert Schweitzer Environmental Youth Award is presented annually to individuals or groups of students between the ages of 12 and 18 who have initiated a project to effect positive environmental change. First place award: $1,000; second place: $500. For more information contact: The Albert Schweitzer Institute for the Humanities; P.O. Box 550, Wallingford, CT 06492 U.S.A.; 203-697-2744; (fax) 203-697-2748; asih1@aol.com; www.SchweitzerInstitute.org

PVA Conference

The Western Section of The Wildlife Society and The University of California present "Population Viability Analysis: Assessing Models for Recovering Endangered Species," 15-16 March 1999 in San Diego, CA. For information on logistics and registration, contact William Hull (510-465-4962, whull@cgbd.org) or visit the conference website http://www.cccweb.com/tws-west/pva.

Announcements for the Bulletin Board are welcomed.

Endangered Species UPDATE

School of Natural Resources and Environment
The University of Michigan
Ann Arbor, MI 48109-1115

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