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Endangered Species **UPDATE**

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Cover: A wild Bactrian camel. Courtesy of John Hare.

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To our readers,

The new editors of the *Endangered Species UPDATE* would like to thank Beth Hahn and Saul Alacron Farfan for their dedicated service as past editors at the *UPDATE*. Their hard work and dedication have been greatly appreciated and resulted in increased exposure and improved editorial content for the *UPDATE*. We wish them continued success in their new pursuits. Their efforts have allowed a smooth transition for us to continue the *UPDATE*'s mission.

In order to improve the on-time production of the *UPDATE*, we have decided to shift to a quarterly production cycle, publishing four expanded issues each year. These four issues will hold the same content as the previously offered six issues and will allow us to achieve savings in printing and mailing costs. We will continue to include abstracts in Spanish for every article in the *UPDATE*, although we have decided to eliminate our French abstracts. The *Endangered Species Technical Bulletin* will still be made available as an insert when issued by the U.S. Fish and Wildlife Service.

As we work to improve the *UPDATE* and refine our long-term business plan, we would appreciate hearing from you, our readers, with any suggestions you have about the direction you would like to see the *UPDATE* take. We will soon be mailing out a reader survey and hope that you will be able to take a few minutes to let us know how we're doing. We are also working on updating our website (www.umich.edu/~esupdate) to ensure that all links are accurate and that we present useful information about upcoming events for our readers. One ongoing *UPDATE* goal is the archiving of past issues and the maintenance of an author index online; we continue to work towards the completion of this goal.

We would like to thank you for your continued support for the *Endangered Species UPDATE* and hope that you will enjoy our upcoming issues.

Sincerely,

Andrea Kraljevic & Sean Maher
Editors

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Integrating Animal Behavior and Conservation Biology - A Review

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Abstract

Recent book and journal publications indicate a new movement toward integrating animal behavior and conservation biology. The integration is slow, however, due to cultural and scientific roadblocks. Differences in scale, themes, and approaches have hindered progress, but with the development of the right "currencies" that allow us to transfer studies across disciplines, behavior and conservation can be mutually beneficial. I have compiled a list of the major themes (with examples) in integrating animal behavior and conservation, organized explicitly by conservation goals. Conservation biologists should be using all available tools to prevent species loss, and behavioral ecologists should care deeply about preserving the wild behaviors in natural habitats that they study.

Resumen

Libros y publicaciones científicas recientes indican un movimiento hacia la integración de la etología y la biología de la conservación. Esta integración, sin embargo, ha sido lenta debido a obstáculos culturales y científicos. Diferencias en escala, temática, y métodos han dificultado el avance, sin embargo, con el desarrollo de "puntos en común" apropiados que permitan transferir resultados científicos de una forma interdisciplinaria, la etología y la biología pueden beneficiarse mutuamente. En este estudio, he compilado una lista de los temas mas importantes (con ejemplos) en la integración de la etología y la conservación. Los temas y ejemplos han sido organizados según objetivos de conservación. Los biólogos de la conservación deben usar todos los instrumentos disponibles para impedir la perdida de especies, y los etólogos deben preocuparse sobre la preservación en estado silvestre del comportamiento de las especies que estudian en sus habítates naturales.

As the threat of worldwide biodiversity loss becomes more apparent, researchers from a growing number of fields have taken a keen interest in conservation biology. Recently, ethologists have applied the study of animal behavior to an increasing number of problems relating to conserving rare, declining, and threatened animal species.

A new movement toward integrating these two disciplines is indicated by the recent publication of four books (Animal Behavior and Wildlife Conservation 2003; Behaviour and Conservation 2000; Behavioral Ecology and Conservation Biology 1998; and Behavioral Approaches to Conservation in the Wild 1997) and several journal articles (e.g. Reed and Dobson 1993; Ulfstrand 1996; Sutherland 1998; Martin 1998; Caro 1999) that discuss the value and role of combining behavioral ecology with wildlife conservation and management. Students are increasingly interested in conservation, and agencies have been more willing than ever to support applied conservation research.

The integration, however, is only beginning.[1] Behavioral ecology, or ethology, is currently "not considered a significant component of conservation biology" (Clemmons and Buchholz 1997a). Although many conservation projects involve animal behavior in a trivial way, such as passing references to food preferences or home range, most do not use the full body of theory available (Sutherland and Gosling 2000). This chasm is shown clearly in the historic separation between animal behavior and wildlife biology and conservation in academia. Many college wildlife management programs offer no courses in animal behavior or evolutionary ecology and vice versa. Most behavioral ecology textbooks contain no, or only perfunctory, discussion of conservation; similarly, conservation biology textbooks barely mention behavior as a component discipline. For example, the two main texts used in university conservation biology classes (Primack 1993; Meffe and Carroll 1997) make no mention of behavior in the index. An Introduction to Behavioural Ecology by J.R. Krebs and N.B. Davies (1993)[2] has no reference to conservation or endangered species in the index. Two newer behavioral ecology texts (Drickamer et al. 2002; Dugatkin 2004) each have one paragraph devoted to conservation biology. This integration gap is also revealed in the published periodical literature. William Sutherland reviewed 229 papers from Animal Behaviour and 97 papers from Conservation Biology in 1996 and determined that there was "a complete lack of papers in Animal Behaviour that related directly to conservation" and only a few papers in Conservation Biology that "include(d) an aspect of behavior in the title" (Table 1). Using a consistent methodology, I looked at those same journals from 1997 to 2002 and found no trend toward integrating behavior into Conservation Biology or toward integrating conservation into Animal Behaviour (Figure 1). The two fields, however, have at least one common ultimate goal: to understand and maintain healthy, wild animal populations in increasingly human-altered landscapes (Martin 1998).

	Journals	
Subject	Animal Behaviour	Conservation Biology
Conservation	0	88
Behavior	229	0
Conservation and Behavior	0	9

Table 1. Classification of subjects of research papers in the journals Animal Behaviour and Conservation Biology in 1996. From Sutherland (1998).

Why hasn't behavioral ecology been incorporated more into conservation biology? Five major reasons have been proposed by Morris Gosling and William Sutherland (2000): (1) conservation biology is not perceived by ethologists as a rigorous or prestigious subject, and is often seen as dull; and animal behavior is often seen by conservation biologists as irrelevant (see also Sutherland 1998) (2) there is a "cultural separation" because most ethologists work in universities, while most conservation biologists work in government or for non-profit organizations; (3) patterns of funding tend to reinforce the separation as conservation work is typically funded by charitable grants and behavior work is typically funded by scientific foundations; (4) the "historical lag" may be a result of the relative youth of the two disciplines, with little time for integration; and (5) it is sometimes technically difficult to combine the two subjects due to different scientific foci. The first four reasons are cultural, so I will spend more time discussing the last.

Tim Caro (1998) explains that behavioral ecology has traditionally focused on the strategies that individuals use to maximize their fitness through survival and reproductive success, while conservation biology has been concerned

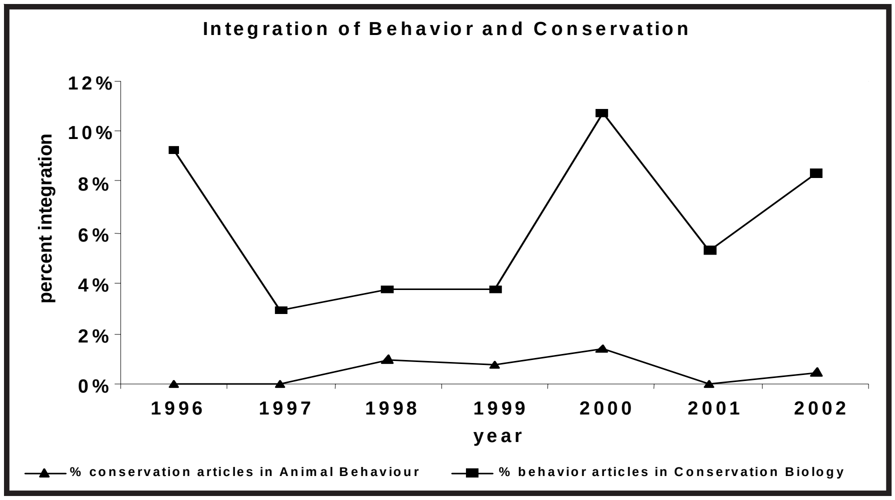

Figure 1. Percentage of conservation articles found in Animal Behaviour and percentage of behavior articles found in Conservation Biology from 1996 to 2002. Thanks to University of Michigan School of Natural Resources & Environment students Andrew Strassman, Kari Jensen, Melissa Pelkey, Beth Hahn, and Laura Kearns for help in compiling these data.

with the means by which small populations become rare and face extinction and how the habitats that they rely on can be conserved. The first involves basic research on individuals, the second applied research on the fate of populations or communities (Caro 1998). This discordance in the level of focus has been one of the greatest roadblocks to integration, and it stems from the popular belief that conservation should be directed at the "ecosystem level." The term "ecosystem," however, has been widely misused to mean large spatial or temporal scale, when in reality, the ecosystem level (as well as organismal, population, and community levels) can be at practically any spatial or temporal scale depending on the organisms of concern (Clemmons and Buchholz 1997a). For example, the population level scale of barnacles can be, temporally and spatially, much smaller than that of the organismal level scale of the wolf. By studying the behavior of either a single or several individuals, we do not necessarily work at a small scale. In fact, in studying certain behaviors (like bird migrations) the scale can be enormous. When conservation biologists say that preservation of biodiversity should be aimed at ecosystems, what they probably mean is that research should be directed at larger spatial and temporal scales, thereby encompassing greater biological diversity due to habitat heterogeneity (Clemmons and Buchholz 1997a). This problem can be solved by focusing on large vertebrate species or on behaviors that occur on large scales (migration, dispersal, habitat selection) or affect many other species ("keystone species effects").

Most biodiversity efforts have been "coarse filter" (Beissinger 1997) and concentrate on general patterns of habitat suitability or metapopulation dynamics of protected or natural areas. Behavior has traditionally been thought of as "fine filter," which acts as a safety net to catch species that will inevitably fall between the cracks. However, as discussed above, many behavioral studies can serve as coarse filters as well. And as the need for so-called coarse-filter work diminishes as the rate of reserve establishment falls (due to decreasing available wild lands), some of the fine-filter work of behavioral ecology will be in greater demand (Beissinger 1997).

Wildlife science, the traditional academic arm of the conservation and management field, has typically focused on questions at the population level, and the goal is often to diagnose the decline or fluctuation of rare, threatened, or game species and assess habitat suitability in the context of demographic, environmental, and genetic stochasticity. Animal behaviorists in academia have typically addressed how animals are selected to forage, defend territories, escape from prey, and mate within the constraints of the biotic and abiotic environment (Table 2 from Martin 1998). Although these major themes and approaches seem at first to be divergent, there are enough similarities in the practice of behavioral ecology and wildlife management to allow scientists and managers to integrate the two. For instance, as Kathy Martin (1998) notes, even though animal behavior studies and wildlife management studies tend to focus data collection differently, both types of research concentrate on the ecology of one or a few species, employ observational and experimental approaches to predict responses to changing conditions, follow individuals through multiple periods of their life history, and conduct relatively small-scale and short-term studies. With the development of the right "currencies" (translated into demographic or spatial terms) that allow us to transfer studies across disciplines, behavior and conservation work can be mutually beneficial (Beissinger 1997).

How, then, can behavioral studies help conservation? William Sutherland (1998) has identified numerous areas where animal behavior studies can contribute to conservation biology, and others

(Clemmons and Buchholz 1997; Martin 1998; Caro 1998; Gosling and Sutherland 2000) have listed and described major conservation questions that will benefit from behavioral studies, both of humans and non-human animals. One may organize these topics in a number of ways: by behaviors studied (reproductive strategies, group living, dispersal behavior, etc.); by research type according to the four questions in behavior (Tinbergen 1963) (understanding mechanisms, evolutionary ecology, animal physiology, etc.); by environmental problems (toxic waste, habitat fragmentation, etc.); or by conservation goals. I have chosen the latter and list the major conservation goals that can be aided by animal behavior studies. This is by no means a complete list, but I have tried to incorporate as many ideas as possible from disparate sources. I have also attempted to compile all of the major themes in integrating animal behavior and conservation biology into a single list organized explicitly and exclusively by conservation goals.

1) Improving captive breeding, reintroduction, augmentation, and translocation programs.

Many reintroduction programs fail or have limited success because they neglect to account for the behavioral ecology of the species of concern. Some animals have an "innate" ability to recognize and avoid predators, while others must be taught predator avoidance (Caro 1998), such as black-footed ferrets (*Mustela nigripes*). Understanding the behavior and ontogeny of a species will help to ensure that proper training and conditioning is practiced before release. The first efforts to release golden lion tamarins (*Leontopithecus rosalia*) in the wild were largely unsuccessful because the animals lacked basic locomotory skills and the ability to recognize food or predators (Wallace 2000). After the zoo environment was enhanced to include moving limbs and ropes to simulate vines and feeding devices that stimulated foraging, success in the wild increased substantially.

Most barriers to successful captive breeding and reintroduction programs are behavioral (Beissinger 1997) and can prevent disastrous reintroduction mistakes. When ibex (*Capra ibex*) from the Tartra Mountains in Slovakia were extirpated, ibex were translocated from Austria, Turkey, and the Sinai. The offspring from the crosses of these subspecies mated in the fall instead of the winter as the extirpated ibex and the nearby Austrian ibex did. The young, born in the harsh Slovakian winter, died (Martin 1998).

Captive breeding programs can also be improved at the zoo facilities by recognizing the importance of mate choice, naturalistic exhibits, and appropriate animal groupings in promoting successful breeding ex situ. Ignoring mate choice has led to decreased fecundity and survival of offspring in various species (Festa-Bianchet and Apollonio 2003).

Animal behavior	Wildlife science and management
Major research themes addressed	
How animals acquire, defend & use space	Population dynamics
Parental care	Uncertainty and risk assessment (PVAs)
Predator-prey interactions (hunting and fleeing)	Diagnosis and treatment of declines
Mating systems	Habitat suitability
Reproductive strategies	Human-wildlife interactions
Social and feeding behavior	Censusing and monitoring techniques
	Design of wildlife management areas & reserves
Contrasting focus in approaches to research questions	
Individual-based	Population-based
Inter-individual	Animal-habitat
Mean and **variance**	**Mean** and variance
Life-time fitness	Annual indices
Explanatory mechanisms	Patterns and correlations

Table 2. Comparisons and contrasts between the disciplines of animal behavior and wildlife science and management. From Martin (1998).

2) Improving animal control programs.

Managers often attempt to control a predator that is having a large impact on a threatened species. Introduced, invasive, or highly successful generalist predators may negatively affect rare species and thus require control. Ethical, ecological, or financial constraints, however, may prevent managers from using lethal methods. One solution is to manipulate the known behavior of a predator or prey by aversive conditioning. Fish Crows (*Corvus ossifragus*), when given prey eggs treated with distasteful chemicals – "conditioned taste aversion" (Cowan et al. 2000) – learned to avoid eggs of that species. And aversive conditioning via electrified mannequins has been used successfully to reduce predation by tigers (*Panthera tigris*) on humans (Sutherland 1998). Similar behavioral aversion techniques have been used to control browsing damage by ungulates (Gosling and Sutherland 2000). Simple knowledge and testing of behavioral theory of predator-prey relationships will yield valuable conservation tools.

3) Manipulating animal behavior for conservation.

Understanding animal behavior means being more easily able to manipulate it for conservation purposes. Sutherland (1998) relates a case of Lesser White-fronted Geese (*Anser erythropus*) which winter in southeastern Europe where they are vulnerable to overhunting. By placing their eggs with captive Barnacle Geese (*Branta leucopsis*), which had been translocated to Lapland, the White-fronted Geese followed their "foster parents" to the wintering grounds in the Netherlands and returned to breed in Lapland with conspecifics. The Barnacle Geese returned the next spring to the Stockholm Zoo! Knowledge of migratory behavior and natal philopatry made this effort possible.

4) Improving reserve design.

Proper reserve design has been a major goal in conservation biology (Noss and Cooperrider 1994). Behavioral studies of dispersal behavior and home range could greatly aid in the effort to understand metapopulation dynamics and necessary reserve size, shape, and connectivity for minimum viable populations. With fragmentation of habitats, it is important to learn the extent to which and conditions in which animals will disperse to help answer questions about barriers to dispersal and effectiveness of corridors. However, few models of metapopulation dynamics and dispersal use empirical data from behavioral ecology (Caro 1998a). Two kinds of dispersal data are critical: how far individuals disperse and the willingness of individuals to use corridors (Beissinger 1997).

Scientists especially need information on how human-caused habitat degradation affects dispersal (Caro 1998a). Some animals will disperse readily through converted lands with no negative impact, some will not disperse through converted lands, and others will disperse but pay a high cost. For example, endangered Spotted Owl (*Strix occidentalis caurina*) juveniles dispersed into clearcuts and farmlands even though a survival cost was observed (Martin 1998). André Desrochers (2003) has shown in a relocation study of 200 forest songbirds that birds homed back less often and after greater delays in fragments as opposed to intact forests.

Similarly, knowledge of the species' home range, as well as its seasonal shifts in range, will improve reserve design and prepare people for potential human-animal conflicts (Apollonio et al. 2003).

5) Attracting animals to wildlife reserves.

Conservationists in the field have typically relied upon habitat protection and restoration to maintain or attract desired wildlife species. Recent studies, however, have shown that many species, both colonial and territorial, rely on conspecifics to provide cues to assess the suitability of habitat for feeding and breeding sites (Reed and Dobson 1993). Moreover, apparently excellent habitat sites are absent of species that prefer them simply because others are not there already. Conspecific attraction, therefore, can be an important tool in conserving species. When such behavior is known to exist, managers can use this information to attract birds to areas that are safe from predators, less disturbed by humans, or are designated wildlife refuges. Successful seabird colonies were established based on this concept (Reed and Dobson 1993), and by using decoys and song playbacks, other potential areas could become attractive after a disturbance, natural or otherwise.

6) Improving management of fish and game species and improving hunting and fishing regulations.

Knowledge of animal behavior could have solved many problems encountered by game managers. Sutherland (1998) gives the example of overexploitation of Atlantic cod (*Gadus morhua*) off eastern Canada, whose numbers plummeted. This led to the closing of the fishery in 1992. When cod are at low densities, individuals congregate at the best site; however, at higher densities, cod are more widely distributed. As the cod population declined, the numbers seemed to be holding steady as the fish concentrated at the primary fishing sites, where they were easily caught.

Behavior studies can be influential to timing and length of hunting seasons, as well. By establishing the stage when offspring are independent from parents through removal experiments of targeted game species' parents, ecologists will be able to assess the true cost of hunting adults at a given time of year (see Martin (1998) for the discussion of Mourning Doves). Reproductive strategy can determine the "importance" of one sex or the other, which should affect the setting of cull rates and harvest sex-ratios in order to maintain population numbers (Caro 1998a).

7) Improving management of small populations.

The classic example of extinction due to human ignorance of animal behavior concerns the Passenger Pigeon (*Ectopistes migratorius*). Perhaps at one time the most abundant bird in the world, the pigeon's population was greatly reduced in the 19th century by hunting and conversion of eastern forests. Due to the Allee effect – a decline in population growth rates at low population sizes (Allee 1931; Stephens and Sutherland 1999), the Passenger Pigeon experienced a population vortex because their numbers were too low to support their social structure which required large numbers to trigger breeding behavior (Reed and Dobson 1993). Large numbers may also be required for effective vigilance or group defense (Sutherland 1998).

As in #6 above, the mating system will affect the effective population size (N_e), which affects the level of homozygosity, which affects inbreeding depression (Sutherland 1998). Thus, knowing the minimum viable population size depends on knowing the mating system. Anthony and Blumstein (2000) have listed many other ways in which behavioral traits can affect effective population size. The mating system and accompanying behavior also affects how one can increase numbers in small populations. At the Montezuma National Wildlife Refuge in upstate New York, refuge managers attempted to increase the number of Wood Ducks (*Aix sponsa*) - cavity nesters - by adding a large number of nest boxes, some very close together. But by neglecting behavior, the project failed since Wood Ducks will adopt a free-rider strategy and opportunistically dump their eggs in nests of other Wood Ducks if the boxes are conspicuous. The result was that some boxes contained 20-30 eggs and the mothers were unable to successfully incubate them, actually reducing the hatching success (Eadie et al. 1998).

8) Identifying which species will be at greatest risk.

Behavioral ecology could help us determine which animals are more at risk than others. It is possible to predict which species will be impacted based on mating system (monogamous species tend to be more at risk than polygynous ones), nest requirements (cavity nesters are vulnerable), foraging behavior (specialists are more vulnerable than generalists), or a host of other life history characteristics (see Piersma and Baker 2000 relating shorebird life history to vulnerability). Animals that are adapted to stable, unchanging environments will have narrow tolerance (steno-tolerant). Obviously, as human activity alters the physical environment, whether changing the extremes or the range of variation, specialists will be hardest hit.

9) Evaluating the effects of human disturbance.

Animal behavior may be a more sensitive indicator of stress than more frequently-used measures, such as mortality or reproductive failure. Some anthropogenic disturbances produce physiological or behavioral responses before the onset of detectable disruptions of critical demographic processes, so that monitoring hormone levels or behavioral responses may provide early warning (Clemmons and Buchholz 1997a). Furthermore, studies at the behavior level will provide a better clue to causal mechanisms than some broader demographic studies.

Studies that examine behavior in natural and disturbed habitats will answer questions about why some species are more impacted than others by anthropogenic change. For example, ornithologists have used playbacks of predator mobbing calls to determine the response of various songbirds to forest gaps created by logging (Martin 1998).

10) Mitigating the effects of human disturbance.

Knowledge of sea turtle swimming behavior was crucial in the development of turtle excluder devices (TEDs), which prevent bycatch of endangered turtles during shrimp fishing (Luschi 2003). Similarly, the best locations and characteristics for highway over- and under-passes to reduce roadkill have been determined largely through behavioral studies of wildlife (Clevenger and Waltho 2000). Because resource exploitation and habitat modification will continue indefinitely, we will always need information on the best ways to mitigate human impacts on vulnerable species; behavior studies will provide valuable information.

11) Improving field recovery of endangered species.

Behavioral studies can determine the limiting factors to population growth in the wild, allowing us to counter those factors. Finding the limiting factors is best accomplished by using a combination of individual and population-level approaches (Beissinger 1997). Only by proposing specific hypotheses that can be tested by examining behaviors such as foraging, mating, disease infection, etc., can we link demographic consequences to particular causes. These studies may also lead to specific suggestions for management practices to reverse population declines (Beissinger 1997).

12) Predicting responses to novel environments and anthropogenic change.

If we know the basis for behavioral decisions by individuals, it will be easier to predict their response to novel environments brought on by anthropogenic change, such as habitat loss, habitat degradation, and increased mortality. Male lions (*Panthera leo*) who take over prides participate in infanticide; thus a rapid turnover of males as a result of hunting or disease will result in a secondary effect of reduced reproductive output in the prides (Sutherland 1998).

Just as we can measure tradeoffs between predation risk and resource use, we can also measure the tradeoffs between human disturbance and resource use. In quantifying the tradeoffs, we can also predict the future responses of individuals to novel environments. For example, Pink-footed Geese (*Anser brachyrhynchus*) spend the winter months feeding in sugar beet fields in southern Great Britain where there is frequent disturbance from roads, which results in a strong negative relationship between distance from the road and proportion of beets consumed (Gill et al. 1996). By extrapolating from these data, we can predict the affect of road building projects on goose foraging.

13) Identifying habitat requirements of species of concern.

Habitat requirements are more than just a simple decision for species based on a broad vegetation classification. Habitat choice often involves decision rules that include predation, food supply, social stimulation, and other behavioral factors. Careful study of habitat selection behavior will produce better data for deciding how best to manage, protect, and restore landscapes. Many species of crabs and lobsters, for example, are limited to specific microhabitats due to behavioral constraints: they require rocky areas with crevices for protection from predators and for mate guarding during breeding (Reynolds and Jennings 2000).

14) Improving sampling and monitoring techniques.

Sampling techniques are, by necessity, proxies for actual counts of individuals. Usually numbers are assessed by tracks, scat, songs, or capture rates. Knowing the behavioral ecology of the species studied will greatly increase the accuracy of those estimates (Sutherland 1998). Often wide-ranging movements can cause gross overestimates of the population size as with a small population with very large home ranges mistaken as a large population with small home ranges (Apollonio et al. 2003). Moreover, counts are usually done of breeding individuals in the spring or of annual production in late summer, but often fail to capture a true picture of why animals succeeded or failed in their breeding attempts. Behavioral components of monitoring techniques may help solve these riddles (Martin 1998).

15) Improving population models.

Population Viability Analysis (PVA) is a novel tool in conservation biology which involves the development of species-specific models dependent upon detailed demographic and ecological information to predict risk of extinction relative to various management options. Behavioral studies can aid in the life cycle component of PVAs by eliminating many assumptions that are inevitably made when data are lacking. Dispersal dynamics and social system data are more helpful than simple life tables (Beissinger 1997).

16) Improving ecosystem restoration programs.

Behavioral studies of animals can discover the roles of certain species in harming or improving the condition of the land. For instance, species that retard vegetation recovery such as browsers or seed predators may impede restoration efforts, while seed dispersers or pollinators may aid ecological restoration. Research could focus on attracting desirable species or determining barriers to the movements of desired restoration-favored species (Beissinger 1997).

17) Controlling the spread of disease.

Behavioral ecology can also be used to help control the spread of diseases. By knowing the grouping patterns and movement behavior of individuals, especially how readily organisms will disperse, managers can better understand the mechanisms of SIR models which predict the proportion of susceptible, infectious, and recovered individuals within and across populations. Empirical study of behavior can help prevent disease in species of conservation concern like phocine distemper in grey seals (*Halichoerus grypus*). Conversely, disease can work as an effective tool to kill invasive species that may cause harm to native biodiversity (Caro 1999).

18) Improving baseline information.

Acquiring knowledge of baseline behavioral data on what constitutes normal, adaptive behavior in the wild will provide a basis for comparison after ecological disruptions have occurred (Clemmons and Buchholz 1997).

19) Providing effective data for political solutions.

Before making difficult decisions, policy-makers often require specific data on the effects of human activity on individual animals. Demographic data alone are often inadequate to turn public opinion. It was not until the specific effect of eggshell thinning was shown to disrupt the breeding success of raptors that the public cried out for the ban of DDT (Clemmons and Buchholz 1997). Politicians and government agents often want data on causal mechanisms that are provided by behavioral studies.

20) Highlighting charismatic behavior.

Animal behavior is inherently fascinating to most people. Behavioral studies highlight the dramatic and complex lives of animals that inspire a conservation ethic. Such aspects as cognitive ability, emotional expression, parental care, helping, vocal and visual displays, play, and sexual behavior engage the public more than, say, demographic stochasticity (Clemmons and Buccholz 1997). By highlighting fascinating behaviors of otherwise uncharismatic species like ants, behavioral studies promote conservation of a greater cross-section of species.

21) Improving understanding of human behavior.

Human behavioral ecology is also crucially important. Unfortunately, most conservation effort is prescriptive, without taking into account the dilemmas of human behavior. The behavioral ecological approach to understanding human behavior argues that humans evolved to gain resources for survival and reproduction and therefore, methods to encourage sustainable development must not assume individual altruism (Heinen and Low 1992). All conservation efforts should acknowledge the Darwinian roots of human behavior and work within that framework.

Because conservation biology is a crisis discipline (Soulé 1986), all relevant fields must be employed immediately to solve the problems of biodiversity loss. Behavioral ecology can provide the type of unique perspective that may end up being more helpful than we ever imagined. As William Sutherland (1996) stressed in his book <u>From Individual Behavior to Population Biology</u>,

> a knowledge of the behavioral basis of population ecology has the advantage that, as well as being more intellectually satisfying, it enables extrapolation to novel conditions, for example predicting the responses of populations to habitat loss. Population ecology suffers from having no overall, a priori theory from which explanations and predictions can be devised. Behavioral ecology has such a theory – evolution by means of natural selection – which yields the prediction that individuals maximize fitness. Thus, basing population ecology on behavioral ecology will increase the overall explanatory, and perhaps, predictive power of population ecology.

Both conservation biologists and behavioral ecologists should care greatly about integrating their fields. Conservationists must realize that behavior plays a role in nearly all ecological processes including nutrient cycling, pollination, seed dispersal, succession, predation, and community dynamics; and ethologists must realize that their own studies of variation in wild behaviors depend upon a diversity of organisms living in their natural habitats (Clemmons and Buchholz 1997).

[1] For a partial rebuttal to the claim by Caro (1999) and others that "use of behavioral knowledge has never been expounded by the behavioral community or explicitly recognized by conservation biologists," see Harcourt (1999).
[2] The Fourth edition of Krebs and Davies (1997) Behavioural Ecology – An Evolutionary Approach does contain one chapter entitled "Individual behaviour, populations and conservation" which strives not to list the many ways in which behavior studies may be used in conservation, but to outline one example – "how behavioral studies of individuals enable us to derive demographical functions that can be inserted into population models in order to make quantitative predictions of population responses to new environments."

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Human Behavior and Conservation

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Abstract
Many problems in managing and protecting endangered species arise not from our ignorance of the species' ecology, but from human conflicts of interest. As humans become ever more numerous, and more efficient in extracting resources, finding workable solutions becomes urgent. Here I suggest that strategies that work with our evolved tendencies have the potential to be more effective than strategies that ignore them.

Resumen
Muchos de los problemas en el manejo y protección de especies en peligro de extinción no provienen de nuestra falta de conocimiento sobre la ecología de la especie, sino de conflictos de interés entre los humanos. Con el crecimiento de la población humana, y su cada vez más eficiente extracción de recursos, la necesidad de encontrar soluciones factibles es urgente. En este articulo, sugiero que las soluciones acordes con las tendencias evolutivas de los humanos tienen mayor potencial para ser efectivas que las estrategias que las ignoran.

Today, conservation biologists face problems of unprecedented pace and scale. It is increasingly clear that a species' behavior and life history, molded by environmental pressures, can make the difference between conservation success and failure, particularly for endangered species (Dietz, this issue).

Human behavioral ecology is also important to the conservation and management of other species, especially endangered species, and of ecosystems. We repeatedly encounter cases in which failure arises not from the managed organism's life history and behavior, but our own. Often, we know the species' biology well enough to manage it properly —but human considerations block solutions.

Basics of Human Behavior: How to Cooperate to Conserve

It isn't something most of us think about: how our personal goals and constraints in our professional and daily lives connect to our evolutionary history. But there are links, and perhaps understanding them will help us find effective solutions. Here is a brief outline of the major issues of human behavioral ecology: how natural selection, and our evolutionary past, influence our decision-making; and how, despite today's complexity, that influence affects our ability to work toward successful conservation.

At the heart of our evolutionary history, and that of every other species, is the "selfish gene" (Dawkins 1989; review in Low 2000: Ch 1-4). Individually we live and die, but our genes (or their "replicates") can be immortal, which leads to interesting complexities in behavior. Obviously, getting and using resources effectively is a winning strategy and overt competitive behavior can (and does) work to get genes copied in all species. But in social species, cooperative behavior is extremely effective in getting our genes passed on—typically those we help are our relatives, with whom we share genes (parental and nepotistic behavior), or friends who will help us in return (reciprocity). Reciprocity can be complex and indirect: we help each other, but not on a one-to-one basis. Finally, we humans are not only social, but extraordinarily smart and complex: we invent "third party" interventions and institutions. Many other species have territories, but so far as we know, no other species has the equivalent of law enforcement and a judicial system to protect property rights.

We are complex and change our environments rapidly and repeatedly. Today, societies are large, and it is not at all clear that there are definite correlates of lineage success. It is tempting to ignore our past and the resource behavior of people in traditional societies today (our best reflection of past human behavior). We should not for two reasons. First, traits, including human traits, that are profitable for long periods, tend to remain even when environments change so that they would now be deleterious. Second, we know that cultural strategies that significantly reduce the reproduction of their followers tend to decline. The Shakers, for example, is one religious group that required its members to be celibate: the only new Shakers came from recruitment. And only a handful of Shakers remain alive today.

In our evolutionary past, we mostly lived and worked in small groups of related families; hence the importance of nepotism and reciprocity, and our desire to build "social capital" (e.g., Putnam 2001). Even when societies became larger and more complex, families and friends remained central. Our main problems were getting enough resources from the environment for our needs, maintaining satisfactory and stable friendships, finding mates, and raising families. The inability to control or predict the environment made long-term planning usually futile. Most of the time, our populations and technology were sufficiently limited that over-exploitation only did local damage to our environment. As a result, we evolved to strive for resources and seldom, if ever, found ourselves evolutionarily "rewarded" for conscious restraint.

We evolved to be efficient short-term environmental managers, not long-term global conservationists. Thus, cross-culturally, in the 186 societies of the Standard Cross-Cultural Sample, almost no societies report conservation concerns, but people in many societies worry that they may not be able to get enough, or that extrinsic environmental fluctuations will cause shortages, and much human activity is devoted to activities like storage and trade that ensure against shortages (Low 1990, 1996; Ember and Ember 1992; see also Smith and Wishnie 2000).

Recent studies of hunting in traditional societies reinforce this conclusion. Among the Piro and other hunter-gatherers, hunting follows the rules of optimal foraging: always take a profitable item when encountered. Hunters know quite well which species are endangered, but when a profitable prey is seen, it is taken, regardless of whether it is an endangered species (e.g., Alvard 1994, 1998; Hames 1988, 1989, 1991; Stearman 1994; Krech 1999; Gibson 1999). Calories, not conservation, dictate. An additional complication is that in some traditional societies, being a terrific hunter, or its equivalent, is worth more than the resource itself—a good hunter gets more status, more mates, and more children (e.g., Hawkes 1991; Hill and Hurtado 1996). Most cases of "low impact" reflect a combination of relatively low (human) population density, inefficient resource-extraction technology, and a lack of markets or low market value of the resource (Low 1996). This does not mean that unrestrained greed prevailed. A variety of governance systems have managed resources over relatively long periods (e.g., Dietz et al. 2003). Most traditional societies have been good short- to medium-term ecological managers, although not large-scale, futuristic preservationists.

Pleas that we can solve environmental problems through "a radical re-interpretation of the human place in the world" (Katz 1997) seem less likely to be effective than strategies that work with our evolved, rather self-centered, tendencies (Ridley and Low 1993; Low and Heinen 1993; Low and Ridley 1994; Low 1995, 1996; Penn 2003). If we could set aside our evolutionary past and act without self-interest, perhaps we could easily act as if the earth were our family. Yet that is precisely what we have been exhorting ourselves to do for literally hundreds of years, and it hasn't happened yet.[1] We have become ever more numerous and efficient, better at doing what we evolved to do, but our ability to extend costly cooperation to large scales lags behind. Perhaps we can co-opt our tendencies.

Conflicts of interest ("social traps": Cross and Guyer 1980; Costanza 1987) hinder us. Calls to "Just Save It" or to preach that "If we only had the will" may make the proposer feel good, but are largely ineffective (e.g., Hawkes and Charnov 1988; Low and Heinen 1993). Our individual behavior is cost-sensitive.[2]

Many centralized approaches to issues, such as species and natural area conservatio, pollution abatement, have the potential to produce inherent benefits for society at large, but may produce local or regional costs. Some endangered species recovery programs are locally costly but nationally beneficial. Recovery programs for large mammalian predators such as wolves (in both the US and Norway), grizzly bears, and endangered species like the Spotted Owl in the Pacific Northwest come to mind.

These become one kind of "commons" dilemma: widely dispersed benefits and concentrated costs, as in the Spotted Owl controversy. Conservationists across the US urged protection of the old-growth forests that support the Spotted Owl; but lumber companies and local workers saw their livelihoods disappearing. Not surprisingly, even when such programs have general public support, there are frequently free-rider problems and stark local dissent. As a result, these programs can be difficult to implement. Further, the issues are typically scientifically complex as well as highly emotional; as a result, opinions about "success" vary greatly. In contrast, the recovery plan for the Kirtland's Warbler, an endangered bird that nests in early successional Jack-pine forests in north-central Michigan, has never been controversial. This program includes regular cutting and sale of pine that generate local, short-term profits, which lowers conflicts (Solomon 1998).

Natural Selection, Behavioral Ecology, and Human Resource Use

A reasonable goal, then, is to design conservation programs that work with, not against, our evolved tendencies. Because humans evolved to use resources in reproductively selfish ways, while resources may or may not enhance fertility today, it's hard to shake very old, deep patterns (e.g., Low 2001; Clarke and Low 2001). Could we become more effective if we were more informed in our strategies? Behavioral ecology makes specific predictions about the patterns of resource exploitation we are likely to see. These predictions are increasingly supported, which suggests that we could design better strategies by appealing to people's perceived short-term interests, both familial and local (e.g., Low and Heinen 1993; Ridley and Low 1993; Low 2001).

If this approach is correct, government agencies and private organizations may find it productive to devise policies that create real, personal incentives to conserve: *the more immediate and significant the benefit, the more successful should be the outcome*. Indeed, political scientists, such as Elinor Ostrom (1998) in her presidential address to the American Political Science Association, have strikingly convergent ideas about how incentives work.

Some strategies will be easier than others. The more costs and benefits are separated (across individuals, across space, or across time), the more difficult sustainable solutions are likely to be. What comprises rational behavior for an individual is not necessarily (or even usually) a rational policy for society as a whole. The most difficult resource conditions are:

[1] *Inadequately-known resource base.* We can guess that a species is endangered long before we know enough to convince skeptics, or implement policy. Many fisheries, for example, have experienced these difficulties, and we are still arguing over the amount of recoverable oil reserves as well.

[2] *Slow feedback about the effects of our actions*. Visible species with a short generation time (e.g., many ungulate species) are far easier to manage than species with long generation times and low visibility, such as condors or whales (see Dietz, this issue).

From a human point of view, the most difficult issues are these:

[1] *Ineffective property rights and inability to detect and punish cheaters.* If resource users cannot control access and use of a resource, conserving it has no point (see Ostrom 1990; Hames 1991; Dietz et al. 2003). Public goods and common-pool resource regimes are notoriously vulnerable to exploitation. Open-ocean whaling is in theory a common-pool good, with rules and restrictions; but because it is difficult and expensive to monitor whalers' actual take, numbers are declining, in contrast to more-easily monitored coastal species like Minky whales.

[2] *Externalized costs.* When we can make others pay the costs of our actions, there is, of course, no incentive to change. Perhaps the best-known proposal to externalize costs is Lawrence Summers' World Bank memo of 1991 (reprinted at http://www.whirledbank.org/ourwords/summers.html), in which he proposed that African developing nations were vastly under-polluted, and that the US should export toxics to these nations.

[3] *Resources used by large, fluid, non-interacting individuals—especially when group membership is unrestricted* (Ostrom 1990; Low and Heinen 1993). Convergence of interests is low, and the temptation to take profit and defect is great; there is low social capital. In small, stable-membership societies, the value of social currencies can be high.

In part, the scale (in both time and space) of inherent costs and benefits limits potential solutions. We discount what is not here, now, and clear. This ability is an evolved response to living with environmental unpredictability (Low 1990; Cropper et al. 1992; Portney et al. 1994). The longer or farther away something is from our immediate interests, the less it pays to invest time, money, or energy in its consideration. The arguments over long-term costs of global warming, and the U.S. response to the Kyoto agreements, are cases in point. If we are asked to pay now to avoid future costs, we are likelier to argue about the actual likelihood of costs and the quality of the data rather than paying.

These scale issues, in one form or another, influence what solutions will work. We are likely to respond most immediately to relatively small scale, short-term problems which affect us directly. Notice that if humans were, in fact "group selected" (see Low 2000, Ch 10) to do (regardless of cost) what is best for the whole group we would have few problems; we would easily convince a majority of people to do things at their own short-term cost, for the long-term good of humanity.[3] Instead, we direct costly help to those we care about, and those who can help us in return.

Strategies for Resource-related Problems

How costs and benefits are manifested, and how they are influenced by the evolved human propensity to engage in spatial, temporal, sensory, and possibly in species discounting, lie at the heart of our difficulties. It is relatively easy to get fourth-graders to "care" about an endangered species (especially if we have a singular example, and a great story); it is far more difficult to get their parents to pay more in taxes, or give up access to protected areas—to shoulder real costs—in order to make real advances in endangered species management.

Widely proposed "solutions" to conservation problems, including endangered species management, differ in their time and geographic scale, and thus in how easily we might hope to implement them successfully. It seems likely that solutions will be easier for problems that are smaller in scale, and more immediate to the actor. Here I consider several categories: information/education programs, social incentives (through direct reciprocity), economic incentives (fines, taxes, trading permits, etc.), coalitional influence, and broad governmental regulations.

Information/Education:

It's obvious that we need information about the state of any resource, and the effect of our use of it, to be efficient resource managers. Consider: whale numbers are hard to assess; when we hunt whales, how much do we decrease the populations? If we can't measure a resource, one common response is to "get mine and get out." Resource economist Colin Clark (1973) made this point strongly: he showed that from a purely economic standpoint, the sensible thing to do about large whales is to hunt them to extinction, and bank the profits, because money grows faster than whales.[4] This, of course, assumes that the only value of whales is economic. If we wish to convince a majority of people that whales are "worth" more to them alive (even if never seen) than extinct, sheer information is not a strong approach.

Information about the effects of our behavior is obviously important; self-interest dictates avoiding our own destruction. But time scale matters: predicted changes in a species' condition in 10, 20, or 50 years, do not motivate many people. If a change is seen as costly (in individual time, money, or even "attention") we need more than simple information to effect change. *Information will probably work most effectively at the local and short-term level.* It should work best in situations most analogous to traditional societies' management of rapid-feedback resources, when property rights are clear. Still, information, although necessary, is unlikely to solve any major environmental issue alone.

Exhortation, Inculcation, Success Stories.

Can it help to exhort ourselves (and perhaps especially others) to "Do the Right Thing?" Political scientists are recognizing the importance of reputation and status (Ostrom 1998), since, in many situations, the opinions of others matter to us. We can, and do, use this to our advantage: children raised to have a strong conservation ethic, and told stories of children successful in creating change, are more likely to become active in promoting conservation.

We evolved to be teachable, and eager to learn. Children raised in a conservation ethic may well, as adults, find it less onerous than did their parents to perform slightly costly behaviors that will have a long-term benefit (e.g., Cavalli-Svorza and Feldman 1981; Boyd and Richerson 1985; Low 2000). However, this solution is plausible only for problems in which we have a generation or more in which to try to change attitudes and willingness. Time can be a problem: today's enthusiastic grade-schoolers, without reinforcement, may become quite pragmatic as adults.

Social Incentives

Our costs and benefits were not originally monetary; they are older than the invention of barter and money, though not older than family structure and reciprocity. Social capital still matters so some modern solutions may be possible without economic levers. The promotion of conservation ethics as a social norm plays on our evolved sociality—if we all agree one "ought" to do it, it can become socially costly to defect. Social norms are particularly effective when members of a group agree not only to punish cheaters, but also to penalize anyone who does not also punish cheaters.[5] It is important, as always, that we are able to monitor and detect cheating, and it helps if the group membership is stable (see Latane and Rodin 1969).

Seeking "small wins" plays on social incentives. When we "think globally, act locally" we are picking small pieces of the problem—we see results, feel reinforced, and continue. It's debilitating to try to imagine how to solve all our problems globally, so strategies that pick local issues can be very effective. Even in extreme cases, if appropriate incentives can be provided, we expect use patterns to change.[6] Again, most amenable to social incentives are *local* problems that exist among *relatively stable groups*. Perhaps, we can manipulate our sense of group, to help counter our tendencies to discount and to externalize. As we gain more information, we need to stress our ecological interdependence and try to [1] design ways to lower current cost of desired behaviors, and [2] extend the boundaries of "others" we are willing to accept as sharing our benefits. This may, obviously, prove difficult.

Economic Incentives:

The two previous strategies are likely to work best in small-scale problems for obvious reasons. They are relatively ineffective when conflict exists between local actors and others, as in the Spotted Owl debate. Sometimes we can construct payoffs for local actors, to ameliorate the costs; for example, the USFWS's agreement with Mexico on the protected areas for the Monarch butterfly, and Lincoln Brower's and others' work to engage local citizens as tour guides and protectors. Tourism is now a major endeavor in that region.[7]

Tradeable environmental allowances (TEAs) have been useful in several environmental arenas (e.g., Tietenberg 2002), but to be really useful for species management, they may need some adjustment. TEAs, as currently structured, tend to leave unprotected any resources not specifically covered by the agreement, like by-catch of uncovered fish (see Dietz et al. 2003). Monitoring, especially with regard to endangered species, will also be difficult.

Economic incentives can work in situations in which information alone is unlikely to work: larger, more fluid, and more heterogeneous groups with little willingness to pay individual costs for the good of the group (e.g., due to lack of social interactions and/or familial ties).

Coalitions and Negotiations

These are really implementation approaches. The most successful coalitions comprise individuals who have convergent interests. In our past, these were kin (who have fewer reproductive conflicts than competitors), monogamous mates (who have convergent reproductive interests), and frequently reciprocating individuals, as in Ostrom's 1990 examples of successful commons. Common-pool resources are among the most difficult to manage for long-term group-level good. There are effective common-pool resource regimes (Ostrom 1990; Dietz et al. 2003), and while they differ dramatically in many ways, they have important similarities: there are recognized property rights, and rights of the group to make decisions, the populations are stable and relatively non-mobile, and cooperators can monitor use and punish defectors.

All of us are loathe to inflict costs upon ourselves, but we may form coalitions, sometimes accepting small costs in order to impose greater costs on others/society at large. This can help us 'leapfrog' from small-scale solutions to larger-scale successes. State gas taxes for road repair are not uncommon; and the Maine lobster fisheries appeal to the regional fisheries organization helped regularize the protective "V-notch" practice in a wide area. Eliminating externalities (shifting the costs to others while retaining the benefits) at local and regional levels may help this strategy. Stakeholders must be involved in these decisions; otherwise, we see defection.

Negotiation is a standard strategy in the face of conflicts of interest in, for example, labor relations, and a large literature exists about successful strategies. Incentives, regulations, and taxes for environmental problems, however, are currently not negotiated in the standard way. Within existing legal constraints, is there a way we can bring what we know about negotiation to bear on these problems?

Government Regulations:

So long as we imagine "government" as a unified, external force, we will have trouble solving any conservation problem.

It is only too easy to suggest that "the government" should do this or that; the real problem is how to make it worthwhile to individuals (e.g., Western U.S. Senators and Representatives) to create such a governmental response. This is problematic at multiple levels. We have a long history of refusing to tax ourselves, even when it is clear that additional taxes will ameliorate an environmental concern.

Coalitions and negotiations can significantly influence government decisions. Prominent social scientists are suggesting that basic premises of much research is flawed because of the assumption that government is a singular entity acting in isolation from, and above, other actors (e.g., Ostrom 1990, 1998). Individual actors (e.g., middle managers in an institution) have multiple incentives; retaining budget can become as important as the conservation goal itself.

Groups of individuals with common interests can affect governmental regulations, by planning strategies that include gaining knowledge of the voting record and constituency of individual members of congresses or parliaments, and by lobbying the members most heavily who are the most powerful and/or are undecided. Many (or most) environmental regulations in the USA, for example, have been influenced by the lobbying efforts of environmental NGOs whose membership is made up largely of people with personal interests in conservation (bird watchers, anglers, hunters, campers, and other recreational users).

Conclusions

Environmentalists frequently stress the need for sustainable development, however defined. The material in this issue suggests that, particularly for endangered species, it is important to understand not only the behavior of other species, but our own if we hope to achieve sustainability and design successful conservation efforts. The three most persistent challenges to all these strategies are discounting, externalization of costs, and (in fewer cases) insufficient information. We need to work in both the short and long term, to use both economic and social costs and benefits, and to design education and social norm strategies on the most local scale we can, appropriate to each problem.

Knowledge of the evolution of resource use by humans may help us tailor successful solutions to some resource-related problems in modern industrial societies. In a few cases, information alone may be effective; in other cases, playing on our evolutionary history as social reciprocators may help. Environmental problems that tend to be relatively local and short-term may be solvable in these ways. Economic incentives can provide solutions to many other types of problems, by manipulating the cost and benefits to individuals. Large-scale environmental problems are difficult to solve, precisely because humans have evolved to discount such themes.

Management and protection of endangered species present particularly complex problems. First, we must understand how environmental pressures shape the life histories and behavior of organisms (Dietz, this issue). But we must also understand how human behavior has evolved, and what that means for the likelihood of success of any proposed strategy. *No one set of solutions is likely to work in all types of environmental conflicts*—precisely because humans are likely to respond in various ways, depending on the spatial and temporal scale of the problem, and on the degree of separation between actors who profit and actors who pay. Specific solutions must be sensitive to these tradeoffs, and new work on fostering relatively large-scale cooperation is important (Ostrom and Walker 2003; Hammerstein 2003). This approach is new, but with elaboration and testing, will allow us to assess different important, previously ignored dimensions in conservation issues, including the issues of convincing ourselves to pay real costs to protect endangered species.

[1] Two complexities are important. First, the statement that human behavior is sensitive to individual costs and benefits is a statistical one, not a declaration of universals. It is not that there are no environmental Mother Teresas out there; it is that if, to be successful, we must rely on a large proportion of people accepting costs willingly, we are in trouble. Second, the costs and benefits are not simply monetary (cf. rational actor economics), but include non-monetary "currencies" like reputation and status (e.g., Ostrom 1998; Ostrom and Walker 2003; Putnam 2003)

[2] Ecological economists Herman Daly and John Cobb (1989) raised this issue when they discussed the problem of how to build a "public" – a large group willing to bear individual costs for the common good.

[3] "Group selection" is a term that has been given multiple meanings (e.g., Low 2000: Ch 10). Experimental economists have new data that some proportion of individuals will "cooperate" in one-shot Prisoner's Dilemma games (this is equivalent to accepting a cost for others). However, the proportion is not all that large; and in fact if everyone cooperated, they would profit (cooperate-cooperate pays more in this game than defect-defect). So this is probably not a good model for assuming people will broadly support paying individual costs for dispersed benefit.

[4] Population growth rates are calculated as compound interest rates, with births and immigration (like deposits), death and emigration (like withdrawals). Species like whales, that take years to mature and have widely-spaced births of a single calf, have very slow population growth rates compared to species that mature earlier and have several young. Ecological economists (e.g., Kellert 1984; Daily 1997; Costanza et al. 1997) ask as well about other values and services of ecosystems.

[5] Among non-relatives, our neighbors are those with whom we are most likely both to have had (socially) profitable reciprocal relationships, and those on whom we are least likely to defect (e.g. in tit-for-tat games, repeated interaction is important). If we have promoted a normative standard regarding conservation, compliance is likely to be higher the better we know, and the more we interact with, our neighbors. Latane and Rodin (1969) described the well-known "bystander effect": in many circumstances, when there are sufficient bystanders, people defect—their chance of remaining anonymous is greater. Thus, information (recycling, above), reciprocal interactions, and promotion of social norms, are all likely to be more effective when translated into local scenarios.

[6] Defining manageable portions of any problem to be tackled seems to be an important strategic device related to our evolutionary past in small groups with shared interests. Long litanies of problems may preclude any solution, for people become too overwhelmed to take action. Instead, he argues, building a series of 'small wins' creates a sense of control, reduces frustration and anxiety, and fosters enthusiasm. Small, specific, and visible objectives are obtainable, and success generates the energy to attack another small goal. The sooner the visible reward, the more effective the strategy. William Ruckelshaus announced on day one of his tenure as head of the US Environmental Protection Agency that the agency was pursuing five major lawsuits against large American cities. Other sources of pollution were more visible; other sources of pollution were perhaps more widespread and damaging. But Ruckelshaus' move was dramatic, well-researched, well-orchestrated – and winnable It built a foundation of success and a sense of effectiveness (Weick 1984).

[7] Continued monitoring of success is important. Over time, other options arise, and at some point, local people may no longer wish to cooperate. In the Monarch case, since 1997, the USFWS, several non-governmental organizations and the Mexican government have cooperated to keep a closer eye on changes, and have done a number of pro-active projects.

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Biology, Policy and Law in Endangered Species Conservation: I. The Case History of the Island Fox on the Northern Channel Islands

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Abstract

Endangered species recovery often requires strategies that are risky, contentious, and difficult to implement. These qualities can lead to recovery actions that result from human dimensions of endangered species conservation instead of biological extent. Here we discuss the recovery actions implemented by the National Park Service in conserving three subspecies of the critically endangered island fox, *Urocyon littoralis*. We present an overview of how these subspecies became endangered, chronicle the existing and future threats to their persistence, and summarize the actions implemented and needed to save the fox from extinction. Similar to other endangered species programs, this recovery program suffers from a bureaucracy that prevents timely implementation of recovery actions and that is risk averse in its strategies to save the fox. Consequently, even though a wealth of biological information now exists on this species and the threats to its existence are well known, necessary recovery actions are being delayed. Bold, aggressive, and controversial actions are likely to be requisites to save the island fox from extinction.

Resumen

La recuperación de especies en peligro muchas veces necesita estrategias arriesgadas, contenciosas, y difíciles de implementar. Estas características pueden derivar en acciones de recuperación que resultan de las dimensiones humanas de la conservación de especies en peligro en lugar de la dimensión biológica. En este articulo, discutimos las acciones de recuperación implementadas por el Servicio de Parques Nacionales en la conservación de tres sub-especies de la críticamente amenazada el zorro isleño, *Urocyon littoralis*. Presentamos una visión de conjunto de como estas sub-especies han llegado a estar en peligro de extinción, describimos las amenazas presentes y futuras, y resumimos las acciones implementadas y las necesarias para salvar al zorro de la extinción. Igual que otros programas de especies amenazadas, este programa de recuperación sufre los efectos de una burocracia que impide la implementación oportuna de acciones de recuperación y que es adversa al riesgo. En consecuencia, aun cuando hoy existe abundante información biológica sobre esta especie y se conocen muy bien las amenazas a su supervivencia, las acciones necesarias para lograr su recuperación no se ejecutan. Para salvar el zorro isleño de la extinción, acciones audaces, agresivas, y controversiales son probablemente las indispensables.

Introduction

A premier and vital piece of endangered species legislation, the U.S. Endangered Species Act (ESA), has been critiqued and often criticized on its efficacy (Clark et al.1994; NRC 1995; Clark et al. 2002; Kareiva 2002; Roemer & Wayne 2003). Although criticism stems from how the law is worded and its intent (e.g., single species vs. multiple species vs. ecosystem approaches), most censure reflects not an inadequacy in the structure of the law itself, but rather in its implementation. Endangered species recovery plans frequently lack detailed biological information on the species at risk, and the threats to the species persistence are often not the primary focus (Tear et al. 1995; Clark et al. 2002; Lawler et al. 2002). Even when sound decisions based on the biology of the species at risk can be reached and implemented, the legal, political, and financial realities of endangered species conservation can take precedence. Because "the ultimate causes of most species' endangerment lie in human values that are manifest in varying social, economic, and political institutions and activities" (Clark et al. 1994: 419), such institutions must be engaged for recovery to elude failure (Clark and Wallace 1998). Here we summarize the evolution of a current endangered species issue that concerns the decline and conservation of the island fox (*Urocyon littoralis*), a carnivore endemic to the California Channel Islands. This first essay describes the conservation scenario of the island fox on the northern Channel Islands; future essays portray the conservation of fox populations on the southern Channel Islands (Figure 1). Our focus is to present the biological issues that should be paramount and discuss the real world issues that are.

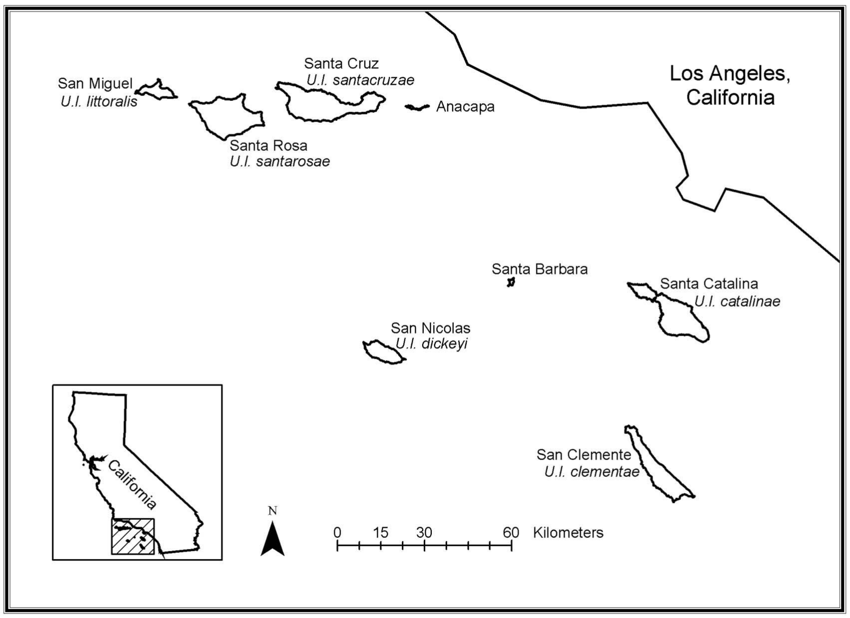

Figure 1. Island foxes (*Urocyon littoralis*) are distributed as six insular populations, each recognized as a separate subspecies, within the California Channel Islands. An archipelago located off the southwestern coast of the United States.

One of only two species of the genus *Urocyon*, the island fox is a dwarf form and direct descendant of the mainland gray fox (*U. cinereoargenteus*). It is restricted to the six largest of the eight California Channel Islands (Figure 1; Moore and Collins 1995). Each island fox population is recognized as a separate subspecies (Collins 1982, 1993; Wayne et al. 1991; Goldstein et al. 1999). It is hypothesized that over 20,000 years ago, gray foxes colonized the northern Channel Islands when the three islands were connected as one large island (Santa Rosae), a land mass located only six kilometers from the North American continent (Collins 1993). At the end of the Pleistocene era sea levels increased, splitting Santa Rosae into the northern Channel Islands and creating three island fox populations (Figure 1). Approximately 10,000 years ago, Native Americans colonized the Channel Islands and then transported foxes from the northern Channel Islands to the southern Channel Islands (Santa Catalina, San Clemente and San Nicolas) as either pets or semi-domesticates (Collins 1991a, 1991b). Thus, the island fox's association with humans is a deep one that historically contributed to their biogeographical distribution and differentiation, and one that today has brought the species to the brink of extinction.

Currently, the three northern island fox subspecies are critically endangered owing to heightened predation by a novel apex predator, the golden eagle (*Aquila chrysaetos*), whose presence was facilitated by an exotic prey, feral pigs (*Sus scrofa*; Roemer et al. 2001, 2002). The subspecies on San Miguel (*U. l. littoralis*) and Santa Rosa Islands (*U. l. santarosae*) are extinct in the wild and the subspecies on Santa Cruz Island (*U. l. santacruzae*) has declined from approximately 1500 adults in 1994 to less than 100 in 2003 (Roemer et al. in press). These three subspecies, along with a fourth on Santa Catalina Island (*U. l. catalinae*), are currently being considered for protection under the ESA (USDI 2001).

In response to the decline of the island fox on the northern Channel Islands, the National Park Service (NPS) in collaboration with The Nature Conservancy (TNC) developed a recovery plan for the island fox (Coonan 2003a) and a restoration plan for Santa Cruz Island (USDI 2002). The ownership and management of Santa Cruz Island is split between the NPS and TNC. Both plans employ an ecosystem approach that includes: 1) captive breeding and eventual release of island foxes to the wild, 2) monitoring of the wild fox population remaining on Santa Cruz Island, 3) live-capture and removal of golden eagles, 4) reintroduction of bald eagles (*Haliaeetus leucocephalus*) as a potential deterrent to nesting golden eagles, 5) eradication of feral pigs, and 6) control of invasive plants such as fennel (*Foeniculum vulgare*). An ad hoc group of experts from academia, non-governmental organizations, and federal and state resource agencies was also established to guide the fox recovery effort (Island Fox Conservation Working Group; Coonan 2003a).

Despite this holistic approach, which includes the recovery of the fox as a focal point, the plan suffers not in concept, but in timing and implementation. These deficiencies result from a bureaucracy that prevents timely implementation of recovery actions (Miller et al. 1996), an organizational policy that is conservative and risk averse, and an authority and control structure that places key decisions in the hands of administrators rather than scientists and managers that are advising and implementing the actions on the ground. A brief chronology of events may help to elucidate these points.

The Chronology of a Decline and the Creation of an Endangered Species

Prior to the decline of the island fox on the northern Channel Islands, a monitoring program was established on several islands to track their demography (Roemer et al. 1994; Coonan et al. 2000). The establishment of a monitoring program within Channel Islands National Park was initially opposed by some staff due to differing opinions and attitudes toward its usefulness (e.g., previous trapping has made foxes “skittish”), as well as politics with past landowners from whom Santa Rosa Island was purchased (Coonan and Schwemm 1995). Despite this opposition, monitoring programs were established on San Miguel and Santa Cruz islands; these programs would later prove instrumental in a viability analysis that formed the biological basis for the fox recovery plan (Roemer 1999; Roemer et al. 2000b; Coonan 2003a).

On Santa Cruz, additional facets of island fox biology were intensively studied, including demography, social organization, foraging ecology, and disease ecology (Roemer 1999). As island fox research progressed, fox survival began declining rapidly. Monitored populations were plummeting, and the agent(s) of the decline were unknown. Disease, in particular heartworm (*Dirofilaria immitis*), was initially suspected in playing a role in the island fox decline (Crooks et al. 2001). However, further study implicated predation by golden eagles as the primary agent of decline (Roemer et al. 2000a, 2001, 2002). Golden eagles colonized the northern Channel Islands in 1994 and began to prey heavily on foxes. In the first nine months of the Santa Cruz study, none of the 32 radio-collared foxes had died; 17 months later, cumulative survival dropped to 0.21 and by 1998 the study population was extirpated. The decline in foxes on Santa Cruz was linked to the presence of feral pigs. Pigs, by acting as an alternative, abundant food source, allowed golden eagles to colonize the island and through the process of apparent competition drove the foxes toward extinction. This dynamic also had community-level implications: the decrease in foxes allowed its only competitor, the island spotted skunk (*Spilogale gracilis amphiala*), to increase in numbers. The interaction between the native, introduced, and colonizing species caused apparent competition to replace resource competition as a dominant force structuring the vertebrate community on Santa Cruz Island (Roemer et al. 2002).

During this same period (1993 – 1996), the NPS documented a coincident decline in foxes on nearby San Miguel Island. The monitoring program revealed that the fox population had dropped from an estimated 300 adults in 1993 to less than 100 by 1996 (Coonan et al. 2000; Roemer et al. 2001). Estimated fox density on one grid dropped from 15.9 foxes/km^2 in 1994 to 0.9 foxes/km^2 in 1996; this study population was extirpated the following year. To investigate whether golden eagles were also the agent of decline on San Miguel, the Resources Management division requested $40,000 from the National Park Service Western Region in 1996 to implement a survival study using radio telemetry. The request for funds was denied (T. Coonan, pers. comm.). Research funds were eventually obtained in the fall of 1998. Seven of the 15 radio-collared San Miguel foxes died between November 1998 and July 1999, five as a result of eagle predation (Roemer et al. 2001). By summer 1999, five years after golden eagle predation had been identified as the principal mortality factor for foxes on Santa Cruz, only 15 foxes were known to be alive on San Miguel.

During the same period that fox populations on San Miguel and Santa Cruz were rapidly declining, there was concern that the population on Santa Rosa, where monitoring had been thwarted, was also declining. In 1998, trapping efforts on Santa Rosa validated the concern; only 9 foxes were captured in 132 trap nights (Roemer et al. 2001). Foxes had declined precipitously on all three northern Channel Islands and were in danger of extinction.

The decline of the fox populations on Santa Cruz and San Miguel was documented because monitoring programs were in place. Further, the agent of the decline, golden eagles, was elucidated due to the in-depth study on Santa Cruz, albeit somewhat serendipitously. In response to these declines, 14 of the remaining 15 foxes on San Miguel were taken into captivity under what was termed "protective custody" and a captive breeding program initiated in 1999 (Coonan 2003a). While a captive facility was also needed on Santa Rosa where only 9 foxes had been captured the previous year, the establishment of a second facility was delayed because of funding restrictions and prohibitive logistical considerations. Eventually, due to local public sentiment spearheaded by local media coverage (Johnson 1999) and insistent support from the scientific community, additional funds were supplied by the NPS and a captive facility for island foxes on Santa Rosa was established in 2000. Only 14 foxes could be found to initiate this second captive facility (Coonan 2003a). Island foxes are now extinct in the wild on San Miguel and Santa Rosa islands, with a total of 38 and 56 foxes currently in captivity, respectively (Coonan 2003a). If these facilities had not been established, it is likely that these subspecies would have gone extinct.

The Next Step: The Complete Removal of Golden Eagles

Given the impact of golden eagle predation on fox survival and population dynamics, it was clear that reducing the number of golden eagles on the islands would be necessary if foxes were to recover. In 1999, the first confirmed golden eagle nest was located on Santa Cruz Island (Roemer et al. 2001), with subsequent nests located on Santa Cruz and nearby Santa Rosa (Coonan 2003a). In November 1999, the Santa Cruz Predatory Bird Research Group under contract by the NPS captured the first golden eagle on Santa Cruz (Coonan et al. in press). Through June 2003, a total of 31 golden eagles were translocated (26 juveniles, sub-adults and adults, and 5 nestlings; Coonan 2003a). Despite the success of the live-capture program, golden eagles still remain and continue to prey on wild foxes. Four to five golden eagles are thought to remain on Santa Cruz with 1-3 eagles on Santa Rosa (Coonan 2003a, 2003b). After eagle removal was initiated, continued monitoring of wild foxes on Santa Cruz revealed that eagles killed 16 of 19 radio-collared foxes found dead between 2001 and 2003 (Coonan et al. in press).

Although golden eagle removal efforts have been successful, the inability to remove all resident eagles from the northern Channel Islands is preventing fox recovery. An additional step in fox recovery and island restoration includes a plan to eradicate feral pigs from Santa Cruz (USDI 2002). This action will help restore vegetation on the island and should remove the eagles' prey base thereby leading to eagle disappearance. A recent modeling exercise suggests caution in the implementation of such a strategy while eagles remain (Courchamp et al. 2003). Given the susceptibility of foxes to golden eagle predation (e.g., of 47 radio-collared foxes found dead since 1994, 40 were killed by eagles), removal of pigs, a key prey item, could increase predation pressure on foxes. This would drive the remaining wild foxes on Santa Cruz further towards extinction.

While live-capture efforts of golden eagles are continuing, certain eagles have proved difficult, if not impossible to capture. Such individuals may require lethal removal (Courchamp et al. 2003). Lethal removal of an emblematic bird like the golden eagle is, by necessity, emotionally charged, politically unsavory and legally challenging. Resource agencies are necessarily wary of instituting such a policy owing to public sentiment and perception of the agency's role as protectors of our natural heritage. Membership organizations such as TNC are also likely to be wary of such aggressive actions that may reduce their donations and consequently constrict their funding base. In addition to the political obstacles, golden eagles are protected in the United States by two federal laws, the Migratory Bird Treaty Act (1918) and the Bald Eagle and Golden Eagle Protection Act (BEGEPA; as amended in 1962). While both acts prevent "take" of golden eagles, the Secretary of the Interior can grant exemptions. For example, in the 1962 amendment, the Secretary, on request from a state governor, can authorize the taking of golden eagles "for the purpose of seasonally protecting domesticated flocks and herds in such State,…in such part or parts of such State and for such periods as the Secretary determines to be necessary to protect such interests" (16 U.S.C. § 668a). If domesticated flocks are worthy of eagle protection, surely nearly extinct endemic taxa are as well. Moreover, golden eagles have a Holarctic distribution and are not threatened with extinction in North America. Recent population surveys within the Intermountain West suggest that golden eagles exhibit regular population cycles coupled to their prey, and, although the most recent trends suggest a decrease in numbers in the western U.S., eagle numbers are generally stable or increasing particularly at high latitudes (Hoffman and Smith 2003). The BEGEPA was further amended in 1978 authorizing the Secretary to permit "the taking of golden eagle nests which interfere with resource development or recovery operations." This additional non-lethal approach to reducing golden eagle breeding attempts has not been pursued. There is no legal precedence for not pursuing lethal removal. Public perception and financial burden also should be viewed in light of the critical state of the island fox; averting extinction should be paramount. The lack of action on the development of lethal removal options by the NPS and the U.S. Fish and Wildlife Service represent risk aversive strategies to endangered species recovery that places political and financial considerations above biological ones, and which ultimately ignores the main impediment to fox recovery (Clark et al. 2002). Certainly no resource organization wants to see golden eagles shot or the fox go extinct, yet the resource agencies involved appear unwilling to pursue controversial actions that could possibly ensure recovery and would certainly speed implementation of recovery actions (e.g., successful release of captive-borne foxes). Unfortunately, politics continues to precede biology in the recovery of the fox.

The Release of Captive-Reared Island Foxes in the Presence of Golden Eagles

In response to the overwhelming evidence that golden eagle predation caused the decline in foxes and is preventing their recovery, both the Island Fox Conservation Working Group and the IUCN/SSC Canid Specialists Group support the maintenance of the captive breeding facilities and the retention of foxes within until the threat of golden eagle predation can be completely mitigated (Coonan 2003a,b; http://www.canids.org). Despite this advice, the NPS unilaterally released six captive-borne foxes on Santa Rosa and three captive-borne foxes on Santa Cruz on November 20 and 21, 2003, respectively (Coonan 2003c). More releases were planned for December 10, 2003. The NPS suggested that these releases were conducted for three reasons: 1) begin the recovery of the wild fox populations, 2) evaluate survivorship of the released foxes, and 3) evaluate alternative release methods. These motives are flawed on several fronts. First, with eagles still present on the islands, there is little hope that recovery of wild populations can occur. Since the initiation of golden eagle removal on Santa Cruz, the wild fox population has declined from an estimated 133 individuals to less than 70. Annual measures of survival are still too low to allow recovery (Roemer et al. 2000b, 2001; Coonan 2003a). Other factors related to small population size, such as Allee effects, demographic and environmental stochasticity or disease also could doom the remaining foxes (Roemer et al. 2000b, 2001; Timm et al. 2002). Second, the survival of released foxes would most likely be lower than the survival of wild foxes (Breitenmoser et al. 2001). Wild foxes on Santa Cruz have been experiencing predation pressure from golden eagles for nearly a decade and may have responded to such intense selection by becoming more nocturnal (Roemer et al. 2002). There is no reason to expect that captive-borne foxes that have not experienced predation nor have been conditioned to avoid predation would have a higher survivorship than wild foxes. Moreover, in 2002, NPS released three captive-borne foxes on Santa Cruz and two were killed by golden eagles (Coonan 2003a). Finally, the small sample size of foxes being released, their make-up (on Santa Rosa one mated pair and four juvenile females and on Santa Cruz one mated pair and one adult male were released), and the similar manner of release would preclude a valid comparison of "alternative release methods." In sum, the release of island foxes was, at the least, a poor attempt to rigorously evaluate the efficacy of fox recovery, and was most likely a response to the fact that captive breeding facilities were either at capacity or have exceeded capacity and the NPS lacked funds to sustain such captive populations (Coonan 2003b).

Conclusions and Recommendations

In March 2004, four of the six fox subspecies will likely be granted protection under the ESA. A strategy has been formulated that lists actions needed for recovery, including objective criteria for defining a successful recovery and the costs of such an effort (Coonan 2003a). These objectives are requirements of a recovery plan structured under the ESA (Clark et al. 2002). The current recovery strategy also has taken advantage of information amassed on the evolutionary biology and ecology of the island fox over the past two decades. This information has identified the primary threats to the persistence of fox populations, and has provided the biological foundation necessary for the development of a sound recovery plan. Nevertheless, the current approach to saving the fox has suffered from delays (e.g., establishing the San Miguel and Santa Rosa captive breeding facilities), conservative risk-averse actions (e.g., lack of pursuit of lethal removal of golden eagles or non-lethal destruction of nests), and unilateral decisions that have led to actions based on agency agenda and constraints rather than on sound science (e.g., release of captive-borne foxes in the presence of golden eagles). Further, research projects suggested by Working Group members that could improve fox recovery, such as a comparison of activity patterns in captive versus wild foxes on Santa Cruz and mate choice studies of captive foxes, have also not been pursued.

The lethal removal of golden eagles is a valid and sound management option. And the legal, public, and political obstacles are surmountable. In stark contrast to killing a few golden eagles on Santa Cruz Island, a wind farm in the Altamont Pass of California has resulted in an annual take of 40 - 60 golden eagles and an estimated total take of between 600 – 1,000 eagles (Center for Biological Diversity 2003). It seems ironic that the USFWS has not prevented take of golden eagles at Altamont Pass but at the same time, has failed to initiate lethal removal on Santa Cruz Island to save the fox.

While certain progressive long-term approaches, such as the reintroduction of bald eagles, are underway that may contribute to fox and ecosystem restoration, the necessary immediate and aggressive actions needed to save the fox have not been pursued. Politically based, risk-averse decisions that have plagued other endangered species recovery programs (Clark et al.1994; Miller et al. 1996) are influencing the recovery of the island fox, and the species has yet to receive protection under the ESA.

The ESA is promulgated under the concept that sound science will prevail over alternative actions that could negatively influence the recovery of endangered or threatened species. Biology is the foundation upon which species at risk are identified and upon which recovery programs must rest. Nevertheless, the realities of endangered species conservation all too often go well beyond biology, in fact, the issues surrounding the laws, organizational policy, funding constraints, and even personal gain may influence recovery trajectory more than species biology does (Miller et al. 1996). The structure of the ESA may not be flawed, but often implementation of the law is. There are ways in which it may be improved. Echoing others who have proposed similar action (Clark et al. 1989; Tear et al. 1995; Clark et al. 2002), we believe the constituency of recovery teams and the authority invested therein is a critical component that could be improved (Miller et al. 1996; Gerber & Schultz 2001). All too often members of recovery teams stand to gain from the selected course of action or are constrained to support an agency agenda. We recommend that alternative members including individuals who guide the process but do not gain from it, similar to a National Science Foundation review panel, should be established. This governing body also should wield legal authority under the ESA to enforce recovery actions and prevent misguided management actions that are based on factors other than biology. For the recovery of our endangered species, biology must be foundational and our policies bold.

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The Wild Bactrian Camel; A Critically Endangered Species

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Abstract

There are an estimated 900 wild Bactrian camels that survive in the world today. Located in China and Mongolia, these remnant herds are critically endangered due to ever-increasing threats from wolf-predation, hunting, illegal mining and cross-breeding with domestic camels. The Wild Camel Protection Foundation, WCPF, a UK registered charitable foundation, was established in 1997 in an attempt to do something about this dire situation. Working with both the governments of China and Mongolia, the WCPF has aided in establishing nature reserves and captive-breeding programs to help this species survive.

Resumen

Se estima que hoy en día existen 900 camellos Bactriana que sobreviven en estado silvestre en el mundo. Situadas en China y Mongolia, las manadas remanentes están en peligro de extinción por el incremento de la predación por los lobos, la caza, la minería ilegal, y la domesticación a través de la cruza con camellos domésticos. La Fundación Wild Camel Protection (WCPF), registrada en Inglaterra, fue fundada en 1997 con la intención de hacer algo sobre esta grave situación. Trabajando con los gobiernos de China y Mongolia, WCPF ha colaborado en el establecimiento de reservas y programas de reproducción en cautiverio para ayudar a esta especie a sobrevivir.

It is estimated that no more than 660 wild Bactrian camels, *Camelus bactrianus ferus* (Figure 1), and possibly as few as 500 survive in China. In Mongolia there are thought to be between 300 and 400 camels. What is quite clear is that they are all under ever-increasing threat from wolf-predation, hunting, and illegal mining in the Trans-Altai Gobi in Mongolia. Only the wild Bactrian camels in the Chinese Gashun Gobi, usually found in herds of no more than twelve, are completely isolated from domestic Bactrian camels. This lack of an opportunity to hybridize is what makes their survival in their unique desert habitat so critical (Tulgat and Schaller 1992).

These remnant wild Bactrian herds are possibly descendants of the primordial camels, which crossed the land bridge replaced by the Bering Strait sometime in the Pliocene era, about three to four million years ago. It was those primordial camels going west that probably pioneered the two known camel species Bactrian and Dromedary (Littledale 1894).

The most obvious difference between these two camel species are the number of humps, localized fat deposits that provide a source of energy. In the hotter climates of south-west Asia and Africa, a 'mutant' with only one hump, the Dromedary, became the dominant species. The severity of extreme winter temperatures has an effect on other aspects of body conformation. The Bactrian has generally a more massive body than the dromedary, is set on shorter legs, and clad in longer, darker hair; all are useful attributes in conserving heat. Both species have a long gestation period: the dromedary 12-13 months and the Bactrian 13-14 months. At most, one calf is born every other year. With puberty late at 4-5 years and low calving rates, it is incredibly time-consuming to reverse trends in a declining camel population, domestic or wild (Gu and Gao 1985).

Compared to the domestic Bactrian camel, the wild Bactrian is greyer, slimmer, and has smaller sized humps spaced more widely apart. Its head and feet are also shaped differently. The fact that the dromedary fetus commences development with two humps but is born with only one points to a long term development from the Bactrian and makes saving the gene pool of these remnant wild Bactrian camels exceptionally important (Zhirinov and Ilyinsky 1986; Bannikov 1976).

In 1877, it was Przewalsky, the distinguished Russian explorer, who took three skins and a skull of a wild Bactrian home to St. Petersburg and introduced the wild Bactrian camel to the outside world. However, the Petersburg zoologists could not determine whether Przewalsky's specimens were from original wild stock (Prejevalsky 1879). Today, researchers have more sophisticated methods to draw on. Dr. Han Jianlin of the International Livestock Research Institute commented that the recent genetic tests initiated by the Wild Camel Protection Foundation are "very interesting and there is evidence that they may be distinct from their relatives" (www.wildcamels.com). Furthermore, there is a consistent 3% base genetic difference between the wild and the domestic Bactrian (Yuan et al. 2000).

Today, there are approximately 18 wild Bactrian camels in captivity, with thirteen of these in Mongolia and approximately five in China. There are no wild Bactrian camels in captivity in any other country in the world. In 1999, there were 26 in captivity. These figures emphasize the seriousness of the situation and the need for urgent

Photo Courtesy of John Hare

Figure 1. This wild Bactrian camel is one of the few left in the world.

action. No one can forecast what will happen to the wild Bactrian camel in the Mongolian and Chinese protected areas 30 years from now. Having established that the wild Bactrian camel has a unique genetic make-up, it is essential that everything is done to see that this is preserved, in the case that the wild Bactrian camel disappears. When the Przewalski horse (*Equus przewalskii*), otherwise known as the Asian wild horse, died out in the wild in 1969, there were hundreds of captive horses in zoos around the world. This is not the case with the wild Bactrian camel (Zhirinov and Ilyinsky 1986).

The Wild Camel Protection Foundation, WCPF, a UK registered charitable foundation, was established in 1997 in an attempt to do something about this dire situation. In 1999, a proposal was set forth to the Chinese Government to establish the Lop Nur Wild Camel Nature Reserve. The proposal gradually won government support and the WCPF obtained funding from the Global Environment Facility in Washington. The State Environmental Protection Administration (SEPA) of China and the Xinjiang Environmental Protection Institute gave support for the establishment of the Reserve. In 2001, the Reserve was established and in July 2003 it was upgraded to a national Nature Reserve by the Chinese Central government, enjoying the same status as the Reserve that protects the Giant Panda (www.wildcamels.com).

The Mongolian government has recently signed an agreement with the WCPF to initiate a captive wild Bactrian camel breeding program near the Great Gobi Protected Area in western Mongolia. This program will be scientifically controlled and monitored. In October 2003, twelve captive wild Bactrian camels were moved to the new holding area near Bayan Tooroi in time for the 2003-2004 breeding season.

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News from Zoos

Audubon Announces New Crane Breeding Center

President Bush has signed into law a bill funding a whooping crane breeding facility at the Audubon Nature Institute's Center for Research of Endangered Species in New Orleans. The facility will house the Audubon's Whooping Crane Recovery Program, modeled on its successful Mississippi sandhill crane breeding program, and adhere to the Whooping Crane Recovery Team's plan for saving the endangered Whooping crane.

With the Mississippi sandhill crane breeding facility in operation for seven years, the Audubon facility has proven that dwindling crane populations can be boosted through a combination of artificial insemination and hand-rearing. In addition, the Audubon Center for Research of Endangered Species can preserve material from genetically important birds in the Frozen Zoo, meaning those birds can continue to contribute to the health and genetic diversity of the overall population for many years.

Audubon's history with Whooping cranes extends back to 1941, when the Audubon Zoo cared for a bird named Josephine, one of only two known survivors of a non-migratory southwest Louisiana whooping crane population. Josephine became something of a New Orleans legend. Audubon acquired a small flock over the years, and Josephine produced 52 eggs with three surviving chicks. After Josephine died in the aftermath of Hurricane Betsy in 1965, the Audubon Zoo maintained a small group of Whoopers who unfortunately did not produce chicks. Audubon's last two cranes were sent to the International Crane Foundation in the mid-1970s.

Josephine made a lasting impression on Audubon. The Zoo's logo continued to be a stylized whooping crane many years after Josephine had passed on. Audubon will work with a number of birds at the research facility with the aim of increasing the population, and will also exhibit a non-breeding pair at Audubon Zoo.

Cincinnati Participates In Successful Avian Release

The second historic release of blue-and-gold macaws (Ara ararauna) to the protected Nariva Swamp on the island of Trinidad took place in December 2003. Twelve birds were successfully released and all have been sighted in the area, including two bonded pairs.

The Cincinnati Zoo and Botanical Garden has been actively involved in the reintroduction of the blue-and-gold macaws into their native Trinidad since 1993. The macaw was extirpated from the island in the early 1960s due to habitat alteration and poaching for the pet trade. In 1993, the Wildlife Section of the Forestry Division of Trinidad and Tobago, the Centre for the Rescue of Endangered Species of Trinidad and Tobago (CRESTT), and the Cincinnati Zoo embarked on a mission to restore the species.

After several attempts to obtain chicks through captive breeding, a pilot study on the reintroduction of wild-caught blue-and-gold macaws was implemented in 1999. Fourteen birds were released over a three-month period into the protected Bush Bush Wildlife Sanctuary on the east coast of Trinidad. Nine of those birds are not only surviving, but continue to reproduce, providing the foundation for reestablishing a wild population. Over a three-year period, twelve surviving chicks were produced.

In September 2003, twelve females and eight males were placed in a secure pre-release fight enclosure for acclimation to the Wildlife Sanctuary. Villagers constructed the enclosure under the supervision of Trinidad's Forestry Division. The birds were cared for and provided with 24-hour security by villagers, who also monitored the birds for their first reintroduction. Villagers were also trained to collect and record behavioral data such as eating habits, flight capability, flock socialization, pair bonding, and aggression. Twelve additional birds were released in December 2003 to provide new genetic stock, which will increase the genetic diversity in the birds of Trinidad. The remaining eight birds will be cared for until their release in the spring.

New York Aquarium Receives Toshiba America Grant

The Wildlife Conservation Society's New York Aquarium recently received an $11,222 Science and Math Improvement Grant from the Toshiba America Foundation for the Exploring the Earth, Sea & Sky project. The grant money will enable 140 eighth-grade students from McKinley Junior High School in Brooklyn to study earth science using the Aquarium's living collection and resources. The mission of the Toshiba America Foundation is to contribute to the quality of science and mathematics education in United States communities by investing in projects designed by and with classroom teachers.

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

Instructions to Authors

The *Endangered Species UPDATE* is committed to advancing science, policy, and interdisciplinary issues related to species conservation, with an emphasis on rare and declining species. The UPDATE is a forum for information exchange on species conservation, and includes a reprint of the U.S. Fish and Wildlife Service's *Endangered Species Technical Bulletin*, along with complementary articles relaying conservation efforts from outside the federal program.

The *UPDATE* welcomes articles related to species protection in a wide range of areas including, but not limited to:

- Research and management of rare and declining species;
- Theoretical approaches;
- Strategies for habitat protection and reserve design;
- Policy analyses and approaches to species conservation;
- Interdisciplinary issues;
- Emerging issues (e.g., wildlife disease ecology).

In addition, book reviews, editorial comments, and announcements of current events and publications are welcome.

Subscribers to the UPDATE are very knowledgeable about endangered species issues. The readership includes a broad range of professionals in both scientific and policy fields including corporations, zoos, and botanical gardens, university and private researchers. Articles should be written in a style that is readily understood but geared to a knowledgeable audience.

Acceptable Manuscripts

The *Endangered Species UPDATE* accepts several kinds of manuscripts:

1. Feature Article — on research, management activities and policy analyses for endangered species, theoretical approaches to species conservation, habitat protection, and interdisciplinary and emerging issues. Manuscripts should be approximately 3000 words (8 to 10 double spaced typed pages).
2. Opinion Article — concise and focused argument on a specific conservation issue; may be more speculative and less documented than a feature article. These are approximately 450-500 words (About 2 double spaced typed pages).
3. Technical Notes/Reports from the Field — ongoing research, application of conservation biology techniques, species conservation projects, etc., at the local, state, or national level. These are approximately 750 words (3 double spaced typed pages).
4. Species at Risk — profiles of rare and declining species, including the following information: taxonomy, distribution, physical characteristics, natural/life history, conservation status, and economic importance. These profiles are approximately 750-1500 words (3 to 6 double spaced typed pages).
5. Book Reviews — reviews should include such information as relevant context and audience, and analysis of content. Reviews are approximately 750-1250 words (3 to 5 double spaced typed pages). Please contact the editor before writing a book review.
6. Bulletin Board — submissions of news items that can be placed on the back page. These items can include meeting notices, book announcements, or legislative news, for example.

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Manuscripts should be typed, double-spaced, with ragged right margins to reduce the number of end of line hyphens. Print must be in upper- and lower-case letters and of typewriter quality. Metric measurements must be given unless English measurements are more appropriate, in which case metric equivalents must be given in parentheses. Statistical terms and other measures should conform to the *Council of Biology Editors Style Manual.* All pages should be numbered. Manuscripts must be in English.

Initial acceptance of a proposal or manuscript does not guarantee publication. After initial acceptance, authors and editors work closely on all revisions before a final proof is agreed upon.

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Policy on Reviewing Proofs

Authors are asked to do the final copy editing of their articles. It is in the authors' power to save themselves and the journal the embarrassment of having to explain mistakes that could have been avoided.

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