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# *Endangered Species* UPDATE

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*Endangered Species* UPDATE

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Cover: Photo of *Gentiana kurroo* provided by A.A. Khuroo.



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# Observations on *Gentiana kurroo* Royle, a Critically Endangered Medicinal Plant from the Kashmir Himalaya, India

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**Abstract**

*Gentiana kurroo* Royle, a Critically Endangered (CR) medicinal plant species, endemic to the northwestern Himalayas, is fast heading towards local extinction in the Kashmir Himalaya. The plant species, previously distributed throughout the region, is presently represented by only a single wild growing population, found in a protected area. This paper reports the rediscovery of *Gentiana kurroo* Royle after a gap of more than half a century from this region of Himalaya. A brief account on the taxonomy, phytogeography, ecology, and the medicinal uses of the plant species has been provided. The information provided can augment the knowledge-base on the natural history and hopefully, supplement the efforts urgently required for the successful conservation of the species at risk.

**Resumen**

Gentiana kurroo Royle, una especie de planta medicinal en peligro crítico de extinción, endémica al noroeste de las Himalayas, esta rápidamente desapareciendo localmente de Kashmir Himalaya. Esta especie de planta, previamente distribuida por toda la región, es ahora representada solamente por una población que crece silvestre en un área protegida. Este articulo relata el redescubrimiento de Gentiana kurroo Royle luego de mas de medio siglo sin verse en esta región del Himalaya. El artículo provee una breve descripción de la taxonomía, fitogeografia, ecología, y los usos medicinales de esta especie. La información provista puede aumentar el conocimiento de la historia natural y esperamos que ayude a suplementar los esfuerzos urgentemente necesarios para la conservación exitosa de esta especie en riesgo.

## Introduction

World over, Gentianaceae is represented by more than 90 genera and 1000 species. The family is widely distributed, but more diverse in temperate and subtropical regions. The genus *Gentiana* (gentian) contains about 300 species in the world (Judd *et al.*, 1999). In India, the family is represented by 16 genera and approximately 145 species; while the genus *Gentiana* by about 62 species (Sunita & Bhattacharyya, 1982). In Kashmir Himalaya, a biotic province of the hotspot Himalaya (Mittermeier, *et al.*, 2005), the family is represented by 6 genera and 55 species. The genus *Gentiana* is believed to have high diversity in this region with 35 species. Out of these, 31 reach alpine / sub-alpine levels (Dhar & Kachroo, 1983).

Royle (1835) described a new plant species - *Gentiana kurroo,* on the basis of specimens collected from Kuerkoolee, Mussooree, Budraj, and Shimla areas of the northwestern Himalayas. At that time, Royle deposited the type specimen of the species at Liverpool (LIV), U.K., which at present is untraceable (Omer, 1995). After Royle, several workers included the plant species in their publications dealing with floristics of the Kashmir Himalaya.

From the Kashmir Himalaya, Coventry (1927) first reported *G. kurroo* from the Pahalgam area at an altitude of 1850-2000 m (a.s.l). He provided the description of the species, supported by line illustration. After, Blatter (1929) collected the species from the localities of Kangan and Wangat. In Kashmir Himalaya, the last report dates back to 1943 when Ludlow and Sherriff collected its specimens from the Bringhi valley (present Kokernag, Kashmir). During the last half century, despite extensive floristic exploration of the region there has been no authentic report of the collection of *G. kurroo*, even from the localities where it was previously collected. In many floristic works dealing with Kashmir Himalaya the plant species has been included, not based on the author's personal collections but by citing the pre-1943 collections (Javeid, 1970; Dhar & Kachroo, 1983; Sharma & Jamwal, 1998; Dar *et al.*, 2001).

During November 2004, while on a floristic expedition to the Dachigam National Park in Kashmir Himalaya (India), blooms of a deep-bluish herb in an otherwise autumn grassland caught the attention of the authors. Upon critical investigation with the help of relevant literature, the specimens were identified as *Gentiana kurroo* Royle. The present report of this species from the Kashmir Himalaya comes after a gap of about six decades from its last collection. Thus, the rediscovery assumes significance from the conservation point of view. It reveals how a once common plant species has been rendered locally critically endangered (Ved & Tandon, 1998). The causes for its decline in local populations are many. Anthropogenic pressures in particular have probably pushed the plant species to seek 'asylum' in the National Park. This example highlights the role of protected areas in the conservation of biodiversity.

Considering its threatened status and the medicinal value, the present communication provides an updated taxonomic treatment of *Gentiana kurroo* Royle, including its nomenclature, description, line drawings and other relevant information. This information is intended to provide baseline data for further studies. Insights gained can prove helpful in devising sound conservation strategies, in order to restore the plant species to its past glory. The specimens examined have been deposited in the Kashmir University Herbarium (KASH) for further reference and consultation. The present collection is the first deposition of this species in the said herbarium.

## Taxonomic description:

***Gentiana kurroo*** Royle, *Illus. Bot. Himal.* 278, 1835; Clarke in *Fl. Brit. Ind*. IV: 117. 1883; Coventry, *Wild. Fls. Kashm.* III: 81, Pl. XLI, 1927; Blatter, *Beaut. Fls. Kashm.* II: 37, Pl. 41, 1927; Javeid, *Fl. Srinagar* I: 544, 1970; Stewart, *Ann. Cat. Vas. Pl. W. Pak. & Kashm.* 557:1972.

*Pneumonthe kurroo* (Royle) G. Don, *Phil. Mag*. 75, 1836; *Gentianodes kurroo* (Royle) Omer, Ali & Qaiser, *Pak. J. Bot*. 20 : 16. 1988.

Perennial herb, with thick, stout rootstock. Flowering stems ascending to semi-erect, one to many from rootstock, simple, purplish, 30-45 cm high, 1-5 flowered. Leaves radical as well as cauline; radical ones rosulate, linear to oblong-oblanceolate, 5-10 X 0.5-1.5 cm, entire-crenate, connate at base, slightly reflexed at margins, single veined, acute; cauline leaves, opposite decussate, smaller, in pairs, linear-oblong, 2-5 X 0.3-0.6cm, entire, acute, reflexed at margins, each pair connate at base and forming a 0.4-1.0 cm long tube. Flowers 1-5 on each stem, axillary as well as terminal, on 1-3 cm long pedicels, campanulate, showy, 3-5 cm long. Calyx 2.5- 4 cm long; tube 0.8-1.2 cm long; lobes unequal, linear, acute, 1-2 cm long, sinuses between lobes obtuse. Corolla 2.5-5 cm long, bright-blue, freckled with white and yellowish inside; tube 1.5-3.5 cm long; lobes ovate, entire, acute, 0.5-1.2 x 0.4-0.9 cm. Stamens 5; filaments slender, adnate at middle of the corolla tube, slightly winged at base; anthers dorsifixed, bilobed, ± sagittate, creamy-white. Ovary lanceolate, shortly stipitate, 1-2.3 x 0.3-0.7 cm; style not distinct; stigma prominent, slightly bilobed. Capsule stalked, lanceolate, 1.8-3.2 x 0.5-1 cm. Seeds numerous, oval, reticulate (Fig. 1 & 2).

**Flowering:** September-October

**Fruiting:** November

**Specimens examined:** Dachigam National Park (Srinagar, Kashmir), 2150 m (a.s.l), 28.10.2004, *Anzar, Dar & Zafer* 1051 - 1055 (KASH).

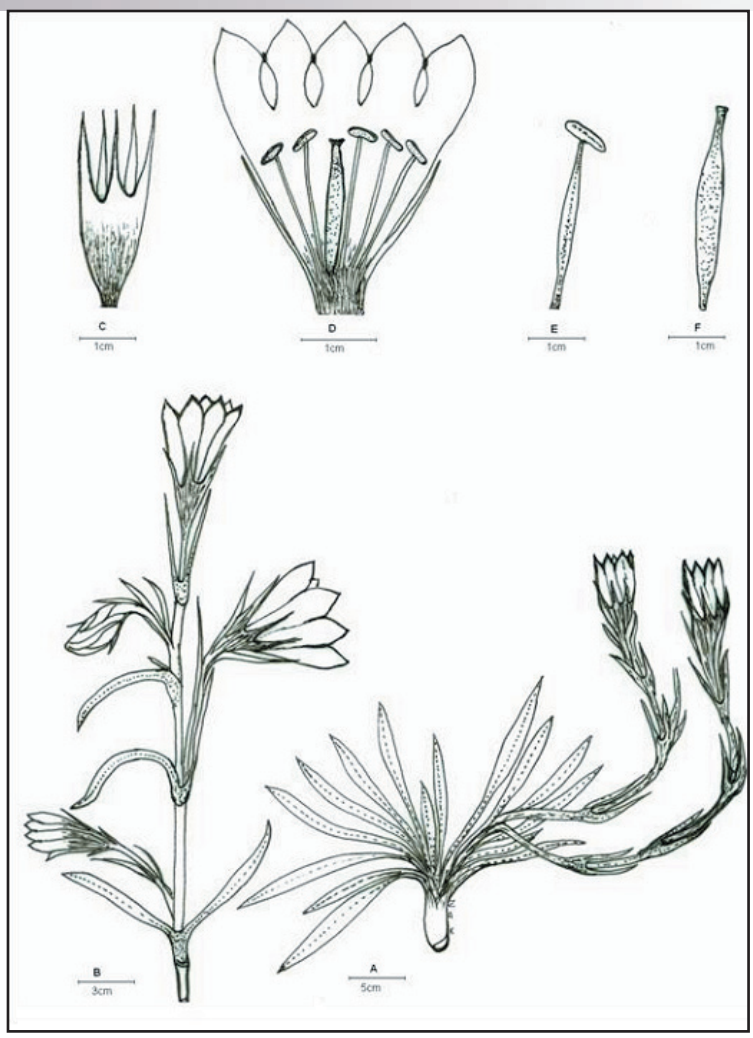


**Figure 1:** *Gentiana kurroo* Royle: A. habit; B. flowering branch; C. calyx; D.corolla; E. stamen; F. carpel

**Phytogeography**: In Hooker's *The Flora of British India* (1885), C.B. Clarke mentioned the common occurrence of the species throughout the northwestern Himalayas. Polunin and Stainton (1984) reported the wide distributional range of the species, starting from Pakistan in the northwest, up to the Indian state of Uttar Pradesh (modern Uttranchal) in the central Himalaya. Chowdhery and Wadwa (1984) also described the species from the Shimla and Chamba districts of Himachal Pradesh, India.

**Ecology**: A rosette-forming perennial herb, growing along sub-alpine altitudes from 1700-2300 m (a.s.l). Usually found on south-facing steeper slopes along dry and rocky sites in semi-natural grasslands and sparsely shrubby scrubs. The plant species prefers to be

overshadowed by the tall grasses and shrubs. Roots are soft, creamy white, penetrate deep into the sandy-loam soil, and show a unique folding pattern with the younger ones tightly entwined all along the length of older ones (i.e. previous year). Within the rhizosphere, the roots are clumped together with those of companion plant species; prominent companion species includes the dominant grass, *Themeda anathera* Hack. Some other characteristic associated plant species are: *Artemisia absinthium, A. scoparia, Asparagus filicinus, Bidens cernua, Erigeron multicaulis, Hackelia macrophylla, Indigofera heterantha, Lespedeza elegans, Medicago minima, Rosa macrophylla, Sium latijugum,* etc. The greener leaves and young flowering tops are grazed by herbivores, including insects. The present study observed the plant species distributed at a very low density within the last surviving natural population in the region. Only few individuals in small aggregates at each patch have been sighted throughout the landscape. The effective population size in no case exceeded 20 individuals. As we know, the size of local populations and their interconnectedness all along the species range are critical for the persistence of the species at the regional scale. Most likely, population decline triggered by anthropogenic activities over the past half century may be the probable reason for its local extinction.


**Fig. 2**. *Gentiana kurroo* Royle
A. Habit; B. Single flower

**Medicinal uses:** The generic name of *Gentiana* has been derived from 'Gentius', a king of Illyria (Europe), who is believed to have discovered the medicinal value of the gentian root. In fact, the specific name of *Gentiana kurroo* Royle is from the local name for the root of the plant, 'Karu' meaning bitter. The dried roots contain 20% of a yellow, transparent, and brittle resin (Coventry, 1927). The drug (rootstock) is administered in fevers and urinary complaints. It is used as a bitter tonic, antiperiodic, expectorant, antibilious, astringent, stomachic, antihelminthic, blood purifier and carminative (Kirtikar, & Basu, 1935). The roots are also used as ingredients in preparing a paste for flattening horses (Kaul, 1997).

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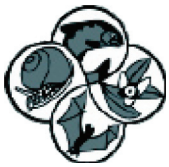

# Biology, Policy and Law in Endangered Species Conservation: II. A Case History in Adaptive Management of the Island Fox on Santa Catalina Island, California

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## Abstract

Successful recovery of endangered species at first would seem to have a clear answer: simply remove the anthropogenically-induced agent(s) and recovery should follow. While programs attempt to focus conservation efforts in such directions, endangered species recovery is more complex than biology alone, encompassing several, mostly human-related, dimensions. Two separate but concurrent programs involving the island fox (*Urocyon littoralis*) highlight the many dimensions of species recovery efforts, and the roles they play in hastening or preventing successful recovery. The non-profit organization, the Catalina Island Conservancy, successfully averted the potential extinction of the Catalina Island fox (*U. l. catalinae*) after a decline occurred due to canine distemper virus. To the north, the National Park Service and partners continue on-going efforts to recover three subspecies of the island fox on the northern Channel Islands that declined owing to heightened predation by golden eagles (*Aquila chrysaetos*). In-place monitoring programs, biology of the decline agents, geography, adaptive management, organizational structure, and public perception all played influential roles in the island fox recovery efforts. On Catalina Island, many of these factors contributed to a speedy, successful recovery. On the northern Channel Islands, some factors have slowed and inhibited recovery; however, substantial progress is being made. Elucidating novel mechanisms and policies that can mitigate for factors that impede species recovery should be of paramount importance.

## Resumen

La recuperación exitosa de una especie en peligro de extinción parece tener, a primera instancia, una contestación clara: simplemente remover los agentes antropogénicamente inducidos y la recuperación ocurrirá. Mientras algunos programas intentan enfocar sus esfuerzos de conservación en esta dirección, la recuperación de especies en peligro de extinción es mas compleja que solamente la biología, incorporando varias dimensiones, incluyendo algunas dimensiones humanas. Dos programas separados pero concurrentes con relación al zorro isleño (Urocyon littoralis) llaman la atención a las muchas dimensiones de los esfuerzos para la recuperación de una especie, y los papeles que estos juegan en acelerar o prevenir una recuperación exitosa de esta. La organización sin fines de lucro, Conservación de la isla Catalina, ha evitado exitosamente la posible extinción del zorro isleño (U. l. catalinae) en la isla Catalina luego de una disminución que ocurrió debido al virus de trastorno canino. Al norte, el Servicio de Parques Nacionales y sus socio continúan con los esfuerzos de recuperar tres sub-especies del zorro isleño que disminuyeron en el norte de las islas Channel debido a un aumento en la depredación por el águila real (Aquila chrysaetos). Programas de monitoreo, la biología de los agentes de disminución, la geografía, el manejo adaptable, la estructura de la organización, y la percepción pública tuvieron papeles importantes en los esfuerzos de recuperación del zorro isleño. En la isla Catalina, muchos de estos factores contribuyeron a una recuperación rápida y exitosa. En el área norteña de las islas Channel, algunos factores han disminuido o impedido la recuperación; sin embargo, se ha hecho un gran progreso. Iniciar políticas y mecanismos innovadores que puedan mitigar los factores que impiden la recuperación de una especie debe ser de importancia suprema.

## Introduction

In contemporary time, species endangerment is all too often a consequence of anthropogenic influences that reduce population viability. Successful recovery of species at risk at first would seem to have a clear answer: simply reverse the impacts or remove the anthropogenically induced agent(s) and recovery should follow. Although recovery programs attempt to focus conservation efforts in such directions, endangered species recovery is more complex than biology alone, encompassing several, mostly human-related dimensions (Clark, Reading & Clarke 1994). Successful implementation and subsequent recovery often depend heavily on attitudes, societal values, institutional policy, political agendas, and the organizational structure of recovery teams and stakeholders. These dimensions are the real aspects of endangered species recovery. One way to elucidate their importance and to derive practical lessons for improvement is to compare programmatic differences in recovery programs.

Recovery programs have received much attention, from special sections or summaries that have extensively reviewed numerous recovery plans and their efficacy (Clark et al. 2002; Karieva 2002), to edited works that have drawn upon detailed case histories and the professionals directly involved (Clark, Reading & Clarke 1994), to requests from Congress for a greater understanding of how science is used in species recovery (National Research Council 1995). A wealth of information exists providing salient recommendations for improving endangered species recovery efforts. Here, we provide a detailed comparison of two contemporaneous recovery programs dealing with independent declines of the same species. The first is a recovery program implemented by a non-profit organization, the Catalina Island Conservancy, that successfully averted the potential extinction of the Santa Catalina Island fox (*Urocyon littoralis catalinae*) after a drastic decline occurred due to canine distemper virus (CDV). The second is an on-going effort implemented initially by the National Park Service with subsequent support from The Nature Conservancy and the U.S. Fish and Wildlife Service; this effort is attempting to recover three subspecies of the island fox on the northern Channel Islands that declined owing to heightened predation by golden eagles (*Aquila chrysaetos*). We examine the program elements that have led to success and/or setbacks in the respective recovery efforts, with a particular focus on the Catalina program. A more detailed account of past efforts in the recovery program for the northern Channel Islands can be found elsewhere (Coonan 2003; Coonan et al. 2004, 2005; Roemer & Donlan 2004); however, we do provide an update here. Because these recovery programs differed in manifold ways, our comparison is focused into six areas: (1) the agents that caused the declines, (2) the spatial extent of the declines, (3) the science-based strategies and adaptive management used, (4) the speed of implementation, (5) the public

Island Fox

and legal support for recovery actions and (6) the institutional structure and policy of the organizations involved. Our purpose is not to pit one effort against another or to suggest that one organization performed better than the other, but rather to examine, in detail, why one effort has been successful and the other, still ongoing, has an uncertain but promising future.

## From Abundant to Rare to Near Extinction: How the Island fox Declined

Santa Catalina Island (194 km) is located approximately 42 km off the coast of southern California, almost due west of one of the largest urban centers in North America – Los Angeles, California. Catalina is a major tourist attraction, with over 400,000 visitors per year, and contains two small communities, Avalon and Two Harbors; total resident population is approximately 4,000 people (Catalina Island Chamber of Commerce & Visitors Bureau, www.visitcatalina.org). Catalina's residents and visitors can own and transport pets, including domestic dogs, to and from the island. Among other unique and endemic taxa, Catalina is home to the Santa Catalina Island fox (Moore & Collins 1995). At some point in 1998 or 1999, it is hypothesized that a domestic dog infected with CDV was brought to Catalina. This dog infected the endemic fox population and a CDV epizootic ensued.

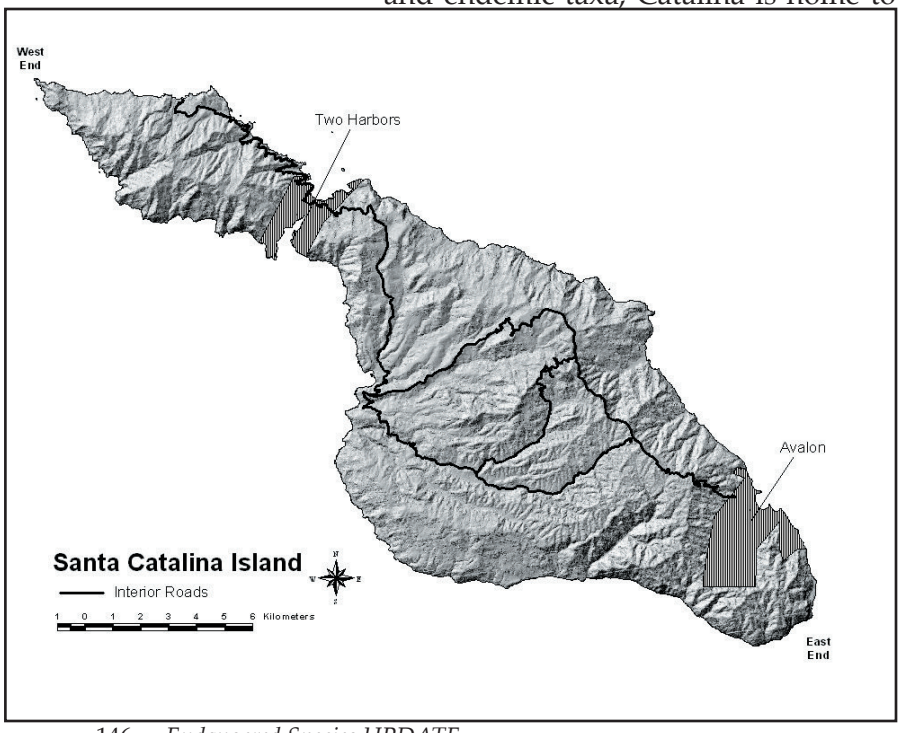


**Figure 1**. A map of Santa Catalina Island, California showing the rugged topography, location of the two communities, Avalon and Two Harbors and the East and West Ends of the island.

Reduced sightings of foxes by island residents and biologists coupled with observations by island residents of "sick foxes" were the first signs of a decline. These observations were followed by an intensive island-wide trapping effort that revealed a significant reduction in fox trap success on the eastern portion of the island (Timm et al. 2000). In the course of seven months of trapping, only ten foxes were captured in 1,046 trap nights (0.96% capture success) on the east side; however, on the western end of the island 137 trap nights yielded 49 fox captures (35.7 % capture success). Capture success of healthy island fox populations typically varies from approximately 10% to over 40% (Roemer et al. 1994, 2000a, 2002; Timm et al. 2000). A subsequent more intensive trapping effort corroborated earlier results with a total of 20 individual foxes being captured on the much larger eastern portion of the island compared with 166 individual foxes captured on the west end (Timm et al. 2002). These data strongly suggested that a decline had occurred and that the decline was restricted to the larger eastern portion of the island.

The reason for the restricted spatial distribution of the decline was likely related to the location of a community, Two Harbors, and the causal agent, CDV. Two Harbors is located between two small bays on the western portion of the island on what is essentially a constriction that forms an isthmus (Figure 1). The isthmus separates the island into a larger eastern portion (87% of the island area) and a smaller west end (remaining 13%). This natural topographic feature and the location of the com-

munity likely played a role in the spatial extent of the decline by preventing infected foxes from freely crossing the isthmus, a fortuitous geographic occurrence.

Although sparse, the evidence showing that a CDV epizootic had occurred on the island was conclusive. During the initial trapping effort, two foxes on the east side had high serological titers for CDV (1:256+ and 1:128+) compared to foxes from the west end (< 1:24+). High titer values indicated that these foxes had likely been exposed to CDV and recovered (Timm et al. 2000). Further, tissues from a single fox carcass submitted for histopathological analysis showed evidence of septic pneumonia secondary to viral infection and viral inclusion bodies in the pulmonary alveolar tissue that were a result of CDV (Timm et al. 2000). Circumstantial evidence also suggested that CDV was the agent of decline. After the decline was documented and publicized, subsequent discussions with the on-island small animal veterinarian revealed that a domestic dog pup treated in Avalon showed symptoms of a clinical CDV infection. At the time this particular disease was not implicated in the pup's diagnosis (S. Timm, pers. comm.), perhaps because CDV had never before occurred on the island. This series of observations supported the contention that foxes on Catalina had suffered a CDV epizootic that swept through the eastern portion of the island and which had reduced the entire island fox population by 90%.

The etiology of the decline on the northern Channel Islands was quite different. Although disease was initially suspected as a contributory agent, further investigation proved that the primary driver of the fox population declines was the presence of an exotic species, the feral pig (*Susscrofa*) and the predator it attracted, the golden eagle (Roemer et al. 2000a, 2001, 2002; Roemer & Donlan 2004). Pigs, by acting as an abundant food, enabled mainland golden eagles to colonize the northern Channel Islands. Pigs indirectly caused the decline in foxes through a process known as hyperpredation. Hyperpredation is a form of apparent competition whereby an introduced prey, well adapted to high predation pressure, indirectly facilitates the extinction of an indigenous prey by enabling a shared predator to increase in population size (Holt 1977; Courchamp et al. 1999). Pigs, by producing large numbers of piglets, sustained the eagle population and because of their high fecundity could cope with the increased levels of predation.

In addition, as piglets mature, they eventually escape predation by growing beyond the size range that eagles typically prey upon (Roemer et al. 2002). Foxes, on the other hand, are small, active during the day, and produce relatively few young each year. Predation by eagles had an asymmetrical effect on the unwary fox, driving the fox populations toward extinction.

Unlike Catalina, the decline in foxes was not restricted to a portion of one island but rather occurred across three islands: Santa Cruz, Santa Rosa and San Miguel (Roemer et al. 2004).

Further, unlike Catalina, where CDV swept through the eastern portion of the island and apparently "burned out", golden eagles have been a continuous presence on the northern Channel Islands for over a decade (1994 – 2005) despite a vigorous campaign to live-capture and relocate the eagles (Latta 2005). Thus, the agents of the declines and the spatial and temporal extent of the declines differ considerably between the two scenarios. Although these biological differences played a momentous role in the relative success of the recovery programs, other factors influenced the character of the recovery efforts with arguably equal import.

## Swift Action, Science-based Conservation and Adaptive Management: Their Importance to Successful Recovery

The Catalina Island fox Recovery Program can be characterized as adaptive management with swift implementation of science-based strategies that ultimately led to a successful recovery. This success can be largely attributed to the work of the Institute for Wildlife Studies (IWS), the non-profit organization supported by the Catalina Island Conservancy and charged with recovering the Santa Catalina Island fox. This program was adaptive in that data analyses were routinely employed to update and improve conservation strategies, which were then quickly implemented and subsequently modified so that benefits accrued by learning from both the mistakes and successes. A chronology of events elucidates these points.

The fox decline on Catalina was investigated within months after it was suspected that something was amiss. In 1998, during a serological survey of canine heartworm (*Dirofilaria immitis*), fox capture success was relatively high (26%; Roemer et al. 2000a; Timm et al. 2000). But a decline in fox sightings on Catalina in the summer of 1999 coupled with observations of sick foxes prompted additional investigation. Trapping was initiated in October-November 1999, followed by a more intensive effort from January through April 2000.

During this same timeframe, with mounting evidence suggesting that CDV played a role, the IWS began a vaccination trial using an experimental CDV recombinant vaccine that utilized a canarypox virus as a vector (Timm et al. 2000). Canarypox virus will not cause disease in mammals, but can express recombinant DNA from CDV and thereby elicit an immune response in the vaccinated mammal. The trial used only 6 foxes, with 5 animals receiving the vaccine and a single control; such few foxes were justified because of the severity of the decline. All foxes were serologically tested for CDV prior to vaccination and 4 foxes were vaccinated twice (initial vaccination followed by a booster) in an effort to assess the level of seroconversion and whether one injection of vaccine would confer CDV protection. Two independent laboratories analyzed the serum collected. Only the vaccinated foxes seroconverted, showing that the experimental vaccine was safe and would elicit an immune response with a single injection. A booster, however, appeared necessary to maintain a high titer after six weeks. The next step was to vaccinate the remaining wild foxes to ensure some degree of protection in case another CDV epizootic were to occur.

In fall of 2000, less than one year after the decline in the fox population, the IWS began an island-wide serology assessment and vaccination program against CDV. Within a year, 159 wild foxes were vaccinated in an experimental approach: 82 received two shots of vaccine, 42 received a single shot, and 35 received a control shot of sterile water (Timm et al. 2002). Annual boosters were also delivered to another 50 foxes (Timm et al. 2002). Of 141 fox serum samples tested before vaccination, eight (6%) tested positive to CDV indicating exposure to the disease. This vaccination program represented swift and aggressive action that would likely have prevented another CDV epizootic from occurring or at least curtailed its impact.

In addition to the vaccination program, a captive breeding program was initiated to aid in repopulating the east end of the island. The captive breeding effort involved 12 large pens (279 m ) with den boxes buried with earth to simulate real dens, prey boxes that allowed the introduction of live prey, environmental enhancements and native vegetation including prickly pear

cactus (*Opuntia littoralis*) for pup education, and an extensive 72-camera, video monitoring system with den box cameras and infrared cameras for night-time viewing. Pen construction and design allowed for almost complete monitoring of the captive animals without human intervention.

As with all recovery programs, however, mistakes were made, yet knowledge gained was used toward programmatic improvements. For example, during the construction of the captive facility a decision was made to bring pregnant foxes into captivity in late spring 2001. Twelve of 18 pups born in captivity subsequently died, owing to apparent stress-related abandonment by the females (Timm et al. 2002). In the subsequent breeding season, a cautious approach was adopted under the premise that capturing and "imprisoning" pregnant females may have contributed to the inanition observed (S. Timm, pers. comm.). Females were monitored, but little attempt was made to intervene. Of 14 pups born in the facility, 6 died, and one mother was observed eating a newborn pup, the event captured on video (Kohlmann et al. 2003). After aberrant female behaviors and pup deaths were observed in two consecutive reproductive periods, a more proactive approach was adopted. During the 2003 breeding season, females were intensively monitored. Ultrasound was used to assess pregnancy, physical exams were administered, video monitoring was employed during and after parturition, and pups were pulled from inattentive mothers, often receiving intensive care in the form of incubation and tube feeding. Pups were subsequently cross-fostered into pens with other mothers. Of 19 pups born in 2003, two died, one cross-fostered pup became habituated to humans owing to repeated but necessary veterinary care and was subsequently used as a captive, educational ambassador, and the 15 remaining healthy pups were vaccinated and released into the wild in November (IWS 2003a, b, c, d, e). Captive care continually improved throughout the program, with the successful rearing of 33%, 57%, 79% and 83% of 18, 14, 19 and 12 pups that were eventually readied for release into the wild from 2001-2004, respectively. This success can be largely attributed to a comprehensive husbandry and veterinary care program that learned from its mistakes, capitalized on its successes and continually adapted itself to ensure improvement. Such adaptive management was not restricted to the captive-breeding program but also occurred in both the release and translocation strategies.

Captive breeding pens.

In addition to the release of captive-reared foxes, animals from the disease-free west end were captured, transported, and released to areas on the east side of the island. All released or translocated foxes (along with some remaining wild foxes) were fitted with radio telemetry collars and monitored on a regular basis to assess their movements, survival, pair formation and reproduction (Timm et al. 2002; Kohlmann et al. 2003; Schmidt et al. 2005). Due to these efforts, island-wide population esti-

| Year | East End | West End | Total Foxes |
|---|---|---|---|
| 2000 | 28 | 75 | 103 |
| 2001 | 59 | 166 | 225 |
| 2002 | 96 | 119 | 215 |
| 2003 | 144 | 102 | 246 |
| 2004 | 219 | 141 | 360 |

**Table 1.** Estimates of the size of the Santa Catalina Island fox population from 2000 to 2004. Adapted from Figure 5 of Schmidt et al. (2005).

mates have steadily increased (Table 1). Nevertheless, the west end population appeared to be declining, perhaps related to the translocation efforts and because breeding pairs were captured on the west end and placed into the captive facility. To address this potential impact of the recovery strategy, and assess overall extinction risk for the fox population, a comprehensive population viability analysis was conducted (Kohlmann et al. 2005). At the time of the analysis, the total island population size was estimated at 207 foxes (95% CI = 200 – 219). Based on model inference, a recommendation was made to maintain a total island population of 300 foxes to maintain an acceptable risk of extinction, solely based on demographic stochasticity. The analysis further suggested that transporting foxes from the west end to the east side influenced the extinction probability of both subpopulations, but in opposite directions. It appeared that the west end subpopulation was not large enough to handle the annual management action of transporting 12 foxes from west to east. Further, the east side subpopulation showed higher growth rates compared to the west, perhaps owing to lower density and positive density dependent effects at low population size; even without further management, the eastern subpopulation was predicted to recover. Translocation of foxes from the west end to the east side was stopped and all captive foxes were released into the eastern subpopulation. The program was a resounding success – by September 2004 a total of 262 individual foxes were known to be alive on the island with an estimated total population size of 360 (Schmidt et al. 2005). The recovery of the population is all but certain.

The IWS and Catalina Island Conservancy used a multifaceted approach to ensure recovery of the Santa Catalina Island fox. Island-wide surveys of population decline and serological assessment documented the decline and determined its cause. An experimental vaccine trial was administered to determine its efficacy and safety after which an island-wide vaccination program was implemented to protect the remaining wild foxes. An adaptively managed, captive-breeding program increased the number of pups that were released on the east side. Foxes also were translocated from the unaffected west end and all released foxes were intensively monitored.

Finally, a population viability analysis revealed the potential impact of translocating foxes from the west end subpopulation leading to a cessation of this management action. The analyses also lent support that while still vulnerable to further catastrophic events, the overall fox population had recovered to the point that the captive-breeding program could be disbanded. In sum, the Catalina Island Fox Recovery program is a case study in conservation that within five years recovered a critically endangered subspecies.

## Current Status of the Recovery Program on the Northern Channel Islands

Since our summarization of the island fox recovery program on the Northern Channel Islands (Roemer & Donlan 2004), substantial progress has been made. On Santa Cruz Island annual survival estimates of adult, wild foxes for 2004 increased above a threshold level of 80% that was predicted to drive deterministic population decline (V. Bakker et al. Unpubl. data; Roemer et al. 2000b; Coonan et al. 2005); the wild fox population is now estimated at over 200

individuals (S. Morrison, pers. comm.). This increase in wild fox numbers may be related to an evolutionary response by the foxes to become more nocturnal in the face of eagle predation (Roemer et al. 2002). Although captive-bred, released foxes on Santa Cruz have fared poorly in the face of golden eagle predation (Courchamp et al. 2003; Dratch et al. 2004; Roemer et al. 2004), captive foxes are successfully breeding, and the facility currently houses 62 foxes (20 pups were produced in 2005 breeding season; Coonan et al. 2005). Because of high predation rates on released, captive-reared foxes, it is unlikely that animals will be released in 2006 unless eagle predation is significantly reduced. This conservative strategy appears justified because other management actions in progress may contribute to ensuring fox recovery in the near future. Bald eagles (*Haliaeetus leucocephalus*) were reintroduced to Santa Cruz Island (approximately 25 reside on the northern islands) and a feral pig eradication program began in early 2005 with 3,500 pigs already removed from approximately 3/5 of the island (N. Macdonald & S. McKnight, pers. comm.). Bald eagles may act as potential deterrent to nesting golden eagles and feral pigs may represent the essential food resource golden eagles need to persist on the islands (Roemer et al. 2001, 2002) Once pigs are eradicated, golden eagles may be unable to breed on the island. These efforts should improve the outlook for releasing foxes on Santa Cruz Island in the very near future.

Captive foxes recently released on Santa Rosa Island have also experienced golden eagle predation (5 of 13 foxes released in 2004 were killed by eagles). Nonetheless, some foxes have avoided predation and successfully bred (one litter was produced in 2004 and three litters were produced in 2005; Coonan et al. 2005). Foxes recently released on San Miguel Island, where golden eagles are absent, are doing even better: ten foxes (6 males and 4 females) were released from the captive facility in 2004, all have survived and each female produced a litter in 2005 (Coonan et al. 2005). In addition to these efforts on the ground, a recent population viability analysis workshop sponsored by The Nature Conservancy brought together empirical biologists, managers, and quantitative ecologists and the resulting analyses provided instructive management recommendations (G. Roemer, pers. obs.). Although it is too early to tell if recovery of these populations is assured, the outlook is much brighter than a decade ago when the decline and its cause were first discovered.

## A Comparison of Biological and Organizational Realities in the Recovery of the Island fox

The two recovery programs discussed here were similar in some respects but also differed in many key aspects (Table 2). For example, the programs were similar in that monitoring programs were in place and biologists/veterinarians were present on the islands. In both cases, this facilitated rapid identification of fox population declines and their cause. Yet the biological agents responsible for the declines, their duration of impact, and the required interventions necessary to encourage recovery were quite different. On Catalina Island, efforts put in place to deal with the CDV outbreak were rapid and widely accepted in both the scientific and public communities; there was no public outcry against dealing with a disease. In the case of the northern Channel Islands, we suggested that golden eagle removal was paramount to fox recovery and that lethal take should have been explored; however, there was significant public opposition to such action and this, along with other sociopolitical, economic and legal considerations made both the National Park Service and The Nature Conservancy unwilling to pursue such

**Table 2**. A comparison of recovery programs for the island fox on Santa Catalina Island (SCI) and the northern Channel Islands (NCI) involving biology, policy, law and economic and organizational characters.

| Character | SCI | NCI |
|---|---|---|
| Agent of Decline | Canine Distemper Virus | Golden Eagle |
| Duration of Decline | ~ 1 year | > 10 years |
| Extent of Decline | Portion of one island | Three entire islands |
| Source Population Present | Yes | No |
| Biologists Present | Yes | Yes |
| Monitoring Program Present | Yes | Yes |
| Advisory Group Available | Yes | Yes |
| Reintroduction Experience | Yes | No |
| Financial Directors Present | Yes | No |
| Flexible Funds | Yes | No |
| Organizational Structure | Heterarchical | Hierarchical |
| Legal Impediments | No | Yes |
| Public Trust and Support | Yes | No |

action (Courchamp et al. 2003; Dratch et al. 2004; Roemer et al. 2004; Roemer & Donlan 2004). From a biological standpoint, lethal removal of golden eagles made sense because it likely would have prevented fox deaths, hastened recovery, and reduced long-term economic costs. The implementation of such an action, however, could have precipitated serious adverse impacts on the solvency of the recovery program and on the public's perception of both the program and organizations involved. From an organizational, social representation, and trust standpoint, these are not trivial considerations (Cvetkovich & Winter 2003). Golden eagles also are protected by at least two federal laws, the Migratory Bird Treaty Act and the Bald Eagle and Golden Eagle Protection Act, although exemption for lethal take under these acts is not unprecedented (Roemer & Donlan 2004).

The Catalina Island Fox Recovery Program also benefited from observing earlier recovery actions and interventions on the Channel Islands. In general, the IWS had previous experience in containment of island foxes and in the successful captive-rearing, release and monitoring of vertebrates (Garcelon & Roemer 1990; Roemer & Wayne 2003). This extensive experience may have aided in the swift recovery of the Santa Catalina Island fox. For example, an attempt was made to limit captive-reared fox exposure to humans unless necessary (i.e., during whelping and cross-fostering); this approach, also used by the IWS for over 20 years in the Catalina Island Bald Eagle Reintroduction Project, may have lowered stress on captive foxes. Similarly, just as video cameras were employed to monitor wild nests and captive bald eagle chicks (G. Roemer, pers. obs.), video monitoring was employed to ensure breeding success of foxes.

## The Role of Organizational Structure

The organizational structure of the institutions involved in the recovery programs likely played a role in the character of the responses and actions. The effects of organizational structure on program outcome is seen in other disciplines; for example, in primary healthcare, large managed care organizations often fail to provide quality care due to complexities and fragmentation of the organization (Barr 1995). Large gov-

ernmental organizations, such as the National Park Service, face many challenges when decisions need to be made swiftly (e.g., when a species is rapidly declining) given the multi-layered, largely hierarchical decision-making infrastructure. Further, annual federal budgets have funds "ear-marked" for specific purposes but rarely are flexible funds available that can be used in an emergency. In contrast, many non-governmental organizations, such as the Catalina Island Conservancy, are often small with decision-making more horizontal in nature, and have flexible funding allocations. Heterarchical organizations can hold a number of advantages over those more hierarchical in structure, including speed of action (Fairtlough 2005). For example, the Conservancy had a modest reserve account of funds that was originally setup for the purpose of infrastructure maintenance, but was subsequently used to fund the fox vaccination and captive breeding programs (A. Muscat, pers. comm.). Ready access to flexible funds is more easily achieved by private organizations that are not bound to annual fiscal constraints, as are most, if not all, governmental organizations. Further, the Conservancy's Board of Directors were life-long residents of the island and witnessed the decline with "their own eyes"; this led to the sense of urgency in the matter (A. Muscat, pers. comm.). While such intimacy is also often true with "on-the-ground" governmental managers, this is not the case with regional or national directors who are far removed from the day-to-day occurrences in the field but who typically make fiscal decisions for governmental organizations. The above characteristics of private organizations make swift decision-making and intervention easier.

Other aspects of governmental organizations that may prevent swift action is their adherence to internal policy, as well as the pressures of public opinion and perception on the role of governmental agencies. For example, prior to the listing of the fox, the management of Channel Islands National Park was apprehensive regarding guidance from the Island fox Conservation Working Group (Coonan 2001), an ad hoc group of island fox experts that later became the Island fox Integrated Recovery Team. The National Park Service also was reticent regarding the lethal removal of golden eagles (Dratch et al. 2004; Roemer et al. 2004). While the decision not to pursue lethal take of golden eagles may have been important in improving the public view and its trust of the National Park Service, the act itself was based on sound science, was legally tractable, and would have hastened recovery (Roemer et al. 2001, 2002; Courchamp et al. 2003; Roemer & Donlan 2004). One potential avenue to mitigate for such conflicts may be to implement science-based policies and/or to shift from internal policy setting to informed public involvement (Hutchings et al 1997; Wagner 2001). With internal policy making, an agency may have tendencies to resist science that is critical of its own decision-making (Downs 1967; Wagner 2001). Mostly in response to important legislation (e.g., National Environmental Policy Act), some governmental agencies (e.g., U.S. Forest Service and Bureau of Land Management) have integrated public involvement in policy setting procedures. In general, the National Park Service has done so with less verve (Wagner 2001).

## Conclusions

Species decline is often a convoluted process; species recovery is more complex yet. On Catalina and the northern Channel Islands, monitoring programs, the natural history of the agents causing the declines, geography, an adaptive strategy, organizational structure, and public relations all played pivotal roles in contributing to the speed and success of island fox recovery efforts.

On Catalina Island, a swift recovery of the fox subspecies was aided by the etiology of the disease agent and island geography. A number of facets of the Catalina Island Conservancy's organizational structure likely contributed to a speedy recovery including flexibility in funding allocations, intimate knowledge of the decline by decision makers, an adaptive approach to decision-making, and a more heterarchical structure. For the following factors, the opposite was true for the northern Channel Islands and the National Park Service: fox decline was cosmopolitan and severe; the agent of decline, the golden eagle, itself a protected and charismatic species, maintained its presence; and the agency is highly hierarchical with, to a certain degree, distant decision makers tied to inflexible budgets. Such conditions clearly make recovery programs more challenging and progress slower. Because endangered species recovery programs often call for interventions that are risky and contentious, human dimensions dealing with public trust and perception also can slow or inhibit progress of recovery plans (Roemer & Donlan 2004). Elucidating novel mechanisms and policies that can mitigate for factors that slow or impede species recovery should be of paramount importance. As Tim Coonan (Coonan 2001), National Park Service Director of Island fox recovery put it "Ecological crises will continue to occur more rapidly than bureaucratic wheels can turn. NPS thus needs to become more comfortable with management actions borne of necessity, or else develop effective Service-wide tools and funding mechanisms to deal with rapid ecological crises." While easier said than done, such changes may be crucial if certain species or populations are to be saved from extinction.

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*Report from the Field*

# Captive Propagation as a Tool for the Conservation and Recovery of the Hawaiian Avifauna

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The Hawaiian Islands, because of their geographic isolation and evolutionary history, have a highly endemic native avifauna, significant portions of which are quickly being lost due to the introduction of alien species and disease. The State of Hawai`i, which encompasses only 0.2 percent of the land area of the United States, has 33 percent of the nation's total endangered species. The remaining native forest birds probably constitute less than 20 percent of the original avifauna, and without intervention, several additional species are likely to become extinct within the next five to ten years. Overall, nearly 75 percent of the recorded extinctions in the United States have involved endemic Hawaiian species. The factors causing the loss of species in Hawai`i are also responsible for the degradation of Hawai'i's native ecosystems. According to recent estimates, only15 to 20 percent of Hawai'i's native ecosystems remain intact.

Akepa male

The Hawaiian Endangered Bird Conservation Program is a unique partnership composed of government agencies (United States Fish and Wildlife Service, United States Geological Survey – Biological Resource Division, and the State of Hawai'i), the Zoological Society of San Diego's Department of Conservation and Research for Endangered Species, and private land-owners. Together, these groups develop restoration techniques for the remaining species of endangered Hawaiian forest birds. Hands-on recovery strategies are being used to increase reproductive output in rare bird populations during this period of environmental crisis. Wild eggs are collected and artificially incubated, chicks are hand-reared, and juveniles are subsequently released or retained in captivity for propagation. In 1999, this collaborative effort resulted in the first successful passerine conservation program in which captive-bred birds (offspring of parents that originated as wild-collected eggs) were reintroduced in the wild and not only subsequently survived, but also successfully fledged chicks (Puaiohi). These intervention restoration techniques provide a means to preserve options while the habitat is secured and wild populations are stabilized. However, captive propagation/reintroduction programs are costly endeavors and are not necessarily the best conservation strategy for all Hawaiian species. The Hawaiian Endangered Bird Conservation program endorses commensurate action to protect and enhance the habitat required to maintain and re-establish viable self-sustaining wild populations of avian species.

The Keauhou Bird Conservation Center on the Big Island of Hawai'i was inaugurated in 1996,

'Alala pair, pose

and now includes an incubation and brooding building with laboratories, fledging aviaries, office space and a neo-natal food preparation area. Additional structures include two forest bird buildings with 37 aviaries, a bird kitchen, twelve 'Alala aviaries, a workshop, and two caretakers' accommodations. Also in 1996, the program assumed the operations of the Maui Bird Conservation Center. This facility has areas for incubation and hand-rearing, 'Alala and Nene breeding complexes, and indoor-outdoor forest bird aviaries. The facility also serves as an incubation and neonatal area for the endangered Maui forest bird eggs that are brought from the field for captive management.

Since the program's inception in 1993, over 750 native Hawaiian forest birds of 14 taxa have been incubated and hatched (Table 1). Eight of these species are classified as federally endangered, and include 'Alala (*Corvus hawaiiensis*), Maui Parrotbill (*Pseudonestor xanthophrys*), Hawai'i Creeper (*Oreomystis mana*), Hawai'i 'Akepa (*Loxops c. coccineus*), `Akohekohe (*Palmeria dolei*), Puaiohi (*Myadestes palmeri*), Palila (*Loxioides bailleui*), and Hawaiian Goose or Nene (*Branta sandvicensis*). Five non-endangered native Hawaiian species; `Oma`o (*Myadestes obscurus*), Hawai'i `Elepaio (*Chasiempis sandwichensis*), `Apapane (*Himatione sanguinea*), `I`iwi (*Vestiaria coccinea*), and Common `Amakihi (*Hemignathus virens virens* and *H. v. wilsoni*), were propagated to serve as surrogate models for the development of captive propagation and release technology.

With the wild population of `Alala numbering fewer than twelve individuals, the Hawai'i Endangered Bird Conservation Program joined with the `Alala Partnership (US Fish and Wildlife Service, USGS-BRD, Kamehameha Schools, and McCandless, Kealia and Kai Malino Ranches) in an intensive reintroduction program from 1993-1998. During that period, thirty-six 'Alala were hatched and thirty-four survived to fledging. Twenty-seven 'Alala were released into historical habitat in the South Kona District of Hawai'i. Twenty-five birds survived until independence (~120 days post-release). Although the long-term survivorship of the released 'Alala was lower than first expected (21 of 27 did not survive to breeding age), biologists, through the release and monitoring program, have been able to better identify the factors that limit the long-term 'Alala survivorship in the native Hawaiian forests (predators, disease, etc.). In an effort to accelerate the recovery of the 'Alala, the U.S. Fish and Wildlife Service is reviewing the options to establish additional release sites with expanded and enhanced habitat restoration efforts to ensure the long-term survival of released 'Alala. Although the wild population of 'Alala is likely extinct, the captive population continues to grow and now numbers 52 birds, with the addition of six chicks reared in 2005. Once this flock reaches a level of genetic sustainability (approx. 75-80 birds), it is expected that releases will once again take place in secure and managed habitat.

**Table 1. Summary of Eggs and Chicks Hatched and Reared in Captivity: Hawaii Endangered Bird Conservation Program: 1993 – 2005**

| Species | Year | Total Eggs Collected/ laid | Eggs Viable at Collection | Chicks Hatched From Viable Eggs | Chicks Survive to Independence | % Hatch From Viable Eggs | % Survival of Chicks |
|---|---|---|---|---|---|---|---|
| Common `Amakihi (*Hemignathus v. virens*) | 1994-1995 | 38 | 26 | 21 | 21 | 81 | 100 |
| Common `Amakihi (*Hemignathus v. wilsoni*) | 1997-2000 | 11 | 1 | 1 | 1 | 100 | 100 |
| `I`iwi (*Vestiaria coccinea*) | 1995-2001 | 15 | 12 | 11 | 6 | 92 | 55 |
| `Oma`o (*Myadestes obscurus*) | 1995-1996 | 36 | 29 | 27 | 25 | 94 | 93 |
| Hawai`i `Elepaio (*Chasiempis sandwichensis spp.*) | 1995-2003 | 33 | 16 | 11 | 10 | 69 | 91 |
| Palila (*Loxioides bailleui*) | 1996-2005 | 109 | 80 | 61 | 45 | 76 | 74 |
| Puaiohi (*Myadestes palmeri*) | 1996-2005 | 777 | 228 | 195 | 151 | 86 | 77 |
| `Akohekohe (*Palmeria dolei*) | 1997 | 6 | 6 | 6 | 5 | 100 | 83 |
| Hawai`i Creeper (*Oreomystis mana*) | 1997-2005 | 36 | 19 | 17 | 14 | 89 | 82 |
| Maui Parrotbill (*Pseudonestor xanthophrys*) | 1997-2005 | 29 | 17 | 15 | 13 | 88 | 87 |
| `Apapane (*Himatione sanguinea*) | 1997 | 7 | 2 | 2 | 2 | 100 | 100 |
| Hawai`i `Akepa (*Loxops coccineus coccineus*) | 1998-2005 | 38 | 20 | 18 | 13 | 90 | 72 |
| `Akiapola`au (*Hemignathus munroi*) | 2001 | 1 | 0 | 0 | 0 | - | - |
| `Alala (*Corvus hawaiiensis*) | 1993-2005 | 337 | 146 | 80 | 68 | 55 | 85 |
| Nene (*Branta sandvicensis*) | 1998-2005 | 571 | 346 | 292 | 276* | 84 | 95 |
| **Totals** | | **2,044** | **948** | **757** | **650** | **80%** | **86%** |

*Nene goslings are precocial and unlike the passerine species in this table, are independent at hatch. For purposes of this metric, "independence" for the Nene is considered to be 30 days of age.

Perhaps the most spectacular of Hawai'i's endemic avifauna is the sub-family of Honeycreepers (*Drepanidinae*). Reproductively isolated from the mainland populations and from each other on their respective Hawaiian islands, this group evolved into more than fifty unique species and subspecies. Many of these are now extinct, with the majority of the remaining taxa threatened with extinction. To test the effectiveness of captive-rearing and release strategies for this sub-family for future restoration efforts in Hawai'i, a pilot study was conducted with the Common 'Amakihi in forests where introduced avian disease and mammalian predators were present. The methodology that was used resulted in the first successful artificial incubation, hatching, and rearing

of a *Drepanidinae*. Sixteen chicks were hatched (mean hatch weight = 1.4 g) and reared. Two different release strategies were evaluated for small Honeycreepers; a ten to fourteen day acclimatization period in a hacking aviary (4 m square) in the native forest with subsequent food supplementation ("soft release") and a two-day adjustment period in small field cages (1m square) with food supplementation. Although all the birds survived the initial release and returned for food supplementation, twelve of the sixteen birds succumbed within thirty days to malaria infections, and four birds were not seen nor were their bodies recovered after fourteen days. This is a clear demonstration that irrespective of successful propagation techniques, recovery will not succeed unless mosquito-free, predator-controlled reintroduction sites are available, or strategies are developed to decrease mortality in naïve Honeycreepers exposed to disease after release. Nonetheless, the experience gained in the incubation and the rearing of the Common 'Amakihi has subsequently provided the technology to hatch and rear seven additional species of Honeycreepers, the smallest being the Hawai'i 'Akepa, with an adult weight of 9-11 g. and an average hatch weight of 1.1 g.

MAPA male in flight

Very similar to the mainland Solitaires, five species of Hawaiian *Myadestes* Thrushes survived until very recently. Nevertheless, it is now thought that only two of these species persist: the 'Oma'o on the Big Island of Hawai'i and the Puaiohi on the island of Kauai. In 1995 and 1996, the first restoration attempt of a small Hawaiian passerine in disease-free, predator controlled habitat was made with the release of captive-reared `Oma`o into the Pu`u Wa`awa`a Forest Reserve; habitat that has been without this species for nearly 100 years. In 1995, two birds were reintroduced as a preliminary test release, and in 1996, twenty-three birds were released in cohorts numbering from two to seven birds. Of the twenty-five released birds, twenty-three are known to have survived 30 days (the life of the transmitters). Follow-up surveys in 1997 and 1998 indicate that many released `Oma`o survived to sexual maturity and did successfully breed.

The Puaiohi is an endangered thrush that is endemic to the island of Kauai and is restricted to the Alaka'i Wilderness Area above elevations of 3,000'. Since 1995, this Hawaiian Solitaire has been the focus of an aggressive recovery effort that has incorporated the funding, the field efforts, and the captive propagation and release expertise of several governmental and private agencies. In 1996 and 1997, fifteen Puaiohi eggs were collected from the wild and were hatched and reared at the Keauhou Bird Conservation Center, becoming a captive breeding flock in 1998 and 1999. Since that time, nearly 200 Puaiohi have been reared in captivity. Since 1999, ninety-four Puaiohi have been transported to Kauai, acclimatized for seven to fourteen days in hacking aviaries (3m square), and transmittered

and soft-released from two release sites in the Alaka'i Wilderness Area. Supplemental food is offered at the hacking cages, but only a few of the birds return to feed. Although each of the birds carries a radio transmitter, the Alaka'i Wilderness Area is extremely difficult terrain for tracking birds so survivorship of the entire release cohort is difficult to ascertain with accuracy. Nonetheless, many of the birds have been confirmed to survive into the breeding season, with documentation of many successful breedings between captive and wild birds as well as between captive-captive birds. For example, in the first year's release (1999) of fourteen birds, there were twenty-one nesting attempts from which seven chicks successfully fledged. This is the first release program for a passerine that has successfully incorporated all of the following techniques: collection of wild eggs, artificial incubation and hand-rearing, captive-breeding, and release and subsequent breeding of the released birds in native habitat. This complete reintroduction scenario for the Puaiohi, from the wild to captivity and back to the wild, where breeding has been confirmed on several occasions, occurred over only three years time - a remarkably successful recovery action.

In 2003, the first release of a captive bred Palila took place in Puu Mali on the north side of Mauna Kea Volcano on the island of Hawai`i. Currently, the Palila survives in one population on the west side of Mauna Kea (Puu La`au). This release, coupled with a translocation effort by USGS-BRD in the same area of managed and recovering mamane forest, will, with any luck, establish a resident breeding population of Palila that is disjunct and independent of the main population on the other side of the mountain. Over the past three seasons, 21 Palila have been released from the captive flock. The majority of the birds have survived in the managed area and the first successful breeding of a captive bird (with a wild translocated bird) in the wild was confirmed this season (2005)—an exciting first for the recovery program.

The first 11 years of this program present a more optimistic future for the beleaguered avifauna of the Hawaiian islands. As the captive flocks of the endangered species grow, and the techniques for rearing and release are refined, it is hoped that many of the endangered Hawaiian birds will benefit from restoration efforts. However, it must be emphasized that captive propagation and reintroduction is only one aspect of the ecosystem management tools required in Hawai`i to conserve and restore endangered native bird species.

*Species at Risk*

# Knowing Wildlife and the Impact of Tourism on Cheetahs

**Rosie Coggins**

## Common and Scientific names

**Kingdom:** Animalia
**Phylum:** Chordata
**Class:** Mammalia
**Order:** Carnivora
**Family:** Felidae
**Genus:** *Acinonyx*
**Species:** *jubatus* (IUCN, 2004)
**Sub Species:** *Acinonyx jubatus hecki, Acinonyx jubatus jubatus, Acinonyx jubatus raineyi, Acinonyx jubatus ngorongorensis, Acinonyx jubatus soemmeringii, Acinonyx jubatus fearsoni, Acinonyx jubatus venaticus (*IUCN Cat Specialist Group, 2004).
**Common name:** Cheetah (IUCN, 2004)

## Natural History

Until 10,000 years ago, 'cheetahs were common in North America, Asia, Africa, and Europe' (University of Michigan Museum of Zoology, year unknown).

Around this time, it is thought that the cheetah genus narrowly escaped extinction and consequently experienced a bottleneck event, followed by a period of inbreeding (Merola, 1994), creating the limited genetic variation that is seen today among the sub-species of cheetah.

Only the king cheetah exposes a vast variation in cheetah morphology, with longer fur on the back of the head and neck and elongated spots that join to form irregular markings over the rest of its body. However, this variation is caused by a recessive gene in the species, and is not another sub-species of cheetah (University of Michigan Museum of zoology, year unknown).

Cheetah numbers continue to decrease, in part caused by the increase in human populations, continuing conflict with local farmers (Marker *et al*, 2003), and decreasing natural habitat (University of Michigan Museum of zoology, year unknown).

### *Habitat and Range Distribution*

Cheetah's habitats range from dry savannah to tropical and subtropical shrublands, and from temperate, tropical and subtropical grasslands to hot and temperate deserts (IUCN, 2004).

Cheetahs have a relatively wide distribution throughout sub-Saharan Africa, including countries such as Algeria, Niger, Kenya and Namibia; as well as the critically endangered Asiatic cheetah (*Acinonyx jubatus ssp. venaticus*) that now survives only in Iran (IUCN Cat Specialist Group, 2004). Numbers of the Asiatic cheetah are believed to be less than 60, with numbers of the sub-Saharan African cheetah estimated to be 9,000-12,000 (IUCN, 2004).

### *Ecological Requirements*

Ecological requirements for the cheetah include their prey base, which mainly consists of gazelles (IUCN, 2004), as well as small to medium sized ungulates such as impalas.

The habitat cheetahs occupy provides them with protection from larger predators and coverage during hunting.

As a semi-nomadic species (IUCN, 2004), cheetahs require relatively large areas for movement. Female cheetahs can occupy home ranges of up to 800km squared within their roaming habitat (IUCN Cat Specialist Group, 2004).

### *Natural Predators*

Natural predators of cheetahs include the more successful carnivores of African plains such as lions, leopards, hyenas, and even baboons, which usurp cheetah kills and prey on young cheetahs, contributing to their high infant mortality rate (IUCN Cat Specialist Group, 2004).

Cheetah predators can include humans, especially farmers and poachers, as decreasing cheetah numbers have been the result of hunting for pelt,

and shooting of cheetahs to protect livestock.

## Conservation Status

*World Conservation Union (IUCN) red list:*
Cheetah (*Acinonyx jubatus*): vulnerable
Northwest African Cheetah (*Acinonyx jubatus ssp.hecki*): endangered
Asiatic Cheetah (*Acinonyx jubatus ssp. venaticus*): critically endangered
(IUCN, 2004)

*US Federal list:*
Cheetah (*Acinonyx jubatus*): Endangered
(University of Michigan Museum of Zoology, year unknown).

*CITES:*
Appendix 1.
Appendix 1 lists species that are the most endangered among the CITES-listed animals. CITES prohibits commercial international trade of any specimen of these species (IUCN, 2004).

National legislation has the cheetah protected over its known extant range and in many historical range states. Hunting of cheetahs has been prohibited in around twelve countries including, Algeria, Iran and Niger (IUCN Species Specialist Group, 2004).

## Impact of Tourism

*Three major impacts of tourism on the Cheetah:*

- Damage, destruction and 'desertification' (Gros, 1997) of the natural habitat of cheetahs by safari tour vehicles, especially those that go 'off track'. Driving 'off track' depletes the grass and shrubs (Tourism Support Package, 1995) that provide camouflage for cheetahs and feeding grounds for their prey.
- Disruption of the natural behaviours and habits of cheetahs and their prey species by tourist vehicles. Such disruptions cause disturbances among the wildlife that make up the cheetah prey base, therefore reducing the success rate of the cheetahs to catch their prey. "One example of cheetah disruption by tourists has occurred in Kenya, where cheetahs became so disturbed at times that they did not feed, mate or raise their young" (Tourist Support Package, 1995).
- Depletion of cheetah prey base species through emigration of gazelle and other cheetah prey species from tourist areas; and prey death from decreased vegetation. This may be caused by increases in the demand for tourist facilities in wildlife areas (IUCN, 2004) contributing to lower wildlife and cheetah population densities (Gros, 2001).

## Specific Management Measures

- Tourism Support Package: This package is used as a resource for government agencies and non-governmental organisations (Tourism Support Package, 1995) in the development of better-managed eco-tourism operations in Africa. It provides examples and control methods aimed at reducing the impact of tourists on African wildlife, including the cheetah. One example of tourist control methods in the package is, 'permit off-road vehicles only in the least sensitive areas'.
- Cheetah Conservation Fund: Works in affiliation with the Kenya Wildlife Services (Wykstra, 2005) to provide a number of services including 'presentations to tourists through local and international tour operators' (Wykstra, 2005). The fund aims to educate both tourists and tour operators on the survival of the cheetah and the importance of their conservation.

## Perceptions on Human-Wildlife Interactions

Far too often, human-cheetah interactions have had negative impacts on the cheetah's plight for survival (Wykstra, 2005). The cry for cheetah conservation grows louder as the numbers of these animals continue to diminish.

Eco-tourism is able to play a major role in promoting cheetah conservation, if managed correctly. There is also great opportunity to educate thousands of tourists and tourist operators that visit the cheetah's habitat.

If not managed correctly, traditional tourism and eco-tourism will continue to damage the resources and wildlife that increasingly attract tourists (Tourism Support Package, 1995).

Through education, the attitudes and behaviours of tourists and tourist operators can be changed from a selfish attitude of using the cheetahs for personal enjoyment, to one of concern for the welfare and survival of the diminishing cheetah populations.

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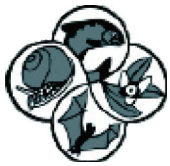

# Book Review

## *The Encyclopedia of Animals: A Complete Visual Guide*

Cooke, Dingle, Hutchinson, McKay, Schodde, Tait, Vogt
University of California Press 2004

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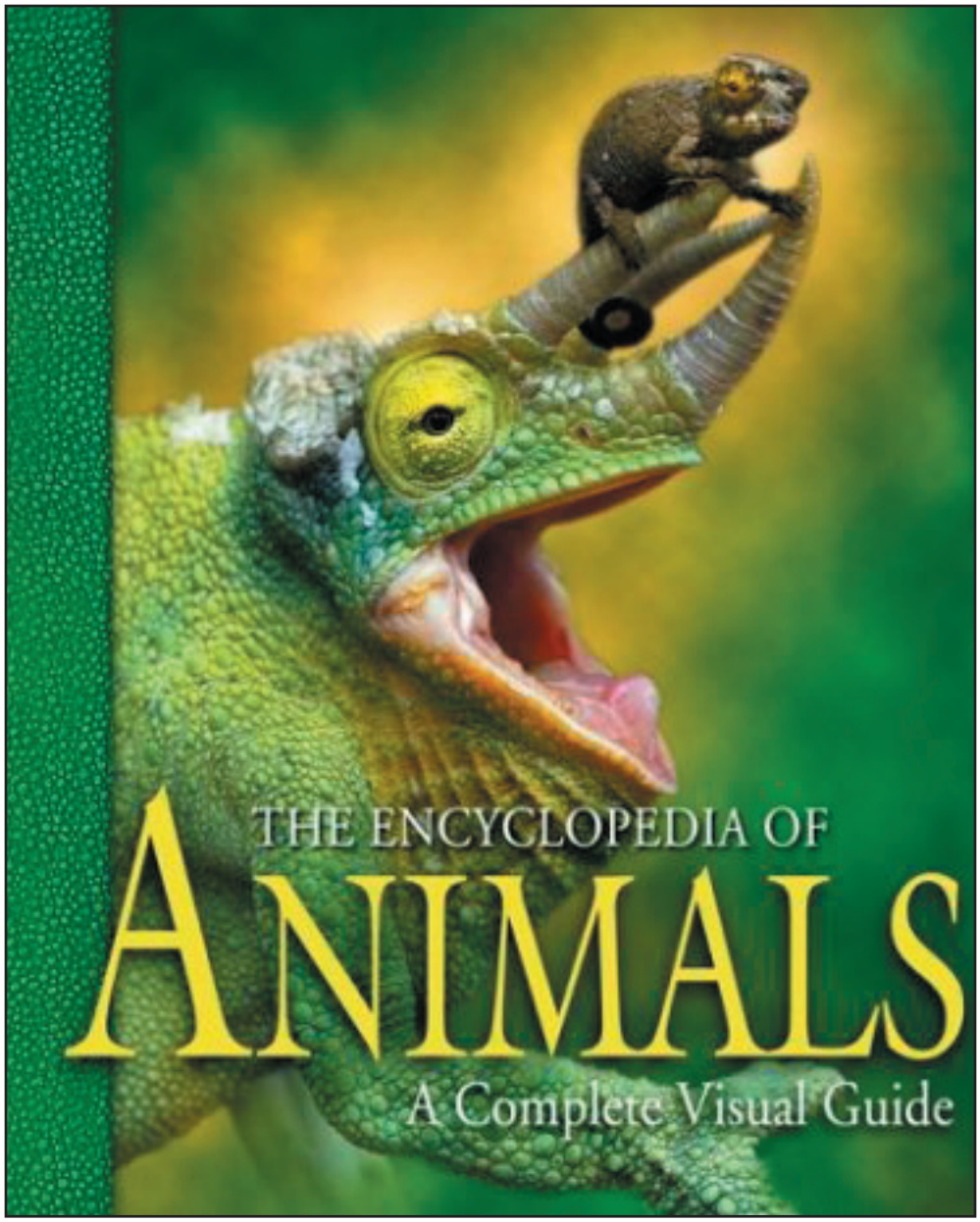


There are over one million animal species in the world; this encyclopedia touches on this great diversity in a visually appealing and highly informative 608 page book. This encyclopedia is very user-friendly and is divided into six taxonomic sections: mammals, birds, reptiles, amphibians, fishes, and invertebrates. As an encyclopedia should, it covers an impressive variety of topics in a concise manner. Importantly, there is a strong emphasis on conservation with each section containing a "conservation watch box" that lists how many species in that group are listed on the IUCN (The World Conservation Union) Red List of Threatened Species. Another useful tool is the "fact file statistics" which lists life history and other general facts about the animals.

The first portion provides an excellent background about the kingdom Animalia, including its distinguishing features, classification system, evolution, adaptations to different habitats, and groups that are of particular conservation concern.

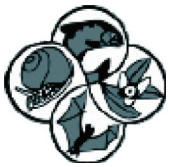
The bulk of this encyclopedia consists of pictures and information about a wide range of species. The mammal section (183 pages) is the most extensive segment of the book, feeding our obsession with our closest relatives. Informational sections include: marsupial reproduction, polar bear and wolverine life history, carnivore hunting strategies, and seasonal ungulate migrations. There are 23 pages covering the Primate order with an informative section on primate conservation. The birds segment (109 pages) is packed with information and fantastic graphics. The illustrations are accurate and a joy to peruse. Extensive attention is given to conservation issues with examples from across the world. Other topics include bird morphology, evolution, mating behavior, song, and nest construction. Most sections focus on one order of birds, although some lump as many as five orders together (ratites and tinamous). There is some inconsistency in the classification boxes that accompany each section, sometimes the name of the order is listed here but often it is not.

The reptile segment (59 pages) covers all four reptilian orders: Testudines (turtles and tortoises), Crocodilia, Rhynchocephalia (tuataras), and Squamata (amphisbaenians, lizards, snakes). These sections include fantastic illustrations and photographs as well as detailed segments on the human exploitation of turtles, lizard reproduction and behavior, snake defense strategies, and the predatory behavior of snakes. Next, all three amphibian orders (Caudata, Gymnophiona, Anura) are covered in 31 pages. Information sections cover life-cycles, Cane toads in Australia, and tree frogs.

The fishes portion of the book is 65 pages long. Due to the high number of fish species, this section is broken down by subclasses. Informational section topics range from hermaphroditism to the life history of freshwater eels. The last taxonomic section is the invertebrate section (73 pages). Invertebrates make up more than 95% of known animal species. There is clearly a disproportionate amount of text spent on invertebrates. The authors knowingly acknowledge this clear bias towards the showy birds and mammals. Interesting sub-sections within the invertebrate section include: the social life of honeybees, conservation of coral reefs, zebra mussel introductions, metamorphosis, how spiders produce silk, marine food webs, and termite caste society.

Of course, it is impossible to include everything about the animal kingdom and readers can consult a more detailed text for specifics about certain species found in this book. The extensive index makes it easy to look up specific information and the four page glossary defines a variety of terms ranging from "carnivore" to "musth." This book

is appropriate for all ages, from curious youngsters to professionals. Also, considering the depth of coverage, it is reasonably priced. It is great for browsing; you will find something fascinating with every turn of the page.



# News From Zoos

*Reversing the Plight of the Guam Rail*

Following the end of World War II, the brown tree snake was accidentally introduced to the island of Guam in the Pacific Ocean. This invasive species devastated the ecosystem, obliterating many of the endemic forest species, including the population of Guam rails. These flightless birds didn't stand a chance against the voracious predator and were nearly extinct by the mid 1980s. In an effort to save the species, the last 10 surviving Guam rails were captured for propagation in captivity.

The American Zoo and Aquarium Association (AZA) has a Species Survival Plan (SSP®) established for this species and there are currently about 50 Guam rails housed at AZA-accredited zoos, all of which contribute to the revival of the species. The National Aviary in Pennsylvania recently contributed to the success of this breeding program with the hatching of a Guam rail chick on October 8, 2005. The chick will eventually be sent to Guam for release into the wild.

© Greg Neise/Lincoln Park Zoo

Reintroduction efforts are proving successful on Guam and neighboring islands. About 100 Guam rails are currently housed in a 60-acre sanctuary on Guam, which is fenced in to protect the birds from the brown tree snakes and an increasing population of feral cats. Approximately 100 birds were also introduced to the neighboring island of Rota, where invasive species are not a problem.

*Increasing Wolf Awareness at Connecticut's Beardsley Zoo*

Once upon a time, most native wolf species were close to extinction in North America. From their portrayal as characters in fairy tales to the grisly folklore of their human-eating habits, these fictional images have contributed to the wolves' struggle for survival. These carnivores play a vital role in ecosystems as top predators, and they are now being returned to their native habitat as seen through the successful reintroduction of gray and red wolves. AZA zoos, with assistance from Defenders of Wildlife and other partner organizations, promote wolf reintroduction and protection efforts through education of the American public.

As a prime example of these public education and outreach efforts, Connecticut's Beardsley Zoo held a Wolf Awareness Weekend in the fall of 2005. Visitors learned about the benefits of wolves in America's ecosystems through presentations, crafts, and observation of the zoo's red, gray, and maned wolves. A primary goal of the event was to dispel common myths and misconceptions. The addition of a Wolf Observation Learning Facility (WOLF) at the zoo provided visitors with a more personal experience with the creatures through the log cabin's floor-to-ceiling glass viewing windows. Graphics, artifacts, and sounds inside the WOLF added another interactive aspect to the exhibit. Other wolf-related events include the Asian New Year celebration in February, featuring Year of the Dog activities as they relate to canines and wolves. These interactive education experiences help the public understand the importance of wolves and encourage the support of future reintroduction efforts.

*Shedd's Caiman Lizards Hatch a North American First*

Caiman lizards are listed as a CITES Appendix II species, owing to the possibility that they might soon be under threat of extinction in their native South American habitats. Not only are they growing more rare in the wild, but only seven North American zoos and aquariums feature this lizard

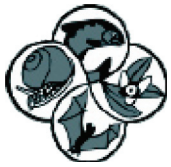
in their collections. In October 2005, the AZA-accredited John G. Shedd Aquarium in Chicago became the first North American institution to successfully breed the caiman lizards in captivity. Three baby caiman lizards hatched after about 160 days of incubation. The eggs were removed from the exhibit following the mother's lack of attention, and the youngsters are currently living separately from one another. They measured about 4 inches long upon hatching and emerged from their eggs with a full set of teeth.

Little is known about caimans both in the wild and in captivity. These beautiful animals spend more time in the water than almost any other lizard species, and have a unique diet consisting primarily of hard-shelled river snails, clams, and crawfish. The adults also enjoy small dead mice. With their sharp teeth, the youngsters consumed smaller river snails and bugs immediately after birth. The gender of the babies is unknown, and will be determined in the future by the prevalent color on their heads: red for males, and orange for females. These births will provide a rare opportunity for researchers to make new discoveries about caiman lizard breeding and development.

### Successful Andean Condor Release

The Incas believed that Andean condors flew the sun into the sky every morning and served as messengers to the gods. These birds had 11-foot wingspans and could be seen riding the currents along the entire length of the Andes in South America. Unfortunately, increasing pressures from humans resulted in near extinction locally during the 20th century and earned it a place on the USFWS list of endangered species in 1973. Several efforts have been made to return this magnificent bird to its home range; the AZA Andean Condor Species Survival Plan (SSP®) in particular recently gave cause to celebrate another successful release.

The Andean Condor SSP has provided over 70 condors for release into the wild in Colombia and a few in Venezuela over the past 15 years. In the fall of 2005, the SSP released three Andean condors in Colombia to continue their trend of success. The released condors were contributed from breeding programs at the AZA-accredited National Aviary, Columbus Zoo, and Cincinnati Zoo. There are currently 48 zoological institutions participating in the SSP, 16 of which have provided condors for the international release effort.



# Call for Submissions

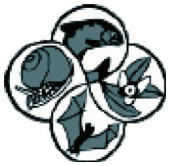
## Our Mission Statement

With increased pressures on our world's plant and animal life, the success of endangered species recovery programs is more important than ever. The major downfalls faced by professionals involved in these programs, however, are based in miscommunication—scientists do not talk to policy makers and policy makers do not consult scientists. The Endangered Species UPDATE, an independently funded quarterly journal published by the University of Michigan's School of Natural Resources and Environment, recognizes the paralyzing power of poor communication. Now entering its 23rd year, the UPDATE's primary goal is to bridge the chasm between policy and science.

## Call for Articles

The UPDATE is seeking articles ranging from feature articles to opinion articles to reports from the field regarding endangered species recovery and policy issues. We are currently accepting submissions for our April–June and July–September 2006 issues.

Interested authors may e-mail esupdate@umich.edu. Please see the instructions to authors on pages 174–175 or visit our website at www.umich.edu/~esupdate for more information.



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The dew is evaporating as the morning sun spreads across the expansive green landscape of Mauna Kea's northern slope. Hidden in her nest built within the deep grass a **PUEO**, or Hawaiian short-eared owl, (*Asio flammeus sandwichensis*) decides to search for some food. She takes flight and first scans the vicinity to check for possible threats to her babies. Fortunately the nocturnal predators (mainly rats and feral cats) are now asleep. Mice, one of the owl's favorite foods, abound in these open grasslands. The movement of approaching cattle sends a family of mice running and the observant owl notices. She swoops down silently and grasps a mouse in her feathered feet. Back at the nest, she tears the prey into bite-sized morsels for her growing chicks. Hawaiian legend believes the pueo is an 'aumakua, or guardian spirit. *Artwork and text by Rochelle Mason Copyright 2003 www.rmasonfinearts.com. (808) 985-7311*


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Endangered Species UPDATE
The University of Michigan
440 Church Street
Ann Arbor, MI 48109-1040

# Notes

# 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.

**Manuscript Submissions and Specifications**

Submit the manuscript to:
Editor, Endangered Species UPDATE
School of Natural Resources and Environment
University of Michigan
440 Church Street
Ann Arbor, MI 48109-1041

To submit your manuscript electronically, e-mail the manuscript as a Word file or rich formatted text (.rft) attachment to: esupdate@umich.edu.

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.

**Citations, Tables, Illustrations, and Photographs**

Literature citations in the text should be as follows: (Buckley and Buckley 1980b; Pacey 1983). For abbreviations and details consult the Editor and recent issues of the Endangered Species UPDATE.

Illustrations and photographs may be submitted as electronic documents or as hard copies. If hard copies are submitted, the author's name and the figure number should be penciled on the back of every figure. Lettering should be uniform among figures. All illustrations and photos should be clear enough to be reduced 50 percent. Please note that the minimum acceptable resolution for all digital images is 300dpi.

Author credit instructions for each author of the article should accompany the manuscript.

**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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