INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

Volume 36, Number 1, 2016

JOURNAL OF WILDLIFE REHABILITATION



IN THIS ISSUE:

Review of strategies for captive rearing and reintroduction of orphaned bears worldwide...

A 22-year review of trends in wildlife intake at a rehabilitation center in Alberta...

Why does the public rescue wildlife?

THE *Journal of Wildlife Rehabilitation* is designed to provide useful information to wildlife rehabilitators and others involved in the care and treatment of native wild species with the ultimate purpose of returning them to the wild. The journal is published by the International Wildlife Rehabilitation Council (IWRC), which invites your comments on this issue. Through this publication, rehabilitation courses offered online and on-site in numerous locations, and its outreach to those in the profession, the IWRC works to disseminate information and improve the quality of the care provided to wildlife.



Left:
Delmarva Peninsula fox squirrel (Sciurus niger cinereus). The species was removed from the ESA Threatened and Endangered Wildlife list in December, 2015.
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On the cover:
Red fox (Vulpes vulpes) in rehab at Suburban Wildlife Rescue and Rehabilitation, Inc.
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IWRC

Providing science-based education and resources on wildlife rehabilitation to promote wildlife conservation and welfare worldwide.

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JOURNAL OF WILDLIFE REHABILITATION

Volume 36(1)

CONTENTS

PEER-REVIEWED PAPERS

7
Strategies for captive rearing and reintroduction of orphaned bears
John J. Beecham, I. Kati Loeffler, and Richard A. Beausoleil

17
Trends in wildlife intake at a rehabilitation center in Central Alberta: A retrospective analysis of birds, mammals, and herptiles, 1990–2012
Dawn Doell and David A. Locky

DEPARTMENTS

Editorial 4
In the News 5
Selected Abstracts 32
Tail Ends 34
Submission Guidelines 35

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EDITORIAL

Why People Care

People who rescue wild animals and call with questions do so for many different reasons. . .

■ A Minnesota hunter contacts a wildlife rehabilitation center to report a bald eagle (*Haliaeetus leucocephalus*) sitting on the ground with its head slumped. This isn't the first time she's observed such behavior in a local bird and she's concerned that it might signal a larger problem with the health of the forest.

■ A retiree in northeastern England wants help advocating for protection of Eastern grey squirrels (*Sciurus carolinensis*). He finds the policy of culling these introduced animals unconscionable and believes they should be rehabilitated because "people should care for all animals equally, regardless of their origin."

■ A backyard birdwatcher loves to begin each workday at the kitchen window, drinking coffee while watching feathered visitors jostle for space at the feeder. When a Carolina chickadee (*Poecile carolinensis*) hits the patio door, he rushes outside, gently scoops the birds into a shoebox, and is late for work so he can transport the injured bird to a local rehabilitator for care.

■ A young family finds a mule deer fawn (*Odocoileus hemionus*) curled up near the edge of their property, alone, lonely, and obviously orphaned. The wild fawn becomes the newest member of the family. It's only when the fawn develops diarrhea that a rehabilitator is asked to assist.

Social ecologist Stephen Kellert has published numerous studies of American, German, and Japanese perspectives on wildlife. He's developed a list of 10 commonly held attitudes[1] and, because humans are complicated, most individuals can be described by more than one category. The examples above illustrate four categories familiar to the rehabilitation community: *ecologistic*—interested in wildlife as part of a larger ecosystem, more interested in the group than the individual animal; *moralistic*—concerned that humans treat animals ethically, may have affection and interest in animals but primary drive is protection from unnecessary harm; *naturalistic*—enjoys nature recreation, especially when it involves interaction and observation of wildlife; and *humanistic*—appreciates and bonds with individual animals, considers animals as dependents of humans.

Of these four groups, most prevalent among the general US population are moralistic and humanistic attitudes.[2] These individuals recognize that animals experience pain and emotions. They care deeply and form attachments to specific animals. They want to help but are unaware that other species require different care protocols than humans, and often inadvertently harm the very creatures they're trying to assist. The general public's knowledge about wildlife is limited and often misinformed. We can't reasonably expect them to know how and when to help.

However, understanding the diverse perspectives and motivations of community members is critical to our success as rehabilitators, allowing us to better connect and communicate with those caring first-responders who make our rehabilitation efforts possible. The result is a better outcome for all.

Kai Williams
Executive Director

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A Cinderella Story

Vladivostok, Russia (December 9, 2015)—WCS and partners report from Bastak Reserve, a 162 square mile (420 km2) protected area in the Pri-Amur region of the Russian Far East, a tiger cub who lost her mother and nearly died, has became a "Cinderella" and is now a mother.

The reserve was devoid of tigers for nearly 40 years until Cinderella was released there two years ago and has now attracted a mate from another region.

Anxious waiting by biologists in the area was rewarded on December 9, 2015, when Ivan Podkolnokov, the reserve inspector responsible for monitoring Zolushka—Russian for Cinderella—returned from the field with historic photos: Zolushka standing under a huge Korean pine tree, with two small cubs huddled underneath her.

"This is a great day for Bastak Reserve," said Aleksandr Yuryevich Kalinin, director of the protected area. "This demonstrates that there is still suitable habitat for tigers in the Pri-Amur region of the Russian Far East, and there is a place for tigers here. Our thanks go out to Severtsov Institute of Ecology and Evolution, WCS, IFAW, the Phoenix Fund, and Special Inspection Tiger and working collaboratively with us to make this happen."

Said WCS Russia Director Dale Miquelle: "This is a watershed event not just for Zolushka, but for the entire population of Amur tigers. These births mark the return of tigers to habitat that had been lost, and the beginnings of a recovery and expansion of the last remaining Amur tiger population into habitat lost years ago."

In February 2012, hunters in the southwestern portion of Primorskii Krai, one of the last strongholds of the Amur (or Siberian) tiger, came across a starving, four-month old tiger cub. Brought to the local wildlife manager, she was nursed back to health. After an operation to remove the tip of her tail which was damaged due to severe frostbite, Zolushka was transferred to the Aleksayevka Rehabilitation Center, managed by Inspection Tiger and supported by the Russian Geographical Society.

Kept away from humans and provided live prey, Zolushka slowly learned how to hunt. In May 2013, when approximately 20 months old (the normal age when young tigers disperse from their mothers), Zolushka was taken to Bastak Reserve and released. On her own, Zolushka quickly figured out how to exploit the abundance of badgers, wild boar, and red deer.

WCS assisted scientists from the Severtsov Institute (Russian Academy of Sciences) with Zolushka's transfer and release into Bastak—some 700 km away. WCS staff spent considerable time tracking Zolushka as she explored her new home to ensure she was properly acclimating to life back in the wild.

WCS's work in rehabilitating, releasing, and monitoring Zolushka was made possible through partnerships with the Liz Claiborne and Art Ortenberg Foundation, Columbus Zoo and Aquarium, International Fund for Animal Welfare (IFAW), and the AZA Tiger Species Survival Plan Tiger Conservation Campaign. Collaborators for this project included the AN Severtsov Institute of Ecology and Evolution from the Russian Academy of Sciences, the Russian Geographical Society, Inspection Tiger, IFAW, and Phoenix Fund.



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Amur (or Siberian) tiger cub (Panthera tigris altaica).

Coalition for Wildlife in Kenya

Kenya (December 6, 2015)—Wildlife loss has recently become a crisis in Kenya; cases of wildlife crime and illegal tracking of trophy have been on the rise during the last three years. But help has come from an unlikely source: communities and landowners. A gathering of conservancy leaders from 96 conservancies across the country meeting at Maanzoni Lodge, Machakos County provided a new source of hope for Kenya's threatened wildlife. "It is a fact that [in] areas where conservancies have been established, poaching is on a downward trend," says Benjamin Kavu, Deputy director, KWS.

Communities and landowners have always been blamed for spearing, poisoning, and snaring wildlife both for meat and to protect their livestock or farms. That they are now taking the lead to conserve the same animals that have been a nuisance must be a big source of relief for wildlife enthusiasts and the tourism sector. Without wildlife there is no tourism, says Grace Nderitu, Ecotourism Kenya CEO. Wildlife tourism is the cornerstone of the Kenya economy, with treasured species

CONTINUED FROM PAGE 5

such as elephants, lions, and migratory mammals combined with iconic landscapes, water bodies, and cultures attract tourists, generating income and creating employment.

The conference, themed "sharing knowledge for a better tomorrow," was organized by the Kenya Wildlife Conservancies Association (KWCA), an umbrella body for conservancies in Kenya established in 2013. The meeting was funded by GEF Small Grants program, WWF, The Nature Conservancy, and USAID.

Kenya's future prosperity as described in vision 2030 hinges on a healthy wildlife population dependent on a network of parks, reserves, and conservancies. A strong protected area network connected by open corridors and dispersal areas is the backbone of a strong tourism industry.

Outside the parks and reserves where the majority of wildlife occurs, eco-tourism opportunities remain underexploited. Here, wildlife is threatened by human settlement, poaching, farming, and construction of infrastructure. In the last 3 decades alone, human population has more than doubled, and the government's effort to provide services often clashes with conservation. The country's wildlife population has also declined by more than half, bringing the tourism industry into stagnation.

"Today, conservancies are diverse, both in size and governance structure. This diversity has put Kenya on the global map as an African leader in community–based conservation. Each day our conservancies are featured in newspapers and magazines across the globe, while at the same time they have become a topic of discussion and area of research among local and international academicians," said Tom Lalampaa, Chairman Kenya Wildlife Conservation Association.

"We heartily thank our communities and landowners for their continued resolve to coexist with the wildlife, even though many times they suffer costs." Baringo and Samburu counties were singled out as leaders in the support of wildlife conservancies.

Because wildlife conservation is a national function, Lalampaa urged the government to support the works being done by conservancies. "The government of Kenya ought to allocate more resources and provide incentives to support conservation of wildlife outside parks and reserves."

"Making the County Wildlife Compensation and Conservation Committees functional, and setting up the endowment fund and compensation scheme are among key legal mechanisms to help reduce the cost of living with wildlife."

New CWD Plan for Wyoming

Casper, Wyoming, US (December 6, 2015)—Chronic Wasting Disease (CWD) is a fatal neurological disease of deer, elk, and moose, first detected in wild populations in Wyoming in 1987. Wyoming Game and Fish will ask the Wyoming Game and Fish Commission to approve a new and final version of its CWD plan at its meeting January 28–29, 2016 in Cheyenne.

The CWD plan focuses on disease management, research, public information, and funding. The draft calls for the continuation of robust surveillance and public involvement, as well as continuing to invest in research here in Wyoming.

"This draft builds on the national collaboration and on recent research, and it outlines an adaptable strategy that is specific to Wyoming," said Scott Edberg, Deputy Chief of the Wyoming Game and Fish Department's Wildlife Division.

Each year, staff at the Game and Fish Department's Wildlife Disease Laboratory in Laramie tests over 1,500 deer, elk, and moose, and provides information to hunters about the presence of disease in animals they had harvested. The Lab tests for CWD in areas where it has not yet been confirmed, as well as in areas where CWD has been for years.

The draft plan includes proactive approaches for the elk feedgrounds in western Wyoming. CWD has not been found there, but Game and Fish has conducted CWD surveillance on these elk there for years. The draft plan calls for continuing surveillance, researching big game migration routes in the area of feedgrounds, and working to reduce the use of feedgrounds in partnership with others. The draft plan also has a strategy in the event CWD is detected at the feedgrounds.

An App to Help Piping Plovers

Washington, DC (December 2)—The piping plover is an iconic shorebird that breeds along the Atlantic Coast, the Great Lakes and the Great Plains. Rising sea levels and storm surges associated with climate change, as well as increased development in their beach habitats, threaten the species. To help track changes in piping plover habitat, Thieler developed a free app called *iPlover*.

Since releasing *iPlover,* scientists have gathered data across 1500 km of breeding range. That equals about a third of the distance across the US, a large area to cover for only 2,000 breeding pairs of piping plovers on the east coast.

Instead of having to travel and spend days at each site, a network of collaborators in the field use the app to collect and send data, allowing scientists to gather data more efficiently. It also allows them to collect data at the same time during each breeding season, providing a better picture of changes that happen over longer periods of time. And fast, centralized access means scientists can look at data quickly to get a real-time idea of where and how piping plovers are using their habitat.

Oldest Living Banded Bird Lays Egg

Midway Atoll, US (November 30, 2015)—Wisdom, a 64-year-old Laysan albatross returned to Midway Atoll National Wildlife Refuge on November 19, 2015, after a year at sea. A few days later, she was observed with her mate. She laid her egg on November 30. Her mate (called Goo or Mr. Goo) took the first very long shift while Wisdom was out to sea in search of squid and fish eggs to replenish her body.

Wisdom was first banded in 1956. And because Laysan albatross do not return to breed until they are at least five

CONTINUED ON PAGE 30

Strategies for captive rearing and reintroduction of orphaned bears

John J. Beecham, I. Kati Loeffler, and Richard A. Beausoleil

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Grizzly bear and cub *(Ursus arctos horribilis)*.

ABSTRACT: Placing orphan bears in captive-rearing facilities and releasing them back to the wild is a management option that has been used for decades. This option has conservation implications that extend beyond obvious welfare benefits, including public support for management programs, maintenance of genetic diversity, and restoration of bear populations. However, the method is infrequently used because of concerns about survival, ethics, and that captive-reared bears may become involved in conflict with people. As a result, many orphaned bears are unnecessarily euthanized. The objectives of captive-rearing and reintroduction are to liberate animals with the necessary physical condition and life skills to survive in the wild, avoid conflicts with humans, and minimize disease and genetic risks to indigenous wildlife populations. Approaches to achieve these objectives vary among rehabilitators, geographic areas, and bear species. We identify components of captive-rearing and reintroduction practices that can be applied across the range of ursids. Releasing orphaned bears back to the wild is a defensible management alternative, and we advocate for agencies to implement the proposed strategies.

KEYWORDS: augmentations, bears, captive-rearing, conservation, management, orphaned, rehabilitation, reintroduction, supplementation, ursidae, welfare

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Introduction

Seven of the eight species of bears in the world are thought to be in decline in all or parts of their historical range as a result of human activities.[1] Only the American black bear *(Ursus americanus)* appears to be stable or increasing across most of its range.[2] Human activities such as habitat encroachment, killing bears to protect life and property, poaching, commercial exploitation for body parts or the pet trade, human–bear conflicts, and global warming may affect bear populations and lead to increasing numbers of orphaned cubs throughout the world.[3]

Placing orphans in a captive-rearing and release program is an alternative that has been available for decades, but is used infrequently by wildlife managers because of uncertainty of survival, ethical considerations regarding risks to the individual and wild populations, and the possibility that captive-reared bears may become a human safety concern.[4-9]

Rearing bears in captivity for reintroduction is challenging because bears require relatively large, complex enclosures, significant maintenance of enclosures, a sizeable amount and variety of food, and sophisticated behavioral and cognitive enrichment. Captive-rearing practices vary among individual facilities because of ecological differences among bear species, geography, logistics, politics, and resources. Rehabilitators are successful using a variety of methods for raising and releasing bears,[10] which makes it difficult to define best management practices.[11,5,12] These disparities notwithstanding, there is agreement on common principles that apply to captive-rearing practices throughout the world and across species, and that integrate ethical issues, welfare concerns, documented

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success, and methods for reducing human-bear conflicts.[4,10,13]

In 2007, the International Fund for Animal Welfare (IFAW) hosted a workshop to discuss methods for captive-rearing and reintroduction of orphan bears. Reintroduction was defined as the release of captive-reared cubs (wild- or captive-born) back to the wild. Discussions were based on the observations and practices of 36 bear rehabilitators, representing 14 countries, and whose collective experience included all eight species of bears. We documented and refined these recommendations based on published literature and an analysis of survival rates, cause-specific mortality, conflict activity, movements, and reproduction of 550 captive-reared bears released as yearlings (12–18 months) from 12 facilities from 1991 through 2012: 424 American black bears in the USA and Canada, 64 brown bears (*U. arctos ssp.*) in Canada, Romania, and Greece, and 62 Asiatic black bears (*U. thibetanus*) in South Korea and India.[13]

The objectives of this manuscript are to: (a) describe consensus items taken from the 2007 workshop and peer-reviewed literature on methods used by rehabilitators to successfully raise orphaned bear cubs for reintroduction; (b) identify criteria that are essential to producing favorable post-release outcomes; and (c) formulate strategies for captive-rearing and releasing orphaned bears across their global range. Extrapolation of these strategies to other species, with the possible exception of polar bears *(U. maritimus)* and giant pandas *(Ailuropoda melanoleuca)*, is conceivable, but should be implemented with caution.

Confirming That a Cub Has Been Orphaned

Bear cubs can wander and/or become temporarily separated from the adult female and be mistaken as orphans. If the condition of the cub does not warrant rescue (e.g., malnourished), and to avoid unnecessary removal of a non-orphaned cub from the landscape, we recommend that agency staff consider capturing the cub(s) and placing it in a sturdy cage, onsite and overnight, with an infra-red camera to monitor for additional bear activity. If necessary, local residents should be notified to stay clear and keep pets contained. If no adult female is seen on the camera the following day, it is likely the cub has been orphaned and can be transported to a captive-rearing facility.

Captive-rearing Facilities

Licensing and Agency Collaboration

In most countries, wildlife rescue and captive-rearing facilities are required to be licensed by the governmental agency responsible for managing wildlife, whether they were privately owned, a charity, or a government-sponsored project. Licensing is intended to promote elevated standards of practice and, in some countries, requires a minimum amount of training and ongoing skill development. Licensees may also be required to comply with jurisdictional and federal laws and regulations, and to work cooperatively with the licensing agency for standards of animal care and to plan the animal's release. In most instances, potentially orphaned cubs have to be reported either to a rehabilitation facility or a wildlife agency by members of the public. Depending on the country, calls are referred to management authorities that confirm whether rescue of the cub is warranted and to safely capture the cub.

Captive-Rearing Facilities and Enclosures

Captive-rearing facilities are located in urban, rural, and wild environments throughout the world.[14,10] The location, funding, and availability of building materials dictates the type of construction, number and design of enclosures, and types of escape deterrents used in these facilities. Bears can be brought into captive-rearing facilities during all months of the year, necessitating flexibility in housing for bears of different ages and sizes, and for a variety of climatic conditions. Although most rehabilitators do not separate bears by sex, they do separate bears by size and/or temperament. Injured or sick bears are quarantined to facilitate treatment protocols, prevent disease transmission, and ensure that they obtain adequate food, water, and space. In temperate climates, where hibernation is encouraged, bears arriving late in the year are typically placed in separate enclosures for feeding into or throughout the winter period.[14]

Most rehabilitators use multiple enclosures to serve a variety of needs at different stages of rehabilitation. Ideally, we recommend at least one outdoor quarantine enclosure and a minimum of two outdoor captive-rearing enclosures for bears. This accommodates two important strategies: (a) new arrivals can be quarantined and treated for veterinary conditions (or prophylactically) prior to interaction with other bears; and (b) bears can be paired or grouped to facilitate positive social interactions, which results in less dependence on caretakers and a more successful release. Quarantine enclosures that are built to accommodate transfer of new arrivals directly from a trailer or container are particularly useful to save staff time and eliminate the need for an additional immobilization event.

Infant cubs (birth to eight weeks of age) are typically housed in a heated indoor room (and/or in a pet kennel) and separated from older cubs because they require bottle-feeding and more frequent handling. Cubs 8–12 weeks of age who are able to eat on their own can be housed in small, outdoor enclosures (6 m^2) that contain structures for protection from weather extremes. Cubs older than 12 weeks of age are housed in larger enclosures (>66 m^2) with similar protection from the elements. The National Wildlife Rehabilitators Association recommends minimum enclosure sizes for American black bears that can be extrapolated across species (Table 1[15]). Although these are minimum standards, we recommend larger enclosures containing natural vegetation and habitat enrichment to provide as much of a natural environment as an enclosure can allow. Moreover, the larger the space and the more complex the environment, the less chance that an individual will develop stereotypic behaviors and, therefore, will have a better chance to successfully adapt to life in the wild.[16,17]

Escape Deterrents and Security from Predators

Smaller enclosures are most often covered with a roof constructed from chain-link fence material or welded wire to prevent bears

from escaping. With larger enclosures, some facilities fit one strand of electric fencing 30 cm from the fence and 1 m above ground, and two strands at the top of the fence 30 cm from the fence and approximately 30 cm apart. Other facilities use 1 m-wide steel sheeting fastened at the top of open enclosures at an inward slant of 45 degrees to prevent bears from climbing to the top of the fence. To prevent digging and possible escape under the enclosure, most facilities bury welded wire, chain-link fence, or concrete 45–65 cm deep along the inside perimeter. Double-entry door systems, secured with locks, are used to reduce the risk of animals escaping and to prevent unauthorized human entry.

TABLE 1. MINIMUM RECOMMENDED SIZES OF CAPTIVE-REARING ENCLOSURES FOR BLACK BEARS, BY AGE CLASS (FROM MILLER 2012).

Age	Infant	Nursing/ Pre-weaned	Juvenile/ Adult	Restricted, Injured Adult
Enclosure Size (Metric)	76 LITERS (0.076 M^3)	W X L X H 0.9 X 1.8 X 0.9 METERS	W X L X H 6 X 11 X 4.9 METERS	W X L X H 2.4 X 3.7 X 2.4 METERS

Visual Barriers

Opaque plastic sheeting, landscaping fabric, tarpaulins, or one-way mirrors are commonly used on enclosure walls at some facilities in urban areas to minimize visual contact between bears and the environment surrounding the enclosure, and to prevent bears from seeing their caretakers during feeding. However, because bears depend primarily on their senses of smell and hearing to obtain information about their environment, it is unlikely that simple visual barriers are effective in preventing the bears from recognizing that people are close by or involved in providing food. Nonetheless, a visual barrier is useful in reducing interactions with facility staff and members of the public, and does provide a sense of security for shy bears, all of which likely reduces stress levels for individual animals.

Video Cameras

In addition to visual barriers, monitoring bears is also an important captive-rearing necessity, and video cameras are a useful tool that reduces unnecessary human interaction. Video cameras allow facility staff to observe bear interactions, as well as (a) monitor if any bears are being excluded from food, water, or shelter; (b) monitor if bears sustain injuries; (c) monitor if bears show any signs of sickness, and (d) visually observe the status of denning bears without disturbance.

Solicitation of donations is an important component of rehabilitation, as expenses are difficult for facilities to sustain. Video cameras allow supporters to observe the bears without interfering with the captive-rearing process, which can promote engagement of the public and thereby encourage fund raising. The recorded video may also be edited and shared online so that the public can experience bear behaviors firsthand.

Denning and Shade Structures

Small, well-insulated structures located at ground level or buried should be provided as a secure environment for hibernating bears in winter. These also serve as shaded areas where bears can rest during high ambient temperatures. Facilities also utilize natural vegetation (trees and shrubs), elevated platforms, netting, and roof structures that cover all or portions of the enclosure to provide shade and protection from the elements. Small denning structures, designed to accommodate one to three cubs, tend to be preferred over larger structures to facilitate removing bears for winter releases and to reduce stress during the denning period.

Habitat Enrichment

Many wild animals housed in captive-rearing facilities are prone to developing stereotypic (e.g., pacing, swaying, bawling) behaviors.[18, 19, 20, 17] In an effort to minimize these behaviors, encourage cognitive development, and promote psychological well-being of cubs, captive-rearing facilities typically provide enrichment, such as water features (streams, pools, or large tubs), climbing structures (trees, logs, stumps), and digging opportunities in the enclosures. Elevated platforms (1–2 m above the ground) serve a dual purpose for climbing to interact with other bears, and also for resting and cooling.

Selection Criteria for Accepting Cubs into a Captive-rearing and Release Program

Cubs with disabilities or requiring long-term veterinary care are generally not recommended candidates for captive-rearing and reintroduction. These individuals require intensive human handling, which can compromise their development. All other cubs (<12 months of age) are considered suitable candidates. Cubs who habituate to their caretakers (i.e., tolerate the caretakers' presence without demonstrated signs of stress), but tend to remain wary of strangers, are good candidates for release. This includes cubs taken into captivity before their eyes are open (<1 month of age). These cubs show no differences in post-release behavior compared to wild cubs: they forage for appropriate foods, demonstrate natural social behaviors, avoid interactions with humans, and are able to den and reproduce successfully.[21,5,22,12,13]

Handling Methods and Husbandry

Contact with Caretakers

Frequent contact between cubs and their human caretakers is inherent to the captive-rearing process and may result in habituation to specific people, especially if cubs are bottle-fed. This early bond with limited human individuals is not detrimental to the eventual independence of the cubs. After weaning, human contact should be restricted to one or two caretakers, and steps should be taken to minimize conversation in the bears' presence,

regardless of whether cubs are raised alone or with other bears. As cubs grow older and more independent, they show less interest in caretakers, especially if they are able to socialize with other cubs within the enclosure. Cubs taken in at an older age (>7 months of age) require less interaction with handlers. Rehabilitation for these cubs should focus on rapid improvement of physical condition with minimal human interaction to reduce the amount of time in captivity.

Minor differences in the way cubs are reared make little difference in the ability of cubs to adapt to their wild surroundings after release.[13] However, frequent contact with large numbers of humans, and feeding cubs by hand after weaning, appear to be associated with unsuccessful release attempts for brown bears (*U. a. arctos*) in Europe,[23] and is not a strategy we recommend.

Aversive Conditioning

Aversive conditioning practices during the captive-rearing process pose ethical concerns because of the stress they cause to confined animals. For this reason, we believe it is unnecessary and do not recommend its use.

Socializing Cubs

Housing cubs together is highly recommended because it provides support for the physical, cognitive, and emotional needs of cubs, and promotes development of appropriate social skills for post-release interactions with wild bears. Providing an opportunity for social interactions among cubs also reduces dependence on caretakers during the latter stages of the captive-rearing process. For this reason, we advise that rehabilitators contact other rehabilitators and arrange the transfer of single cubs to another facility that can raise them with similarly-aged conspecifics.

Rehabilitators hold differing opinions on mixing species and ages of bear cubs. To err on the side of caution, we recommend separating bears by species and general size. Introduction of cubs into enclosures that are already occupied by unfamiliar bears must be done with care to avoid physical injury and psychological distress.[24] Where possible, it is helpful to house bears in adjacent enclosures with opportunity for protected interaction (e.g., through wire fence or bars) to allow them to become familiar with one another, and for caretakers to evaluate their compatibility. The personality and life experiences of individual bears may be as important as size and age in influencing compatibility. Introductions should be made in a space with structures that allow individuals to withdraw if they wish to avoid interaction, or to protect themselves if necessary. Provision of surplus food is helpful because it removes competition for food as one of the most volatile elements for antagonism.[24] Caretakers should be prepared to observe the integration closely and to intervene if necessary.

Veterinary Care

The potential for rescued bears to spread pathogens within captive facilities and into wild bear populations is a concern for captive-rearing programs.[4,9] Recommended preventive health measures include quarantine of sick and newly acquired bears for a minimum of two to four weeks before integrating them into the main enclosure, treatment with anti-parasitic drugs, and proper sanitation. Avoidance of overcrowding is essential for prevention of pathogen transmission and to manage stress, which may contribute to conditions such as alopecia and high or persistent parasite burdens.

Rehabilitators participating in the IFAW workshop described most orphaned cubs entering captive-rearing facilities as experiencing malnutrition, superficial wounds, endoparasite and ectoparasite burdens, or internal injuries. However, most reported that infectious disease and the necessity for extensive veterinary care were not common occurrences or a significant concern.

While bears are susceptible to pathogens of carnivores, most veterinarians and rehabilitators suggest that the cost and uncertain efficacy of vaccination argues against routine vaccination. However, some rehabilitators believe that it is valuable to vaccinate young cubs against common canine pathogens (e.g., canine distemper virus, adenovirus) in areas where dogs and wild canids occur in bear habitat. Where rabies is endemic, it is considered prudent to vaccinate bears prior to release with a killed or recombinant canine rabies vaccine.[10] Monthly examinations and prophylactic treatment for pathogens by a licensed veterinarian reduces the probability of disease and/or parasitic infestations in captive-reared bears.

Sanitation

A critical part of captive animal housing is sanitation of enclosures and in food preparation areas. The frequency of cleaning enclosures is based on considerations for minimizing disturbance of animals, risk of disease in enclosures, and the time of year (e.g., hibernating bears do not need to be disturbed to clean or disinfect dens). Disinfectants should be non-toxic, non-corrosive, and kill a broad spectrum of bacterial, fungal, and viral organisms. Disinfectants should be used on food and water utensils (bowls, bottles, etc.), toys, tubs, food-preparation surfaces and tools, and non-porous surfaces in the enclosure. Maintaining clean, dry enclosures contributes to keeping bears healthy and to controlling infectious disease and parasites.

Feeding

Hand-reared infant bears in the first few weeks of life need frequent, small amounts of milk replacement formula every 2–3 hours that total 15%–25% of their body weight per 24 hours, not to exceed 4%–5% of body weight per feeding. By 30 days of age, this can be reduced to 5–7 feedings per day. The amount of food needed to maintain growth can taper down to 10%–20% of body weight per day by 90 days of age.[25] It is important to avoid over-feeding as much as under-feeding. Over-feeding results in diarrhea and other gastrointestinal disturbances that can quickly become life threatening in infants. Rehabilitators agree that cubs should be trained to drink from a bowl instead of a bottle as soon as possible. This process requires some patience, and caretakers

must ensure that cubs take in enough food during the learning process.

Brown bear researchers experimenting with various formulas for three separate litters concluded that a formula composed of 24% fat, 12% protein, and few carbohydrates simulated the caloric value of milk for brown bears.[26] Milk sugars, particularly lactose, must be low and pre-digested with lactase before being fed to cubs. Whey, casein, and curd formation are important considerations to ensure that cubs are able to digest their food without risk of diarrhea, constipation, or lactobezoar formation. For most bears, facilities use commercial puppy milk replacer such as Esbilac®, in varying dilutions with water or with lactase-treated cow or goat milk, while others prepare formula in a porridge of finely ground cereal grains. To make basic formula more palatable to cubs, ingredients such as applesauce and baby cereal are commonly added. Plain yogurt has been used to address problems with upset stomachs and diarrhea in small cubs.



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Brown bear cub feeding station at a Russian rehabilitation facility *(Ursus arctos)*.

Oftedal and Gittleman[27] and Huber et al.[26] reported that hand-raised brown bear cubs consumed almost twice the amount of food (as a percent of total body weight) as wild cubs, and were 1.3–2.7 times as large as wild cubs of an equivalent age at most stages of growth.

Cubs benefit from order and consistency in the feeding schedule and routine. They show preferences for certain nipple types, the color of the bottle cap, or the position in which they are held while feeding.

The predictability of bottle feedings is important in providing a sense of security for cubs. While there is always concern that cubs bonding with their caretakers will result in a human-bear conflict, such a bond appears to be important and beneficial during a cub's infancy. Cubs who receive inadequate attention tend to show more dependence and later exhibit difficulty with separation from their caretakers. As described earlier, these bonds between infant and caretaker diminish as cubs become older, particularly if they are housed with a compatible companion.

Cubs can be introduced to solid foods (fruit, oatmeal, or dry cereal soaked in formula) at nine weeks of age, but may continue taking formula until they are fully weaned at five to six months.[14] At weaning, the diet consists primarily of fruits, dry dog food (for nutritional balance), nuts (hard mast), vegetables, and occasionally fish or wild game carcasses. Solid foods are presented to bears in a variety of ways (e.g., scattered, hidden, chunks) to increase behavioral enrichment and to encourage bears to search for their food as they would in the wild. Supplemental foods (e.g., grapes, raisins, peanut butter, and honey) should not exceed 3%, by weight, of the total diet provided each day.[25]

Hibernation

The availability of food, daylight length, and weather affect hibernation periods for bears in temperate latitudes. Cubs naturally reduce food intake in late fall (mid- to late October); however, they continue to feed and resist hibernation if food remains available. Rehabilitators should evaluate body condition and health status of cubs to determine whether and when to withdraw food from cubs in fall. When healthy cubs have sufficient fat reserves, their food supply may be reduced gradually over two to three weeks and then completely withdrawn. Drinking water should always be available.14 Regardless of weather conditions, it is important to recognize that bears enter and emerge from a dormant state gradually. It is common for orphan cubs to remain active, although lethargic, for several weeks after their food is completely withdrawn or to emerge from their den for short periods of time when weather conditions are moderate. Mild weather conditions delay the onset of hibernation, while severe cold may cause bears to den earlier. Cubs lacking sufficient fat reserves for hibernation should be placed in separate enclosures and fed longer into winter.10

Selection of Release Sites

Habitat Assessment

Choosing a release site is a critical component of reintroduction plans. Land use issues considered by IFAW workshop participants and others[28,14] include property ownership, straight-line distance to nearest human settlements, history of human–bear interactions in the area, presence and timing of hunting seasons for bears and other animals, predominant land use activity (e.g., agriculture, forestry, wilderness preservation), and public attitudes toward bears. Legal hunting for American black bears and poaching were important causes of mortality for reintroduced bears and should influence decisions about release sites in some localities.[10,13]

TABLE 2. A VISUAL METHOD FOR ESTIMATING THE BODY CONDITION SCORE OF BEARS PRIOR TO THEIR RELEASE TO THE WILD (FROM LINTZENICH ET AL. 2006).

Body Condition Score	Description
1	Pelvic and shoulder bones protruding; ribs very prominent with a deep sunken area between the rump and the last rib; no obvious fat under the skin.
2	Easy to feel the pelvis and ribs; some muscle tissue covering the ribs; the sunken area between the ribs and rump remains obvious, but softer.
3	Body appears to be fully fleshed out; obvious layer of fat covering the pelvis and shoulder region; sunken area between the ribs and the rump is absent.
4	Bear has a blocky appearance; very full bodied over all bony areas; obvious fat over the rump and shoulders.
5	Legs appear short for the size of the body; rolls of fat on the neck, shoulders and abdominal area.

A lack of familiarity with the location of high-quality food resources in the release area contributes to the vulnerability of reintroduced bears, as it does for dispersing wild, subadult bears.[29] Beecham et al.[13] documented a small number of reintroduced bears (6%–10%) took advantage of unfamiliar but readily available anthropogenic food resources, which resulted in conflicts with humans. Therefore, we recommend that bears be released with adequate fat reserves, and in areas where natural food resources are readily available to reduce the likelihood of movement into human settlement areas, improve survival, and lessen the potential for conflicts with humans.[30]

Predation and Resource Competition

Captive-reared bears are most often released at 12–18 months of age, when they have not yet attained adult size. Competition from and predation by bears, large felids, and canids are a concern of rehabilitators in some areas.[31,10] Evaluation of these risks requires knowledge of the demographics of the wild bear population and of the presence of other large predators in the area. The body condition of released bears recaptured by biologists or killed by hunters within a year of release suggests that the bears have no difficulty obtaining adequate natural food resources and that direct competition is not a significant threat to the survival of released bears.[26,13] However, predation is a major source of mortality for released bears in some areas.[13]

Genetics

Genetic considerations are cited as a concern regarding the release of orphaned or captive-bred animals.[32] The primary concern involves the loss of genetic integrity in the recipient bear population as a result of hybridization with released individuals. Orphaned, captive-reared bears are generally returned to the geographical area from which they are obtained. In situations where the provenance of the cubs is unknown, genetic testing of captive-reared cubs and bears from the recipient population is considered the only safe, ethical approach to releasing captive-reared cubs.[33] However, small, isolated bear populations may benefit from an intrusive management strategy that prevents the loss of critical genetic variability.[34] Such an intervention must be scientifically justified and carried out with a well-designed release and post-release monitoring program.

Release Considerations

Ascertaining the Suitability of a Bear for Release

Prior to release, both physical and behavioral characteristics should be evaluated by veterinarians and rehabilitators to confirm that a bear is suitable for release. Physical characteristics are relatively straightforward and involve assessing body (Table 2[25]) and pelage condition and examining the bear for external parasites or injuries that would negatively affect survival. Release should be postponed for bears with a body condition score below 3. Assessing bears from a behavioral perspective is more difficult.[4] As mentioned above, captive bears demonstrate some level of habituation to caretakers, which is generally not considered cause for concern. Assessing how bears react to strangers is more indicative of whether or not there may be a problem. Participants in the IFAW workshop[10] agreed that there was no clear correlation between post-release survival rates for bears showing minimal habituation to caretakers versus those demonstrating clear signs of such habituation. However, higher survival rates were reported for bears held in captivity for periods of less than seven months.[13] We therefore recommend that bears be retained in captivity no longer than 15 months, and ideally less than seven months.

Release Type and Timing

The goal of a release strategy should be to optimize survival rates within the context of constraints imposed by the environment (including predator threats), the age and size of the cub, the bear's relative lack of experience in the wild, and human activities that might compromise survival potential. Within that framework, we recommend that managers and rehabilitators attempt to place the odds of all these factors in the bear's favor when developing a release strategy.

The most common method used by North American and European rehabilitators is a hard release (transporting the bear to the release site and releasing the bear without acclimation or supplemental food). Beecham et al.[13] found that hard-released bears were capable of adapting quickly to environmental conditions at the release sites. Moreover, they reported no difference in post-release survival for bears released using three different hard release strategies: (a) releasing bears in early winter and allowing them to find a winter den on their own; (b) placing bears directly into natural or artificial dens in winter; or (c) releasing them in

the spring when natural food resources became abundant. We strongly encourage using one of these strategies for releasing captive-reared bears in temperate climates. For captive-reared, tropical bear species, we recommend hard releases in seasons and in locations in which natural food resources are readily available.

Rehabilitators in Russia (brown bears), North America (American black bears), Indonesia (Malayan sun bears, *Helarctos malayanus*), and India (Asiatic black bears) use an assisted release option in which cubs are allowed unrestrained access to the forest under the guardianship of a caretaker, and returned to an enclosure at night.[10] The rationale for this strategy is to provide bears an opportunity to explore natural environments and foods for greater behavioral and physical enrichment, while a caretaker protects them against poaching or predation by large carnivores. These walks are initiated after weaning and continued until the bears are large enough to avoid predation or when they refuse to return to the enclosures at night.



American black bear *(Ursus americanus)* emerging from a transport box at a release site in Idaho, USA.

Several criteria are essential to this "walking with the bears" approach. Caretakers who accompany the cubs who, by nature of the protective activity, form a bond with the cubs must be limited to no more than two people to ensure that cubs remain wary of humans in general. As discussed above, the cubs will bond with these caretakers but, as they mature, this bond will weaken as the cubs become more independent. The caretaker is present solely to protect the cubs, but not to interact with them as playmates.

It is also important to ensure that cubs are receiving sufficient food during this program. Assumptions are sometimes made that foraging during the walks provides adequate nutrition, but this may not be the case, particularly while cubs are still small or if cubs are taken out for only eight hours or less per day. Supplemental food may be necessary, and growth rates must be monitored.

Although hard releases are logistically easier and require less manpower, both techniques have resulted in successful releases.[13]

Chemical Immobilization

Immobilization of cubs may be necessary for capture and to perform routine health examinations, treat injuries, or place them in a transport container for release. Government agency and rehabilitation staff should communicate with one another every time an immobilization is planned so each has the opportunity to address respective needs without incurring additional immobilizations and compounding the animal's stress. Personnel who administer anesthesia should be familiar with and trained in safe and humane animal handling protocols[35] and in the management of anesthetized patients and emergency procedures.

Transporting Bears

The size of transport boxes is not critical when all cubs are released at the same location. The container must be sturdy enough to contain the bear and large enough to hold cubs comfortably. It is safest to place no more than two immobilized cubs in a transport box. Transporting cubs long distances (>150 km) necessitates providing them with water. Block ice is an effective option for providing bears with a source of water for extended periods of time. Wrapping transport cages in canvas or plastic tarps protects bears from cold ambient temperatures. Transport of bears during extremely hot weather should be avoided whenever possible and delayed until temperatures become moderate. It is helpful to provide bears the opportunity to wet their fur during transport in hot weather. We recommend carrying emergency immobilization equipment while transporting bears for release.

Measures must be taken to prevent the escape of bears during transport and to minimize handling time. Modifying enclosures to easily transfer bears, to move them from one enclosure to another or into transport boxes, reduces unnecessary stress to the animals and may preclude the need to administer immobilizing drugs. When animals are allowed to become comfortable with walking into and out of transport cages for a few weeks before the time of transport to a release site, stress mitigation and efficiency can be improved further.

Public Relations

Public involvement can be an integral part of reintroduction programs.[36] It provides wildlife authorities and rehabilitators an opportunity to resolve orphan cub issues in a positive light, and to educate and engage the public in wildlife management. In many areas of the world, some people believe that orphan bears should be given an opportunity for a natural life in the wild and have come to expect reintroduction efforts from their wildlife agencies. Other people may be concerned about safety or conflicts with released bears.[37–39] All of these points emphasize the importance of engaging with the public about the reintroduction plan prior to releasing bears. The public gains confidence in wildlife authori-


PHOTO ©SERGEY PAZHETNOV.

Author (JB) marking two yearling brown bears *(Ursus arctos arctos)* prior to release in Russia.

ties when the latter can share plans that clearly identify the steps taken to prepare bears for living in the wild, and that explain post-release monitoring protocols. Public awareness of contingency plans that protect people when necessary results in greater public acceptance and support for bear releases, and may improve the image of wildlife managers.[10,40]

Interventions

In some regions, the potential for bear attacks on people living, working, and recreating in bear habitat has generated concerns about reintroducing bears. Often, these fears are exacerbated by the belief that bears from captive-rearing programs are habituated to humans and that this increases the likelihood of an attack. Most reports of released bears involved in conflict activity occurred within one year of release and were related to bears accessing anthropogenic foods near home sites or in villages.[26,13] Although there is always a slight chance of a bear attack, to our knowledge there are no documented instances in which reintroduced bears attacked people.[13] Nonetheless, post-release monitoring of released bears is appropriate to allow agencies to intervene in a timely manner, should a bear enter a human settlement or demonstrate aggressive behavior toward humans. This type of monitoring is also necessary to reassure the public that human safety is a priority for wildlife officials.

Intervention plans address any conflict situation or aggressive act by a captive-reared bear toward people. In some countries, wildlife protection laws prohibit residents from killing bears who damage private property, threaten human life, or who are otherwise involved in human conflict. Under these circumstances, as in others in which people may take it upon themselves to settle bear conflicts, the prompt and efficient response of officials is of paramount importance. We recommend that intervention plans include information that documents: (a) criteria for damage compensation (where applicable); (b) the party responsible for monitoring movements and activity of released bears, including the frequency and duration of monitoring efforts; (c) criteria for deciding how to respond to an actual or perceived conflict situation, and determining which situations warrant a response; and (d) options for resolving the conflict, including criteria for euthanasia or relocation, and potential relocation areas.

Post-release Monitoring and Evaluation

Post-release monitoring is an essential aspect of captive-rearing and release programs.[4,10,15] Marking bears with an indelible mark such as a tattoo or obtaining a genetic sample from bears released to the wild and post-release monitoring (ideally using GPS–satellite collar technology) is critical to determining if rehabilitation efforts are ethically and financially justified. It can also contribute much needed information regarding success criteria and rates, as captive-rearing and release data are deficient in scientific literature for many species. Documentation of all aspects of captive-rearing and release protocols are necessary to ensure that data are used to make improvements in the future.

Conclusion

Captive-rearing and release programs have conservation implications that extend beyond obvious welfare benefits to individual animals. These include increased public support for wildlife conservation and management programs;[41,42] management of genetic diversity in small, isolated populations;[8] and restoration of bears to previously occupied habitat.[43,12,33]

We described the consensus among 36 experienced biologists and rehabilitators on important considerations for successfully raising bear cubs in reintroduction programs across the world. An analysis of post-release data documented that survival, human conflict rates, and reproduction of reintroduced bears were comparable to those reported for wild bears.[13]

Important factors that appear to increase post-release survival include restriction of human contact with cubs after weaning, keeping the time that cubs spend in rehabilitation to a minimum, and the release of cubs at body weights approximately 1.5 times the weight of similarly-aged wild cubs. During the captive-rearing process, it is important to provide bears with adequate space in as natural an environment as possible, and with opportunities for them to develop physically and socially with other bear cubs. These factors contribute to the animals' well-being by reducing stressors in the captive environment and by optimizing opportunities for natural behaviors and healthy social development.[4] The location and timing of release should be selected to optimize the bear's chances to find natural food resources.

The primary objectives of captive-rearing and release efforts are for the animals to survive at rates similar to their wild counter-

parts, avoid conflicts with humans, minimize disease and genetic risks to the indigenous wildlife population, and to reproduce. We recommend the following critical components be part of any captive-rearing and reintroduction program involving bears: (a) documenting that efforts are ethically and financially justified; (b) using science-based and data-driven captive-rearing techniques,;(c) structuring releases to give bears the best chance to successfully live in the wild; (d) marking and post-release monitoring; (e) pre-empting or quickly resolving conflicts with humans using planned intervention strategies; and (f) documenting each step of the rehabilitation, release, and post-release stages and applying the resulting data to continually make improvements in the captive-rearing and reintroduction protocols.

Acknowledgments

We thank the International Fund for Animal Welfare (IFAW) and the Trust of Mutual Understanding for supporting the 2007 International Workshop in Bear Rehabilitation and the preparation of this manuscript. We also thank all the dedicated bear rehabilitators who provided information to the authors for this paper: N.V.K. Ashraf (Wildlife Trust of India, India), L. Bereczky (Association for Conserving Natural Values, Romania), D. H. Jeong and B. K. Lee (Species Restoration Center, Korea National Park Service, South Korea), A. Langen (Northern Lights Wildlife Rehabilitation Center, Canada), S. Maughan (Idaho Black Bear Rehabilitation Center, USA), A. Karmandilis (Arcturos, Greece), T. Leaver (Woodlands Wildlife Rehabilitation Center, USA), M. Binks and J. Hamr (Laurentian University, Canada), and L. Rhodin (Montana Wildlife Center, USA). Special thanks go to G. A'Brunzo and Dr. I. Robinson at IFAW's Wildlife Rescue Program for their support and encouragement and to Drs. M. Vorontsova and V. Pazhetnov for hosting the 2007 workshop.

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Trends in wildlife intake at a rehabilitation center in Central Alberta: A retrospective analysis of birds, mammals, and herptiles, from 1990 through 2012

Dawn Doell and David A. Locky

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Great horned owl *(Bubo virginianus)*.

ABSTRACT: Using patient data from the Wildlife Rehabilitation Society of Edmonton, we assessed reasons for admission, overall success of rehabilitation, and compared temporal trends with human population growth in the region. Over the survey period 13,375 individuals from 271 species were admitted. These included 11,637 birds (87%), 1,727 mammals (13%), and 11 herptiles (<0.1%). Outcome data were not reliably collected from 1990 through 2007 so it is not possible to provide a valid rate of the rehabilitated animal release for those years. However, starting in 2008 outcome data was collected for the majority of animals with the average release rate of 45.7% from 2008 through 2012. There was a strong relationship between Edmonton's population growth and the annual intake of wildlife ($R^2 = 0.84$, $F = 104.6$, $P = 0.001$). This study provides an overview of wildlife intake trends from 1990 through 2012 and is the first known published retrospective of wildlife intake in Alberta.

KEY WORDS: birds, mammals, herptiles, retrospective analysis, species At Risk, wildlife injury, wildlife management, wildlife rehabilitation

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Introduction

Clinical wildlife medicine, also known as wildlife rehabilitation, is a subfield of wildlife management, an interdisciplinary field melding animal behavior, natural history, and veterinary medicine.[1,2] Wildlife rehabilitation provides temporary care of diseased, injured, and orphaned animals with their subsequent release into suitable habitats.[3] Facilitating population and species preservation, wildlife rehabilitation affords the unique opportunity to access scientific data in patient reports aiding in the study of human encroachment on natural habitat.[4] A unique form of wildlife management, wildlife rehabilitation acts as an indicator for animal health in urban areas, providing quantitative data essential for the evaluation of human-related effects on wildlife.[5] Anthropogenic causes of wildlife stress, injury, and mortality are numerous: abandonment of captive individuals, chemical exposure, domestic animal attacks, electrocution, entanglement in fishing line, deliberate and accidental poisoning, poaching, shooting, submersion in oil, trapping, and collisions with buildings, fences, power lines, vehicles, and windows.[6-8]

Few studies have assessed wildlife rehabilitation on a long-term scale, and those that are available focus on the mortality of select animal groups, such as birds of prey.[9] Kelley and Sleeman[10] assessed injury and death in red and gray foxes (*Vulpes vulpes* and *Urocyon cinereoargenteusm*) from 1993 through 2001; the principle reasons for admission were orphaning (33%) and trauma (27%). Wendell et al.[11] identified causes of injury and death of 409 birds of prey representing 23 species. From 1995 through 1998, the main reasons for admission were trauma (66%) and orphaning (15%). More recently, Molina-Lopez et

J. Wildlife Rehab. 36(1):17–29. © 2016 International Wildlife Rehabilitation Council.



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Common raven in an outdoor enclosure *(Corvus corax).*

al.[12] described causes of death of 7,021 birds of prey admitted from 1995 through 2007. Again, trauma (50%) and orphaning (32%) were the main reasons for admission, with infectious/parasitic diseases, electrocution, and unknown trauma included as causes. A significantly higher proportion of animals were admitted during the breeding season–brood-rearing period, leading to orphaning. These studies highlight trends of admitted wildlife for a limited range of taxa over relatively discrete time frames.

There are some shortcomings to using data from wildlife rehabilitation centers for retrospective analyses. Databases at wildlife rehabilitation centers tend to focus on specific incidents such as orphaning or domestic animal attacks instead of diagnostic-related data.[13,14] Data sets are only as consistent and accurate as volunteer staff will allow, and human error is inevitable.[3] It is important to understand that wildlife documented by wildlife rehabilitation centers have an element of non-randomness and bias related to a number of factors:[15]

1. Species representation is biased due to public perceptions and sentiments. Animals perceived as dangerous or disease-ridden are generally under-represented in these data sets while charismatic species may be over-represented.

2. Urban and suburban species will be disproportionately admitted.

3. Causes of admission related to anthropogenic factors may be overestimated.

4. The majority of natural deaths of wild animals will be undetectable.

5. Rapid death injuries will not likely be included in the data as these individuals are generally not admitted to wildlife shelters.

Wildlife rehabilitation centers generally lack access to diagnostic services and possess fewer resources, thus infectious diseases may be under-represented.[16] Also, animals that die in care are rarely tested post-mortem. Analysis of wildlife rehabilitation center data sets over longer periods are unique and can more appropriately reveal trends that could be applied to wildlife management. Our study is the first known example in Alberta of assessing long-term patient data, which identifies the overall success rate of rehabilitation on a wide range of taxa and utilizes one of the longest term data sets we are aware of.

The Wildlife Rehabilitation Society of Edmonton (WRSE) is a non-partisan, charitable organization that provides compassionate care for injured, oiled, and orphaned wildlife and educates the public on the importance of wildlife in our community.[17] Wildlife is obtained primarily from the City of Edmonton (53.5333°N, 113.5000°W) and the surrounding metropolitan areas of Spruce Grove, Stony Plain, St. Albert, Sherwood Park, and Leduc. Other collection areas include central, northern, and western Alberta and, to a lesser extent, British Columbia and the Northwest Territories.

Wild animals are admitted to WRSE by conservation officers, veterinarians, and the general public. Humane euthanasia is administered for any animal that cannot be fully rehabilitated for release back to the wild as per the Wildlife Rehabilitators Code of Ethics and Standards of Practice denoted by the National Wildlife Rehabilitator's Association.[17] Admissions are on a case-by-case basis, with detailed physical examinations to allow treatment based on an individual diagnosis. Veterinary treatment and temporary housing are permitted through the Canadian Wildlife Service and Alberta Environment Sustainable Resources Development (ESRD). The ESRD issues annual wildlife handling permits based on management plans for key taxa such as species At Risk. A species At Risk is "known to be at risk after formal detailed status assessment and legal designation as Endangered or Threatened in Alberta."[18] In accordance with section 82 of the Alberta's Wildlife Act,[19] wildlife intake data is compiled into an Annual Wildlife Report and submitted to ESRD. By working collaboratively with wildlife managers such as ESRD, WRSE aims to expand the knowledge base of local species and ultimately assist with wildlife management.

The history of the WRSE is highlighted within the Annual Wildlife Reports. In 1990, the WRSE was called the Alberta Bird Rescue Society (ABRS) and was only permitted to handle specific game, water, and perching birds. Birds of prey admitted to the ABRS were transferred to the Alberta Society for Injured Birds of Prey or the Strathcona Raptor Centre. These individuals may not have been captured in the ABRS annual reports from 1990 through 1992. Permits were issued for birds of prey in 1993, mammals in 1996 (when the organization became known as WRSE), and herptiles in 2001.

In the first ten years of the society, the Annual Wildlife Reports were compiled by the founder and only reflected the species and

animal groups specified by ESRD in accordance with Alberta's Wildlife Act.[19] Common species and invasive species, such as the house sparrow (*Passer domesticus*) and the European starling (*Sturnus vulgaris*), were only recorded intermittently as per direction from ESRD. This reduced the documented number of animals admitted, and may also reduce the ability to identify or track zoonotic diseases. For example, corvids are used to forecast human exposure to West Nile virus.[20] However, urban species listed as Secure in Alberta, such as the black-billed magpie (*Pica hudsonia*), were not required on some Annual Wildlife Reports yet were recorded intermittently (i.e., an average of 40 were admitted each year, but were not reported for 1994, 2000, 2004, or 2007). Resource allocation for black-billed magpies is quite low and disease testing may not be conducted unless the animal was symptomatic.[21] This suggests that the WRSE Annual Wildlife Reports may have underrepresented the number of corvids admitted. More important, this highlights the importance and utility of receiving and tracking as many taxa as possible from the perspective of disease tracking.

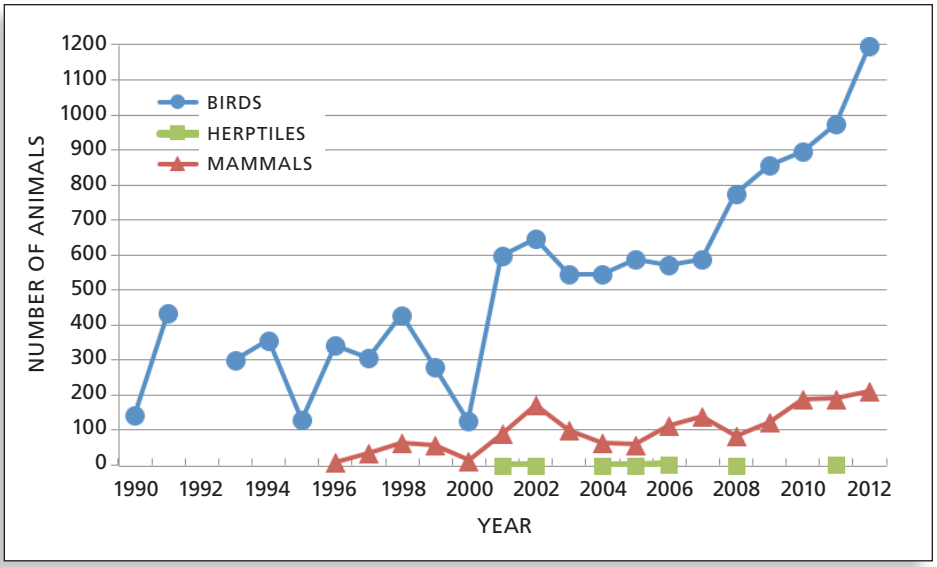


FIGURE 1: Annual admission per year to the Wildlife Rehabilitation Society of Edmonton (Birds *n* = 11,637; Herptiles *n* = 11; Mammals *n* = 1,727).

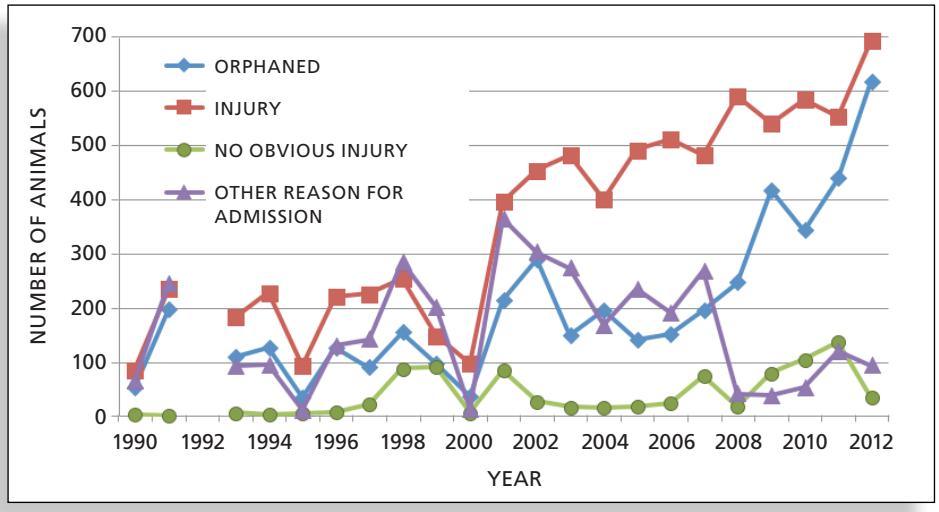


FIGURE 2: Reasons for admission for animals admitted to the Wildlife Rehabilitation Society of Edmonton from 1990 through 2012.

Our study provides an examination of WRSE's long-term data set (1990 through 2012), with data including the year of admission, species, age class, sex, reasons for admission, and the overall outcome. The objectives of our study were to develop a concise synopsis of wildlife trends in the greater Edmonton region over 22 years, aid in the implementation of standardized data collection, and compare the data set with Edmonton's growing population. We completed the following objectives:

- *Digitize data and assess efficacy of current intake recording method:* Create a standardized template for digitizing the WRSE Annual Wildlife Reports, categorize taxa, determine the conservation status of each species, and assess the efficacy of the current system, offering recommendations for an improved intake recording template.
- *Assess general trends among and within taxa:* Summarize data among taxa and within taxa, identify highest intakes by taxa and species, investigate reasons for admission, and determine the outcome of rehabilitation to WRSE.
- *Examine trends across and within taxa over time:* Compare temporal trends within taxa, and examine species currently listed as At Risk, May Be At Risk, and Sensitive.[22,18,23]
- *Examine relationship between intake data and anthropogenic factors using Edmonton population growth as an analog for development in urban areas and a loss of habitat for wildlife.*

Methods

Data Handling

The 1990 through 2012 data set for this study was obtained from hard-copy and digital WRSE Annual Wildlife Reports and transcribed to Excel® v.12.3.2 (Microsoft 2008). The WRSE 1992 data set is missing. These reports contain columns for common name, age class (adult, juvenile, or unknown), sex (male, female, or unknown), injury type (orphaned, internal/skeletal injury, no obvious injury), and the outcome (died in care, humanely euthanized, released, or transferred to another facility for recovery). The

age class and sex were used as the main reference for this study. In order to maintain consistency, an "unknown" column was added to account for discrepencies between injury type and outcome. This is because the outcome was not consistently recorded and the injury type may include multiple entries for a single animal; the total reasons for admission is 16,668, which is actually higher than the total number of animals (13,375) admitted to WRSE (Figs. 1 and 2). Using age class and sex as the basis, the missing data was counterweighted using this "unknown" column to ensure that only the data expressly stated in these reports was used in this study. Taxa were further categorized into the following groups:

- *Birds:* Birds of prey, perching birds, water birds, and game birds
- *Mammals:* Bats, carnivores, leporids, rodents, and ungulates
- *Herptiles:* Reptiles and amphibians

Additional columns were added for taxa classification and the general status within Alberta.[22,18,23] Species, family and order followed the American Ornithologists Union,[24] Mammal Species of the World,[25] and the Reptiles and Amphibians of Alberta.[26] The general status within Alberta was determined using ESRD (2010)[22] and the International Union for Conservation of Nature Red List of Threatened Species (2013).[23] These procedures facilitated a standardized data set that can be easily manipulated, providing a template transferable to the WRSE and potentially other institutions.

Data Analysis

Descriptive statistics were conducted with the results compiled into tables and figures to investigate overall trends across taxa (birds, mammals, herptiles) and within taxa using Microsoft Excel® v.12.3.2 (Microsoft 2008).

The data set was then assessed for temporal trends across the 22-year period using Edmonton population growth as a potential analogue for habitat loss and/or higher incidence of human–wildlife interaction. Data for years where population data was estimated was gleaned from COE[27] for 1994–1995, 1997–1998, 2000, and 2002–2004. Population data for 2007 and 2010 were averaged between preceding and succeeding years as the rate of change was linear through this period.

We wanted to test for associations between Edmonton's population data and the WRSE intake data. After a test to confirm normality for the response variable, intake, a regression analysis was performed on intake data and population data. All statistical analyses and the regression figure were produced using JMP v.11 (SAS 2014).[28] Significance levels for all statistical tests were set at $P <= 0.05$.

Results

General Trends

Between 1990 and 2012 the WRSE admited 13,375 animals and identified 271 species (Table 1.1). In order of abundance there were 11,637 birds (87%), 1,727 mammals (13%), and 11 herptiles (<0.1%) (Table 1.2, Fig. 1). By age class, 2,492 animals were admitted as adults (19%), 6,301 as juveniles (47%), and 4,583 were of unknown age class (34%). By sex, 5,949 were identified as male or female (16% and 28% respectively) and 7,426 (56%) were admitted with an unknown sex. Skeletal (32%) and internal (15%) injuries comprised the highest reason for admission (47%), followed by orphaning (26.6%), other reasons for admission (20.7%), and no obvious injury (5.1%) (Fig. 2). Thirty-percent of animals were not documented (Fig. 3). Outcome data were not reliably collected from 1990 through 2007 so it is not possible to provide a valid rate of rehabilitated animal release for those years. However, starting in 2008 outcome data was collected for the majority of animals with the average release rate of 45.7% from 2008 through 2012. In 2012, WRSE had a 46.8% release rate and only one unknown outcome. Initially, only common names were identified in the annual reports, but major groups were added to the data set. Overall reasons for admission and the outcomes were extrapolated by taxa.

Birds

Birds comprised the majority of animals admitted to WRSE (Table 2). Frequently admitted bird groups included birds of prey, perching birds, and water birds. Perching birds represented 49% of all animals admitted to WRSE, water birds 26%, and birds of prey 11% (Table 3). These three major bird groups comprised 87% of all of the animals admitted to the WRSE (Fig. 4). Individuals from these groups are generally admitted due to injury (61%) or orphaning (33%). However, the release rate was only 25%, with 53% dying in care or being humanely euthanized. There were 2,534 cases of unknown outcomes for these bird groups (23%). A few species of game birds showed recurring admission over the 22-year study period. Most were admitted due to injury (47%) or orphaning (41%). Twenty-six percent were released, with 46% dying in care or being humanely euthanized. Gamebirds represented only a small fraction of data, with only 76 individuals admitted over the entire study period (Table 4).

Mammals

Mammals represented 13% of all animals admitted and were first documented in 1996 (Fig. 5). Rodents and leporids comprised 84% of the mammals admitted to WRSE, while the remaining 17% included carnivores, ungulates, and bats. The mammal group was comprised of 752 rodents (44%), 690 leporids (40%), 138 carnivores (8%), 102 ungulates (6%), and 45 bats (2%) (Table 3). Twenty species of rodents represented 43% of all mammals admitted to WRSE; of these, 56% were admitted for injury and 35% were orphaned. Thirty-six percent of rodents were successfully released, with 34% of cases having an unknown outcome. Leporids comprised four species, representing 40% of all mammals admitted. Nearly 70% were admitted as juveniles, mostly due to injury and orphaning (34% each) and no obvious injuries (24%). Leporids had a lower rehabilitation success rate than other animal groups with approximately 21% (40% unknown

TABLE 1.1: ADMISSION TO THE WILDLIFE REHABILITATION SOCIETY OF EDMONTON FROM 1990 THROUGH 2012: TAXA, OUTCOME, STATUS IN ALBERTA (ESRD 2010).

Year	Taxa				Outcome			Status in Alberta†		
	Birds *(n)*	Mammals *(n)*	Herptiles *(n)*	**Total** *(n)*	% Released/ Transferred	% Died/ Euthanized	% Unknown	SAR	M	S
1990	143	-	-	**143**	15.4	35.7	49.0	0	0	18
1991	434	-	-	**434**	3.0	40.6	56.5	0	0	34
1993	300	-	-	**300**	3.3	66.0	30.7	1	0	25
1994	357	-	-	**357**	7.6	36.1	56.3	2	0	17
1995	130	-	-	**130**	11.5	86.2	2.3	1	1	25
1996	343	9	-	**352**	6.5	52.3	41.2	2	2	27
1997	306	36	-	**342**	6.4	50.9	42.7	0	14	25
1998	430	65	-	**495**	5.1	37.6	57.4	0	0	20
1999	280	58	-	**338**	3.8	36.7	59.5	0	1	22
2000	126	14	-	**140**	5.0	85.0	10.0	0	0	11
2001	598	92	1	**691**	13.5	33.0	53.5	8	4	34
2002	647	172	1	**820**	6.2	49.5	44.3	5	1	40
2003	546	101	0	**647**	16.2	39.1	44.7	5	2	38
2004	546	64	1	**611**	18.2	53.8	28.0	4	1	37
2005	589	60	1	**650**	17.8	44.8	37.4	2	2	46
2006	573	115	2	**690**	20.4	61.7	17.8	6	3	35
2007	588	139	0	**727**	15.0	52.4	32.6	6	4	46
2008	775	85	1	**861**	40.4	57.8	1.7	9	0	52
2009	858	125	0	**983**	46.8	52.7	0.5	3	2	56
2010	896	189	0	**1,085**	43.6	56.4	0.0	5	1	71
2011	975	191	4	**1,170**	50.9	49.1	0.0	3	2	64
2012	1,197	212	0	**1,409**	46.8	53.1	0.1	1	1	94
Total	**11,637**	**1,727**	**11**	**13,375**	**18.3**	**51.4**	**30.3**	**63**	**41**	**837**

†SAR = species At Risk; M = May Be At Risk; S = Sensitive or Species of Special Concern (ESRD 2010)
– Data not collected for these taxa during the indicated years

TABLE 1.2: SUMMARY OF ANNUAL DATA PRESENTED IN TABLE 1.1.

Taxa	Birds	Mammals	Herptiles	Total
# of Species *(n)*	226	42	3	271
Year First Admitted	1990	1996	2001	22 Years
Mean (±SD)	529 (284)	102 (62)	1.6 (1.1)	608 (348)
Minimum	126	9	0	130
Highest Intake Per Year	1,197	212	4	1,409

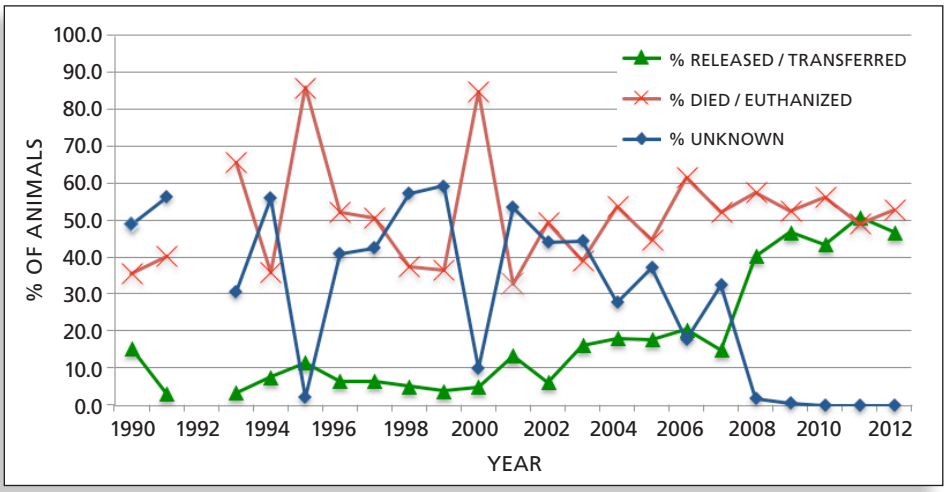


FIGURE 3: Outcome of animals admitted to the Wildlife Rehabilitation Society of Edmonton from 1990 through 2012 (Unknown Outcome *n* = 4,074; Died/Euthanized *n* = 6,727; Released/Transferred *n* = 2,574).

TABLE 2: HIGHEST INTAKE PER SPECIES ADMITTED TO THE WILDLIFE REHABILITATION SOCIETY OF EDMONTON FROM 1990 THROUGH 2012.

Common Name		Species Name	Total *(n)*
American robin		*Turdus migratorius*	1,995
mallard		*Anas platyrhynchos*	1,244
black-billed magpie		*Pica hudsonia*	699
American crow		*Corvus brachyrhynchos*	636
white-tailed jackrabbit		*Lepus townsendii*	634
red squirrel		*Tamiasciurus hudsonicus*	562
blue jay		*Cyanocitta cristata*	365
Canada goose		*Branta canadensis*	360
bohemian waxwing		*Bombycilla garrulus*	351
ring-billed gull		*Larus delawarensis*	336
common goldeneye		*Bucephala clangula*	335
house sparrow		*Passer domesticus*	329
great horned owl		*Bubo virginianus*	311
cedar waxwing		*Bombycilla cedrorum*	268
red-tailed hawk		*Buteo jamaicensis*	225
merlin		*Falco columbarius*	224
house wren		*Troglodytes aedon*	177
northern flicker		*Colaptes auratus*	168
Swainson's hawk	†	*Buteo swainsoni*	146
chipping sparrow		*Spizella passerina*	132
blue-winged teal		*Anas discors*	106
lesser scaup	†	*Aythya affinis*	97
American coot		*Fulica americana*	93
white-tailed deer		*Odocoileus virginianus*	90

† *Listed as Sensitive in Alberta (ESRD 2010)*

TABLE 3: NUMBER OF SPECIES AND TOTAL INDIVIDUALS ADMITTED TO THE WILDLIFE REHABILITATION SOCIETY OF EDMONTON.

Group	Taxa	Species *(n)*	Total *(n)*
Birds	Perching	117	6,592
	Water	71	3,439
	Birds of Prey	27	1,531
	Game	13	76
Mammals	Rodents	20	752
	Leporids	4	690
	Canids	9	138
	Ungulates	3	102
	Bats	6	45
Herptiles	Reptiles	2	9
	Amphibians	1	2

outcomes). Intake of rodents and leporids was comparatively variable year to year (Table 5). Forty-five bats from six species of bats were admitted from 1996 through 2011 (Table 3). Injuries were the main reason for admission (62%), and the rehabilitation success rate was 42% with 18% unknown outcomes.

Nine species of carnivores totaling 138 individuals were admitted during the study period (Table 3). Carnivores had a high frequency of admission with no obvious injuries (39%) or they were admitted with multiple injury types (i.e., 138 individuals, but 214 reasons for admission). Twenty-six percent were treated on-site and then transferred to neighboring rehabilitation facilities for long-term recovery. Of the total admitted carnivores, 43% had unknown outcomes.

One hundred and two ungulates were admitted during the study period (Table 3). Ungulates had a high rate of injury, 40% of all reasons for admission. Generally admitted as juveniles (78%), 18% were orphaned, and 12% were treated and then transferred to another facility for long-term recovery. The documented rehabilitation release rate for ungulates was only 25%, with 43% of animals having an unknown outcome. Similar to carnivores, 78% of ungulates were admitted as juveniles, most likely because they are far easier to capture as juveniles and due to safety concerns regarding interactions with adults.

Herptiles

Herptile intake began in 2001 and averaged two individuals per year, representing less than 0.1% of all animals admitted (Tables 1.1 and 1.2). There were 11 individuals from three species: the garter snake (*Thamnophis spp.*), the tiger salamander (*Ambystoma tigrinum*), and the western painted turtle (*Chrysemys picta*). Three garter snakes were admitted between 2001 and 2012; two had skeletal damage and the third had no obvious injury, and all three were released. An adult tiger salamander was released on-site in 2006, while in 2011 an injured individual was euthanized due to its injuries. A western painted turtle was admitted in 2002, 2005, 2006, 2008, and two were admitted in 2011. One died in care, four were released, and one had no known outcome. The tiger salamander is listed as Secure in Alberta, and the garter snake and western painted turtle are listed as Sensitive in Alberta.[22]

Intake Trends

Since 1990, annual admission rates have increased steadily, with 2012 having the highest overall intake (Tables 1.1 and 1.2). Of the 1,409 animals admitted that year, the highest intake was for birds (1,197) and mammals (212) (Fig. 1). Based on wildlife permits acquired by WRSE, birds were admitted to WRSE since 1990, mammals since 1996, with wildlife handling permits issued for herptiles in 2001. Between 1990 and 1995, 1,364 birds from 127 species were documented. The majority could not be identified by age class (84%), but were identified as mostly female (60%). Most were admitted

due to skeletal injuries (34%), orphaning (28%), and other reasons for admission (27%). Only 87 individuals from 46 species were successfully released (6%) in the first five years. The rest were humanely euthanized (14%), died in care (35%), or were listed as "unknown" (45%). It is important to note that the data set from 1992 was not found, and 1995 featured lower documentation than adjacent years.

In 1996, wildlife handing permits were issued for certain mammals. Between 1996 and 2000, the WRSE admitted 182 individuals from 15 mammal species in all taxa: bats, carnivores, leporids, rodents, and ungulates (Tables 1.1 and 1.2). All mammal species were listed as Secure in Alberta. There was a high intake of juveniles (77%), admission due to various injuries (22%), orphaning (20%), and other reasons (44%). Rehabilitation of mammals featured a high incidence of unknown outcomes (81%).

Bird intake increased from the previous five-year period, with 1,485 birds admitted from 1996 through 2000. While the previous period (1990–1995) featured a high degree of unknown age classes, the second period (1996–2000) showed a higher proportion of adults (15%), juveniles (53%), and a lesser degree of unknown age classes (31%). Sex was more difficult to determine. Only 132 males (9%) and 296 females (19%) were defined, yet 1,057 individuals were not identified (71%). The reasons for admission included skeletal injury (27%), orphaning (21%), internal injury (14%), and other reasons (30%). Seventy-seven (5%) birds were released, similar to the success rate between 1990 and 1995.

TABLE 4: DESCRIPTIVE STATISTICS FOR THE ANNUAL ADMISSION OF BIRD GROUPS ADMITTED TO THE WILDLIFE REHABILITATION SOCIETY OF EDMONTON FROM 1990 THROUGH 2012.

Bird Group	Birds of Prey	Game Birds	Perching Birds	Water Birds
Mean (±SD)	69.7 (36.9)	3.5 (3.3)	299.5 (167.9)	156.3 (89.5)
Range	129	14	643	341
Minimum	0	0	44	34
Maximum	129	14	687	375
Sum	1532	76	6589	3439

TABLE 5: DESCRIPTIVE STATISTICS FOR THE ANNUAL ADMISSION OF MAMMAL GROUPS ADMITTED TO THE WILDLIFE REHABILITATION SOCIETY OF EDMONTON FROM 1990 THROUGH 2012.

Mammal Group	Rodent	Leporid	Carnivore	Ungulate	Bat
Mean (±SD)	44.2 (31.4)	40.6 (35.9)	8.1 (6.9)	6.0 (4.2)	2.6 (2.7)
Range	99	118	26	15	8
Minimum	0	0	0	0	0
Maximum	99	118	26	15	8

TABLE 6: BIRDS OF PREY AND THEIR STATUS IN ALBERTA AS ADMITTED PER YEAR TO THE WILDLIFE REHABILITATION SOCIETY OF EDMONTON FROM 1990 THROUGH 2012.

Common Name	Species Name	Status in Alberta	Total *(n)*
great horned owl	*Bubo virginianus*	Secure	311
red-tailed hawk	*Buteo jamaicensis*	Secure	225
merlin	*Falco columbarius*	Secure	224
Swainson's hawk	*Buteo swainsoni*	Sensitive	146
northern saw-whet owl	*Aegolius acadicus*	Secure	79
peregrine falcon	*Falco peregrinus*	At Risk	57
sharp-shinned hawk	*Accipiter striatus*	Secure	56
snowy owl	*Bubo scandiacus*	Secure	53
bald eagle	*Haliaeetus leucocephalus*	Sensitive	49
long-eared owl	*Asio otus*	Secure	42
Cooper's hawk	*Accipiter cooperii*	Secure	41
great gray owl	*Strix nebulosa*	Sensitive	40
American kestrel	*Falco sparverius*	Sensitive	38
short-eared owl	*Asio flammeus*	May Be At Risk	36
northern goshawk	*Accipiter gentilis*	Sensitive	32
rough-legged hawk	*Buteo lagopus*	Secure	23
northern hawk owl	*Surnia ulula*	Secure	15
golden eagle	*Aquila chrysaetos*	Sensitive	15
osprey	*Pandion haliaetus*	Sensitive	12
boreal owl	*Aegolius funereus*	Secure	11
barred owl	*Strix varia*	Sensitive	9
broad-winged hawk	*Buteo platypterus*	Sensitive	8
northern harrier	*Circus cyaneus*	Sensitive	4
turkey vulture	*Cathartes aura*	Secure	3
prairie falcon	*Falco mexicanus*	Sensitive	3
ferruginous hawk	*Buteo regalis*	At Risk	1
Harlan's hawk	*Buteo jamaicensis*	Secure	1

Total: 27 species, 1534 individuals

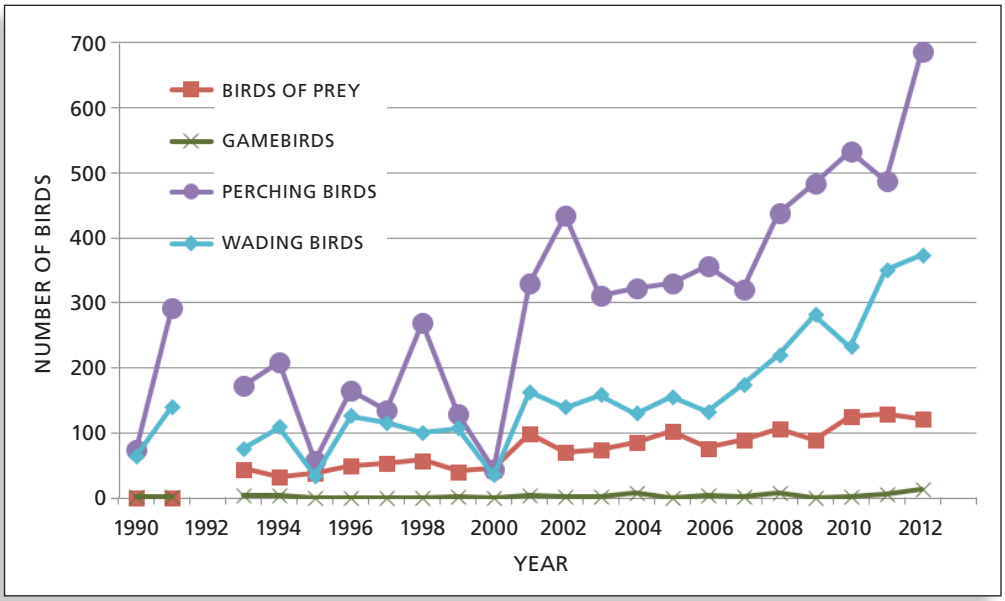


FIGURE 4: Major bird groups admitted to the Wildlife Rehabilitation Society of Edmonton from 1990 through 2012 (Birds of Prey *n* = 1,531; Gamebirds *n* = 76; Perching Birds *n* = 6,592; Water Birds *n* = 3,439).

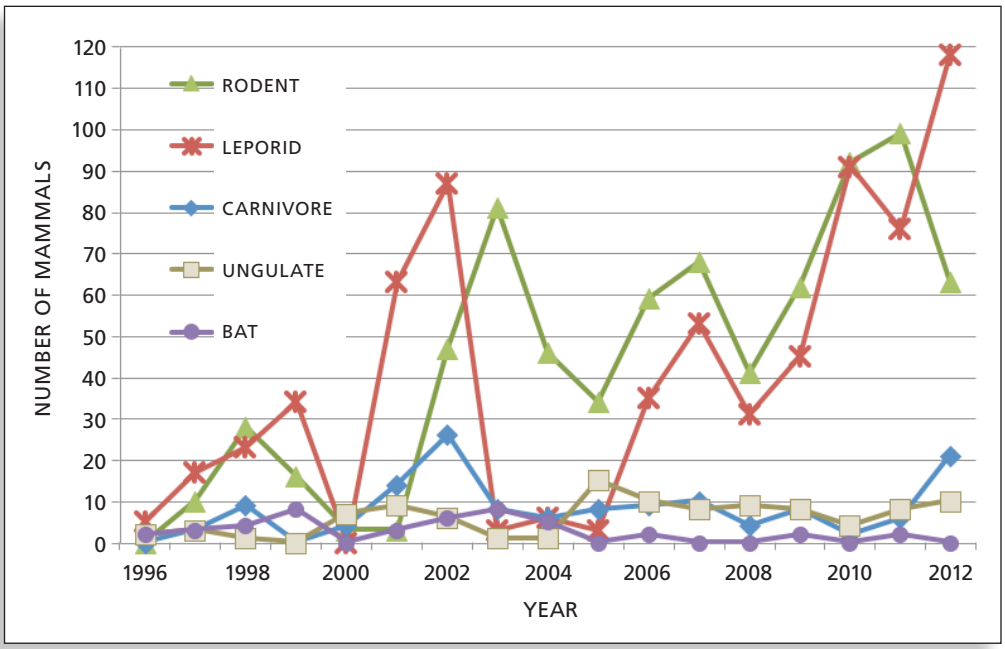


FIGURE 5: Major mammal groups admitted to the Wildlife Rehabilitation Society of Edmonton from 1996 through 2012 (Rodent *n* = 752; Leporid *n* = 690; Carnivore *n* = 138; Ungulate *n* = 102; Bat *n* = 45).

Risk Status

Of the 13,375 animals admitted to WRSE over the last 22 years, 942 (7%) were listed as Sensitive, May Be At Risk, or species At Risk as per the general status of Alberta Wild Species Report[18,22] (Table 6). Of these, 74% were admitted in the last 12 years including 90% of all documented species At Risk. Of the 942 animals with an identified status in Alberta, 63 birds were identified as species At Risk: the ferruginous hawk (*Buteo regalis*), piping plover (*Charadrius melodus*), trumpeter swan (*Cygnus buccinator*), and peregrine falcon (*Falco peregrinus*). Sixty-seven percent of the species At Risk were admitted due to skeletal and internal injury, while 13% were admitted as orphaned individuals. The remaining birds did not have observable injuries and were either transferred to another care facility or released. Species At Risk have a relatively high release rate of 41%, higher than the overall release rate (26%). Species At Risk may represent a small percentage of all animals admitted, yet at least one Species At Risk was admitted per year from 1993 through 1996 and 2001 through 2012.

There were only two species of birds listed as May Be At Risk in Alberta: the olive-sided flycatcher (*Contopus cooperi/borealis*) and the short-eared owl (*Asio flammeus*). Considered near-threatened by the International Union for Conservation of Nature,[23] two female olive-sided flycatchers were admitted in 2007. Orphaned with skeletal damage, the outcome for these individuals is unknown. Short-eared owls, also classified as May Be At Risk in Alberta, were admitted regularly from 1995 through 2012 and average two individuals per year. Admitted due to injury (92%) and orphaning (8%), only two were successfully released, one in 1997, the other in 2012. Nearly 59% were humanely euthanized, 18% died in care, and the rest resulted in unknown outcomes

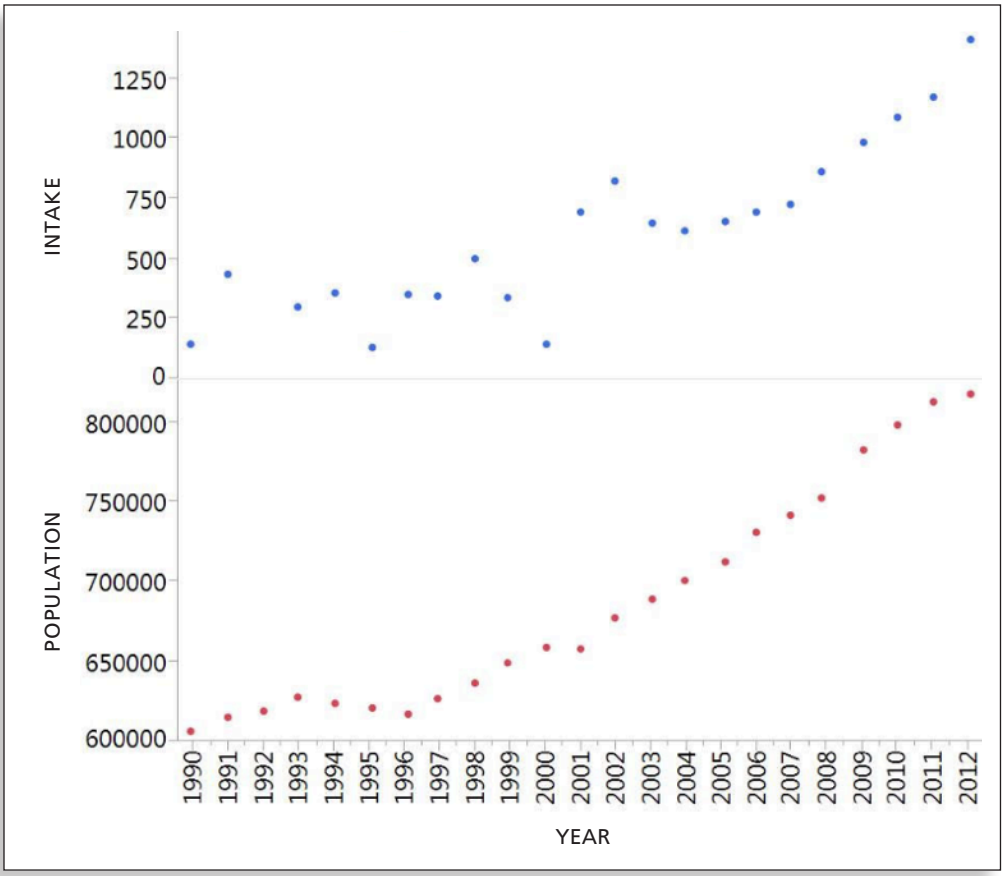


FIGURE 6: Comparison between annual wildlife intake from WRSE (top panel) and Edmonton's population, from 1990 through 2012 (bottom panel) (Data Source, COE 2012).

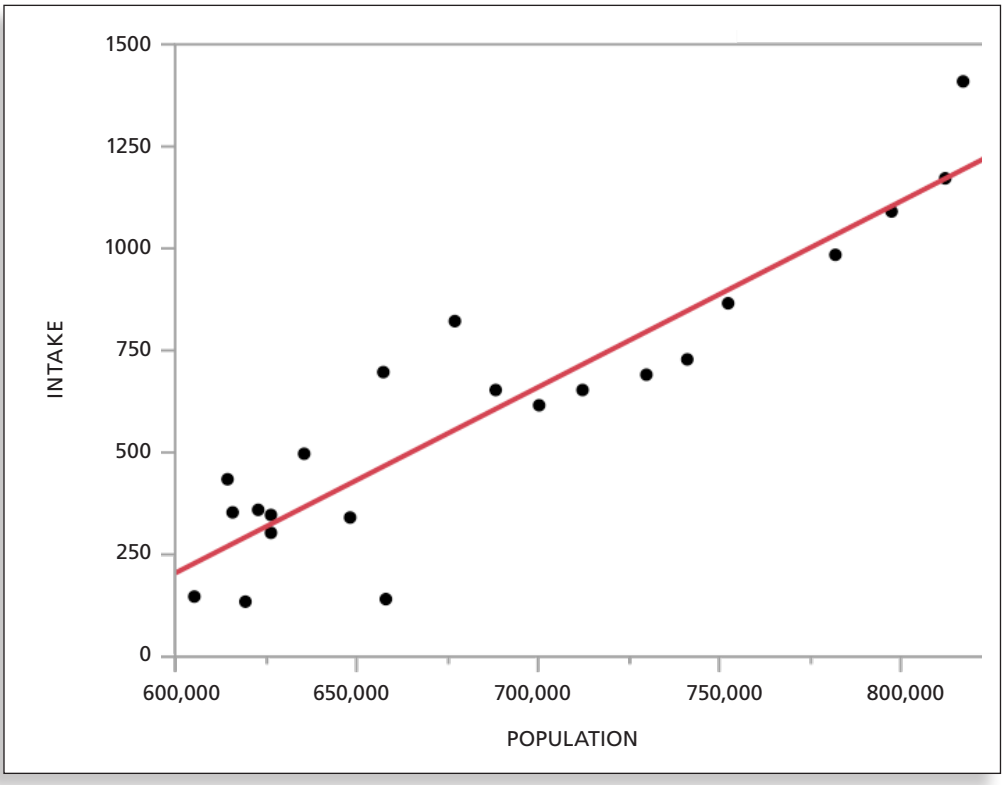


FIGURE 7: Relationship between annual wildlife admission from WRSE and Edmonton's population from 1990 through 2012 (R^2 = 0.84, F = 104.6, P = 0.001)

(18%). These two species represent native species in Alberta that May Be At Risk.

Wildlife Intake and Human Population Growth

We compared the WRSE data set to anthropogenic factors using Edmonton population growth as an analog for development and habitat loss. Edmonton's population growth was not entirely linear over the period, with 1990 through 1996 reflecting the boom and bust cycle of Alberta's economy (Fig. 6). Post 1996, Edmonton's population growth grew relatively linearly to 2012. There were strong relationships between population growth and annual intake of wildlife ($R^2 = 0.84$, $F = 104.6$, $P = 0.001$) (Fig. 7). The trend was relatively linear, particularly from 2004 through 2013 (Fig. 6). A very large increase in percent release rate is evident from between the years 2007 and 2008, when the rate jumped from 15% to 40%. This trend continued in a positive linear fashion until the end of the study period.

Discussion

Efficacy of Annual Wildlife Reports

The Wildlife Rehabilitation Society of Edmonton (WRSE) produces wildlife reports that are submitted annually to Alberta Enivironmental Sustainable Resource Development (ESRD). These reports were intended to reflect species intake, particularly of species such as birds of prey, migratory species, and species listed as Sensitive, May Be At Risk, or At Risk in Alberta.[18,22]

Properly staffed and resourced wildlife rehabilitation facilities are capable of gleaning tremendous amounts of quantitative and qualitative data from a single animal.[29,3] Combined into a long-term data set, researchers may obtain access to these records, but the quality may vary considerably.[30] The legibility, variety, completeness, and overall accuracy may vary annually, and there may also be differences between species' relative importance and a caretaker's dedication to reporting requirements. Preliminary information on species, age, sex, and intial cause of injury tend to be inconsistently recorded, and the primary reasons for admission are frequently recorded as an incident, such as "orphaned" or "caught by cat." Patient medical records include species, sex, age, date of admission, township where found, reason for admission (injury, disease, or uninjured), cause of injury, weight, body condition, primary diagnosis, treatment, outcome, and release month and site.[29,31] However, the underlying clinical, etiological, or pathological diagnosis may be determined during care, but this is rarely transcribed to Annual Wildlife Reports.[32] Improving transferral of information from clinical diagnosis back to the original report would greatly enhance our knowledge of wildlife intake trends and associated diseases, particularly post-mortem.

Calculating accurate mortality and rehabilitation success rates is difficult to determine due to a lack of standardized data collection methods on Annual Wildlife Reports.[3] In this study, it is important to note that the data set from 1992 was not found, and 1995 featured lower documentation than did adjacent years. This was attributed to sparse requirements for reporting and staffing issues. Animal care, facility cleaning, and equipment maintenance were the main priorities for the first ten years, and it wasn't until the facility grew in popularity and the shelter started attracting more volunteers that the annual reports were given more attention.

Data digitized from WRSE's hard-copy reports also contained sum discrepencies for each column, corrected by adding an "unknown" column to account for missing data. As a not-for-profit charity, the WRSE relies on volunteers, donations, and funding to operate. However, there was a need for this service in the community, and the last twelve years saw a remarkable dedication to improving reporting and increasing the awareness of wildlife in our community. Increased release rates are attributed to "advancement of veterinary science and veterinary education, biodiversity conservation and ecological health, wildlife health monitoring, public health and biosecurity, as well as public education and public policy."[3] In regard to the overall outcomes, this study features a 26% overall release rate with 24% unknown outcomes, potentially reducing the overall successful release rate. The documented release rate was approximately 5% for the first ten years, but since 2001 has averaged 32% per year.

General Trends

Anthropogenic causes of wildlife stress, injury, and mortality are numerous. Abandonment of captive individuals, chemical exposure, domestic animal attacks, electrocution, entanglement in fishing line, deliberate and accidental poisoning, poaching, shooting, submersion in oil, trapping, and collisions with buildings, fences, power lines, vehicles, and windows are some of the significant issues.[7,8] Many of these are evident in behavior profiles, feeding habits, body size, and overall disposition, all of which influence the risks for injury and death.[5,33] These factors contribute to an animal's survival in temporary captivity and their response to medical treatment.[3] Animals admitted for trauma may have an underlying condition that enabled capture and subsequent admission to the WRSE.[11] Owing to the cost of analysis, many suspected cases of poisonings were not confirmed, and were classified as unknown.

Since 2001, there was a steady increase in wildlife admission with relatively uniform proportions of birds, mammals, and herptiles. As of 2001, the WRSE was staffed year-round and the Annual Wildlife Reports were given priority, indicated by the spike in documented admissions from 2001 through 2012. WRSE documented 77% of all animals admitted during this period. This indicates an improved efficiency in documentation. The difference in reporting is most obvious between 2000 and 2001 where admission increased from 143 to 691. The principle reasons for admission over this twelve-year period were orphaned animals (28%), while half of the animals were admitted due to injury. The unknown outcomes have also decreased annually; 24% of the animals died in care while 27% were humanely euthanized.

The first 10 years did not encapsulate all of the species admitted to the WRSE, as they were focused on species of interest specified by ESRD. However, the last 12 years saw an overall increase

in species admission. More stringent data collection methods have allowed for a more accurate verification of the annual rehabilitation success rate. The release rate was approximately 5% for the first 10 years, but since 2001 has ranged between 32% and 45%. Accurately identifying age class or sex can be challenging, with 34% of unknown age class and 56% admitted with an unknown sex. The great scope of intake taxa, increased resources, and more rigorous reporting have resulted in significant increases in WRSE report accuracy.

Intake Trends

While the majority of birds are listed as Secure in Alberta (92%), several species were considered uncommon in central Alberta. For instance, in 1990 an orphaned male juvenile harlequin duck (*Histrionicus histrionicus*) was admitted but died in care. Its range is west of the Rocky Mountains, so its admission in central Alberta was noted as rare. A juvenile glaucous gull (*Larus hyperboreus*) was admitted in 2001 with no known injuries and was immediately transferred to another facilty. A migratory sea bird that breeds in the Arctic and Atlantic coasts of Europe, the glaucous gull's wintering grounds are the North Atlantic and North Pacific oceans, and northern states of the USA. Its conservation status is of Least Concern by the IUCN (2013), yet it is considered uncommon in central Alberta. An individual male Northern mockingbird (*Mimus polyglottos*) was admitted in 2004 due to injuries and was humanely euthanized. Its range is central to southern United States, so its admission in central Alberta is considered a very rare anomaly. Black-headed grosbeaks (*Pheucticus melanocephalus*) were admitted in 2007, 2011, and 2012, and may indicate a rising trend for this uncommon species. Unfortunately, none survived. An orphaned juvenile wood duck (*Aix sponsa*) was successfully released in 2012. Considered of least concern by IUCN (2013), and found only along the river systems in southern Alberta, it is uncommon in central Alberta. These species represent a small percentage of the overall species intake, yet represent unusual or rare anomalies in the data set that may require further investigation.

No mammals admitted to WRSE were At Risk, but there were some species of note. In 2001, a male juvenile northern raccoon (*Procyon lotor*) was admitted with no obvious injuries and was transferred to another rehabilitation facility. Traditionally residing in the province's southeast, racoon territory has expanded into central Alberta.[22] In 2011, a female juvenile eastern grey squirrel (*Sciurus carolinensis*) was humanely euthanized due to internal injuries. The eastern grey squirrel was introduced into the city of Calgary in southern Alberta,[22] and even though it is considered to have sparse extralimital populations in Alberta, it is considered an invasive species that may compete with native species.[34]

Listed as Secure in Alberta, three native mammal species were well-represented despite being admitted only within the last 16 years: 634 white-tailed jackrabbits (*Lepus townsendii*), 562 red squirrels (*Sciurus vulgaris*), and 90 white-tailed deer (*Odocoileus virginianus*). Even though 1996 was the first year WRSE was permitted to admit mammals, orphaned white-tailed jackrabbits and red squirrels soon became one of the top intakes for WRSE. This trend inspired major components of the Education Programs at WRSE and highlights the efficacy of volunteer wildlife rehabilitation programs in communities.

Herptiles represent the lowest intake of all taxa, yet their presence in WRSE records suggests that the public are concerned for native herptile species in Alberta. In a 14-year study of herptile admissions to Willowbrook Wildlife Center (WWC) in Illinois, Hartup[31] determined risk factors, assessed protocols, and reviewed preventive measures against human-caused injury and mortality. More frequent admission of healthy, uninjured herptiles translated into hundreds of unnecessary admissions into WWC that ultimately resulted in translocations into forest preserves. This action could potentially disrupt population structures in natal habitats, encourage the spread of transmitable diseases, and affect the population dynamics within the preserve itself. Hartup[31] showed a progressively decreasing proportion of uninjured herptiles that was ultimately attributed to WWC's public education initiatives to prevent interference with uninjured native wildlife. While this study highlighted a high rate of release, it concluded that a more profound contribution to herptile conservation is the prevention of human-related impacts to local populations. Rehabilitation of reptiles and amphibians is a growing field within wildlife rehabilitation.[35,30]

Wildlife Intake and Human Population Growth Trend

There is a close relationship between the total number of animals admitted to WRSE to Edmonton's population growth over 22 years. As human populations encroach into wild areas, habitat is lost, domestic animals increase in number, and the rate of intake to rehabilitation centers will concomitantly increase. Education programs provided by WRSE and associated organizations inform citizens about when wildlife should be brought into rehabilitation centers. This may serve to reduce unnecessary intake and also foster a greater appreciation for urban wildlife.

The role and responsibilities of WRSE and similar rehabilitation centers appear to be increasing over time. A pilot study conducted on Vancouver Island, BC, examined opportunties and obstacles in regard to collecting and evaluating wildlife data for public health surveillance.[32] This study inventoried existing sources of data and evaluated approaches to data collection for causes of wildlife morbidity and mortality. Wildlife rehabilitation facilities were shown to frequently encounter the greatest variety of wildlife taxa within a wide geographic area. However, it was shown that only a few select groups encounter wildlife on a regular basis: wildlife rehabilitation facilities, veterinarians, government environmental departments, municipal public works, road maintenance crews, animal control groups, public health units, universities, hunters, and trappers. Trained researchers play an important role in wildlife detection, including field personnel, biologists, conservation officers, naturalists, and park wardens.[36] And yet, WRSE, like most wildlife rehabilitation societies,

relies on the general public for wildlife capture. Public training and education are the key to reducing anthropogenic causes of wildlife stress, morbidity, and mortality.[32] Public education programs increase compliance to wildlife handling procedures and may ultimately reduce the number of uninjured individuals admitted. Public participation in wildlife detection and capture is highlighted in the WRSE public education programs and wildlife intervention protocols are recorded on the public wildlife hotline. While population growth in itself will lead to increased wildlife intake, improved WRSE public education protocols have very likely enhanced WRSE animal intake over time.

Conclusions

Wildlife rehabilitation societies possess vast amounts of information readily available for the purpose of research. From 1990 through 2012 WRSE admitted 13,375 animals from 271 species. The statistics obtained by analyzing our intake data are consistent with similar retrospective analyses of wildlife rehabilitation in terms of cause of admission and eventual disposition. Outcomes varied among animals groups (birds, mammals, and herptiles), but also within taxa (e.g., birds of prey), and among species status within Alberta (Sensitive, May Be At Risk, or At Risk). Outcome data were not reliably collected from 1990 through 2007 so it is not possible to provide a valid rate of the rehabilitated animal release for those years. However, starting in 2008 outcome data were collected for the majority of animals with the average release rate of 45.7% from 2008 through 2012. This significant improvement in release rates is attributed to more-stringent collection of rehabilitation outcomes on the Annual Wildlife Reports.

The principle obstacle to retrospective analyses of wildlife rehabilitation is a lack of detailed data in Annual Wildlife Reports. With modest effort, standardized procedures could be implemented to improve data collection. These data sets could easily be incorporated into a larger, networked database that could be accessed by neighbouring rehabilitation facilities, greatly expanding the geographical area. Data collected from wildlife rehabilitation centres are a unique resource: they provide opportunities for retrospective analyses that highlight regional wildlife population trends and expansion of species natural history, thus improving our awareness of rare species distributions and populations, providing more insight into the dynamics of wildlife diseases, and ultimately informing wildlife management.

About the Authors

Dawn Doell, primary and corresponding author, has a diploma in Applied Communications & Professional Writing and a Bachelor of Science majoring in Biological Sciences. A long-standing volunteer with the Wildlife Rehabilitation Society of Edmonton, she observed that an analysis of the society's data had never been conducted. Dawn obtained a data-sharing agreement and began the two-year process of digitizing hard-copy annual reports. She worked closely with the secondary author to analyze and interpret the data set.

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years old, it is estimated Wisdom is at least 64 years old, but she could be older.

Although Laysan albatrosses typically mate for life, Wisdom has likely had more than one mate and has raised as many as 36 chicks. Laying only one egg per year, a breeding albatross will spend a tiring 130 days (approximately) incubating and raising a chick. When not tending to their chicks, albatrosses forage hundreds of miles out at sea periodically returning with meals of squid or flying fish eggs. Wisdom has likely clocked over six million ocean miles of flight time.

Fox Squirrel Subspecies Removed from US ESA

Milton, Delaware, USA (November 13, 2015)—The US Fish and Wildlife Service (FWS) officially removed the Delmarva Peninsula fox squirrel from the list of Threatened and Endangered Wildlife under the Endangered Species Act (ESA) in December, 2015. The removal was due to concerted conservation efforts by states, landowners, and others working with the FWS. The squirrel, one of the animals included on the first list of endangered species nearly a half century ago, is no longer at risk of extinction.

"The fox squirrel's return to this area, rich with farmland and forest, marks not only a major win for conservationists and landowners, but also represents the latest in a string of success stories that demonstrate the Endangered Species Act's effectiveness," said Michael Bean of the US Department of the Interior. "The Act provides flexibility and incentives to build partnerships with states and private landowners to help recover species while supporting local economic activity. I applaud the states of Maryland, Delaware, and Virginia, and the many partners who came together over the years to make this day possible."

"This is a major conservation success story that is the result of strong partnerships and good stewardship of our land and wildlife," said US Senator Chris Coons. "I am so proud of the peninsula's landowners, conservation organizations, and state officials for their work to bring the Delmarva fox squirrel back from the brink of extinction."

"The natural world is amazingly resilient, especially when a broad collection of partners works together to help it," said US Senator Ben Cardin, a senior member of the Environment and Public Works Committee. "Today's announcement is a major victory for the Endangered Species Act and the Delmarva fox squirrel itself, and much credit is due to the federal biologists who have worked for decades to rebuild the squirrel's populations. But we could not have reached this point without the many citizen-conservationists who changed the way they managed their forest lands to make this victory possible, and I am deeply appreciative of their efforts. I will continue to champion the work that the Fish and Wildlife Service does to protect endangered species in the future."

Larger than other squirrel species and generally not found in suburban or urban areas, the Delmarva Peninsula fox squirrel ranged throughout the Delmarva Peninsula of Maryland, Delaware, and Virginia before experiencing a sharp decline in the mid-20th century due to forest clearing for agriculture and development, short-rotation timber harvest, and over-hunting. With its range reduced more than 90 percent, the squirrel was one of 78 species listed under the Endangered Species Preservation Act in 1967, the predecessor of the ESA enacted six years later.

With more than 80 percent of the squirrel's home on private land, the squirrel has thrived on the rural, working landscapes of the peninsula where mature forests mix with agricultural fields.

Since listing, the squirrel's range has increased from four to 10 counties, and a population of up to 20,000 squirrels now covers 28 percent of the Delmarva Peninsula, primarily in Maryland.

Efforts contributing to recovery include translocation of animals to establish new populations, closing of the targeted hunting season, growth and dispersal of the population, and protection of large forested areas for habitat.

Prior to its 2014 proposal to remove the squirrel from the endangered species list, FWS followed a rigorous and detailed process to assess the Delmarva fox squirrel's extinction risk. The agency's 2012 five-year review analyzed the status of populations, habitat, and threats; considered the delisting criteria from the 1993 recovery plan (PDF); and ultimately recommended to delist the species because it is no longer in danger of extinction. A post-delisting monitoring plan will ensure the squirrel remains secure from extinction.



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Gray wolf *(Canis lupus).*

Progress Against Poaching

Washington, DC, USA (November 2, 2015)—The House passed the Global Anti-poaching Act (H.R. 2494), legislation authored by US Rep. Ed Royce (R-CA), Chairman of the House Foreign Affairs Committee, which helps the United States and partner countries combat today's unprecedented level of poaching and wildlife trafficking. The bill is now with the US Senate Committee on Foreign Relations.

On the legislation's passage, Chairman Royce said,

> The very disturbing reality is that some of the world's most majestic animals have become 'blood currency' for rebel groups and terrorist organizations in Africa. Poaching is bigger than natural security. It is a national security issue. Wildlife trafficking is now among the most lucrative criminal activities worldwide—worth an estimated $10 billion annually.
>
> Time isn't on our side. Each day of inaction means more animals poached and more cash for terrorists. This vital legislation holds foreign governments accountable by 'naming and shaming' the worst violators and adds greater consequences for traffickers in this illicit trade. And it presses the Administration to continue to provide important security assistance to African park rangers.

Additionally, the legislation:

- requires the Secretary of State to identify the foreign countries determined to be a major source, transit point, or consumer of wildlife trafficking products and make a special designation for those countries that have "failed demonstrably" in adhering to international agreements on endangered or threatened species (the Secretary of State is authorized to withhold certain assistance from countries that have received this special designation);
- puts wildlife trafficking in the same category as weapons trafficking and drug trafficking, making it a liable offense for money laundering and racketeering, and requires fines, forfeitures, and restitution received to be transferred to federal conservation and anti-poaching efforts;
- presses the Administration to continue to provide security assistance to African countries for counter–wildlife-trafficking efforts;
- expands wildlife enforcement networks to help partner countries strengthen coordination and share information and intelligence on illegal wildlife trafficking on a regional basis; and
- supports increased professionalization of partner countries' wildlife law enforcement rangers on the front lines of the fight against poachers, who are often armed with night-vision goggles, heavy weaponry, and even helicopters.

Applying Science to Carnivore Hunting

New York, USA (December 17, 2015)—An international group of carnivore biologists, writing in the journal *Science,* say that policies regulating the hunting of large carnivores do not always align with basic scientific data.

The team, which includes scientists from the Wildlife Conservation Society (WCS), Montana State University, Trent University, and Oxford University, who collectively have decades of experience studying wolves, lions, African wild dogs, tigers, dingoes, and sharks, found that current harvest levels for the recently de-listed population of gray wolves in the northern Rocky Mountains of the United States have led to decreased survival and reproduction, smaller packs, social disruption, and a reversal from population growth to decline.

Lead author Scott Creel of Montana State University noted: "Current policies state that half of a wolf population can be shot annually without causing the population to decline. On the basis of ecological theory, this suggestion is not likely to be correct for the wolf, or indeed for any large carnivore."

The study emphasizes that many large carnivore populations are managed sustainably, including the use of regulated hunting, but that current harvest rates and related policies for western US wolves are not sustainable. Creel concluded: "It is a bit surprising for the US Fish and Wildlife Service to conclude that 'no risks were identified' for these populations, despite data showing decreased survival, reproduction, and population size at the level of entire states."

Among several recommendations, the paper notes that some apparent population increases appear to be the result of changes in methods of accounting and increased effort to count wolves. Ullas Karanth of the WCS, a co-author noted for advancing methods to count large carnivores, said: "Studies on many large carnivores, including tigers, wolves, and lions, emphasize that population surveys must account for detection probability and sampling effort if they are to generate valid estimates."

The analysis also suggests that policies regulating carnivore hunting would benefit from more attention to the distinction between populations that are locally stable and those that are maintained only by immigrants from other areas. Andrew Loveridge of Oxford University said: "With lions, for example, we have found that hunting in one area can create a "vacuum effect" that draws lions out of adjacent areas. This movement and social disruption can have a strong effect on a population's growth or decline."

Creel said: "The North American model of wildlife management works very well for species like ducks or elk, but becomes much more complex for species like wolves that compete with hunters. The management agencies involved have a difficult task, but current data suggest that more attention to the consequences of hunting large carnivores is warranted."

Although wolf populations are harvested sustainably in several other jurisdictions in North America, the findings in the *Science* study call for several revisions and clarifications to policies in the northern Rocky Mountains, where the wolf population faces ecological and societal challenges that are likely to limit its recovery.

Climate Change Threatens Snow Leopards

New Delhi, India (October 23, 2015)—Urgent international action must be taken in the face of climate change to save the snow leopard and conserve its fragile mountain habitats that provide water to hundreds of millions of people across Asia, according to a new WWF report.

CONTINUED ON PAGE 33

Feathers as a Tool to Assess Mercury Contamination in Gentoo Penguins: Variations at the Individual Level

S Pedro, JC Xavier, S Tavares, PN Trathan, N Ratcliffe, et al. *PLoS One.* 2015 Sept. DOI: 10.1371/journal.pone.0137622

Feathers have been widely used to assess mercury contamination in birds as they reflect metal concentrations accumulated between successive moult periods: they are also easy to sample and have minimum impact on the study birds. Moult is considered the major pathway for mercury excretion in seabirds. Penguins are widely believed to undergo a complete, annual moult during which they do not feed. As penguins lose all their feathers, they are expected to have a low individual-variability in feather mercury concentration as all feathers are formed simultaneously from the same somatic reserves. This assumption is central to penguin studies that use feathers to examine the annual or among-individual variation in mercury concentrations in penguins. To test this assumption, we measured the mercury concentrations in 3–5 body feathers of 52 gentoo penguins (Pygoscelis papua) breeding at Bird Island, South Georgia (54°S 38°W). Twenty-five percent of the penguins studied showed substantial within-individual variation in the amount of mercury in their feathers (Coefficient of Variation: 34.7–96.7%). This variation may be caused by differences in moult patterns among individuals within the population leading to different interpretations in the overall population. Further investigation is now needed to fully understand individual variation in penguins' moult.

The Structure of Mixed-species Bird Flocks, and their Response to Anthropogenic Disturbance, with Special Reference to East Asia

E Goodale, P Ding, X Liu, A Martínez, X Si, et al. *Avian Research.* 2015;6(14)

Mixed-species flocks of birds are distributed world-wide and can be especially dominant in temperate forests during the non-breeding season and in tropical rainforests year-round. We review from a community ecology perspective what is known about the structure and organization of flocks, emphasizing that flocking species tend to be those particularly vulnerable to predation, and flocks tend to be led by species that are able to act as sources of information about predators for other species. Studies on how flocks respond to fragmentation and land-use intensification continue to accumulate, but the question of whether the flock phenomenon makes species more vulnerable to anthropogenic change remains unclear. We review the literature on flocks in East Asia and demonstrate there is a good foundation of knowledge on which to build. We then outline potentially fruitful future directions, focusing on studies that can investigate how dependent species are on each other in flocks, and how such interdependencies might affect avian habitat selection in the different types of human-modified environments of this region.

Polymelia and Syndactyly in a Swainson's Hawk *(Buteo swainsoni)*

KH Rogers, Aslı Mete, S McMillin, and R Shinn. *Journal of Wildlife Diseases.* 2016 Jan;52(1).

A hatch-year Swainson's Hawk *(Buteo swainsoni)* recovered from Modoc County, California, USA, on 12 August 2012 had malformations of the rear limbs consisting of bilateral polymelia and syndactyly. We describe the malformations and evaluate potential causes. Postmortem examination revealed varus rotation of both femurs and abnormal appendages originating from the distal medial surface of the tibiotarsi with two nonfunctional digits on the right leg and one digit on the left leg. There was syndactyly between digits III and IV of both feet. Avian pox viral dermatitis was present on the skin of the ventral abdomen. A definitive cause of the skeletal malformations was not identified.

Integrative Taxonomy of the Russet Bush Warbler *Locustella mandelli* Complex Reveals a New Species from Central China

P Alström, C Xia, PC Rasmussen, U Olsson, B Dai, et al. *Avian Research.* 2015 May;20156(9).

The Russet Bush Warbler *Locustella* (previously *Bradypterus*) *mandelli* complex occurs in mountains in the eastern Himalayas, southern China, Vietnam, the Philippines, and Indonesia. The taxonomy has been debated, with one *(L. seebohmi)* to four *(L. seebohmi, L. mandelli, L. montis and L. timorensis)* species having been recognised.

We used an integrative approach, incorporating analyses of morphology, vocalizations and a molecular marker, to re-evaluate species limits in the *L. mandelli* complex.

We found that central Chinese *L. mandelli* differed from those from India through northern Southeast Asia to southeast China in plumage, morphometrics and song. All were easily classified by song, and (wing + culmen)/tail ratio overlapped only marginally. Both groups were reciprocally monophyletic in a mitochondrial cytochrome b (cytb) gene tree, with a mean divergence of 1.0 ± 0.2%. They were sympatric and mostly altitudinally segregated in the breeding season in southern Sichuan province. We found that the Mt Victoria (western Myanmar) population differed vocally from other *L. mandelli,* but no specimens are available. Taiwan Bush Warbler *L. alishanensis* was sister to the *L. mandelli* complex, with the most divergent song. Plumage, vocal and cytb evidence supported the distinctness of the south Vietnamese *L. mandelli idonea*. The Timor Bush Warbler *L. timorensis,* Javan Bush Warbler *L. montis* and Benguet Bush Warbler *L. seebohmi* differed distinctly in plumage, but among-population song variation in *L. montis* exceeded the differences between some populations of these taxa, and mean pairwise cytb divergences were only 0.5–0.9%. We also found that

some *L. montis* populations differed morphologically.

We conclude that the central Chinese population of Russet Bush Warbler represents a new species, which we describe herein, breeding at mid-elevations in Sichuan, Shaanxi, Hubei, Hunan and Guizhou provinces. The taxonomic status of the other allopatric populations is less clear. However, as they differ to a degree comparable with that of the sympatric *L. mandelli* and the new species, we elevate *L. idonea* to species status, and retain *L. seebohmi* and *L. montis* as separate species, the latter with *timorensis* as a subspecies. Further research should focus on different populations of *L. montis* and the Mt Victoria population of *L. mandelli.*

Avioserpens in the Western Grebe *(Aechmophorus occidentalis)*: A new Host and Geographic Record for a Dracunculoid Nematode and Implications of Migration and Climate Change

PJ Latas, HDS Walden, L Bates, S Marshall, Tammy Rohr, et al. *Journal of Wildlife Diseases.* 2016 Jan;52(1).

We report a new host and geographic range for the dracunculoid nematode *(Avioserpens sp.)* in a Western Grebe *(Aechmophorus occidentalis)* from southern Arizona. This discovery underscores the importance of parasite discovery and identification in the wildlife rehabilitation setting. Climate change and weather events affect the migratory spread of unusual parasites.

Evolutionary Aspects of the Use of Predator Odors in Antipredator Behaviors of Lumholtz's Tree-Kangaroos *(Dendrolagus lumholtzi)*

BA Schulte, TE Goodwin, and MH Ferkin. In: Chemical Signals in Vertebrates 13. Springer International Publishing, SR Helse-Pavlov, ed. 2016 Jan; p. 261–280.

In multi-predator systems with different predator 'archetypes', prey have an advantage when applying 'archetype'-specific responses. However, antipredator responses can be lost or modified during times of 'relaxed predation selection'. As a consequence, prey may become vulnerable when novel predators are introduced into their environments. This study investigates whether the Lumholtz's tree-kangaroo (LTK) (Dendrolagus lumholtzi), an arboreal folivore marsupial of rainforests in North Queensland, Australia, (1) recognizes odor cues from arboreal and terrestrial predators, (2) exhibits archetype-specific antipredator responses to them, and (3) is able to transmit archetype-specific antipredator responses to novel predators of similar archetype. Five captive LTKs were exposed to lavender oil as neutral odor, fecal material from an extant arboreal predator, the amethystine python (Morelia amethystine), from two novel terrestrial predators, the domestic dog (Canis lupus familiaris) and the dingo (Canis lupus dingo), and a control odor (water). All subjects showed an increase in durations and frequencies of vigilance, and a decrease in the duration of comfort behaviors when exposed to the fecal material compared to the control odor, but not when the neutral odor was presented. This suggests that the presented fecal material is associated with predatory threats. Subjects increased duration and frequency of their movements in trials with fecal material from a python and a dingo, but not in trials with fecal material from a dog or the neutral odor which indicates that tree-kangaroos do not respond differently to arboreal and terrestrial predators. This conclusion is discussed with respect to the relatively recent descent of tree-kangaroos from rock-wallabies at a time when its ancient terrestrial predators became extinct, and with respect to reported fatalities of tree-kangaroos when encountering domestic dogs or dingoes. ■



Russet bush warbler *(Locustella mandelli).*
PHOTO © HOUMENG ON INATURALIST.ORG. CC BY-NC-SA.

News
CONTINUED FROM PAGE 31

The report, titled "Fragile Connections: Snow leopards, people, water, and the global climate" launched on 23 October 2015, International Snow Leopard Day. It reveals that more than a third of snow leopard habitat could be rendered unsuitable for the endangered big cats if climate change is not checked. Warmer temperatures could see the tree line shifting up the mountains and farmers planting crops and grazing livestock at higher altitudes, squeezing the remaining snow leopards into smaller pockets. The year 2015 is also the "International Year of the Snow Leopard" and marks an important turning point as snow leopard range countries across the WWF network commit to take action and start an exciting new global initiative to save the world's snow leopards.

The report also highlights the fact that it is not just snow leopards that are at risk since their high-altitude habitat spans many of Asia's major watersheds. Over 330 million people live within 10km of rivers originating in snow leopard territory and directly depend on these rivers for their daily water supplies. Climate change could drastically alter the flow of water down from the mountains, threatening the livelihoods of vast numbers of people across the continent.

There could be as few as 4,000 snow leopards left in the wild, with only around 500 in India—and their numbers are continuing to fall. Increased habitat loss and degradation, poaching, and conflict with communities have contributed to a 20 per cent decline in the population in the past 16 years and left the species hanging on in many places. Unchecked, climate change will exacerbate these threats and could push the species over the edge.

Time is running out now. In 2013, twelve snow leopard range states signed up to the ambitious Global Snow Leopard and Ecosystem Protection Program in Bishkek. The landmark agreement signalled an unprecedented level of commitment to conserve the snow leopard as well as a new era of collaboration between governments, international organizations, and civil society groups. However, snow leopard numbers have continued to dwindle. ■

TAIL END



Okay, who's got the selfie stick!?

Llama at Machu Picchu (*Lama glama*).
PHOTO © GERAINT ROWLANDS, FLICKR.COM. CC BY-SA 2.0.

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POLICY Original manuscripts on a variety of wildlife rehabilitation topics (e.g., husbandry and veterinary medicine) are welcomed. Manuscripts that address related topics such as facility administration, public relations, law, and education are invited as well.

Associate editors and anonymous reviewers, appropriate to the subject matter, evaluate each submitted manuscript. Concurrent submission to other peer-reviewed journals will preclude publication in the *Journal of Wildlife Rehabilitation* (JWR). The International Wildlife Rehabilitation Council (IWRC) retains copyright on all original articles published in the JWR but, upon request, will grant permission to reprint articles with credit given to the IWRC–JWR.

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Include the name of each author. Specify the corresponding author and provide affiliation, complete mailing address, and email address. The affiliation for all authors should be included in a brief (maximum of 100 words) biography for each that reflects professional experience related to rehabilitation or to the manuscript subject matter rather than personal information. Biographies may be edited due to space limitations.

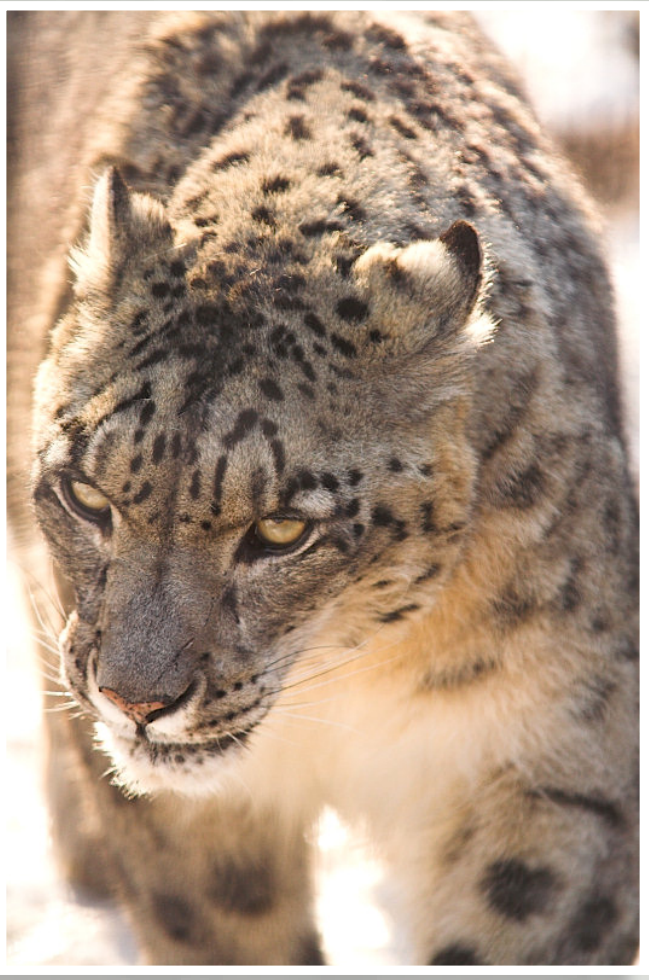
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Snow leopard *(Uncia uncia),* whose habitat is limited to the fragile high mountains of Central Asia.
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