

JOURNAL OF WILDLIFE REHABILITATION

Volume 44, Number 2, 2024

INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

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.



ON THE COVER:

Hoffmann's two-toed sloth *(Choloepus hoffmanni)*
IUCN red list category–least concern.
PHOTO © KOEN SWIERS.
CREATIVE COMMONS LICENSE.

LEFT:

Urich's tyrannulet *(Phyllomyias urichi),* in Turimiquire, Venezuela. IUCN red list category–Endangered
PHOTO © DAVID ASCANIO.
CREATIVE COMMONS LICENSE.

INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

International Wildlife Rehabilitation Council
PO Box 3197
Eugene, OR 97403 USA
Phone: 866.871.1869
Fax: 408.876.6153
Toll free: 866.871.1869
Email: office@theiwrc.org
director@theiwrc.org
www.theiwrc.org

INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

Providing evidence-based education and resources on wildlife rehabilitation to move the field of wildlife rehabilitation forward; to promote wildlife conservation and welfare; and to mitigate human-wildlife conflicts worldwide, through better understanding of wild animal ecology, behavior, and welfare.

Editor
Kieran J. Lindsey, PhD
Center for Leadership in Global Sustainability
Virginia Tech University
JWR Editorial office: St. Louis, Missouri, USA

Art Director
Julissa Favela
International Wildlife Rehabilitation Council
Eugene,Oregon, USA

Production Consultant
Nancy Hawekotte
Cumulus Creative
Art offices: Omaha, Nebraska, USA

The *Journal of Wildlife Rehabilitation* is published by the International Wildlife Rehabilitation Council (IWRC), PO Box 3197, Eugene, OR 97403 USA. ©2024 (ISSN: 2166-9198). All rights reserved.

JOURNAL OF
WILDLIFE REHABILITATION

VOLUME 44, NUMBER 2, 2024

CONTENTS

PEER-REVIEWED PAPERS

7

Husbandry and soft-release techniques for rehabilitated Hoffmanns' two-toed sloths in Panamá
Chelsea Morton, Clayton K. Nielsen, Andrew D. Carver, Nestor J. Correa, Yiscel S. Yanguez

13

Florida Avian Rehabilitation Intake and Disposition Rates: 2009 to 2022
Aaron Pahl

DEPARTMENTS

Editorial	4
In the News	5
Selected Abstracts	26
Tail Ends	30
Submission Guidelines	31

BOARD OF DIRECTORS

President
Brooke Durham
Rep4Wildlife, California, USA

Vice President
Meredith Whitney
Washington DC, USA

Secretary
Danene Bartell
California, USA

Treasurer
Susie Sullivan
Washington, USA

Robert Adamski
Ohio, USA

Jennifer Boonstra
Illinois, USA

Lloyd Brown
Wildlife of Dade County, Florida, USA

Danielle Castillo
California, USA

Elise Gundlach
Oklahoma, USA

Diane Séguin
Quebec, Canada

Peter Strathis
New South Wales, Australia

Susan Wylie
Le Nichoir, Quebec, Canada

Kai Williams
Executive Director

Julissa Favela
Programs Manager

Katie McInnis
International Outreach and Content Specialist

Alexandra Reddy
Membership and Development Coordinator

Samantha Lyon
North American Course Coordinator

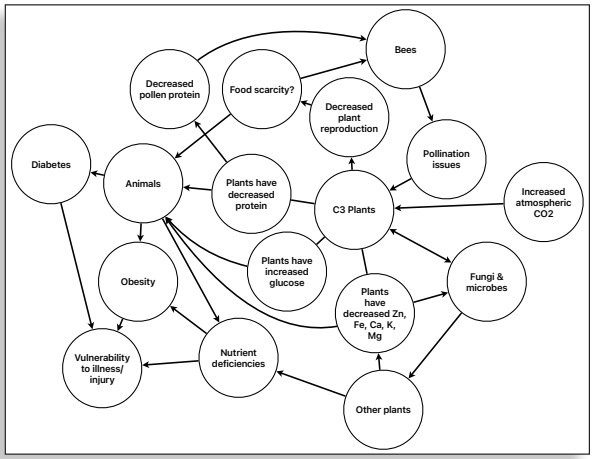
EDITORIAL

A few years ago I came across a footnote on how increased CO_2 impacts plant growth and nutrient availability when preparing for a conference talk on climate change implications for wildlife rehabilitation. I noted the implications for wildlife in my talk and moved on. This spring I was reminded of this research by a conversation hosted by Women in Systems Thinking. It started me thinking on the impossibility of keeping everything we need to know in our heads at all times but also how so many aspects of climate change are One Health problems.

By one aspect, these two realizations are quite disheartening, but knowing we aren't facing our problems in a vacuum provides more than a glimpse of hope. The impacts of climate change are shared challenges that affect everyone, and need to be addressed as a community. And this means we are not alone in our work. We are one of the professions dealing with the resulting fallout for wildlife, but scientists of all sorts, from mathematicians to biochemists are working to understand how the world is changing, and organizations are working to communicate the information to inform the public, policy makers, and businesses. The Environmental Working Group is starting work on climate toxics - delving into issues in the climate/health interface. This is a true One Health situation.

Increased atmospheric CO_2 is causing plants to grow larger while decreasing key mineral uptake and in some cases protein content within the 95% of plant species that use the C_3 pathway to fix carbon. Mathematician Irakli Loladze analyzed 130 plant varieties and found an average 8% decrease in 25 minerals. Over 100 studies have found similar reductions in protein. This impacts the many creatures who rely on plants for sustenance, from bees, to seriemas, to humans.

An important aspect of systems thinking is relational, Felicia Chavez describes this aspect as "the connections between people, groups, species, the environment, and abstract principles". The last item on that list might seem odd, but abstractions are ideas we have created as a way to make sense of the world, and interact with tangible entities. Increased atmospheric CO2 changes plants which affect invertebrates & vertebrates, biogeochemical cycles, and soil health.



A web showcasing possible impacted relationships caused by an increase in atmospheric CO_2.

My purpose in this short editorial is not just to let you know of the nutrient issue, what Politico calls "The Great Nutrient Collapse" but to highlight that we aren't alone in working on these big scary issues. We need to connect with our larger community(s) surrounding all the challenging, wicked problems we face. If we don't make those connections and share knowledge, then the collective "we" are not going to get very far. Supporting wildlife in the face of climate challenges requires thinking, and listening, outside our usual pathways.

—Kai Williams
IWRC Executive Director

SR3 Provides veterinary support to pinniped field research project

WASHINGTON, USA *(April 15, 2024)*—This past winter, Sealife Response, Rehabilitation & Research (SR3)'s veterinarian, Dr. Michelle Rivard, spent two months on Sable Island, Nova Scotia, contributing to gray seal research. Dr. Rivard has now made this trip two years in a row to collaborate on multiple projects studying seals in the wild, conducted by the Department of Fisheries and Oceans Canada, Texas Tech University, University of Alaska Fairbanks and Woods Hole Oceanographic Institute.

Not easily accessible to people, Sable Island is located in the Atlantic Ocean, 180 miles southeast of Halifax, Nova Scotia, and is protected and managed by Parks Canada. The island is a narrow, crescent-shaped sandbar, approximately 26 miles long and only 0.75 miles across at its widest point. The island is home to hundreds of wild horses, as well as the largest gray seal colony in the world.

Gray seals live for 30-40 years and gather in large groups during the breeding season each winter. Every December to February, 400,000 gray seals aggregate on Sable Island to have their babies and mate, and about 80,000 pups are born each year on the sandy shores. Moms nurse their pups for approximately three weeks, during which time pups triple their birth weight! Pups typically wean at around 50 kg (110 lbs), at which time the mothers return to the ocean and the pup's fat reserves help to sustain them throughout a post-nursing fast that can last for several weeks as they learn how to swim and hunt on their own. Gray seal pups are born with long, white fur that sheds around the time of weaning. Read the rest here.



PHOTO © MARTIN KAEHRLE. USED WITH PERMISSION.

Atlantic grey seal (*Halichoerus grypus atlantica*)

New analysis reveals 126 birds are lost to science and haven't had a confirmed sighting in at least a decade

(June 17, 2024)—The Search for Lost Birds, a collaboration between Re:wild, American Bird Conservancy and BirdLife International, has developed the most complete tally of bird species that are lost to science. Of the approximately 11,849 species of birds, 126 meet the criteria of being "lost." These birds have not had a documented sighting in at least 10 years (meaning there are no photos, videos or audio recordings of them), and they are not assessed as extinct or extinct in the wild by the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species. Citizen scientists and birders' enthusiasm for documenting birds provided important data that helped create the list of lost birds.

> "Birds are the most well-documented group of animals on Earth, and it's a testament to just how much people love them that only about one percent of the world's birds have evaded documentation during the last decade," said Cameron Rutt, lead author of the paper and former lost birds science coordinator with American Bird Conservancy.

Ornithologists with the Search for Lost Birds analyzed more than 42 million photos, videos and audio recordings of birds collected by three citizen science platforms (The Cornell Lab of Ornithology's Macaulay Library, iNaturalist and xeno-canto), as well as museum collections and media from search engines and scientific research papers. They also conferred with local experts to identify birds that have not had a documented sighting between 2012 and the end of 2021. Read the rest here.

High Pathogenicity Avian Influenza in Cattle

World Organisation for Animal Health *(May 8, 2024)*—The ongoing spread of High Pathogenicity Avian Influenza (HPAI) in different regions of the world, alongside the recent detections of cases in cattle, is raising concerns within the international community.

While HPAI primarily affects poultry and wild birds, avian influenza can occasionally be transmitted to mammals, including humans. In the last two years, an increasing number of H5N1 avian influenza cases are being reported in terrestrial and aquatic mammalians animals.

The recently reported detections of HPAI in dairy cattle in the United States

of America , have raised international concerns. Infected cattle may be asymptomatic or with mild illness showing non-specific clinical signs such as decreased milk production, thicker-colostrum-like milk, reduced appetite, lethargy, fever and dehydration. These infections in cattle could indicate an increased risk of H5N1 viruses becoming better adapted to mammals, and potentially spilling over to humans and other livestock.

Initial investigations so far have revealed that raw milk from infected cows is a high-risk material. Thus, only milk produced by healthy cows should be commercialised. There are evidence of horizontal virus transmission from infected lactating cows to other animals including cows, cats and poultry. No specific adaptation of the virus to either humans or mammals was identified. Several studies are being carried out to further explore the pathogenesis and transmission routes of these viruses, including among cattle and from cattle to other animals.

In collaboration with its Reference Centres, our networks of experts and Members, the World Organisation for Animal Health (WOAH) is closely monitoring the situation to assess the risks to animals, but also to humans, which is currently considered low. Timely and transparent reporting is crucial to maintain a good understanding of the disease situation and prevent any type of misinformation or disinformation.

WOAH reminds its 183 Members that, based on the information currently available, restrictions to the international trade of healthy cattle and their products are not recommended unless justified by an import risk analysis conducted according to the WOAH Terrestrial Animal Health Code Chapter 2.1.

Grassland birds, forest birds and other migratory birds to benefit from more than $22 million in funding throughout the Americas

UNITED STATES OF AMERICA. *(May 7, 2024)*—The U.S. Fish and Wildlife Service is announcing more than $22 million in funding has been approved for grants through the Neotropical Migratory Bird Conservation Act (NMBCA) for conservation projects to benefit migratory birds and people throughout the Americas.

For over two decades, the Neotropical Migratory Bird Conservation Act has provided critical support for neotropical bird conservation and research throughout the Western Hemisphere each year. It is the only source of federal funding solely dedicated to the conservation of migratory birds shared throughout the Americas. This year, more than $4.87 million in federal funds will be matched by more than $17 million in partner contributions going to 30 collaborative conservation projects in 19 countries across the Americas.

> "These investments will help neotropical birds that are at risk and are declining, protecting millions of acres of diverse habitats needed by grassland birds, forest birds and shorebirds for wintering, breeding and migration. Neotropical migratory birds capture our imagination, yet they face an increasingly complex range of threats, including development pressures, invasive species , avian diseases and climate change." said Service Director Martha Williams.

NMBCA benefits most of the 390 species of neotropical migratory birds that migrate across the Western Hemisphere, to and from the U.S. each year. Priority is given to funding projects that proactively conserve species listed on the Service's Birds of Conservation Concern 2021 report to prevent species from being listed as threatened or endangered under the Endangered Species Act. In addition, at least 7 ESA listed bird species will also benefit from these conservation efforts, including the golden-cheeked warbler, willow flycatcher, snowy plover, piping plover, roseate tern, least tern and grasshopper sparrow.

This year's project highlights include:

Conserving Grassland Birds in Canadian Prairies (Canada)

This project will support landowners and land managers to improve management for migratory grassland birds, such as grasshopper sparrows, marbled godwit and bobolink, by enabling innovative incentive tools to create a rewarding policy environment for becoming active and purposeful agents of change in the agricultural system.

Improved Neotropical Migratory Bird Habitat Conservation in Caribbean Guatemala (Guatemala)

Partners will work with local communities to increase support for bird protection and improve habitat in the Caribbean flyway through improved management to conserve a biological corridor between protected areas in non-breeding grounds.

Long-term Improvement of Habitat Quality and Connectivity in Southern South America (Argentina, Brazil, Paraguay, Uruguay)

The Southern Cone Grasslands Alliance will improve habitat quality for both neotropical migratory birds and resident birds through sustainable ranching practices. The partners aim to reduce threats and losses to native grasslands, such as conversion to crop and forest monocultures. They will also increase awareness about the importance of grasslands conservation and the ecosystems services.

Neotropical migratory birds are among the most attractive and interesting birds to birdwatchers. These birds are also economically important for their role in pest control and pollination for agriculture. The Service's National Survey of Fishing, Hunting, and Wildlife-Associated Recreation revealed more than 96 million people observed birds, contributing $250.2 billion to wildlife-related recreation.

Since 2002, the NMBCA has provided more than $94.2 million in grants to support 747 projects in 43 countries. These projects have positively affected more than 6 million acres of bird habitat and inspired partnerships on multiple levels contributing an additional $363 million.

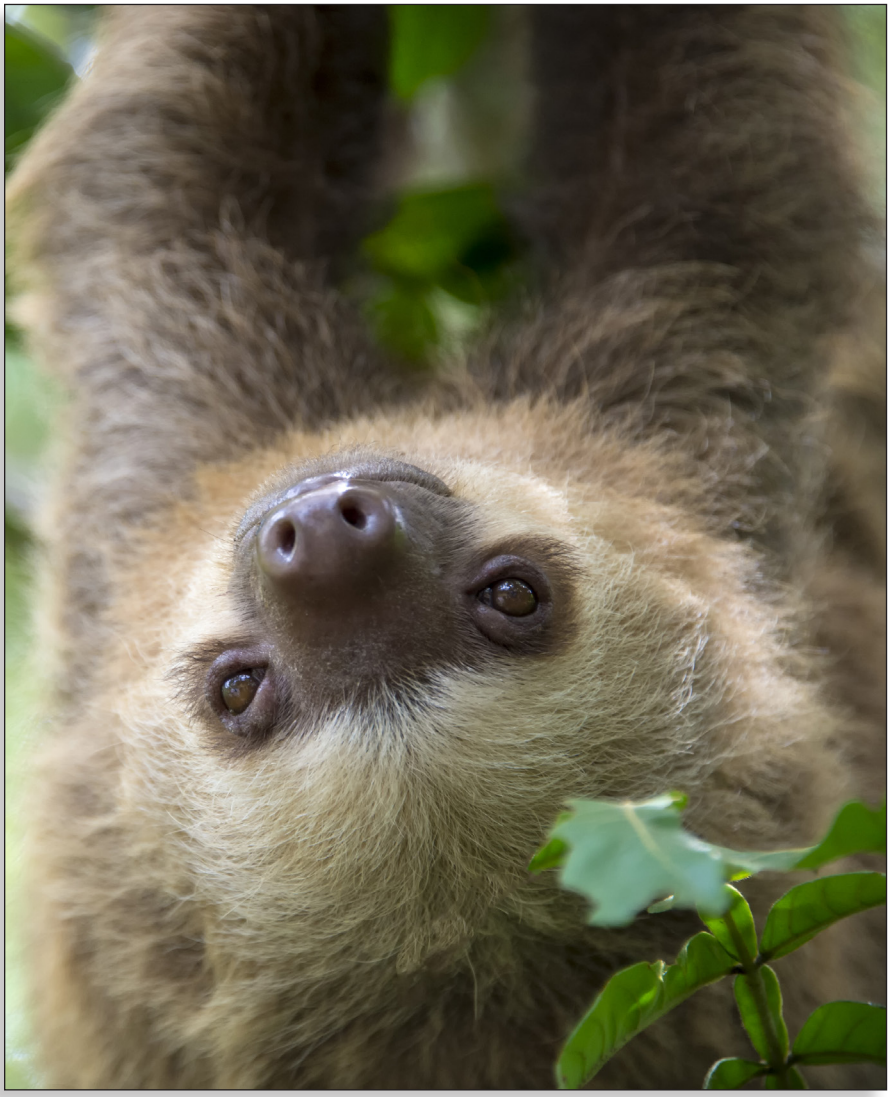
A complete list of this year's approved grants projects is available and all projects in the database. Additional information about migratory bird conservation can be found by visiting online the Service's Migratory Bird Program. ■

PHOTO

Husbandry and soft-release techniques for rehabilitated Hoffmanns' two-toed sloths in Panamá

Chelsea Morton,[1] Clayton K. Nielsen,[1] Andrew D. Carver,[1] Nestor J. Correa,[2] Yiscel S. Yanguez[2]

PHOTO © TOMALU. CREATIVE COMMONS LICENSE.



Introduction

Throughout Latin America, sloths (*Bradypus* spp. and *Choloepus* spp.; order Xenarthra) are commonly admitted to rescue centers for medical treatment from trauma, during relocation from urban areas, and as orphans requiring long-term care in captivity.[1,2,3,4,5] Sloths are especially sensitive to deforestation and human development due to their low rates of movement and activity, and poor dispersal ability.[1,6,7,8,9] The most common threats sloths face are power line electrocution, domestic dog attacks, illegal trafficking, and vehicle collisions.[1,5,10,11] In some cases, healthy adults that are disoriented in urban areas are simply translocated to protected forested areas.[1] Many individuals, however, arrive as orphaned neonates that require long term care in captivity.[2,4] The increase in sloths rescued as neonates and juveniles has obligated many rescue centers to become specialized in the hand-rearing of orphans with the intent to rehabilitate

AUTHOR AFFILIATIONS
[1]Cooperative Wildlife Research Laboratory, Forestry Program, Southern Illinois University, Carbondale, IL USA
[2]Pan-American Conservation Association (Asociación Panamericana para la Conservación), Colón, Panamá

ABSTRACT: Sloths (*Bradypus* spp. and *Choloepus* spp.) are frequently rescued in Latin America and are typically rehabilitated in captivity until considered suitable for release back into the wild. Although husbandry techniques and soft-release methods are both influential in the success of wildlife rescue programs, few practitioners have described these techniques for hand-reared sloths. Here, we describe husbandry during captive care and soft-release conditions that were used during the rehabilitation of Hoffmann's two-toed sloths (*C. hoffmanni*) in central Panamá. Thirteen two-toed sloths rescued from the wild were hand-reared in captivity for 727 ± 193 days (mean ± SE value across all sloths) at the Pan-American Conservation Association facilities in Colón Province, Panamá, during 2019–2020. Sloths were divided into two groups and placed in an outdoor 500 m^2 soft-release enclosure for three months. While in captivity, sloths were raised in pens that resembled the environmental conditions of soft-release and fed a diet of natural browse to encourage natural foraging behaviors. We suggest that the consistency and suitability of captive husbandry measures contributed to the increased fitness of rehabilitated two-toed sloths during their transition from captivity to soft-release. We also recommend soft release to be used for rehabilitated two-toed sloths, as this method allows dehabituation from human contact and time for sloths to develop natural behaviors to increase chances of survival in the wild.

KEYWORDS: husbandry, Neotropical, Panamá, rehabilitation, rescue, soft-release, two-toed sloth

CORRESPONDING AUTHOR
Chelsea Morton
E: chelsea.morton@siu.edu

J. Wildlife Rehab. 44(2):7–12. ©2024 The International Wildlife Rehabilitation Council.

and release back into the wild (e.g., Jaguar Rescue Center, Costa Rica; The Pan-American Conservation Association, Panamá; Toucan Rescue Ranch, Costa Rica; The Sloth Institute of Costa Rica, Costa Rica; AIUNAU, Colombia; Green Heritage Fund Suriname, Suriname). However, determining which husbandry methods and release techniques are most effective in increasing the likelihood of survival in the wild can be challenging, even for experienced rehabilitators, given sloths' unique biology.[4,11]

Two-toed sloths (*Choloepus* spp.) have been studied extensively in the wild to document feeding ecology, activity patterns, habitat selection, and survival.[5,6,7,12,13,14] Studies detailing the biological needs and functions of sloths in the wild are useful for rescue centers to develop rigorous rehabilitation protocols that will support the needs of sloths while in captivity. For example, appropriate diet-related husbandry measures used during rehabilitation are essential in aiding the development of natural foraging behaviors.[11,15,16] Such behaviors, usually learned from the mother in the wild before becoming independent, prepare the juvenile for survival while navigating new territories and environmental pressures.[7,17,18] Studies on wild sloths have also indicated juvenile survival is lowest immediately following maternal independence,[14] designating soft release as an ideal release method to allow captive-raised sloths time to acclimate to new conditions following their dependence from human care. Contrary to hard release, which is a direct transition into the wild with no period of acclimation, soft release involves an acclimation period prior to release and may include supplemental food or shelter.[11,15,19] Providing a gradual transition from captivity to release can help stimulate these natural behaviors that are necessary to increase the chances of survival after long-term rehabilitation.[11,15,20] Nonetheless, to our knowledge, few studies have documented the husbandry protocols and techniques used for the release of wild-born, captive-reared two-toed sloths.[21,11] We documented the husbandry protocols used during the rehabilitation of Hoffmann's two-toed sloths that were rescued from the wild and hand-reared in captivity. We then released the rehabilitated two-toed sloths in the wild via a soft-release technique. We provide perspectives from the experience of using soft release for rehabilitated two-toed sloths and discuss husbandry measures that were used for sloths while in captivity.

Study area

The Pan-American Conservation Association (APPC) Rescue Center is located in Gamboa, Colón Province, Panamá and is 1.2 km from the Gamboa Rainforest Reserve adjacent to Gatun Lake (Figure 1). [22] The study area lies in the buffer zone of Soberanía National Park in the Panama Canal Watershed at 9°N latitude. Soberanía National Park contains 22,104 ha of protected land consisting of mature tropical moist forest.[22,23,24] This region has a dry season during late December to early April, and a wet season during late April to mid-December with a mean precipitation of 234.5 mm and a mean temperature of 25.7°C.[22,24,25] Forests are composed of humid semideciduous lowland forest with a dense understory of bromeliads, tree saplings, and lianas.[24] In well-drained sites, the closed canopy reaches 20 to 40 m tall with emergent trees reaching >50 m.[24] In the entire canal corridor >950 species of trees and shrubs have been identified, and 470 species can be found in the central isthmus of Soberanía.

Methods

Husbandry

Thirteen two-toed sloths rescued from the wild were rehabilitated in captivity at APPC facilities from November 2016 to October 2019. During rehabilitation, two-toed sloths were housed separately in 5 m x 3 m x 3 m pens (Figure 1) at the APPC Sloth Sanctuary facility in Gamboa, Panamá for 727 ± 193 days (mean value across all sloths). These animals were 1–6 yr old and included six females and seven males. Within each captive pen, tree branches and trunks and vines were assembled to provide ample space for the sloths to move and forage. Eight-quart rubber bins filled with water were available, and sloths were fed twice daily with vegetables and leaves. Feedings during 1000–1300 hr included 4.0 g of boiled carrots, chayote, and green beans per sloth. Natural

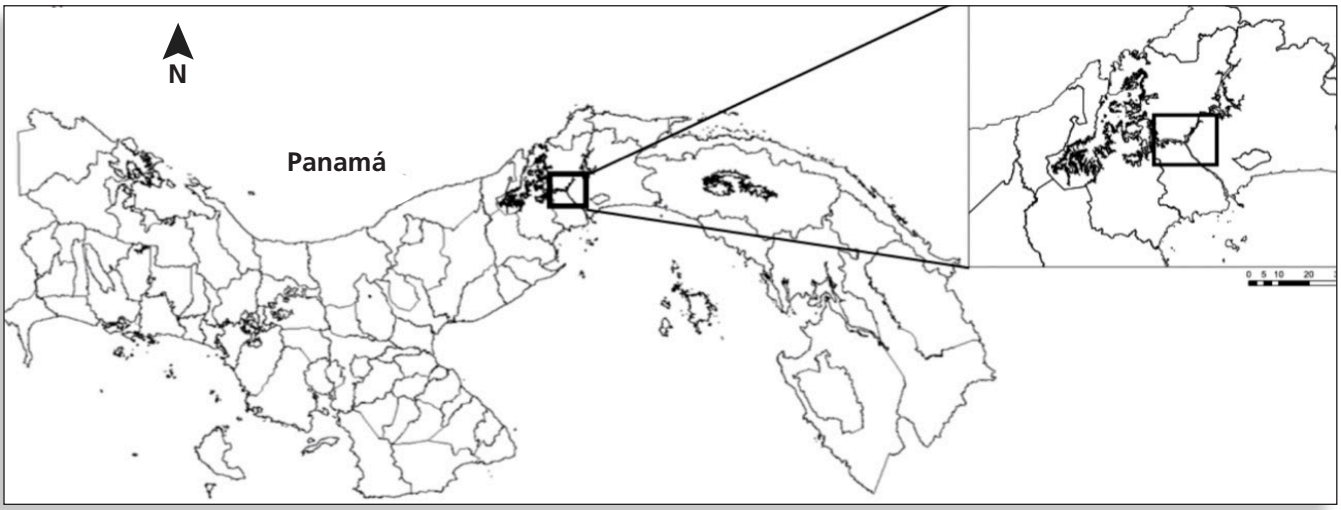


Figure 1. Study area where Hoffmann's two-toed sloths were rehabilitated at APPC Rescue Center facilities in Gamboa, Colón Province, Panamá, November 2016 through October 2020.

browse (700–1,000 g/sloth) was cut from the surrounding area and fed to sloths between 1700–1800 hours. Mango (*Mangifera indica*), ciruelo/jocote (*Spondias purpurea*), West Indian elm (*Guazuma ulmifolia*), gumbo limbo (*Bursera simaruba*), buttercup tree (*Cochlospermum vitifolium*), jobo (*Sponidas mombin*), and espavé (*Anacardium excelsum*) were hung in random locations within the enclosure to encourage two-toed sloths to forage independently. When natural browse was scarce, spinach, mustard greens, and bok choy were used as supplemental feeding and were also hung throughout the enclosure for sloths to forage independently.

When necessary, two-toed sloths were handled by two trained APPC keepers by grabbing the front and back limbs and allowing the sloth to hold onto the handlers. Immediately prior to soft release, each sloth was measured, weighed, and sexed by examining the external genitalia.[26,27] Two-toed sloths were then aged as juvenile or adult, based on age and body weight.[27] Individuals were fitted with a VHF radiotransmitter harness (Model TXF-325B, Telenax, Playa del Carmen, Mexico) weighing approximately 50 g. Sloths were fitted with VHF radiotransmitters in soft release to familiarize them with wearing the harnesses which would allow for post-release monitoring via radiotelemetry in the wild. These efforts are detailed by Morton et al.[28] where radiotelemetry was used to gather data on the movement patterns, home range sizes, habitat selection, and survival of the rehabilitated two-toed sloths used in this study. Two-toed sloth husbandry, handling, and tracking were conducted as approved by Institutional Animal Care and Use Committee protocol #19–017 of Southern Illinois University Carbondale.

Soft Release

The 13 sloths were divided into two groups for soft release. The first group consisted of five individuals that were placed in a soft-release enclosure from 31 October 2019 through 3 February 2020, and a second group of eight individuals was placed in a soft-release enclosure from 22 March 2020 through 22 June 2020. Two-toed sloths were removed from their captive pens and placed ≥20 m apart on different habitat structures within the soft-release enclosure. The soft-release enclosure was a 500 m^2 outdoor area enclosed by a 1.40 m high concrete wall with a predator fence surrounding the entire perimeter (Figure 2). The predator fence had four rows of aluminum wire mounted onto 1.45 m tall plastic ground stakes, with one steel door for APPC staff-authorized access.

Vegetation within the soft-release enclosure included gumbo limbo, buttercup tree, jobo, trumpet tree (*Cecropia obtusifolia*),



Figure 2. Soft-release enclosure for rehabilitated Hoffmann's two-toed sloths, Gamboa, Panamá, October 2019–October 2020. The soft release enclosure was a 500 m^2 outdoor area enclosed by a 1.40 m concrete wall with no additional restraints above. The enclosure had a 1.45 m high electric predator fence with four rows of aluminum wire mounted to plastic ground stakes.

and barrigón (*Pseudobombax septenatum*), ranging 10–30 m tall; with an understory vegetation of lantana (*Lantana* spp.) and purple morning glory (*Ipomoea purpurea*). There were areas with extensive canopy closure for refuge during the day and an abundance of lianas to provide additional connectivity throughout the enclosure. Tree branches along the perimeter of the enclosure were trimmed so that sloths could not climb out of the enclosure via canopy tree connectivity. Natural browse (700–1,000 g/animal) was placed within the enclosure five times a week as supplement, and included mango, buttercup tree, gumbo limbo, ciruelo, and espavé. Several 8-quart rubber bins filled with water were also available. Two-toed sloths were removed by hand from the soft-release enclosure and transported in kennels to release sites. The sloths were then released onto different trees ≥300 m from one another and monitored using radiotelemetry.[28]

Discussion

We believe the husbandry measures used during captivity were influential in two-toed sloths' ability to adapt to soft-release conditions. Over the duration of time in soft release, the two-toed sloths exhibited nocturnal behavior,[28] which coincides with the cyclic patterns of wild two-toed sloths.[29] Primarily, two-toed sloths moved more throughout the soft-release enclosure, fed more, and were more alert at dusk;[28] all of which are natural behaviors described in wild two-toed sloth populations.[6,7,8,30] These behavioral patterns are the main antipredator strategies of sloths, and these distinct cyclic patterns of activity not only reduce resource competition with other arboreal folivores but also allow for maximum energy conservation.[29,31,32]

Captive enclosure conditions (i.e., various-sized branches and tree trunks of different diameters for moving and resting, hanging plants for foraging) resembled those in the soft-release enclosure, and these similarities in conditions likely contributed to the sloths' fitness in being able to navigate the outdoor enclosure. Being almost exclusively arboreal, it is necessary for sloths to safely traverse new environments, especially since mortality is highest for juveniles upon separating from the mother.[14] Sloths also had the option to rest in trees of taller height in the soft-release enclosure, a behavior that is common among wild two-toed sloths that have been reported to typically be located ≥9 m above the ground.[6] Habituating sloths to occupy taller trees within the canopy is essential to avoiding terrestrial predators on the forest floor and increasing survival.[33,34,35]

In the wild, two-toed sloths have been documented to use ≥50 different species of trees, either for resting or eating.[7,12] For logistic reasons, we were only able to consistently feed a variety of seven different plant species while in captivity. Several of these species were used due to their availability in the soft-release enclosure, to encourage sloths to find food sources directly from the trees. We suggest documenting the tree species that are available and accessible either at release sites or in soft release, and providing a varied diet in captivity containing these plants to aid in food acquisition once sloths are released into the wild.

We suggest soft release be used over hard-release for rehabilitated two-toed sloths since this species has such a low dispersal capacity and is likely to experience significant predation pressure following long-term care in captivity.[20] Generally, wild-born, captive-reared animals tend to display atypical behaviors compared to wild conspecifics.[36,37,38] Additionally, survival may be affected by stress from transitioning between long-term captivity and the wild, hence the use of soft release, where animals can acclimate in semi-captive conditions.[19,38]

Another benefit of using soft release is to dishabituate animals from human contact and increase responsiveness to potential threats, since negative behaviors resulting from human habitation can affect survival.[36,38,39] We found that rehabilitated two-toed sloths began to exhibit natural behaviors during soft release,[28] and believe these behaviors were developed as a result of a gradual transition between environments. We also maintained consistency in our husbandry measures (i.e., enclosure habitats and diet), but aimed to dishabituate sloths from human contact over time by refraining from all direct contact with the animals after they were placed in the soft-release enclosure. We believe this allowed the two-toed sloths to become independent and develop behaviors that would be crucial to survival in the wild.

Literature cited

1. Chiarello AG, Chivers DJ, Bassi C, Maciel MAF, Moreira LS, Bazzalo M. A translocation experiment for the conservation of maned sloths, *Bradypus torquatus* (Xenarthra, Bradypodidae). *Biol Conserv*. 2004;118(4):421–30.
2. Larrazábal LB. Crianza en cautiverio de perezoso de dos dedos (*Choloepus didactylus*). *Edentata*. 2004;6:30–6. [In Spanish.]
3. Martínez N, Antelo C, Rumiz DI. Rehabilitación de perezosos (*Bradypus variegatus*) urbanos en reservas privadas aledañas a Santa Cruz de la Sierra: Una iniciativa multipropósito de investigación, manejo y educación. *Revista Boliviana de Ecología y Conservación Ambiental*. 2004;16:1–10. [In Spanish.]
4. Duarte Riaño DM, Villamizar NP, Brieva Rico CI. Casuística de perezosos (*Bradypus variegatus* y *Choloepus hoffmanni*) atendidos en la Unidad de Rescate y Rehabilitación de Animales Silvestres (URRAS) de la Universidad Nacional de Colombia entre 2005 y 2010. *Edentata*. 2016;17:34–40. [In Spanish.]
5. Plese T, Reyes-Amaya N, Castro-Vásquez L, Giraldo S, Feliciano O. Distribution and current state of knowledge of Hoffmann's two-toed sloth (*Choloepus hoffmanni*) in Colombia, with comments on the variations of its external morphological traits. *Therya*. 2016;7(3):407–21.
6. Montgomery GG, Sunquist ME. Impact of sloths on neotropical forest energy flow and nutrient cycling. In: Golley FB, Medina E, editors. Tropical Ecological Systems. Berlin, (Germany): Springer. 1975. p. 69–98.
7. Montgomery GG, Sunquist ME. Habitat selection and use by two-toed and three-toed sloths. In: Montgomery GG, editor. The Ecology of Arboreal Folivores. Washington (DC): Smithsonian Institution Press. 1978. p. 329–59.

8. Chiarello AG. Sloth ecology: An overview of field studies. In: Vizcaíno SF, Loughry WJ, editors. The Biology of the Xenarthra. Gainesville (FL): University Press of Florida. 2008. p. 269–80.
9. Swan JL, Carver A, Correa N, Nielsen CK. Wildlife rescue and relocation efforts associated with the Panamá Canal Third Locks Expansion Project. *Trop Zool*. 2019;32(2):58–74.
10. Moreno SR, Kays RW, Samudio R Jr. Competitive release in diets of ocelot (*Leopardus pardalis*) and puma (*Puma concolor*) after jaguar (*Panthera onca*) decline. *J Mammal*. 2006;87(4):808–16.
11. Dünner C, Pastor G. Manual de manejo, medicina y rehabilitación de perezosos. Fundación Huálamo, Chile, South America. 2017. [In Spanish.]
12. Vaughan C, Ramírez O, Herrera G, Guries R. Spatial ecology and conservation of two sloth species in a cacao landscape in Limón, Costa Rica. *Biodivers Conserv*. 2007;16:2293–310.
13. Peery MZ, Pauli JN. The mating system of a "lazy" mammal, Hoffmann's two-toed sloth. *Anim Behav*. 2012;84:555–62.
14. Garcés-Restrepo MF, Pauli JN, Peery MZ. Natal dispersal of tree sloths in a human-dominated landscape: Implications for tropical biodiversity conservation. *J App Ecol*. 2018;55(5):2253–62.
15. Hall E. Release considerations for rehabilitated wildlife. National Wildlife Rehabilitation Conference. 2005.
16. Plese T, Moreno S. Protocolos de rehabilitación, reintroductión o reubicación de perezosos de dos uñas (*C. hoffmannii*) y de tres uñas (*B. variegatus*). Fundación UNAU CORANTIOQUIA. Medellín. 2005. p. 46. [In Spanish.]
17. Taube E, Keravec J, Vié J, Duplantier J. Reproductive biology and postnatal development in sloths, *Bradypus* and *Choloepus*: review with original data from the field (French Guiana) and from captivity. *Mammal Rev*. 2001;31(3–4):173–88.
18. Ramirez O, Vaughan C, Herrera G, Guries R. Temporal and spatial resources use by female three-toed sloths and their young in an agricultural landscape in Costa Rica. *Rev Biol Trop*. 2011;59(4):1743–55.
19. Campbell L, Croft DB. Comparison of hard and soft release of hand reared eastern grey kangaroos. In: Martin A, Vogelnest L, editors. Veterinary Conservation Biology; Wildlife Health and Management in Australasia. Proceedings of International Joint Conference, Taronga Zoo, Sydney Australia. 2001. p. 173–80.
20. Mitchell AM, Wellicome TI, Brodie D, Cheng KM. Captive-reared burrowing owls show higher site affinity, survival, and reproductive performance when reintroduced using a soft-release. *Biol Conserv*. 2011;144(5):1382–91.
21. Avey-Arroyo J. Sloths. In: Gage LJ, editor. Hand rearing wild and domestic mammals. 1st ed. Ames (IA): Iowa State University Press. 2002. p. 81–9.
22. Canuto M. Observations of two hawk-eagle species in a humid lowland tropical forest reserve in central Panama. *J Raptor Res*. 2008;42(4):287–92.
23. Holdridge LR. Life Zone Ecology. Tropical Science Center, San Jose (CA). 1976.
24. Condit R, Robinson WD, Ibáñez R, Aguilar S, Sanjur A, Martínez R, Stallard RF, García T, Angehr GR, Petit L, et al. The status of the Panama Canal Watershed and its biodiversity at the beginning of the 21st century. *BioScience*. 2001;51(5):389–98.
25. Harris I, Osborn TJ, Jones P, Lister D. 2020. Version 4 of the CRU TS Monthly High-Resolution Gridded Multivariate Climate Dataset. https://www.nature.com/articles/s41597-020-0453-3. Accessed 23 June 2021.
26. McCrane MP. Birth, behaviour and development of a hand-reared two-toed sloth *Choloepus didactylus*. *Int Zool Yearb*. 1966;6:153–63.
27. Meritt Jr. DA. The two-toed Hoffman's sloth, *Choloepus hoffmanni* Peters. In: Montgomery GG, editor. The Evolution and Ecology of Armadillos, Sloths, and Vermilinguas. Washington (DC): Smithsonian Institution Press. 1985. p. 333–41.
28. Morton C, Nielsen CK, Carver AD, Correa NJ, Yanguez YS. Post-release ecology of rehabilitated Hoffmann's two-toed sloths in Panamá. *Trop Zool*. 2023;36(1–2):1–20.
29. Sunquist ME, Montgomery GG. Activity patterns and rates of movement of two-toed and three-toed sloths (*Choloepus hoffmanni* and *Bradypus infuscatus*). *J Mamm*. 1973;54(4):946–54.
30. Miranda EBP, Kenup CF, Campbell-Thompson E, Vargas FH, Muela A, Watson R, Peres CA, Downs CT. High moon brightness and low ambient temperatures affect sloth predation by harpy eagles. *Peer J*. 2020;8:1–16.
31. Goffart M. Function and Form in the Sloth. Oxford (GB): Pergamon Press. 1971.
32. DiGiusto CG. An ethogram and time budget of Hoffmann's two-toed sloth, *Choloepus hoffmanni* [dissertation]. [Syracuse (NY)]: State University of New York College of Environmental Science and Forestry; 1993.
33. Bezerra BM, Barnett AA, Souto A, Jones G. Predation by the tayra on the common marmoset and the pale-throated three-toed sloth. *J Ethology*. 2009;27:91–6.
34. Sobroza TV, Gonçalves AL, dos Santos LS. Predation attempt and abnormal coat coloration of the tayra (*Eira barbara*) in the Brazilian Central Amazon. *Stud Neotrop Fauna Environ*. 2016;51(3):231–4.
35. Sáenz-Bolaños C, Montalvo V, Carillo E, Fuller TK. Tayra (*Eira barbara*) predation of a brown-throated three-toed sloth (*Bradypus variegatus*) in Costa Rica. *Edentata*. 2018;19:70–3.
36. Beringer J, Mabry P, Meyer T, Wallendorf M, Eddleman WR. Post-release survival of rehabilitated white-tailed deer fawns in Missouri. *Wildl Soc Bull*. 2004;32(3):732–8.
37. Kelly A, Scrivens R, Grogan A. Post-release survival of orphaned wild-born polecats *Mustela putorius* reared in captivity at a wildlife rehabilitation center in England. *Endang Species Res*. 2010;12:107–15.
38. Mella VSA, Gillies C, McArthur C, Webb E, Herbert C. Factors influencing the success of hand-reared juvenile brushtail

possums (*Trichosurus vulpecula*) released into the wild. *Wildl Res*. 2022;50(2):96–107.
39. Guy AJ, Curnoe D, Banks PB. A survey of current mammal rehabilitation and release practices. *Biodiv Conserv*. 2013;22:825–37.

About the authors

Dr. Clay Nielsen is Professor of Wildlife Ecology and Conservation in the Department of Forestry and Cooperative Wildlife Research Laboratory at Southern Illinois University, where he received his Ph.D. in Zoology in 2001. Dr. Nielsen has devoted much of his research career to wildlife conservation, having conducted research on dozens of primarily mammalian wildlife species in North America, Central America, South America, and Asia. He has published more than 240 scholarly works and given more than 650 invited lectures and presentations at professional meetings. Dr. Nielsen is a Certified Wildlife Biologist® and was a member of three IUCN Species Survival Commission Specialist Groups.

Dr. Andrew Carver is a Professor of Conservation Planning and Sustainable Development and Director of Engagement for the College of Agricultural Sciences at Southern Illinois University. Dr. Carver leads a globally recognized teaching and research program in international natural resource conservation and international development. His outreach duties include building domestic and international partnerships for the SIU College of Agricultural Sciences and has served as Vice President of the Pan-American Conservation Association (Panamá wildlife rescue and rehabilitation nonprofit organization), since 2005.

Nestor Correa is the founder, President, and Executive Director of the Pan-American Conservation Association (APPC, 2005) in Panamá. Mr. Correa received his B.S. in Law from the University of Panamá and a M.S. in Forestry from Southern Illinois University. Beyond academics, Mr. Correa has >20 years of experience in wildlife rescue and rehabilitation. The APPC has rescued and released over 4,000 animals in the past 12 years and continues to be Panama's leading wildlife rescue and conservation organization.

Yiscel Yanguez currently serves as the Administrative Director for the Pan-American Conservation Association in Panamá. Yiscel has more than 15 years in wildlife rehabilitation, specializing in sloth husbandry. Yiscel is the head of neonate care and oversees all operations involving the daily rehabilitation of rescued sloths. She also coordinates relocation efforts to release sloths admitted to the organization back into the wild in Panamá.

Florida Avian Rehabilitation Intake and Disposition Rates: 2009 to 2022

Aaron Pahl

PHOTO ©RICHARD CROOK. CREATIVE COMMONS.



Florida scrub jay (*Aphelocoma coerulescens*)

ABSTRACT: Using extensive data to analyze and understand avian rehabilitation rates and patient dispositions will allow researchers to identify issues plaguing avian wildlife and form the foundation for new research aimed at implementing innovative treatments. Those treatments can enable better care, resulting in higher survival rates for avian wildlife species in Florida and beyond. The data set for this study is extensive. It contains data from over 50 rehabilitation facilities in Florida between 2009 and 2023. The data includes patient intake details and rehabilitation outcomes from over 500 species and 385,000 avian patients. Over 60 species are considered Near Threatened, Vulnerable, or Endangered according to the International Union for Conservation on Nature's Red List, along with the Florida scrub jay (*Aphelocoma coerulescens*), a species of special concern in Florida, and the endangered Florida grasshopper sparrow (*Ammodramus savannarum*). In addition to the imperiled species, there were 62 species considered invasive in the state of Florida. This study provides avian rehabilitators with information to substantiate and quantify the impact of their work and to consider new approaches to rehabilitation.

KEYWORDS: avian rehabilitation, Florida avian rehabilitation, invasive species, Muscovy duck, patient disposition, raptor rehabilitation, wildlife rehabilitation

CORRESPONDING AUTHOR:
Aaron Pahl
Digital Curation Librarian
University of Alabama at Birmingham
418 Wildwood Crossing
Birmingham, AL 35211 USA
E: aaronpahl@yahoo.com

Introduction

Wildlife rehabilitators interact with hundreds of thousands of injured wild animals across thousands of species every year.[1,2,3] This experience provides these rehabilitators with an exceptional view of the natural environment and the myriad of threats facing local wildlife populations, all while rehabilitating and returning wild animals to their natural habitat.

Avian rehabilitators in Florida have interacted with and treated a tremendous number of injured birds across the state, creating a valuable source of data that, until now, has been siloed in individual rehabilitation facilities. Wildlife rehabilitation facilities provide a rare opportunity to observe, interact with, and study a diverse range of species while simultaneously providing invaluable information on the trauma and diseases they face in their natural environment. This knowledge can be used to increase the chances of

J. Wildlife Rehab. 44(2):13–25. ©2024 The International Wildlife Rehabilitation Council.

successful treatment protocols and the long-term survival of wildlife populations. The ultimate goal of wildlife rehabilitation is to return as many healthy individuals to the wild as possible while ensuring they have the greatest possible chance of survival post-release. Understanding the common illnesses, treatment success rates, and volume of patients handled by rehabilitation centers will allow rehabilitators to better plan for the future, customize care, and secure funding to continue the important work they do, while also increasing the knowledge of the wider scientific community.

This study provides rehabilitators in Florida with the data they need to quantify the impact of their work by providing a comprehensive view of 386,789 avian rehabilitation intakes across Florida. Data were collected from over 50 rehabilitation facilities, including patient dispositions for more than 500 species between 2009 and early 2023. More than 60 of the species represented were listed as being Near Threatened, Vulnerable, or Endangered according to the International Union for Conservation on Nature's (IUCN) Red List, along with the Florida scrub jay (*Aphelocoma coerulescens*), a species of special concern in Florida, and the endangered Florida grasshopper aparrow (*Ammodramus savannarum*). In addition to the threatened species, there were 62 species considered invasive in the state of Florida, making up 17.37% of all treated patients between 2009 and early 2023.

Understanding the state of avian rehabilitation in Florida encourages additional research that can lead to innovative treatments and better care for rehabilitation patients.

Methods

Current Literature

Reporting on avian rehabilitation is not a new concept. In fact, there are a significant number of studies that examine data obtained from wildlife rehabilitation centers located all over the world, including Florida. However, the vast majority of those studies focus on a single facility each.[4,5,6,7,8] Much of the available literature analyzes data obtained from raptor rehabilitation facilities, and as such focuses on the rehabilitation of raptors.[5,9,10,11,12,13] These very focused studies allow researchers to drill down on the issues affecting a single species, or a small subset of species, in a specific region, and to define local solutions to reduce patient admittance while serving as the evidence necessary to enact change to laws regarding wildlife conservation.[4,14] A study conducted at a rehabilitation facility in Greece found that 32% of all admissions were due to shooting incidents, the most frequent of any cause, and that many of those birds were shot outside of hunting season.[15] In response to those findings, the authors were able to advocate for reform of the hunting regulations in Greece.[16] A number of published avian rehabilitation studies include ten years of data, which allows for a much clearer understanding of trends affecting the local population, but they often only represent a few thousand patients.[6,10,15,16] A few studies represent data from multiple facilities, but of those studies, the patient volumes tend to only be in the 1,200–13,000 range.[17,18,19,20]

Highly focused studies are a valuable resource, but they lack the ability to paint a holistic picture of rehabilitation across a region or to provide a conclusive understanding of species densities in that region. Rehabilitation facilities in many regions are located in close enough proximity that if the data from a single facility were analyzed it could not accurately represent patient trends due to the possibility of a patient just ending up at a nearby facility. For example, if there was a significant drop in red-shouldered hawk (*Buteo lineatus*) intakes at one facility, it could simply mean that those patients were brought to a nearby facility rather than signaling a true decline in that species' patient numbers. In Orange County, Florida alone there are more than six facilities that treat avian patients.

A study conducted across 50 facilities, in New South Wales, Australia includes a significantly more substantial volume of rehabilitation patients, with a total of 469,553 patients, of which 250,688 were birds and including 452 species.[21] The study represented a six-year period and created a more comprehensive picture of the status of wildlife rehabilitation in New South Wales over that time period than a study focused on a singular facility could accomplish.[21] In the United States of America, there is one study with a similar scope that represented all of New York State between 2012 and 2014 and included a total of 58,185 patients, of which 30,182 were birds.[22] These two studies represent large geographic regions, high patient volumes, and more rehabilitation facilities, but they are in the extreme minority of rehabilitation studies. To understand the wider effects of avian rehabilitation and accurately study a single species or group of species it is first necessary to understand the bigger picture through data collection and curation.

Data Collection

The rehabilitation records represented in this study were acquired directly from wildlife rehabilitation facilities across Florida, information management systems including WILD-ONe, and reports obtained from the federal government's requirement that rehabilitators report the intake and status of migratory species. The records were obtained in a mixture of formats including handwritten, scanned, and digital native depending on the originating facility and the acquisition method.

All records were transcribed or transferred into digital spreadsheets and normalized to clean up minor naming discrepancies such as red shouldered hawk, red-shouldered hawk, red-shoulder hawk, and RSHA.

There were a total of 587 unique species included in this data set, along with an additional 67 species where full identification was unknown. Those 67 species include partial designations such as Pigeon–Unknown, Cormorant–Unknown, and Grackle–Unknown, along with fully unidentified avian patients. In total, 10,196 patients (2.6%) fell under the categorization of an unknown species, with nearly half (4,922) of those patients considered to be a Pigeon–Unknown species. The second and third highest categories were Unknown Bird and Cormorant–Unknown,

representing 764 and 536 patients respectively. The "Unknown Bird" category had a 14% average survival rate between 2010 and 2021, while the other unknown designations had average survival rates between 40 and 60%. Those unknown species are included in this study but are separated and distinguished from known species throughout. In total, there was a discrepancy of 161 patients (0.04%) that were listed as being admitted to rehabilitation facilities but did not have a listed rehabilitation outcome. These 161 patients were included in the overall total patient results, but their disposition result percentages were adjusted to remove the discrepancy.

Some species represented in the data appear to be misidentifications, such as the passenger pigeon (*Ectopistes migratorious*), an extinct species that was previously endemic to North America.[23] These species have been identified and comprise an estimated 360 individual patients, but it is impossible to conclusively determine if these species were entered in error or if they ended up in Florida through unusual methods such as being part of the illegal pet trade, seized by Fish and Wildlife, or from captivity such as falconry. In addition to the species that may have been misidentified, there were an additional 257 patients that may have ended up in Florida due to severe weather events such as hurricanes. These species have a higher probability of having been correctly identified and, in many cases, there have been confirmed sightings of those species in Florida through platforms such as iNaturalist and eBird.

One species, the commonly named ring-necked dove, is included in the data although it could be associated with three different species: the Barbary dove (*Streptopelia risoria*), the ring-necked dove (*Streptopelia capicolia*) native to East and southern Africa, or the Eurasian collared dove (*Streptopelia decaocto*) which also has a distinctive ring on its neck. All three species include "ring-necked dove" as a potential common name identifier, but the species referred to as the ring-necked dove in these data is most likely the Eurasian collared dove (*Streptopelia decaocto*) and has been referred to interchangeably as such by researchers at the University of Florida.[24] If they are in fact the same species it would collectively make them the seventh most frequently treated species instead of the 11th (ring-necked dove) and 32nd (Eurasian collared dove) with a combined total of 11,577 individual patients.

Some facilities provided extensive detail about their patients, including, but not limited to, information on the admittance and final disposition dates, location the patient was found, nature of the injury, treatments employed, necropsy results, fecal and blood testing results, and banding information. The designations "Euthanized +24 hours" and "Dead +24 hours" were used by some facilities to enhance data reporting and enable better categorization of patient outcomes. These designations are a valuable clarification on patient outcomes that allow for a better understanding of the patient's initial condition and highlight the impact rehabilitation had, while separating out those patients that did not survive long enough to benefit from treatment of any kind. In addition to the designations "Euthanized +24 hours" and "Dead +24 hours," some facilities used terms like "re-nested," "self-released," and "escaped" to further detail patient outcomes. Since most facilities included in this study did not provide that level of detail, this study will focus on patient volumes and disposition outcomes in line with federal reporting requirements.

More descriptive terms were combined into broader categories in accordance with the terminology required for federal permits, with one exception, Adoption. Adoption was used in a limited capacity to distinguish between patients that survived rehabilitation but were deemed non-releasable and were instead adopted as education animals. This designation seemed necessary as these patients did survive the rehabilitation process but would have been euthanized if no home was available, meaning they did not fit well in any other category. Only 1,699 patients (0.44%) were reported as Adopted.

The federal permit terminology includes Released; Transferred; Pending; Euthanized; Died; and Dead On Arrival (DOA). The 2010 federal permit form did not include the designation DOA but it was still used by facilities. In 2011 it was added to the permit form.

- "Released" refers to any patient that survived the rehabilitation process, was deemed releasable, and was subsequently returned to the wild.
- "Transferred" refers to any living patient that was transported from one facility to another for some purpose, such as flight or live prey testing for raptors prior to release, a surgical procedure, placement in a facility that is better equipped to handle a particular species or life stage such as babies, or movement to a facility that can release a patient into a more suitable environment. There is a possibility that some birds may have been transferred between reporting facilities which could lead to double counting intakes. However, it is assumed that this would represent an insignificant number of birds.
- "Pending" refers to any patient that did not have a clear outcome at the time the report was generated and submitted. This means the patient was still alive, but it was not clear if it would survive or be releasable.
- "Euthanized" refers to any patient whose life was humanely ended because they were in a condition unsuitable for rehabilitation and release.
- "Died" refers to any patient that perished at the rehabilitation facility.
- "DOA" refers to an animal that died prior to arriving at a rehabilitation facility. DOA patients serve as a valuable data point in understanding patient frequency, species distribution, and cause of death, but serve as no reflection on rehabilitation since there is nothing that could have been done to save the patient. In this data set, 16,618 patients, or 4.3%, were listed as DOA and as such were not included in calculations for species rehabilitation survival rates.

The primary focus of this study spans 2010–2021, but limited data was also obtained covering 2009, 2022, and early 2023. Of these years, 2009 and 2022 each include patient numbers from three

different facilities while 2023 only includes data representing part of the year obtained from two facilities. In total those three years add an additional 18,452 patients (4.8%) and five species. The inclusion or exclusion of data from 2009, 2022, and 2023 is clearly distinguished throughout this study.

Facilities

Florida Fish and Wildlife maintains a "Licensed Wildlife Rehabilitators List" of individuals and facilities permitted to rehabilitate wildlife in the state of Florida. This list includes 47 facilities that have active permits to handle avian patients and does not include past permit holders or any information on whether or not a facility is still accepting patients.[25] The data in this study represent 51 wildlife rehabilitation facilities across Florida and four facilities outside of Florida. The four facilities outside of Florida received a total of five birds that were obtained in Florida and then transported out of state to those facilities.

Not every facility was open the entire length of the study, and there are a number of facilities missing data from select years that were assumed lost or unavailable. As part of this study, every permitted avian rehabilitation facility in the state was contacted multiple times using various methods in an effort to obtain data. In some cases, rehabilitation statistics for certain years had been irretrievably lost due to damaged hard drives, hurricanes, flooding, staff turnover, and age. In other instances, the data from lost years were accessed through other sources such as federal permit reports.

Between 2010 and 2021 there were an average of 33 facilities reporting patient numbers each year, with a high of 37 (2013 and 2016) and a low of 26 (2018). In at least one reporting year 20 facilities treated over 1,000 patients, and 14 facilities never treated more than 100 patients in a year. The most active facility treated roughly 8,000 patients a year through 2017, comprising approximately 30% of the total patients treated. Since then, that facility saw a significant decline in avian patient intake to less than 6,000 patients in 2021 (15% of all patients) (Figure 1).

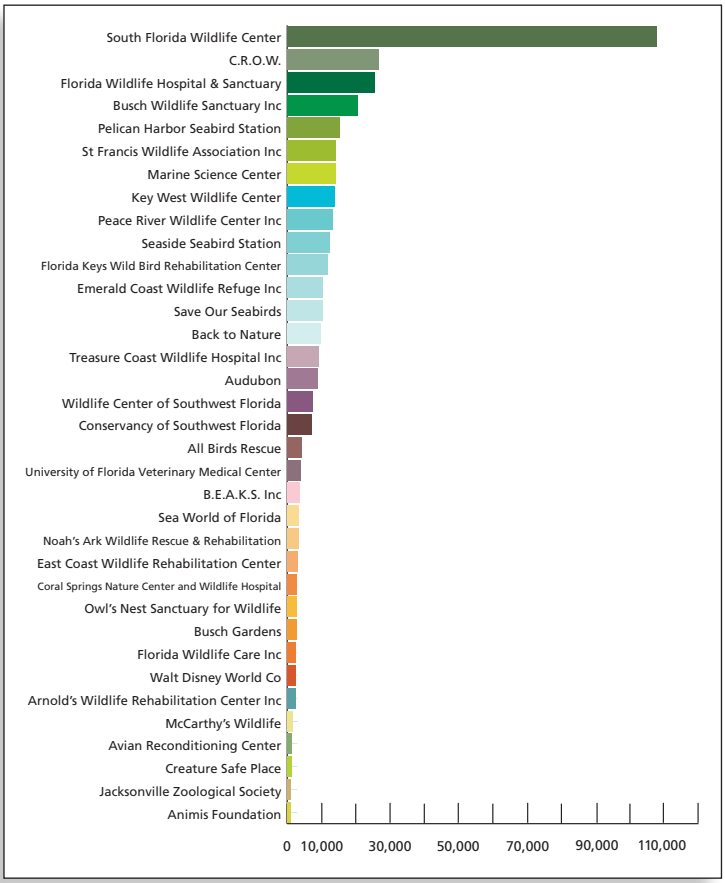


Figure 1: Contributing facilities with total patient volume 2009-2022
The following facilities were not included in Figure 1. These facilities took in less than 1,000 patients over the study years and are listed from most patients taken in to least. Muscovy Sanctuary of Florida, Featherland Wild Bird Rehab, St. Charles Veterinary Hospital, Genesis Zoological Center, Humane Society of North Pinellas, Save all birds, Palm Beach Zoo and Conservation Society, SPCA Tampa Bay, Lion Country Safari, Alaqua Animal Refuge Wildlife Center, Miami Science Museum-Falcon Batchelor Bird of Prey Center, Homosassa Springs State Wildlife Park, Kritter Inc., Sterns Zoological Rescue and Rehab Center, Lowry Park Zoological Society of Tampa, Orange Beach Wildlife Center, Friends of Florida Wildlife, Tort-Beat Wildlife Rehabilitation, Environmental Studies Center, and Center for Wildlife.

Results

Out of the 587 total unique species included in the data, 316 species (53.8%) had ten or more reported cases from 2009 to 2023, 151 species (25.7%) had between nine and two patients, and 120 species (20.4%) had a single patient listed across the entire time period. Of the 120 species with only one patient listed, 44 are known residents or visitors to the state of Florida and 19 are considered exotic pets, gamebirds, or domesticated species. The 57 remaining species appear to be a mixture of misidentifications and species that were potentially blown off course due to severe weather events such as hurricanes.[26,27] There were 65 species, including the species designated as "Pigeon – Unknown," that had over 1,000 reported patients, with the top nine most frequently treated species each reporting over 10,000 patients. Those top nine species account for 166,074 total patients (42.93%) of all avian patients represented in this study. The Muscovy duck (*Cairina moschata*) was the most frequently treated species (9.46%) of all represented patients between 2009 and 2023. The Muscovy duck had almost 10,000 more intakes than the second most frequently treated species (Figure 2, Figure 3, Table 1).

Rehabilitation outcomes

From 2009 to 2023 the average release rate was 35.1% excluding patients that were recorded as "DOA" and including the adopted patients (0.4%). According to other studies conducted on avian rehabilitation, release rates can fluctuate from as low as 21% to as high as 48.2%.[4,5,6,18,19,21,22] In those studies, the facilities used to determine those release rates were located all over the world and

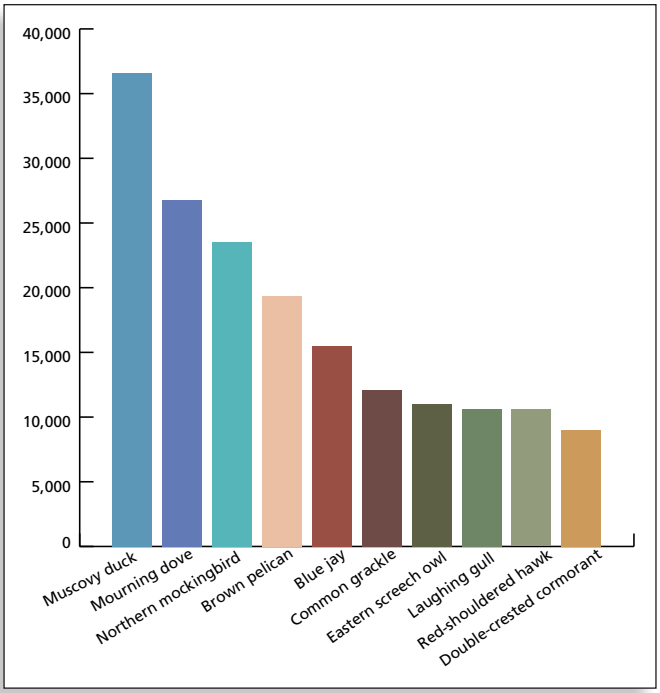


Figure 2: Top 10 intake species

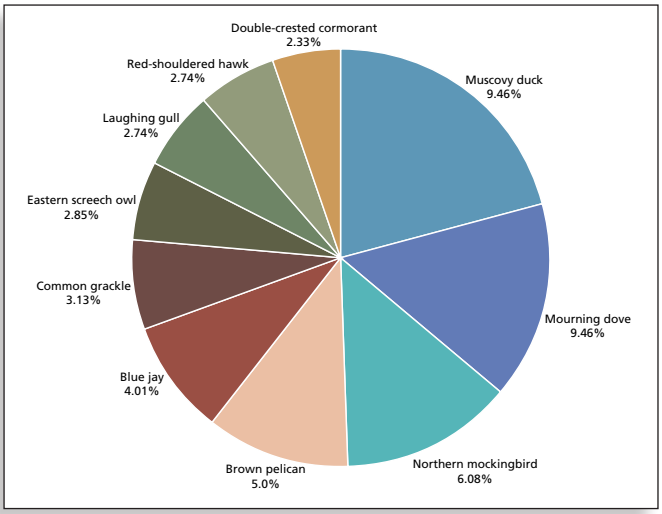


Figure 3: Top 10 species percentages

ranged in size from just over 390 total patients all the way up to over 250,000 total patients, with many focused exclusively on raptor rehabilitation.[4,5,6,18,19,21,22]

The average "Euthanized" rate from 2009 through 2023 was 35.98% and the death rate ("Died") was 24.3% when DOA is excluded. The DOA rate was 4.3%, which some studies include under the dead category, but it should be separated since the rehabilitator has no ability to help a patient that arrives dead.[21,22] Pending was listed at 1.3% and Transferred made up 3.1% of the total between 2009 and 2023.

On initial examination, the 35.1% release rate seems to be on the lower end of the spectrum, but when it is combined with transferred and the already included adopted patients, the survival rate between 2010 and 2021 increases to 39%, moving it much more in line with other reported release rates. Patients that were transferred were included in the survival rate because at the time they left the facility they were still alive. It is expected that a patient would only be transferred if it was stabilized and believed to have a strong chance of survival. For example, at the Marine Science Center, raptors are often transferred once they are fully healed

Table 1: Species with the highest patient volume

COMMON NAME	TOTAL	% OF TOTAL	SURVIVAL RATE
Muscovy duck	36,583	9.46%	40.4%
Mourning dove	26,801	6.93%	42.8%
Northern mockingbird	23,516	6.08%	41.5%
Brown pelican	19,325	5.00%	54.1%
Blue jay	15,529	4.02%	34.2%
Common grackle	12,123	3.13%	30.5%
Eastern screech owl	11,011	2.85%	55.6%
Laughing gull	10,602	2.74%	29.3%
Red-shouldered hawk	10,584	2.74%	42.1%
Double-crested cormorant	9,030	2.33%	32.8%
Ring-necked dove*	8,584	2.22%	31.4%
Osprey	6,653	1.72%	31.0%
Red-bellied woodpecker	6,406	1.66%	41.5%
Northern cardinal	5,452	1.41%	29.6%
Great blue heron	5,344	1.38%	30.3%
Royal tern	5,046	1.30%	29.6%
Pigeon - Unknown	4,922	1.27%	19.0%
Barred owl	4,792	1.24%	41.4%
Carolina wren	4,772	1.23%	33.0%
Cooper's hawk	4,610	1.19%	40.4%
American white ibis	4,220	1.09%	29.3%

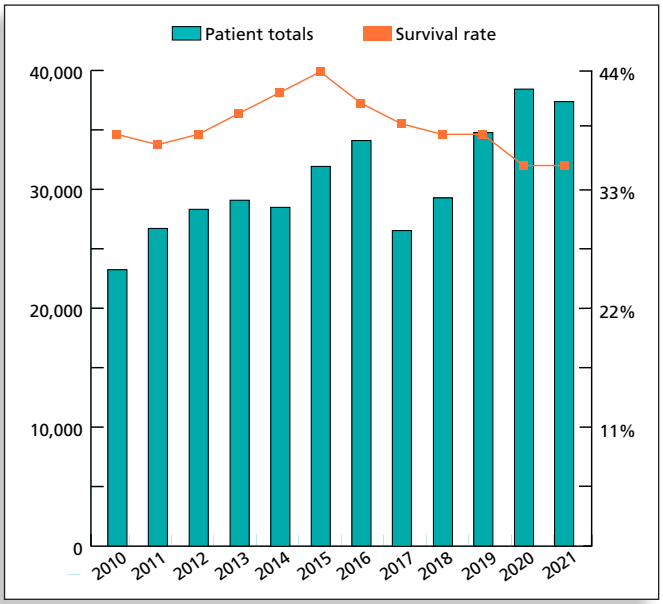


Figure 4: Yearly patient totals with the survival rate percentage

and only need to be flight-tested or live prey tested.

Between 2010 and 2021 the release rate fluctuated from year to year with a high of 44% (2015) and a low of 35% (2020 and 2021). The death rate was much more consistent across all years with a much smaller range of 21% to 26% (four years at 24%). The euthanization rate mirrored the survival rate a bit more with a range of 30% to 39%. The two highest euthanization rate years were 2020 and 2021 (Figure 4).

Threatened Species

The IUCN Red List was used to determine that 474 of the known species (80.7%) included in these data are considered species of Least Concern, totaling 343,127 individual patients or 88.7% of all patients (Figure 5) (Table 2).[28] The remaining 19.3% are characterized below:

- **Near Threatened**: 39 species (6.6%) were listed as being Near Threatened, representing 16,417 (4.2%) individual patients.
  - » The sixth most frequently treated species (n = 12,123) was the common grackle (*Quiscalus quiscula*). The common grackle had an average survival rate of 31% between 2010 and 2021, with its two lowest years being 2020 at 24% and 2021 at 26%. In fact, its survival rate has been in a very gradual decline since 2016, with its highest rate of survival coming in 2014 at 42%.
  - » Of all the Near Threatened species with more than one total patient, the sooty shearwater (*Ardenna griseus*) had the lowest average survival rate at just 8%. Between 2009 and 2023, 38 sooty shearwaters were brought into rehabilitation facilities but only three were released, two in 2010 and one in 2012.
  - » The chuck-will's-widow (*Antrostromus carolinensis*), with 1,254 total patients, was the second most frequently treated Near Threatened species, with an average survival rate of 40% between 2010 and 2021. It exhibited an unusually large survival rate range, spanning from 24% to 61%.
- **Vulnerable**: 14 species (3%) making up 3,335 patients (0.86%) were listed as Vulnerable.
  - » 3,139 (94%) of those patients were chimney swifts (*Chaetura pelagica*) with an average survival rate of 46% between 2010 and 2021 and a high of 60% in 2020.
  - » The Leach's storm petrel (*Oceanodroma leucorhoa*) had the lowest average survival rate of Vulnerable species at 4% across 25 patients, with only one patient getting released.
  - » The Florida scrub jay, considered a species of special concern in Florida with an estimated population of less than 10,000 individuals, had an average survival rate of 53% between 2010 and 2021.[29] In most years, this only represented one or two patients, except for 2013 and 2016 which each had eight patients.
- **Endangered**: The number of species listed as Endangered mirrored those listed as Vulnerable at 14, with a total of 83 individual patients.
  - » Six species appear to be escaped exotic pets, including the African Gray Parrot (*Psittacus erithacus*) (22 patients) and the umbrella cockatoo (*Cacatua alba*) (31 patients).
  - » The Florida grasshopper sparrow is included under the designation Endangered but was not listed on the IUCN Red List. However, it is listed as an Endangered species in the Endangered Species Act and listed as Critically Imperiled in the NatureServe conservation status system. In 2019, there were an estimated 80 Florida grasshopper sparrows left in the wild, which rose to 120 in 2022 thanks to the release of captive-raised sparrows successfully breeding with wild populations.[30] In 2019, one Florida grasshopper sparrow was treated in a rehabilitation facility but did not survive. In 2020, 12 Florida grasshopper Sparrows entered rehabilitation with six getting released, four remaining as pending, and two not surviving treatment.
  - » The parasitic jaeger (*Stercorarius parasiticus*), the second most frequently treated Endangered species with 16 patients, did not have a single release over the entire period.
  - » The red-billed gull (*Chroicocephalus novaehollandiae scopulinus*) (one patient), was listed as Declining on the New Zealand Threat Classification System. This is expected to most likely be a misidentification.
- **Critically Endangered**: There were two species listed as critically endangered: five Bachman's warbler (*Vermivora bachmanii*) individuals, and one spoon-billed sandpiper (*Calidris pygmaea*) patient. Both species appear to be misidentifications, since Bachman's warbler is thought to be extinct.[31]
- **Extinct**: Two additional species were reported that have been classified as extinct: the passenger pigeon (*Ectopistes migratorious*) and the Carolina parakeet (*Conuropsis carolinensis*). Both are likely misidentifications considering they have been listed as extinct for over 100 years.

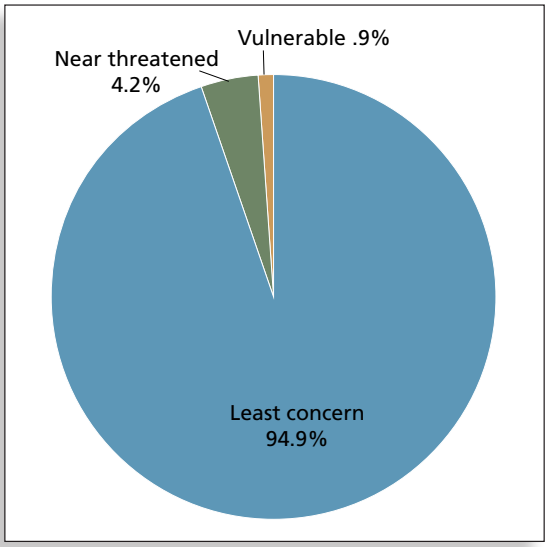


Figure 5: IUCN Status

Table 2: Near threatened to critically endangered species

COMMON NAME	SCIENTIFIC NAME	TOTAL PATIENTS (2009-2023)	SURVIVAL RATE (2010-2021)
CRITICALLY ENDANGERED		**6**	
Bachman's warbler	*Vermivora bachmanii*	5	0.0%
Spoon-billed sandpiper	*Calidris pygmaea*	1	0.0%
ENDANGERED		**83**	
African grey parrot	*Psittacus erithacus*	22	64.7%
Parasitic jaeger	*Stercorarius parasiticus*	16	0.0%
Florida grasshopper sparrow	*Ammodramus savannarum floridanus*	13	66.7%
Black rail	*Laterallus jamaicensis*	11	45.5%
Black-capped petrel	*Pterodroma hasitata*	6	0.0%
Bornean Peacock-pheasant	*Polyplectron schleiermacheri*	3	66.7%
Red-crowned Amazon	*Amazona viridigenalis*	3	33.3%
Sun parakeet	*Aratinga solstitialis*	3	66.7%
Java sparrow	*Padda oryzivora*	1	0.0%
Lilac-crowned parrot	*Amazona finschi*	1	100.0%
Masked quail	*virginianus ridgwayi*	1	0.0%
Salt-marsh sparrow	*Ammospiza caudacutus*	1	0.0%
Tricolored blackbird	*Agelaius tricolor*	1	0.0%
Umbrella cockatoo	*Cacatua alba*	1	0.0%
VULNERABLE		**3,335**	
Chimney swift	*Chaetura pelagica*	3,139	46.3%
Horned grebe	*Podiceps auritus*	120	34.5%
Florida scrub jay	*Aphelocoma coerulescens*	32	53.3%
Leach's storm-petrel	*Oceanodroma leucorhoa*	25	4.2%
Bicknell's thrush	*Catharus bicknelli*	4	75.0%
European turtle-dove	*Streptopelia turtur*	4	66.7%
Black legged kittiwake	*Rissa tridactyla*	2	0.0%
Evening grosbeak	*Coccothraustes vespertinus*	2	50.0%
Military macaw	*Ara militaris*	2	0.0%
Black-capped vireo	*Vireo atricapilla*	1	0.0%
Black-polled yellowthroat	*Geothlypis speciosa*	1	100.0%
Cuban parakeet	*Psittacara euops*	1	0.0%
Long-tailed duck	*Clangula hyemalis*	1	100.0%
Reeves's pheasant	*Syrmaticus reevesii*	1	0.0%
NEAR THREATENED		**16,417**	
Common grackle	*Quiscalus quiscula*	12,123	30.5%
Chuck-will's-widow	*Antrostomus carolinensis*	1,254	39.6%
Loggerhead shrike	*Lanius ludovicianus*	902	40.9%
White-crowned pigeon	*Patagioenas leucocephala*	537	49.5%
Red knot	*Calidris canutus*	395	48.1%
Black scoter	*Melanitta americana*	356	20.8%
Northern bobwhite quail	*Colinus virginianus*	207	52.8%
Eastern whip-poor-will	*Antrostomus vociferus*	196	39.2%
Blackpoll warbler	*Setophaga striata*	57	36.5%
Eastern meadowlark	*Sturnella magna*	53	36.5%

» Not included in the IUCN Red List but designated as Threatened species in the state of Florida:

» The American kestrel (*Falco sparverius*) showed an upward trend in intake numbers, with 2021 having the highest patient volume of any year at 167 individuals and an average survival rate of 57% across 1,138 individual patients between 2010 and 2021.

» The burrowing owl (*Athene cunicularia*) had an average survival rate of 43%, with the lowest rate in 2020 at 36% followed by 38% in 2021. With 1,208 patients between 2010 and 2021, the burrowing owl showed a similar upward trend in intake numbers as the American kestrel, with 2019, 2020, and 2021 having more patients than any other years, rising in ascending order to 165 patients in 2021.

» The crested caracara (*Caracara cheriway*) is listed as Federally Threatened.[32] It had an average survival rate of 50% (22% in 2019 and 78% in 2015), representing nine patients in each of those years. The crested caracara had an average intake rate of eight patients a year with six years all having seven patients, for a total of 96 patients between 2010 and 2021.

Invasive Species

The data included 62 species (10.6%) considered invasive in the state of Florida, making up a total of 67,200 recorded avian patients (17.37%) between 2009 and 2023 (Figure 6, Figure 7, Table 3).[33] Not included in that patient count is the species designation "Pigeon – Unknown" since the exact species is unclear. If these 4,922 individuals were included in the patient figures it would increase the total invasive species patient number to 72,122 (18.6%).

Out of the 62 invasive species, 15 had over 100 patients between 2009 and 2023, while 35 species had less

Table 2: Near threatened to critically endangered species, continued.

COMMON NAME	SCIENTIFIC NAME	TOTAL PATIENTS (2009-2023)	SURVIVAL RATE (2010-2021)
King rail	*Rallus elegans*	49	35.4%
Reddish egret	*Egretta rufescens*	42	35.7%
Sooty shearwater	*Ardenna griseus*	38	8.1%
Semipalmated sandpiper	*Calidris pusilla*	34	30.0%
Snowy plover	*Charadrius nivosus*	32	21.9%
Red-masked parakeet	*Psittacara erythrogenys*	31	16.7%
Bachman's Sparrow	*Peucaea aestivalis*	21	38.1%
Cuban bullfinch	*Melopyrrha nigra*	15	50.0%
Japanese quail	*Coturnix japonica*	15	85.7%
Piping plover	*Charadrius melodus*	10	11.1%
Florida grackle	*Quiscalus quiscula quiscula*	9	44.4%
Red-cockaded woodpecker	*Dryobates borealis*	9	37.5%
Cerulean warbler	*Setophaga cerulea*	8	57.1%
Common eider	*Somateria mollissima*	7	28.6%
Elegant tern	*Thalasseus elegans*	2	50.0%
Fischer's lovebird	*Agapornis fischeri*	2	50.0%
Bar-tailed godwit	*Limosa lapponica*	1	100.0%
Black-tailed godwit	*Limosa limosa*	1	0.0%
Blue-fronted parrot	*Amazona aestiva*	1	100.0%
Curlew sandpiper	*Calidris ferruginea*	1	0.0%
Emperor goose	Anser canagicus	1	100.0%
Germain's peacock-pheasant	Polyplectron germaini	1	100.0%
Golden-winged warbler	Vermivora chrysoptera	1	0.0%
Greater prairie chicken	Tympanuchus cupido	1	100.0%
Heermann's gull	Larus heermanni	1	0.0%
Ivory gull	Pagophila eburnea	1	0.0%
Kirtland's warbler	Setophaga kirtlandii	1	0.0%
Long-billed murrelet	Brachyramphus perdix	1	0.0%
Olive-sided flycatcher	Contopus cooperi	1	0.0%

than ten patients over the same period. The ring-necked dove is included as an invasive species with the caveat that it might be one of three different species.

The invasive species family with the most individual patients was Anatidae with a total of 37,682 patients (9.7%), due in large part to its inclusion of the Muscovy duck and five other species. It was followed by Columbidae with 8,556 patients (2.2%) across six species and Sturnidae with 3,761 patients (1%) across three species. The family with the most individual species was Psittacidae with 18 species and 858 patients, which were most likely primarily escaped pets or intentionally released animals such as the Quaker parrot (*Myiopsitta monachus*).

The most frequently treated species overall was the Muscovy duck, which also happens to be an invasive species in Florida. Muscovy ducks are prolific breeders, laying a clutch of 8–16 eggs (13.6 average) up to three times a year.[34] The Muscovy duck is widespread across Florida and lives in close proximity to people, where they are often fed or abused.[35] Adult Muscovy ducks are often killed, leading to large numbers of ducklings being brought into rehabilitation facilities.[35] It is against state and federal regulations to release Muscovy ducks into the wild, but they can be adopted.[35] This regulation makes it challenging for facilities to treat the species when they have such limited options for a positive outcome. This has led to an increased number of euthanizations upon arrival.

In 2015, the release rate for Muscovy ducks was 56%. In stark contrast, their release rate in 2020 dropped significantly to 18% (11-year average of 49%). The significant drop in Muscovy duck release rates in 2020 can be explained by a sharp increase in euthanization rates, which climbed to 75.46%.

In recent years, the move to reduce the treatment and release of Muscovy ducks in rehabilitation facilities has increased with more facilities instituting policies to euthanize patients on arrival. This has led to the establishment of new facilities not subject to the Migratory Bird Treaty Act that focus solely on the care and rehabilitation of Muscovy Ducks.[35] Those facilities have a very small representation in this study.

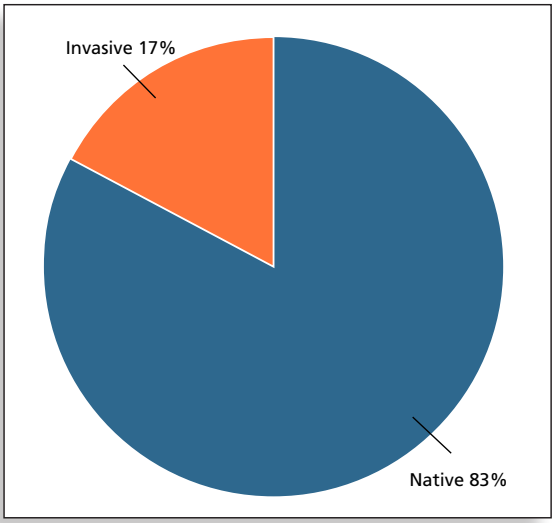


Figure 6: Native vs invasive total intake percentages

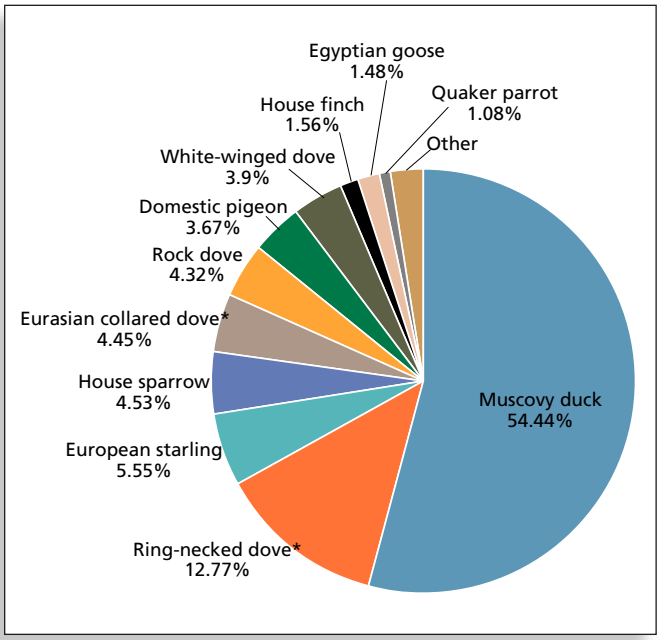


Figure 7: Invasive species percentage breakdown

Table 3: Invasive species volumes and outcomes

Common Name	Survival Rate	Eutha-nization	Death	Total Patients
Muscovy duck	40.4%	49.3%	6.5%	32,858
Ring-necked dove*	31.4%	57.2%	8.0%	7,409
Pigeon - Unknown	19.0%	74.7%	3.3%	4,337
European starling	25.4%	59.2%	12.1%	3,295
Rock dove	39.9%	44.5%	14.3%	2,811
House sparrow	32.7%	32.4%	31.1%	2,753
Eurasian collared dove*	30.1%	45.3%	21.6%	2,329
White-winged dove	25.7%	61.0%	10.4%	2,188
Domestic pigeon	17.8%	75.9%	3.3%	1,860
House finch	33.7%	17.1%	42.1%	999
Egyptian goose	24.8%	64.7%	6.0%	863
Quaker parrot	40.0%	48.5%	10.0%	598
Indian peafowl	31.6%	57.0%	7.6%	342
Budgerigar	63.2%	20.0%	13.6%	250
Cockatiel	64.6%	20.5%	13.8%	195
Spot-breasted oriole	21.8%	30.0%	44.5%	110

*The Ring-necked Dove and the Eurasian Collared Dove are potentially two common names for the same species.

The Muscovy duck release rate increased to 43% in 2021. It is speculated that when members of the public learned that the cute little ducklings faced a strong chance of being euthanized, they became less willing to leave them at rehabilitation facilities. Members of the public would then search out other facilities willing to take the ducklings, try to rehabilitate the chicks themselves, or leave the ducklings in the wild assuming they would have at least a small chance of survival.

Domestic species

In addition to invasive species, the data included a number of domesticated species, including the domestic chicken (*Gallus gallus domesticus*), domestic goose (*Anser anser domesticus*), and domestic turkey (*Meleagris gallopavo domesticus*). Between 2010 and 2021, 945 domestic chickens were treated with an average survival rate of 56%, followed by the domestic goose with 163 patients and a 53% average survival rate. The domestic chicken had a 5% death rate while the domestic goose had a 6% death rate.

Avian euthanization

In several published studies, bird euthanization and death rates were combined into one figure which obscures the actions of the rehabilitation facilities.[21,22] The Muscovy duck euthanization rate is extremely high, while its average death rate (7%) is extremely low. Separating the data into these two outcomes makes it clear that Muscovy ducks are excellent at surviving rehabilitation but are being heavily euthanized due to their status as an invasive species. That trend is repeated when considering the invasive ring-necked dove with a death rate of 8% and a euthanization rate of 57.2%; the Pigeon – Unknown with a death rate of just 3% and a euthanization rate of 74.7%; the European starling with a death rate of 12% and a euthanization rate of 59%; and the domestic pigeon with a death rate of 3% and a euthanization rate of 75.9%. In fact, across the 250 most frequently treated species only those considered to be invasive or domesticated have less than a 10% average death rate. In 2020 and 2021, the Muscovy duck had its lowest death rates at only 3% and 4% respectively.

Taxonomic families

These data include 81 distinct taxonomic families. Ten of those families make up 67.79% of all patients, or 262,214 individuals in 173 species. Columbidae, with 19 or 20 species depending on the classification of the ring-necked dove, had the highest number of patients at 48,994 (12.66%), just edging out Anatidae by 99 patients. Anatidae may have had the second greatest number of patients, but it had the highest overall species count at 50. Following Anatidae, the next highest patient volume falls to 27,295 (7%) with Mimidae across four species. Pelecanidae, which includes only two species, had the seventh highest number of patients (5%), with the brown pelican (*Pelecanus occidentalis*) contributing 19,325 patients and the American white pelican (*Pelecanus erythrorhynchos*) adding 335 patients. The brown pelican was the fourth most frequently treated species, having a 54% average survival rate between 2010 and 2021 with only one year dropping below 50%, 2016 at 46%. The family Parulidae included the second greatest number of species with 43 covering 10,252 patients (2.6%), followed by Scolopacidae with 31, Psittacidae with 25, and Passerellidae with only 376 patients across 24 species.

Raptors

Even though multiple studies have focused exclusively on raptors in wildlife rehabilitation facilities, it is important to put into context how raptors fare in relation to other avian species. Of all the birds treated between 2009 and 2023, raptors made up 14.1% of the total and had an average survival rate of 44.77%. The data include 40 species of raptor, including the "Raptor–Unknown" designation. However, three species may have been misidentified, part of the pet trade, or blown off course: mottled owl (*Strix virgata*), Eurasian eagle-owl (*Bubo bubo*), and western screech owl (*Megascops kennicottii*). Only one western screech owl survived.

In total, 54,574 raptors were treated between 2009–2023, with the eastern screech owl (*Megascops asio*) and red-shouldered hawk (*Buteo lineatus*) being the most frequently treated with 11,011 (2.8%) and 10,584 (2.7%) patients respectively. Overall, the eastern screech owl was the seventh most frequently treated species, with the red-shouldered hawk following close behind in the ninth position. Between 2010 and 2021 the eastern screech owl had the highest average survival rate among raptors with over 1,000 patients, and was in the top 36 most frequently treated species at 56%. The red-shouldered hawk had an average survival rate of 42% over the same period (Figure 8).

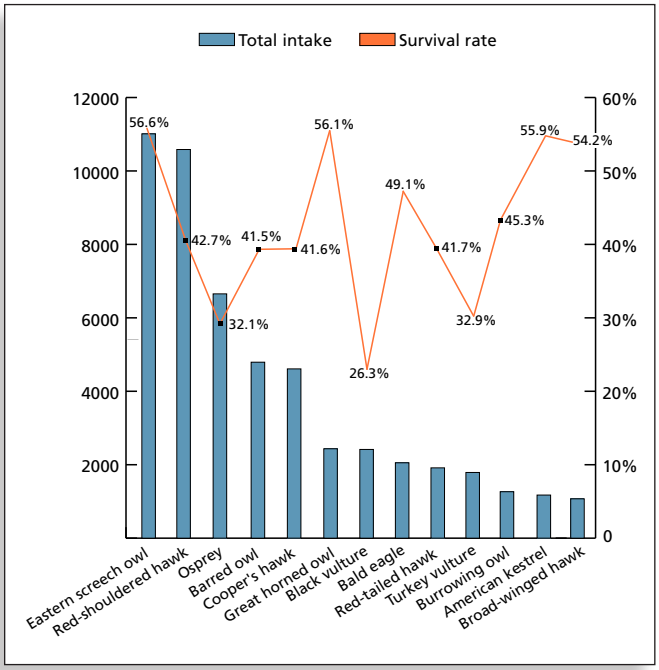


Figure 8: Top raptor intake and survival rate

Among the raptor species, the Swainson's hawk (*Buteo swainsoni*), with 12 patients, had the highest survival rate at 70%, which was closely followed by the barn owl (*Tyto alba*) with 974 patients at a 66% survival rate, and the short-eared owl (*Asio flammeus*) with 11 patients at a 63% survival rate. The barn owl also had the highest survival rate of any species with more than 50 total patients (Table 4).

Bald eagles (*Haliaeetus leucocephalus*) were the eighth most frequently treated raptor species, with 2,053 individuals. Bald eagles had an average survival rate of 44% between 2010 and 2021 and an average death rate of only 10%. The black vulture (*Coragyps atratus*) (2,416 patients) had the lowest average survival rate of any raptor with more than one total patient, at 26%. In 2019, the black vulture had its lowest survival rate at 15%, followed by a 19% survival rate in 2020.

Table 4: Species with the highest survival rates

SURVIVAL %	COMMON NAME	TOTAL PATIENTS
66.2%	Barn owl	985
64.6%	Cockatiel	241
63.2%	Budgerigar	309
60.0%	Least tern	1,259
58.4%	Mottled duck	2,556
56.9%	Roseate tern	65
56.6%	American kestrel	1,174
56.5%	Domestic duck	70
56.5%	Great horned owl	2,435
55.9%	Broad-winged hawk	1,072
55.6%	Domestic chicken	945
55.6%	Eastern screech owl	11,011
55.6%	Hooded warbler	55
55.0%	Mississippi kite	266
54.7%	Swallow-tailed kite	263
54.6%	Black-bellied whistling duck	997
54.6%	Painted bunting	247
54.1%	Brown pelican	19,325
53.9%	Mute swan	88
53.7%	Peregrine falcon	298
53.1%	American Pekin (duck)	369
52.8%	Northern bobwhite quail	207
52.7%	Domestic goose	163
52.3%	Rose-breasted grosbeak	113
51.9%	Song sparrow	104
51.4%	Red-headed woodpecker	226
50.5%	Tennessee warbler	105

Species of Special Concern

The northern gannet (*Morus bassanus*), which was the 26th most frequently treated species representing 3,312 patients (0.86%) between 2009 and 2023, had a 13% survival rate between 2010 and 2021. In 2010, the northern gannet's survival rate was 25%. Since then, it has consistently trended down over the period and reached a low point of 4% in 2019. The northern gannet had the lowest survival rate of the 92 most frequently treated species, which includes every species with over 565 total patients. In fact, only 16 species with more than 10 total patients had a lower average

Table 5: Species with lowest survival rates

SURVIVAL %	COMMON NAME	TOTAL PATIENTS
2.3%	Cory's shearwater	315
4.7%	Great shearwater	565
10.3%	Audubon's shearwater	228
13.1%	Northern gannet	3,312
13.5%	Bridled tern	53
13.7%	Common tern	226
14.0%	Sooty tern	280
14.3%	Razorbill	85
15.5%	Common snipe	76
16.9%	Brown-headed cowbird	159
17.1%	Blue-gray gnatcatcher	435
17.5%	American woodcock	59
17.8%	Domestic pigeon	2,463
17.9%	Least sandpiper	58
18.1%	Sandwich tern	743
18.5%	House wren	578
18.8%	Tree swallow	69
19.9%	Black skimmer	700
20.4%	Limpkin	976
20.8%	Black scoter	356
21.3%	Cattle egret	1,864
21.7%	American redstart	1,175
21.8%	Spot-breasted oriole	133
22.4%	Common loon	3,388
22.6%	Fancy pigeon	639
22.9%	Belted kingfisher	424
23.1%	Eastern phoebe	125
24.8%	Egyptian goose	993
25.0%	Ruddy duck	100

survival rate than the northern gannet (Table 5).

Four shearwater species had a collective total of 1,146 patients and lower overall survival rates than northern gannets.

- The Manx shearwater (*Puffinus puffinus*) had nine total patients and was the only species of shearwater with a higher average survival rate than the northern gannet, at 25%.
- The great shearwater (*Ardenna gravis*) had 565 patients with a 5% survival rate and a 2.3% release rate between 2010 and 2021 (2% in 2012).
- Cory's shearwater (*Calonectris diomedea)* represented 315 patients with an average survival rate of 2% and a release rate of 1% between 2010 and 2021. Eight of those years resulted in a 0% survival rate. In total, only three Cory's shearwaters were released and four were transferred.
- Audubon's shearwater (*Puffinus lherminieri*) represented 228 patients with a 10% average survival rate between 2010 and 2021. The years 2008, 2019, and 2021 all had a 0% survival rate, with 2020 coming in at 4%. As previously mentioned, the sooty shearwater had an average survival rate of just 8%.

Conclusion

Avian rehabilitators across Florida have interacted with at least 386,789 patients across 587 unique species, resulting in an overall 39% survival rate between 2010 and 2021. Patient intakes appear to be slowly trending up while survival rates are slightly decreasing. Invasive species made up 17.37% of all patients in this study, with the Muscovy duck representing the most individual patients of any species.

By combining and consolidating rehabilitation data across numerous facilities, rehabilitators have the ability to better collaborate to identify problem species and share successful treatment protocols. The value of these data could be significantly increased by incorporating more patient-specific data that explores the reason for admission, treatments employed, and the results of any lab tests or necropsies. In the future, rehabilitation data could be shared across facilities at annual conferences like the Florida Wildlife Rehabilitators Association (FWRA) and the National Wildlife Rehabilitators Association (NWRA), or virtual meetings following the federal reporting submission date. With the preponderance of research focused on raptor rehabilitation, it would be beneficial to take an in-depth look at raptor rehabilitation in Florida while incorporating additional data points, like reason for admittance and the sex of the patient.

Species with low survival rates, like the northern gannet and any shearwater, need more attention aimed at finding new treatment methods. These data enhance the ability of wildlife rehabilitators to understand their local environment and provide a greater opportunity to modify treatment protocols, adjust asset allocations, and secure funding to ensure as many healthy avian patients are returned to the wild as possible.

Acknowledgments

The author would like to thank all the rehabilitation facilities that entrusted their data to this project, Wild-ONe for promoting scientific research, the Marine Science Center for inspiring and promoting this project, and Patrick Pahl for editing and providing invaluable feedback.

Literature Cited

1. Parr-Cortes Z. Saving Wild Animals, Before And After Rehabilitation. Faunalytics. 2022 Jul 14 [accessed 2023 Nov 20]. https://faunalytics.org/saving-wild-animals-before-and-after-rehabilitation/.
2. Willette M, Rosenhagen N, Buhl G, Innis C, Boehm J. Interrupted Lives: Welfare Considerations in Wildlife Rehabilitation. *Animals*. 2023 [accessed 2023 Nov 20];13(11):1836. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10252006/. doi: 10.3390/ani13111836.
3. Cope HR, McArthur C, Dickman CR, Newsome TM,

Gray R, Herbert CA. A systematic review of factors affecting wildlife survival during rehabilitation and release Lepczyk CA, editor. *PLOS ONE*. 2022;17(3):e0265514. doi: 10.1371/journal.pone.0265514
4. Cococcetta C, Coutant T, Collarile T, Vetere A, Di Ianni F, Huynh M. Causes of Raptor Admission to the Wildlife Rehabilitation Centre in Abruzzo (Central Italy) from 2005–2016. *Animals*. 2022 [accessed 2023 Jun 27];12(15):1916. doi: 10.3390/ani12151916
5. Deem SL, Terrell SP, Forrester DJ. A retrospective study of morbidity and mortality of raptors in Florida: 1988–1994. *J Zoo Wildl Med*. 1998 [accessed 2023 Jun 27];29(2):160–4.
6. Molina-López RA, Casal J, Darwich L. Final Disposition and Quality Auditing of the Rehabilitation Process in Wild Raptors Admitted to a Wildlife Rehabilitation Centre in Catalonia, Spain, during a Twelve Year Period (1995–2007). *PLOS ONE*. 2013 [accessed 2023 Jun 27];8(4):e60242. doi: 10.1371/journal.pone.0060242
7. Montesdeoca N, Calabuig P, Corbera JA, Cooper JE, Orós J. Causes of morbidity and mortality, and rehabilitation outcomes of birds in Gran Canaria Island, Spain. *Bird Study*. 2017 [accessed 2023 Jun 27];64(4):523–34. doi: 10.1080/00063657.2017.1411464
8. Schenk AN, Souza MJ. Major Anthropogenic Causes for and Outcomes of Wild Animal Presentation to a Wildlife Clinic in East Tennessee, USA, 2000–2011. *PLOS ONE*. 2014 [accessed 2023 Jun 27];9(3):e93517. doi: 10.1371/journal.pone.0093517
9. Morishita TY, Fullerton AT, Lowenstine LJ, Gardner IA, Brooks DL. Morbidity and mortality in free-living raptorial birds of Northern California: a retrospective study, 1983–1994. *J Avian Med Surg*. 1998 [accessed 2023 Jun 27];12(2):78–81.
10. Rodríguez B, Rodríguez A, Siverio F, Siverio M. Causes of Raptor Admissions to a Wildlife Rehabilitation Center in Tenerife (Canary Islands). *J Raptor Res*. 2010 [accessed 2023 Jun 27];44(1):30–39. doi: 10.3356/jrr-09-40.1
11. Rozsypalová L, Rymešová D, Stýblo P, Literák I. Causes of admission and outcomes of white-tailed eagles *Haliaeetus albicilla* in wildlife rescue centres in the Czech Republic during 2010–2020. *Avian Biol Res*. 2022 [accessed 2023 Jun 27];15(3):125–32. doi: 10.1177/17581559221107083
12. Wendell MD, Sleeman JP, Kratz G. Retrospective study of morbidity and mortality of raptors admitted to Colorado State University Veterinary Teaching Hospital during 1995 to 1998. *J Wildl Dis*. 2002 [accessed 2023 Jun 27];38(1):101–6. doi: 10.7589/0090-3558-38.1.101
13. Zoubi MYA, Hamidan NA, Baker MAA, Amr Z. Causes of Raptor Admissions to Rehabilitation in Jordan. *J Raptor Res*. 2020 [accessed 2023 Jun 27];54(3):273–8. doi: 10.3356/0892-1016-54.3.273
14. Thomson VK, Jones D, McBroom J, Lilleyman A, Pyne M. Hospital Admissions of Australian Coastal Raptors Show Fishing Equipment Entanglement is an Important Threat. *J Raptor Res*. 2020 [accessed 2023 Jun 27];54(4):414–23. doi: 10.3356/0892-1016-54.4.414
15. Garcês A, Pires I, Pacheco F, Fernandes LS, Soeiro V, Lóio S, Prada J, Cortes R, Queiroga F. Natural and anthropogenic causes of mortality in wild birds in a wildlife rehabilitation centre in Northern Portugal: a ten-year study. *Bird Study*. 2019 [accessed 2023 Jun 27];66(4):484–93. doi: 10.1080/00063657.2020.1726874.
16. Mazaris AD, Mamakis Y, Kalpakis S, Poulopoulos Y, Matsinos YG. Evaluating potential threats to birds in Greece: an analysis of a 10-year data set from a rehabilitation centre. Oryx. 2008 [accessed 2023 Jun 27];42(3):408–14. doi: 10.1017/s003060530700066x
17. Drake A, Fraser D. Admission trends and mortality correlates for mallard ducklings at wildlife rehabilitation facilities. *J Wildl Rehab*. 2008;29(1):4–14.
18. Kadlecova G, Voslarova E, Vecerek V. Diurnal raptors at rescue centres in the Czech Republic: Reasons for admission, outcomes, and length of stay. *PLOS ONE*. 2022 [accessed 2023 Jun 27];17(12):e0279501–e0279501. doi: 10.1371/journal.pone.0279501
19. Panter CT, Allen S, Backhouse N, Mullineaux E, Rose CA, Amar A. Causes, temporal trends, and the effects of urbanization on admissions of wild raptors to rehabilitation centers in England and Wales. *Ecology and Evolution*. 2022 [accessed 2023 Jun 27];12(4). doi: 10.1002/ece3.8856
20. Romero F, Espinoza A, Sallaberry-Pincheira N, Napolitano C. A five-year retrospective study on patterns of casuistry and insights on the current status of wildlife rescue and rehabilitation centers in Chile. *Rev Chilena Hist Nat*. 2019 [accessed 2023 Jun 27];92(6):1–10. doi: 10.1186/s40693-019-0086-0
21. Kwok ABC, Haering R, Travers SK, Stathis P. Trends in wildlife rehabilitation rescues and animal fate across a six-year period in New South Wales, Australia. *PLOS ONE*. 2021 [accessed 2023 Jun 27];16(9):e0257209. doi: 10.1371/journal.pone.0257209
22. Hanson M, Hollingshead N, Schuler K, Siemer WF, Martin P, Bunting EM. Species, causes, and outcomes of wildlife rehabilitation in New York State. *PLOS ONE*. 2021;16(9):e0257675. https://doi.org/10.1371/journal.pone.0257675.
23. Stanton JC. Present-day risk assessment would have predicted the extinction of the passenger pigeon (*Ectopistes migratorius*). *Biol Conserv*. 2014 [accessed 2023 Nov 20];180:11–20. https://doi.org/10.1016/j.biocon.2014.09.023.
24. Giuliano WM, Selph JF, Hodges KB, Wiley N. Mourning Doves in Florida. University of Florida IFAS Extension. 2007 [accessed 2023 Jun 27];2007(18). https://journals.flvc.org/edis/article/download/116853/115019.
25. Permitted Florida Wildlife Rehabilitators. 2023. https://myfwc.com/media/5423/licensedwildliferehabilitatorsbyregion.pdf.
26. Konkel L. Hurricane Sandy Blows Migrating Birds Off

Track. livescience.com. 2012 Nov 5. https://www.livescience.com/31809-hurricane-sandy-impacts-birds.html.
27. What do birds do in hurricanes? Audubon Florida. 2017 Sep 7. https://fl.audubon.org/news/what-do-birds-do-hurricanes
28. IUCN. The IUCN Red List of Threatened Species. IUCN Red List of Threatened Species. 2022 [accessed 2023 Jun 26]. https://www.iucnredlist.org/.
29. Florida Scrub-Jay | Florida State Parks. www.floridastateparks.org. [accessed 2023 Jun 27]. https://www.floridastateparks.org/learn/florida-scrub-jay#:~:text=The%20current%20Florida%20scrub%2Djay.
30. Kobilinsky D. Rare Florida sparrow makes a comeback. The Wildlife Society. 2022 Sep 28 [accessed 2023 Jun 27]. https://wildlife.org/rare-florida-sparrow-makes-a-comeback/.
31. Proposed Rules Department of the Interior Fish and Wildlife Service 50 CFR Part 17 [FF09E22000 FXES11130900000 201] Endangered and Threatened Wildlife and Plants; Removal of 23 Extinct Species From the Lists of Endangered and Threatened Wildlife and Plants. https://www.govinfo.gov/content/pkg/FR-2021-09-30/pdf/2021-21219.pdf.
32. Species Profiles. Florida Fish And Wildlife Conservation Commission. [accessed 2023 Jun 27]. https://myfwc.com/wildlifehabitats/profiles/#.
33. Nonnative Birds. Florida Fish And Wildlife Conservation Commission. [accessed 2023 Jun 26]. https://myfwc.com/wildlifehabitats/nonnatives/species-not-native-to-florida/.
34. Cahanin MP. Abundance and Habitat Preferences of Introduced Muscovy Ducks (*Cairina moschata*). USF Tampa Graduate Theses and Dissertations; 2017.
35. Williams E, ewilliams@floridaweekly.com. Misunderstood. Mistreated. Maligned. Muscovy. Fort Myers Florida Weekly. 2020 Apr 8 [accessed 2023 Jun 26]. https://fortmyers.floridaweekly.com/articles/misunderstood-mistreated-maligned-muscovy-2.

About the author

Aaron Pahl has spent nearly a decade researching animal mortality, ranging from whales to northern gannets. He is currently a Digital Curation Librarian at the University of Alabama at Birmingham and volunteer at the Alabama Wildlife Center. Amongst past experience he was an avian rehabilitator at the Marine Science Center in Florida. Aaron has also worked at the California Academy of Sciences in San Francisco as a Curatorial Assistant in the ornithology and mammalogy department conducting postmortem research; preserving skeletons, skins, and tissues for the museum's collection. Published article: Curator: The Museum Journal (Dec 2019); Skeleton Preparation Best Practices in the Modern Museum: The Dermestid Approach.



PHOTO ©FRANK CONE. CREATIVE COMMONS LICENSE.

Red-tailed hawk (***Buteo jamaicensis***)

"Dead birds flying": can north American rehabilitated raptors released into the wild mitigate anthropogenic mortality?

Hagen CA, Goodell JM, Millsap BA, Zimmerman GS. *Wildlife Biol*. 2024:e01283. doi:10.1002/wlb3.01283

As the human footprint expands to meet societal energy needs, as do the impacts to wildlife. Raptors in particular are highly susceptible to anthropogenic caused mortality. Industry sectors are encouraged to offset these causes of mortality. Several options to mitigate these losses have been proposed, including raptor rehabilitation. However, its role as a conservation tool is untested. Currently no peer-reviewed demographic analyses exist using post-release data from rehabilitated raptors to evaluate its effectiveness at continental scales. Our objectives were to estimate annual survival of rehabilitated and wild raptors, and then use those estimates in demographic models to assess potential effects at individual and population levels. We hypothesized that rehabilitated raptors would survive similarly to their wild counterparts after an acclimation period, and that longer-lived species (K-selected) would benefit most from these releases. We used US Geological Survey Bird Banding Lab band-recovery data (1974–2018) from 20 raptor species for modeling survival of rehabilitated individuals (n = 125 740) in comparison to wild birds (n = 1 913 352). Results from 17 species with adequate recovery data indicated that five species rehabilitated ≠ wild survival, two species had uncertain estimates, and 10 species rehabilitated ≈ wild survival by years two and three post-release. We acquired admission (n = 69 707) and release (n = 25 740) data from 24 rehabilitation centers across the US (2012–2021). We integrated survival, fecundity and numbers of releases into demographic models. These models quantified the extent to which rehabilitated raptors may contribute to broader conservation efforts, especially in the context of individual take. All but two species, had measurable numbers of individuals added to the population regardless of the number of releases. The general pattern was for K-selected species to yield larger benefits from rehabilitated supplementation to the population. These results provide evidence that rehabilitation may serve as mitigation tool to offset incidental take.

Rehabilitation and release of orphaned Eurasian lynx (*Lynx lynx*) in Europe: Implications for management and conservation

Molinari-Jobin A, Zimmermann F, Borel S, LeGrand L, Iannino E, Anders O, Belotti E, Bufka L, Cirović D, Drouet-Hoguet N, et al. *PLoS One*. 2024;19:e0297789. doi:10.1371/journal.pone.0297789.

Rehabilitation of injured or immature individuals has become an increasingly used conservation and management tool. However, scientific evaluation of rehabilitations is rare, raising concern about post-release welfare as well as the cost-effectiveness of spending scarce financial resources. Over the past 20 years, events of juvenile Eurasian lynx presumably orphaned have been observed in many European lynx populations. To guide the management of orphaned lynx, we documented survival, rehabilitation and fate after the release and evaluated the potential relevance of lynx orphan rehabilitation for population management and conservation implications. Data on 320 orphaned lynx was collected from 1975 to 2022 from 13 countries and nine populations. The majority of orphaned lynx (55%) were taken to rehabilitation centres or other enclosures. A total of 66 orphans were released back to nature. The portion of rehabilitated lynx who survived at least one year after release was 0.66. Release location was the best predictor for their survival. Of the 66 released lynx, ten have reproduced at least once (8 females and 2 males). Conservation implications of rehabilitation programmes include managing genetic diversity in small, isolated populations and reintroducing species to historical habitats. The lynx is a perfect model species as most reintroduced populations in Central Europe show significantly lower observed

heterozygosity than most of the autochthonous populations, indicating that reintroduction bottlenecks, isolation and post-release management have long-term consequences on the genetic composition of populations. The release of translocated orphans could be a valuable contribution to Eurasian lynx conservation in Europe. It is recommended to release orphans at the distribution edge or in the frame of reintroduction projects instead of a release in the core area of a population where it is not necessary from a demographic and genetic point of view. Rehabilitation programmes can have conservation implications that extend far beyond individual welfare benefits.

Problem-solving skills are predicted by technical innovations in the wild and brain size in passerines

Audet J-N, Couture M, Lefebvre L, Jarvis ED. Problem-solving skills are predicted by technical innovations in the wild and brain size in passerines. *Nat Ecol Evol*. 2024. doi:10.1038/s41559-024-02342-7.

Behavioral innovations can provide key advantages for animals in the wild, especially when ecological conditions change rapidly and unexpectedly. Innovation rates can be compared across taxa by compiling field reports of novel behaviors. Large-scale analyses have shown that innovativeness reduces extinction risk, increases colonization success and is associated with increased brain size and pallial neuron numbers. However, appropriate laboratory measurements of innovativeness, necessary to conduct targeted experimental studies, have not been clearly established, despite decades of speculation on the most suitable assay. Here we implemented a battery of cognitive tasks on 203 birds of 15 passerine species and tested for relationships at the interspecific and intraspecific levels with ecological metrics of innovation and brain size. We found that species better at solving extractive foraging problems had higher technical innovation rates in the wild and larger brains. By contrast, performance on other cognitive tasks often subsumed under the term behavioral flexibility, namely, associative and reversal learning, as well as self-control, were not related to problem-solving, innovation in the wild or brain size. Our study yields robust support for problem-solving as an accurate experimental proxy of innovation and suggests that novel motor solutions are more important than self-control or learning of modified cues in generating technical innovations in the wild.

New estimates indicate that males are not larger than females in most mammal species

Tombak KJ, Hex SBSW, Rubenstein DI. New estimates indicate that males are not larger than females in most mammal species. *Nat Commun*. 2024;15:1872. doi:10.1038/s41467-024-45739-5.

Sexual size dimorphism has motivated a large body of research on mammalian mating strategies and sexual selection. Despite some contrary evidence, the narrative that larger males are the norm in mammals—upheld since Darwin's Descent of Man—still dominates today, supported by meta-analyses that use coarse measures of dimorphism and taxonomically-biased sampling. With newly-available datasets and primary sources reporting sex-segregated means and variances in adult body mass, we estimate statistically-determined rates of sexual size dimorphism in mammals, sampling taxa by their species richness at the family level. Our analyses of wild, non-provisioned populations representing >400 species indicate that although males tend to be larger than females when dimorphism occurs, males are not larger in most mammal species, suggesting a need to revisit other assumptions in sexual selection research.

Validation of Fecal Glucocorticoid Metabolites as Non-Invasive Markers for Monitoring Stress in Common Buzzards (Buteo buteo)

Grundei L-L, Wolf TE, Brandes F, Schütte K, Freise F, Siebert U, et al. *Animals*. 2024;14. doi:10.3390/ani14081234.

For wild animals, being in captivity in wildlife centers can cause considerable stress. Therefore, it is necessary to establish and validate non-invasive tools to measure chronic stress during rehabilitation. Eight Common Buzzards which lived in permanent husbandry were placed individually into prepared aviaries and their feces were collected before, during and after a stress event for biological validation over a period of seven days. The extracted fecal glucocorticoid metabolites (fGCMs) were analyzed with three different enzyme immune assays (EIA) to find the most suitable one. Additionally, we aimed to investigate the stability of fGCM levels after defecation because further metabolization by bacterial enzymes can lead to changed results. The Cortisone-EIA performed best in males and females and showed that the stress event led to an fGCM increase of 629% (557% in females and 702% in males) in relation to basal values. We found no significant differences between the sexes, but observed significant differences between different times of day. FGCM concentration significantly changed after eight hours at room temperature. Our study successfully validated the non-invasive measurement of fGCM as a stress indicator in Common Buzzards and could therefore lay the foundation for future studies providing new insights for animal welfare research in Buzzards.

Health and environmental effects to wildlife from radio telemetry and tracking devices—state of the science and best management practices

Manville AM 2nd, Levitt BB, Lai HC. *Front Vet Sci*. 2024;11:1283709. doi:10.3389/fvets.2024.1283709

This paper discusses the potential health risks and benefits to tagged wildlife from the use of radio tracking, radio telemetry, and related microchip and data-logger technologies used to study, monitor and track mostly wildlife in their native habitats. Domestic pets, especially canids, are briefly discussed as radio-tagging devices are also used on/in them. Radio tracking uses very high frequency (VHF), ultra-high frequency (UHF), and global positioning system (GPS) technologies, including via satellites where platform terminal transmitters (PTTs) are used,

as well as geo-locating capabilities using satellites, radio-frequency identification (RFID) chips, and passive integrated responder (PIT) tags, among others. Such tracking technologies have resulted in cutting-edge findings worldwide that have served to protect and better understand the behaviors of myriad wildlife species. As a result, scientists, field researchers, technicians, fish and wildlife biologists and managers, plus wildlife and other veterinarian specialists, frequently opt for its use without fully understanding the ramifications to target species and their behaviors. These include negative physiological effects from electromagnetic fields (EMF) to which many nonhuman species are exquisitely sensitive, as well as direct placement/use-attachment impacts from radio collars, transmitters, and implants themselves. This paper provides pertinent studies, suggests best management practices, and compares technologies currently available to those considering and/or using such technologies. The primary focus is on the health and environmental risk/benefit decisions that should come into play, including ethical considerations, along with recommendations for more caution in the wildlife and veterinarian communities before such technologies are used in the first place.

An integrative framework for tick management: the need to connect wildlife science, One Health, and interdisciplinary perspectives

Machtinger ET, Poh KC, Pesapane R, Tufts DM. *Curr Opin Insect Sci.* 2024;61: 101131. doi:10.1016/j.cois.2023.101131.

Vector-borne diseases pose a significant threat to human and animal health worldwide. Their emergence is influenced by various factors such as environmental changes, host characteristics, and human behavior. The One Health approach is necessary to thoroughly investigate tick-borne diseases and understand the complex interactions between environmental, animal, and human health. Anthropogenic changes have impacted predators, leading to cascading effects on wildlife prey species and the emergence of vector-borne diseases. The increase in global trade and travel has led to the introduction of several invasive vector species, increasing the risk of zoonotic pathogen spillover. Tick and tick-borne disease research requires an interdisciplinary approach to address challenges in a One Health paradigm.

The great urban shift: climate change is predicted to drive mass species turnover in cities

Filazzola A, Johnson MTJ, Barrett K, Hayes S, Shrestha N, Timms L, Maclvor JS. *PLoS One*. 2024;19: e0299217. doi:10.1371/journal.pone.0299217.

Human experiences with nature are important for our culture, economy, and health. Anthropogenically-driven climate change is causing widespread shifts in biodiversity and resident urban wildlife are no exception. We modelled over 2,000 animal species to predict how climate change will impact terrestrial wildlife within 60 Canadian and American cities. We found evidence of an impending great urban shift where thousands of species will disappear across the selected cities, being replaced by new species, or not replaced at all. Effects were largely species-specific, with the most negatively impacted taxa being amphibians, canines, and loons. These predicted shifts were consistent across scenarios of greenhouse gas emissions, but our results show that the severity of change will be defined by our action or inaction to mitigate climate change. An impending massive shift in urban wildlife will impact the cultural experiences of human residents, the delivery of ecosystem services, and our relationship with nature.

The evolutionary drivers and correlates of viral host jumps

Tan CCS, van Dorp L, Balloux F. *Nat Ecol Evol*. 2024. doi:10.1038/s41559-024-02353-4.

Most emerging and re-emerging infectious diseases stem from viruses that naturally circulate in non-human vertebrates. When these viruses cross over into humans, they can cause disease outbreaks, epidemics and pandemics. While zoonotic host jumps have been extensively studied from an ecological perspective, little attention has gone into characterizing the evolutionary drivers and correlates underlying these events. To address this gap, we harnessed the entirety of publicly available viral genomic data, employing a comprehensive suite of network and phylogenetic analyses to investigate the evolutionary mechanisms underpinning recent viral host jumps. Surprisingly, we find that humans are as much a source as a sink for viral spillover events, insofar as we infer more viral host jumps from humans to other animals than from animals to humans. Moreover, we demonstrate heightened evolution in viral lineages that involve putative host jumps. We further observe that the extent of adaptation associated with a host jump is lower for viruses with broader host ranges. Finally, we show that the genomic targets of natural selection associated with host jumps vary across different viral families, with either structural or auxiliary genes being the prime targets of selection. Collectively, our results illuminate some of the evolutionary drivers underlying viral host jumps that may contribute to mitigating viral threats across species boundaries.

Use of a commercial oral moxidectin plus praziquantel combination for treatment of the respiratory nematode *Crenosoma striatum* in rescued Southern white-breasted hedgehogs (*Erinaceus concolor*)

Adam N, Eshar D. *J Exot Pet Med.* 2024;48:17–19. doi.org/10.1053/j.jepm.2023.11.001.

Background—*Crenosoma striatum* lungworm infestation is common in many free-ranging hedgehogs. This report describes the clinical experience when using a commercial moxidectin/praziquantel combination against natural *C. striatum* infestation in rescued Southern white-breasted hedgehogs (*Erinaceus concolor*).

Methods—In total, 24 hedgehogs received a commercial moxidectin/praziquantel combination at 1.2 mg per kg and 7.0 mg per kg bodyweight orally after

showing *C. striatum* larvae in their feces. Weekly fecal rechecks were performed over 4 weeks.

Results—There were no apparent adverse responses, and nearly all treated hedgehogs (96%) had increased their body weights before their release to the wild. When compared to their initial positive check, none of the treated hedgehogs had showed *C. striatum* larvae in their last fecal recheck.

Conclusion and Clinical Relevance—Based on our observations, a single oral administration of moxidectin/praziquantel is safe and effective for treatment of *C. striatum* lungworm infestation in Southern white-breasted hedgehogs.

American black bear cub rehabilitation and release: Jurisdictional practices across North America

Morehouse AT, Mallory M, Derocher AE, Edwards MA, Fleming TB, Obbard ME. *Ursus*. 2024;35e4:1–14. doi:10.2192/URSUS-D-23-00011

Rehabilitation and release back to the wild of orphaned American black bear (*Ursus americanus*) cubs is a wildlife management option used across North America. We reviewed the literature and surveyed wildlife managers and biologists within North America from August 2022 through March 2023 to gather information on their policies and practices regarding rehabilitation and release of orphaned black bear cubs. We define cubs as bears <1 year old but note that most releases happen when the animals are yearlings, typically 12–18 months of age. The literature suggests that when rehabilitation follows science-based protocols, it is a feasible management option, and rehabilitated cubs may survive at rates similar to those of their wild counterparts, die of similar causes, and generally have low rates of conflicts with humans. Repeatedly mentioned within both the literature and survey results was the importance of minimizing human contact and selecting appropriate release sites that consider habitat, food availability, proximity to humans, and the age



PHOTO ©MARLIN HARMS. USED WITH PERMISSION.

American black bear cub (*Ursus americanus*)

structure, genetics, and density of black bears in the release area. We received 99 responses from 63 different jurisdictions. Rehabilitation of orphaned black bear cubs was allowed in 72.5% of surveyed jurisdictions with a breeding black bear population. In 82.3% of jurisdictions, a government agency was responsible for selecting release sites. The most common causes identified by our survey for cubs being orphaned were vehicle collisions (50 of 63 responses) and removal of mothers because of conflict behavior (35 of 63 responses). Almost all (96.9%) jurisdictions required rehabilitation centers to be licensed. On average, over the past 5 years (2018–2022), most (70.8%) jurisdictions rehabilitated <25 orphaned cubs. Lack of reliable and suitable rehabilitation centers following strict, science-based protocols was a frequently mentioned challenge, as was managing public perceptions and expectations. Despite these challenges, most (61%) survey respondents said rehabilitation of orphaned black bear cubs was either somewhat or very successful. ■

TAIL ENDS



Rob watched with vested interest as the new Sand Eels Resort neared completion.

Atlantic Puffin
Fratercula arctica
IUCN Red List–Vulnerable, Population Trend – Decreasing

PHOTO ©JANKO FERLICI. CREATIVE COMMONS LICENSE.

INSTRUCTIONS FOR AUTHORS

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.

SUBMISSIONS All submissions should be accompanied by a cover letter stating the intent of the author(s) to submit the manuscript exclusively for publication in the JWR. Electronic submissions are required; hard-copy manuscripts are not accepted. The manuscript file should be attached to the submission letter (which can be the body of your email) and sent to:

Kieran Lindsey, Editor
jwr.editor@theiwrc.org

MANUSCRIPT Manuscripts should be MS Word documents in either PC or MAC platform (no PDF files). Manuscript should be typed in Times Roman, 12 pt., double spaced throughout with one-inch margins.

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.
Include an abstract that does not exceed 175 words and choose several (up to 14) key words.

Templates have been developed for the following submission categories: case study, technique (including diets), research, and literature review; authors may request a copy of one, or all, of these templates from the editor (jwr.editor@theiwrc.org) before developing a manuscript for submission to the JWR.

STYLE The JWR follows the Scientific Style and Format of the CSE Manual for Authors, Editors, and Publishers, 8th Edition. The complete "JWR Author Instructions" document is available at:

https://theiwrc.org/journal-of-wildlife-rehabilitation/jwr-submission-guidelines

or by email request to the Editor. This document provides formatting guidelines for in-text citations and the Literature Cited section; provides the JWR textual requirements for tables, figures, and photo captions; and describes quality and resolution needs for charts, graphs, photographs, and illustrations.



PHOTO © EGOR KAMELEV CREATIVE COMMONS LICENSE.

Southern white-breasted hedgehog *(Erinaceus concolor)*



International Wildlife Rehabilitation Council
PO Box 3197
Eugene, OR 97403 USA
Voice/Fax: 408.876.6153
Toll free: 866.871.1869
Email: office@theiwrc.org
www.theiwrc.org

Providing evidence-based education and resources on wildlife rehabilitation to move the field of wildlife rehabilitation forward; to promote wildlife conservation and welfare; and to mitigate human-wildlife conflicts worldwide, through better understanding of wild animal ecology, behavior, and welfare.