JOURNAL OF WILDLIFE REHABILITATION

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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.



LEFT:

Proboscis Monkey (*Nasalis larvatus*), one of the species often taken into the illegal wildlife trade (see story on page 30).

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ON THE COVER:

Eurasian lynx (*Lynx lynx*).

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INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

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The mission of the IWRC is to provide 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.

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EDITORIAL

Collaboration in the field of animal welfare: a journey of adventure.

For years I have thrived on seeking out opportunities to bring people together to learn about each other's organizations and share stories and best practices. My search is always with purpose and intention, and often occurs in my day-to-day work, where a challenge presents itself or an opportunity for improvement has been spotted. Sometimes a situation develops that you know others must be experiencing, others who will have expert knowledge to share. There are other moments where a positive idea simply starts to form on my commute to and from work, before or after my day at my animal center, in a few precious moments as my creative mind kicks in. I begin to envision the excited chatter when a group, once strangers, collectively and collaboratively hit on a great solution.

Just recently, in the field of animal behavior, a small group of us who had worked for some months toward a plan arrived at a point where we just couldn't see how we could reach our goal. Despite everything we had been working towards on paper and in discussions, it unexpectedly seemed out of reach and in that moment seemed like it was all over. All of a sudden, at a lull in the conversation, I realized that, for this particular project, it was not about the end game. I realized that our plan should not be shelved just because we had some obstacles in the way. These obstacles were not insurmountable in the long term, only presently. And I realized that our group needed, this once, to start our project with our sights shifted. What we needed was a big hurrah moment, that —not a focus on the end result, but a very firm focus on the starting point.

The very act of starting a project is, in itself, a positive act and an accomplishment. We may not have all the answers when we start out. Those answers may come from the days and weeks ahead of us, as we learn from each other and the animals in our care. We start something to further the cause for animal behavior and welfare, armed in the knowledge that if we can help just one animal, we will have made a difference, together.

Collaboration can take time, piecing together the framework for how we will trust each other, respect each other, and feel able to share ideas without judgment. It requires focusing on the positive elements of the collective skill set of a group and our collective desire to do good.

Collaboration is very much about the journey, the adventure along the way of doing something rather than nothing—the adventure of talking, connecting, being transparent, opening our minds to others' thoughts, feelings, and ideas, and knowing that together we can achieve so much more.

Being a voice is always the right approach to caring for animals. Being a voice together is so much more. Let your own collaborative adventure begin.

—*Suzanne Pugh, President*

U.S. Congress introduces legislation to enhance Neotropical Migratory Bird Conservation Act

WASHINGTON, DC, USA (October 5, 2022)—House of Representatives members Ron Kind and Maria Elvira Salazar introduced HR9135, the Migratory Birds of the Americas Conservation Enhancements Act. The act, if passed, will support 350 neotropical bird species that travel from the U.S. to Central and South America, the Caribbean, and Canada every year, such as the scarlet tanager, purple martin, and blackburnian warbler.

"Migratory birds transcend national borders, which is why we need a hemispheric approach to conservation," said Marshall Johnson, chief conservation officer at the National Audubon Society. "Three billion birds have been lost since 1970, and the same factors that threaten them also threaten our own communities. This bill will help provide the investments we need to protect the places that both birds and people need to survive."

In May a companion bill was introduced into the Senate by Ben Cardin and Rob Portman.

Since 2000, the U.S. has invested $80 million, which has sparked an additional $310 million in matching funds from public–private partnerships. These funds have supported 658 projects in 36 Latin American and Caribbean countries, 40 U.S. states and territories, and provinces and territories across Canada.

USFWS Proposes Changes to Species Covered by the Migratory Bird Treaty Act

WASHINGTON, DC, (December 12, 2022)—The USFWS is proposing changes to the list of species protected by the Migratory Bird Treaty Act (MBTA). These changes may affect Mexico, Canada, Russia, and Japan, as well as the United States. The description in the Federal Register notes, "The proposed amendments (16 additions, three removals, and 30 name changes) would affect a total of 47 species and would result in a net addition of 13 species to the List of Migratory Birds Protected by the MBTA, increasing the number of species on the list from 1,093 to 1,106."

The window for public comments to the changes opened December 11, 2022, and closes February 10th, 2023. Comments may be submitted online or by hard copy.

To comment online, go to the Federal eRulemaking Portal (https://www.regulations.gov).

In the Search box, enter: FWS-HQ-MB-2022-0036 (the docket number for the proposal). Click Search, and on the resulting page under "Document Type" click on "Proposed Rule" to locate the document. Click on "Comment" to submit.

To submit a comment by U.S. mail, send it to:

Public Comments Processing
Attn: FWS-HQ-MB-2022-0036
U.S. Fish and Wildlife Service
MS: PRB/3W
5275 Leesburg Pike
Falls Church, VA 22041-3803.

Hand delivery to this address is also accepted.

Two long time rehabilitators retire in 2022

PENNSYLVANIA AND OREGON, USA (October 4, 2022)—Kathy Uhler recently

IN MEMORIUM

Harry Kelton

(May 3, 1926–August 23, 2022)

By Pelican Harbor Seabird Station

On Tuesday, August 23rd, our community lost a friend and passionate wildlife advocate. Harry Kelton, the founder of Pelican Harbor Seabird Station, passed away peacefully at the age of 96.

Harold Van Smith Kelton was born May 3, 1926 in Raleigh, NC, son of John B. and Mabel Smith Kelton. He graduated from Purdue University in 1948 and moved to North Bay Village in 1970 where he worked as a mechanical engineer until 1996 for several businesses, including designing broilers for Burger King Corp.

When Harry and his wife of 48 years, Darlene, founded PHSS in 1980, the field of wildlife rehabilitation was in its early stages. Harry helped to revolutionize the rehabilitation and care of Brown Pelicans and was instrumental in helping bolster their population by releasing more than 7,000 during a time when they were still on the endangered species list. Harry was extremely respected within the field and served on the board of the International Wildlife Rehabilitation Council for nearly a decade.

Harry and Darlene developed a special medical procedure called "the cotton fish" where they would stuff a fish with cotton balls and feed it to a sick pelican with a hook in its stomach. Once the fish was digested, the cotton would snag and cover the fish hook, and in many cases the pelican would regurgitate it, eliminating the need for surgery. Harry taught many veterinarians and wildlife rehabbers this technique at conferences over the decades.

Pelican Harbor Seabird Station is Miami's native wildlife hospital and has treated over 39,500 native wildlife patients, including over 9,000 pelicans. Harry served on the Board of Directors until 2019.

Harry is survived by two sons, Robert Kelton of Hollywood, FL and John Kelton of Zebulon, NC. He was preceded in death by his wife and cofounder of PHSS, Darlene Kelton in 2003, his stepson David Buckwalter in 1994, and his stepdaughter Kaye Taylor in 2017. He is survived by seven grandchildren and four great-grandchildren.



Everbridge marks three years of supporting WIRES, Australia's largest wildlife rescue organization (Photo: Business Wire)

announced her retirement from Pocono Wildlife Rehabilitation and Education Center. She has been rehabilitating wildlife for over forty years, according to ABC news station WNEP. The center will continue operations in northeastern Pennsylvania under a new name.

Earlier this year, Louise Shimmel retired from Cascades Raptor Center, which she founded in 1987. In early September, Julie Collins was announced as the new executive director. Julie notes, "I am one of the many voices of Cascades Raptor Center, and I will continue to keep Louise's legacy strong while moving us forward and ensuring we are here for future generations."

Effects of Oil on Wildlife Conference is 40 years old

LONG BEACH, CALIFORNIA, USA (September 29, 2022)—The first Effects of Oil on Wildlife (EOW) conference was held in 1982. The 14th EOW Conference concluded with a 40 year retrospective. Highlights of the closing talk included acknowledgement of the matriarchs of oiled wildlife work, Lynn Frink, Alice Berkner, and Althea Wesphal; followed by a discussion of a 1990 EOW meeting which partnered with the International Wildlife Rehabilitation Council.

The conference was a gathering of wildlife professionals, government agencies, and industry partners, meeting on the planning, response, rehabilitation, and research aspects of oil spills and their impacts to wildlife. Speakers further defined the global community of practice now coming to fruition, shared lessons learned from oil spill responses around the world, and presented current research during three days of sessions attended by individuals from five continents.

NOAA researchers perform a monk seal release, observe previously rehabilitated seals with pups, and rescue additional seals during field season

HAWAI'I, USA (September 8, 2022)—Researchers at the National Oceanic and Atmospheric Administration (NOAA) confirmed that two formerly released patients from The Marine Mammal Center's hospital in Kailua-Kona, Ke Kai Ola, have had pups. The news comes as the Center admitted four more seal pups into rehabilitative care and released another seal patient in partnership with NOAA.

"For an endangered species, every patient matters. The birth of these two Hawaiian monk seal pups from former patients is a real milestone to this endangered population and is a powerful example of the impact of conservation efforts by NOAA and programs like ours," says Dr. Sophie Whoriskey, Hawaiian Monk Seal Conservation Veterinarian at The Marine Mammal Center. "The further addition of four female animals that were all underweight and unlikely to survive the winter without intervention is a further testament that our critical mission work is more important than ever."

The mother seals, who rehabilitated at Ke Kai Ola in 2014 and 2015, gave birth at Manawai (Pearl and Hermes Reef) and Lalo (French Frigate Shoals), respectively, this summer. This is the first time NOAA researchers have detected births from Northwestern Hawaiian Island seals that have been rehabilitated at the Center's hospital.

NOAA's field researchers sighted the pups on their annual field camps to the Northwest Hawaiian Islands. Additionally, they discovered four young seals at risk due to poor body condition and were able to successfully rescue them for transport. Scientists onboard the NOAA Research Vessel Oscar Elton Sette performed physical exams and initial treatment on the four female monk seals rescued from Pihemanu (Midway), Manawai (Pearl and Hermes Atoll), and Lalo (French Frigate Shoals).

All four new patients appear stable and are settling in well to their new surroundings. Both PP32 and DQ10 are eating well on their own. QQ22 and QQ26 are both being tube fed for nutritional support and are showing strong interest in fish offers. They will also be treated as needed for intestinal parasites while in care.

A female pup that had transferred into the Center's care in late May was successfully released back to the wild on Kamole in the early stages of the trip.

Since 2014, the Center has rehabilitated and released 37 monk seals, most of which have been rescued from and

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Rehabilitation notes: juvenile Eurasian lynx (*Lynx lynx*)

Stéphanie Borel,[1] Andreas Ryser,[2] Mainity Batista Linhares,[1] Anja Molinari-Jobin,[2] Marie-Pierre Ryser-Degiorgis[1]

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ABSTRACT: Orphan lynx rehabilitation is very challenging, and it is important to aim for high standards of animal care. Rehabilitation requires pre-established procedures and clearly defined responsibilities. Suitable infrastructure with competent staff needs to be identified in advance. In the same way as other wildlife species, an orphaned lynx should receive a thorough initial examination to assess the animal's chances of survival and rehabilitation. Collecting samples and subsequent laboratory analyses are required to complement clinical observations and avoid introducing diseases into the care center and potentially into the population where the animal will be released. A natural, balanced diet and a species-appropriate enclosure must be provided to minimize stress, captivity-related injuries, and habituation, finding a balance between conservation interests and animal welfare. Based on a previous study, this document aims to formulate captivity- and conservation-oriented recommendations for the rehabilitation of orphaned Eurasian lynx.

KEYWORDS: animal care, captivity, conservation, Felidae, health, management, welfare.

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Introduction

An orphaned animal is defined as a young animal that has lost its mother[1] and is too young to survive on its own.[2] For Eurasian lynx, an orphan was formerly defined as a juvenile that has lost its mother and is found emaciated, a situation which typically occurs in autumn near human settlements.[3]

Juvenile animals, whether domestic or wild, may become orphaned for various reasons. Maternal death may occur (e.g., accident, poaching, or disease); young animals may be abandoned due to a suboptimal maternal health condition[4,5] or inexperience (inadequate maternal behavior and care);[5,6] external factors may cause separation of mother and young. For example, mothers may abandon their litter during times of starvation.[4,7] Furthermore, young animals may be temporarily separated from their family group and mistaken for orphans.[8] It is necessary to observe a possible orphan carefully and from a distance for several hours before concluding that it has been abandoned.[9] Surveillance can be conducted by placing a camera trap with a black flash (so as not to dazzle the animal) and by monitoring the area with binoculars, thermal night vision

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Orphaned lynx brought to a wildlife care center for rehabilitation.

goggles, or thermal cameras for one or two nights. Emaciated juvenile lynx observed alone near human settlements can be directly considered orphans.[10]

Description

Taxonomy

The Eurasian lynx (*Lynx lynx*), is the largest of the four lynx species occurring worldwide (*L. lynx, L. pardinus, L. rufus*, and *L. canadensis*), with four subspecies occurring in Europe: *L. lynx lynx* (Northern or Boreal lynx), *L. lynx martinoi* (Balkan lynx), *L. lynx dinniki* (Caucasian lynx) and *L. lynx carpathicus* (Carpathian lynx).[11,12] Although the subspecies are not always easy to distinguish, they show variations in body size, weight, skull shape, and coat pattern.[3,13,14] The Carpathian lynx is distributed in distinct populations in several European countries such as Switzerland because it has been used for reintroductions.[15]

Physical description

Depending on the parts of the distribution range and the season, the coat of the lynx is brown grey to reddish, with few to many dark spots on the back, flanks, and legs. The spots are often more distinct on the legs and flanks than on the back.[3] This coat pattern is classified into four categories: large spots, small spots, rosettes, and unspotted.[16] The belly as well as the sides of the muzzle, chin, and cheeks are white.[17] The ears are relatively large for the size of the skull, and they are characterized by tufts of black hair up to 4 cm long at the tips and white color on the backs. As in the other lynx species, the tail is short. In Switzerland, female Carpathian Eurasian lynx weigh 15 to 21 kg, and males weigh 19 to 26 kg.[18] Their body measurements have been published by Marti and Ryser-Degiorgis (2018).[18]

Habitat

The Eurasian lynx is a solitary and territorial animal.[3] Home ranges vary in size from 50 to 300 km^2,[3] with territories of females being slightly smaller than those of males.[19] Lynx show a preference for heterogeneous forests and avoid human disturbance.[20] The selection of the terrain is influenced by the season and time of day. In winter, lynx are generally found at lower altitudes. At night, they may also use open habitats, such as meadows, where prey may be more abundant. During the day, however, lynx prefer dense undergrowth and rugged terrain away from human infrastructure.[21]

Range

Eurasian lynx are currently present in 23 countries in Europe, distributed in 11 populations.[22] They almost disappeared from the old continent in the 19th century but were reintroduced to Central and Western Europe in the 1970s.[15] Individuals from the Carpathian Mountains (*L. lynx carpathicus*) were released in the Alps, the Jura, the Palatinate Forest-Vosges, the Dinaric, and the Bohemian-Bavarian Mountains.[15] Additionally, lynx from unknown genetic origin were reintroduced into the German Harz Mountains and into the Kampinoski National Park in Poland.[23] Natural recovery also contributed to the current lynx distribution.[24] Nevertheless, reintroduced populations in Central and Western Europe are still small, fragile, and isolated and are either classified as endangered (Jura, Alps, and Dinaric) or critically endangered (Harz, Vosges, Bohemian-Bavarian, and Kampinoski).[25] In these regions where genetic variability is limited, the lynx is protected. On the contrary, boreal lynx populations, which are found in Nordic countries (Finland, Sweden, Norway, and Baltic states) are large and hunted.

Natural diet

The lynx is considered an obligate predator.[26] The Eurasian lynx's wild prey in the Swiss Jura Mountains are mainly roe deer (*Capreolus capreolus*) and chamois (*Rupicapra rupicapra*), sometimes red fox (*Vulpes vulpes*) and brown hare (*Lepus europaeus)*, and very rarely domestic cat (*Felis catus*), wild cat (*Felis sylvestris*), marmot (*Marmota marmota*), pine marten (*Martes martes*), capercaillie (*Tetrao urogallus*), and badger (*Meles meles*).[27] An ungulate carcass is consumed by a lynx in 1 to 7 days, with an average meat quantity of 3.2 kg per night for a single female and 3.4 kg for a male. This can go up to 4.9 kg for a family group composed of a female and two large juveniles in early winter.[27]

Birth and care of young

Females reach sexual maturity around 2 years and males around 3 years.[3] Mating season takes place from February to April.[3] Eurasian lynx in Switzerland are born from the beginning of May to mid-June, with a peak in the second part of May (around May 17 to 31),[3] after a pregnancy duration of 54 to 73 days.[28] A litter

consists of one to four cubs, usually two. Cubs are born with eyes and ears closed and weigh 240–430 g.[28] During the "stationary phase" after birth, juvenile lynx spend most of their time in the den.[3,29] From August to October, lynx cubs become slowly more mobile. From 9 weeks of age, they are able to digest meat.[3] Their lactating mother leaves them alone for longer periods as she expands her territory to hunt and satisfy their ever-growing energy needs. From November, larger juveniles can follow their mother on a hunt to learn how to kill prey by themselves.[3] They will then seek their own territory at the time of dispersal, from January to the beginning of May, with a peak from March to April.[30,31]

Rehabilitation considerations

The success of rehabilitation depends on many factors: health status,[2,32,33] age and body condition at the time of admission,[33-35] facilities, skills of veterinary staff, funding, date and season of admission,[33] individual levels of boldness,[38] time spent in captivity,[39-41] and release sites.[36,37] It is recommended to use these parameters to establish a prognosis and triage cases (i.e., to decide whether to treat or euthanize an animal).[42-46] This triage is essential because providing euthanasia on admission limits costs, required staff, and especially the stress and suffering of animals with very low chances of survival. The probability of recovery should be kept in mind throughout the entire animal care period. It is important to remember that although the goals of rehabilitation may include public awareness, goals should mainly focus on species conservation; returning rehabilitated orphaned or injured animals to the wild allows them to contribute to reproduction.[47,48]

Overall, factors potentially influencing captive conditions should be optimized (i.e., facilities, skills of veterinary staff, release site and season, and time spent in captivity) to maximize the cost–benefit ratio. It is also crucial to determine financial and decisional responsibilities for all steps in rehabilitation before taking an animal into captivity and to include all agreements in an orphan management plan. This will avoid welfare-relevant delays in decision-making. Suitable wildlife care centers (WCC) must be identified in advance, and institutions and people to contact in the event of an orphaned lynx discovery must be listed. It is crucial to establish a communication scheme to facilitate rapid decision-making while limiting the chain of players.[10]

Clinical examination

Upon arrival, orphaned lynx should be examined from a distance to determine if their health condition allows for a more thorough examination under anesthesia. If it does not, individuals can be stabilized without anesthesia.[49] The vital parameters of orphaned Eurasian lynx are summarized in Table 1.

If the cub is weak or already in captivity, it can be caught with a hand net. If the cub is vigilant, a baited small box trap can be used, or distance anesthesia can be employed using a blowpipe without previous physical immobilization.

For chemical immobilization, an intramuscular injection of 0.1 mg/kg medetomidine and 5 mg/kg ketamine[50] allows rapid induction, good muscle relaxation, and analgesia even sufficient for soft tissue surgery.[51] To prevent any risk of regurgitation, it is preferable to place the anesthetized animal in lateral or sternal recumbency.[52,53] Whether the animal will be intubated or not, it is essential to check the oral cavity to make sure that nothing obstructs the airways. Corneas must be protected from drying out with an ophthalmic gel,[54] eyes should be covered with a clean cloth, and noise production must be avoided (including human voices). Ear plugs may be used to reduce auditory stimuli.[52] Leg folds are recommended under field conditions to prevent an escape in case of premature recovery. They are not necessary when working indoors or in an enclosure, but may be helpful. Monitoring of vital parameters should be initiated as soon as possible, including the regular determination of body temperature, heart and respiratory rate, pulse, color of the mucosa, and capillary refill time. A pulse oximeter fixed on the tongue may also be used to observe arterial oxygen saturation. Although hypoxemia is described as a known adverse effect in lynx,[55] injectable anesthesia with this protocol has proved to be safe in wild-born lynx of all ages.[10,56] However, oxygen supplementation is generally recommended during injectable anesthesia.[57] Under field conditions, intranasal administration is most practicable, but in a WCC, intubation is preferable because it allows the best maintenance and airways protection,[58] requires little equipment, and is inexpensive.

Once the animal is safe regarding the anesthesia, a full clinical examination can start, preferably by another team member, so that one person is fully dedicated to anesthesia monitoring. Age is best estimated based on body size and dentition.[59] Sex must be determined, which can be done by measuring the anogenital distance in lynx less than 6 months old when testicles are not yet visible (see Table 2). Clinical examination should begin with the determination of body condition and hydration state followed by a coat inspection (in particular a search for skin wounds, claw damages, and ectoparasites on the skin or in the ears); examination of eyes, nose, and anogenital orifices; close examination of dentition state and oral mucosa; cardiac auscultation; and palpation of superficial lymph nodes and abdominal organs. This initial clinical examination contributes to careful triage and possible euthanasia of individuals that are not viable, will not be able to reproduce due to anatomic defects, or may pose a health risk to the population (see Table 3 for euthanasia justifications).

As a next step, it is imperative to collect blood samples for hematology, biochemistry, and genetics as well as for pathogen screenings and serological tests. This requires several tubes, some

TABLE 1. Vital parameters of anesthetized orphaned Eurasian lynx[147]

PARAMETER	SMALL JUVENILE ≥3 to <6 months (n=6)	LARGE JUVENILE ≥6 to <11 months (n=9)
Body temperature	37.2–39.2°C	36.7–40.2
Heart rate	100–132 beats/min	80–144 beats/min
Respiratory rate	16–28 breaths/min	14–36 breaths/min
Weight	2–5.7 kg	3.5–7 kg

Data from the Insitute for Fish and Wildlife Health (FIWI) database.

TABLE 2. Anogenital distance (cm) of free-ranging juvenile Eurasian lynx from Switzerland.*

AGE	1–2 MONTHS	3–4 MONTHS	5–6 MONTHS	7–8 MONTHS
FEMALE	1.48 (1.4 – 1.5) (4)	1.87 (1.0 – 2.6) (18)	2.11 (1.5 – 3.5) (30)	2.92 (1.4 – 4.7) (11)
MALE	3.10 (2.5 – 3.5) (2)	3.87 (3.2 – 4.8) (11)	4.11 (2.5 – 5.3) (31)	4.70 (3.5 – 6.3) (8)

*First parenthesis = range; second parenthesis = number of examined lynx.
Data from lynx necropsies database of the Institute for Fish and Wildlife Health (FIWI).

TABLE 3. Veterinary justification for euthanasia of wild animals in all age classes, at any time of the rehabilitation process.[42-45]

ISSUES	Justifications
COMATOSE STATE, MORIBUND ANIMAL	Vital parameters are affected
SYSTEMIC DEBILITATING DISEASE, SEVERE NEUROLOGICAL DISORDERS	Poor chance of survival, risk of pathogen transmission to co-specific and/or humans
PROLAPSE OR RUPTURE OF A LARGE AREA OF TISSUE	High risk of infection and complications
CHRONIC OR OPEN FRACTURE	High risk of infection and complications
JOINT DISORDERS	Long-term consequences, complete recovery unlikely
CONGENITAL MALFORMATION	Handicap
PERMANENT BLINDNESS	Inability to move properly, hunt, and avoid danger
NEWBORN ANIMALS	High risk of habituation
SPINAL TRAUMA WITHOUT DEEP PAIN	Low chances of recovery
JAW FRACTURE, SEVERE TEETH LESIONS	Reduced ability to eat, high risk of infection and complications
BEHAVIORAL ABNORMALITIES (E.G., STEREOTYPIES, HABITUATION)	Poor chance of survival upon release, risk of undesirable interactions with humans

of which can be deep-frozen for later examination. The amount of blood that can be collected depends on the animal's weight, health status, and body condition.[60] Blood samples are best taken from the cephalic veins, but sampling is also possible from the jugular or femoral veins. Although different collecting tubes exist, vacuum-sealed plastic tubes are best to keep samples clean. Alternatively, an over-the-needle catheter can be placed, which can also be used to administer fluids or drugs intravenously.[43] Blood values (hematological and biochemical parameters) for captive Eurasian lynx have been published by others[61] but they should be used with caution as free-ranging conditions may influence certain values.[62-65] Additional samples such as oral, conjunctival, and rectal dry swabs are necessary to test for pathogen shedding.[56] The procedure can end with morphometric measurements.[18,66]

Dehydration, a common problem in orphans,[67] must be assessed (Table 4) to determine the amount of fluid to be administered and to select the method of administration. Since it is not realistic to leave an intravenous catheter in place after the end of anesthesia in a wild-born lynx, even a young and weakened one, fluid boluses are recommended. The first bolus of crystalloid or colloid at rates of 20 ml/kg can be given at the beginning of the procedure, and if necessary, a second of 10 ml/kg can be given 30 minutes later. Repeated reassessment is crucial to assess whether rehydration is successful.[43]

Once the health status has been determined and any clinical problem detected, therapy can be performed or initiated. Wounds can be cleaned by curettage and disinfected with a topical antiseptic, such as povidone-iodine. Subcutaneous injection of long-acting antibiotics can be given when there are signs of infection (e.g., amoxicillin 15 mg/kg).

After examination and care (at least 30 to 40 minutes after the injection of ketamine,[68] but preferably after 1 hour[56]) medetomidine can be antagonized with intramuscular injection of atipamezole at 5mg/mg medetomidine,[55] preferably in the caudal tight musculature.[56]

Health monitoring

Before introducing the animal into a large outdoor enclosure, it is recommended to respect a quarantine period until all laboratory results are available,[56] as should be the case for any free-ranging animal that will later be reintroduced into the wild, either for translocation or rehabilitation at the capture site.[69-71] Eurasian lynx should be tested for a range of possible pathogens, in particular, feline parvovirus, feline coronavirus, feline calicivirus, feline herpesvirus, feline immunodeficiency virus, feline leukemia virus, and canine distemper virus.[56]

Ideally, the quarantine pen should be adjacent to an outdoor enclosure and can serve as a shift yard for temporary housing for sick or injured individuals.[71] The smaller pen should allow blowpipe or dart gun anesthesia if indicated by health concerns. Additionally, treatments should also be administered as quickly as possible. Indeed, human presence, manipulations, and anesthesia cause significant stress to wild-born animals,[72,73] increasing the level of blood glucocorticoids.[74] This stress can delay recovery[75] or lead to other pathologies due to decreased immunity,[76] offsetting the benefits of therapy. For this purpose, as soon as the animal can eat, it is preferable to continue the treatment per os rather than manipulating the animal for injections.[77] Daily visual checks without direct contact can be achieved by using cameras,[78] and the progress of the animal can be followed without disturbance.

Diet in captivity

Free-ranging juvenile lynx usually start eating meat from the age of 9 weeks but are still suckling.[3] However, previous experience has shown that six-to-eight-week-old cubs are already capable of feeding on meat only.[10] For younger individuals that would require milk bottle-feeding, a complete protocol has been established for Iberian lynx[79] that may be used for Eurasian lynx.

Refeeding of emaciated animals should theoretically be done gradually to avoid any electrolyte imbalance or maldigestion. Refeeding syndrome refers to a group of clinical signs and

metabolic disturbances that appear within a few days of refeeding of malnourished individuals.[80] Although most of the veterinary literature on this topic concerns the domestic cat, it seems reasonable to assume that, as a feline, the lynx may also be prone to developing this syndrome. Felines are particularly at risk given their natural intolerance to glucose and their inability to regulate their proteolysis.[81] The sudden supply of carbohydrates to a fasting organism leads to potentially life-threatening electrolyte imbalance.[80,82,83] In domestic carnivores, recommendations include stabilizing the animal before refeeding[84] and offering liquid feeds with high digestibility, energy density, and protein content; this may be complemented by a range of food supplements.[81] Wet cat food can then be offered, such as a high protein and energy recovery diet (for example, Prescription Diet a/d from Hill's Pet Nutrition).[85] The recommended amount for the first week of refeeding is 5–10 kcal/kg/day, divided into four to six meals.[86] However, for wild-born animals, frequent feedings represent disturbances inducing considerable stress or, on the contrary, habituation. Habituation to humans and human-associated activities in captivity must be kept to a minimum. Especially when wild mammals get used to human presence and noises associated with food, this habituation may result in a loss of fear of predators, a greater likelihood of getting close to human settlements, an inability to hunt, and therefore decreased survival probability upon release.[38,87-89] Thus, food should be distributed with minimal contact (for example, through a trapdoor).[44] In addition, we formerly documented that young lynx were able to digest much larger and less frequent meals than generally recommended[10] without showing signs of refeeding syndrome.

TABLE 4. Dehydration assessment.[148]

% DEHYDRATION	CLINICAL SIGNS
5 (MILD)	Minimal loss of skin turgor, semidry mucous membranes, normal eye
8 (MODERATE)	Moderate loss of skin turgor, dry mucous membranes, weak rapid pulses, enophthalmos
10 (SEVERE)	Considerable loss of skin turgor, severe enophthalmos, tachycardia, extremely dry mucous membranes, weak/thready pulses, hypotension, altered level of consciousness

Once the animal's status allows it, it is important to progressively strive for feeding a diet with composition and presentation close to natural conditions (i.e., roe deer and chamois carcasses for Eurasian lynx). This shall promote the consumption of similar food when the animal is released back into the wild.[41,90] From a nutritional point of view, whole prey (i.e., including internal organs, without the digestive tract) is to be preferred because it is rich in protein and minerals and has an adequate calcium/phosphorus ratio.[91] Nutritional deficiency can lead to immune deficiency (decrease in bone marrow elements, neutropenia, involution of secondary lymphoid tissues) and decreased efficiency of the skin or mucous barriers (increasing the risk of bacterial infection).[92] In addition, giving natural food containing indigestible hair and feathers positively influences the microbiota[93] and promotes the ability to digest such food once the animal is released.[94] Last but not least, feeding whole carcasses is an important form of enrichment in captivity; it increases feeding time and provides greater sensory stimulation than feeding pieces of meat,[78] reduces time spent sleeping and resting,[95] decreases stereotypical behavior,[96,97] and therefore contributes to stress minimization. Thus, appropriate feeding not only maintains normal species behavior but also reduces health risks.

Before releasing a wild carnivore, it is essential to ensure that it will be able to hunt and feed itself, a sine qua non condition for its survival in the wild.[98] For this purpose, some authors advise giving live prey.[41,99,100] However, this is forbidden by law in some countries, in which circumstances offering native prey carcasses is the most judicious alternative. Several previous experiences have shown that orphaned lynx fed only with carcasses were able to hunt on their own once in the wild.[101-103] Nevertheless, in such cases, post-release monitoring is particularly important to ensure that the animal is self-sufficient.

Housing

Size

Sufficient enclosure size is crucial.[97] For two lynx in permanent captivity, the minimum size enclosure dictated by the Swiss Animal Welfare Ordinance[104] is 30 m^2 outdoors and 20 m^2 indoors. This legal requirement is to be understood as an absolute minimum and not as a recommendation. A German WCC with experience in lynx rehabilitation uses for one to three orphans either a 90 m^2 indoor enclosure adjacent to a 500 m^2 outdoor enclosure, or a 60 m^2 indoor enclosure adjacent to a 108 m^2 outdoor enclosure (F. Brandes, pers. comm. 2022). It is important to note, however, that enclosure quality (i.e., rich environment with structures, hides, and climbing possibilities) also plays a decisive role in the well-being of captive animals and is even more important than enclosure size.[97]

Layout

Animal welfare and the expression of normal behavior are two crucial issues that require a quality enclosure.[97,107,108] This is known for wild animals in zoos[109] but should be emphasized even more for wild-born orphans in provisory captivity. The inability of wild animals born in nature to adapt to captivity is known to potentially lead to physical injuries, behavioral deficiencies, and even neurological damage,[39,46,94,97,107,110] as well as to poor health in general.[97] To reduce stress and prevent captivity-related injuries in wild felids, an appropriate environment must be provided and may include various components, such as climbing and hiding structures or platforms of different heights,[108] both in the quarantine pen and the outdoor enclosure. There should be a sufficient number of visual barriers to increase enclosure complexity. If the enclosure size allows, a total of seven visual barriers is

recommended.[111] Walls with straight angles should be avoided (absent in the wild, they increase the stress of captive animals).[112] Walls of the quarantine enclosure must hamper biting or scratching by the animals to prevent serious teeth and claw injuries, a recurrent problem in provisory captivity of orphaned and quarantined lynx.[10,56] It would be interesting to test whether enclosures offering visibility of the surroundings could reduce escape attempts. This, however, would require the enclosure to be located in a natural environment far from human disturbances.

Substrate

The floor of quarantine enclosures must be easily cleanable and should be made of cement or concrete. It can then be covered with 10 to 15 cm of natural substrates such as wood shavings or straw.[111] These substrates prevent the animal from injuring its paws or lips while eating on the ground, though some animals may ingest them.[10,113]

For the outdoor pen, a natural soil made of earth, grass, plants, rocks, and tree trunks is most suitable as it mimics a natural environment.

Group size and composition

As previously documented, intraspecific contact also plays an essential role in the welfare of captive lynx.[114] Interactions with conspecifics are important for feline cubs of all ages[115] but particularly between 2 and 3 months old for Eurasian lynx.[116] Similarly, it is recommended not to keep a juvenile Iberian lynx isolated but to instead promote its socialization and development by holding it together with one or two other cubs.[79] Keeping orphaned lynx in small groups shall allow them to play together and develop their motor and cognitive skills, which are essential for hunting.[116] Based on previous experiences, it is possible to socialize orphans of the same or different sex even if they are not sisters and brothers.[10] If an orphaned lynx is kept alone in a WCC, it is recommended to put it in contact with another felid of the same age—if possible, place the orphan with an individual of the genus *Lynx*, and if not, with a domestic cat.[79,117]

Care in the wild

When no suitable facilities are available, feeding the orphaned lynx in the wild can be an alternative.[101] This represents a method very close to natural conditions and most respectful of animal welfare, with human intervention limited to providing food until the cub can survive on its own. However, the juvenile animal should be in apparent good health and possibly old enough to be able to shred a carcass by itself (from approximately 5 months of age, i.e., from October, when part of the permanent teeth have erupted)[59] and defend itself against possible predators. The feeding area should be easily accessible for carcass disposal, but relatively far from human facilities.[10] Under these conditions, this method has many advantages.[10] An initial assessment of the general condition of the animal at a distance is recommended to evaluate whether this type of management may be a responsible option. Thereafter, as long as the animal is under surveillance, there is the option to act if there would be indications of a serious health impairment.

Release

Only fit and healthy animals that can survive on their own in the wild should be released.[88] The most appropriate time to release rehabilitated lynx seems to be the peak of the dispersal period, from March to April, when juveniles are 10 to 11 months old[3,30] and leave their mother to become independent, as this mimics normal behavior.[8,32,99,118-120] Once ready to survive in the wild, rehabilitated lynx should be released as soon as possible to minimize the risk of habituation and captivity-related health issues.[10]

Soft and hard release methods have been successfully applied for Eurasian lynx in Europe.[121-123] There does not seem to be any difference between these two methods in terms of survival.[99] However, if it is desired that the animals stay in a specific location, a soft release can be advantageous because it seems to increase the likelihood that animals stay near the release site.[123] However, this is valid only for lynx-free regions. In an established lynx population, released animals have to find free space to establish their own territory.

Regardless of the method used, the most important thing is to monitor the released animal. Different tracking methods exist, each with their own advantages and disadvantages.[124,125] GPS tracking, one of the most effective methods, allows monitoring to determine if the animal is succeeding in hunting, feeding, and surviving in the wild. Camera trapping may also contribute to documenting if the animal has reproduced and thus reached the ultimate goal of rehabilitation.

Conclusion

Rehabilitation of lynx orphans has been practiced in several countries in Europe, with both positive and negative experiences reported. To improve the rehabilitation process with respect to both animal welfare and conservation, we summarized the experiences reported and the practices used in Switzerland, where the rehabilitation of eight orphaned lynx has been documented.[10] This article offers, for the first time, clear advice for the rehabilitation of orphaned lynx, detailing methods of anesthesia and care, housing possibilities, feeding techniques, and determining the best time to release them.

The downsides and benefits of a wildlife care center have been discussed and debated in numerous studies for years.[45,126,127] Wildlife rehabilitation is sometimes strongly criticized as having no conservation value and being time-consuming and expensive.[128] However, others consider the reality that human factors are largely responsible for wildlife mortality as sufficient to justify this investment.[129] Indeed, the Eurasian lynx is no exception to the rule, and human activities, such as road traffic or poaching, are the main documented causes of lynx deaths in Switzerland,[130,131] France,[132] Sweden,[133] and Croatia.[134] Although the Eurasian lynx is not globally classified as an endangered species, the size of most populations in continental Europe are below the recommended threshold for long-term survival,[135] especially considering that the reintroduced ones are characterized by poor genetic variability.[136,137] Thus, even if populations are stable, or slightly increasing as is the case in Switzerland,[138] rehabilitation of orphans could contribute to species conservation at the local level, similar to the

results of rehabilitation of endangered species such as the Iberian lynx (*Lynx pardinus*) in Spain,[139] wombat (*Vombatus ursinus*) in Australia,[140] orangutan (*Pongo* sp.) in Indonesia,[141] and jaguar (*Panthera onca*) in Argentina.[99] Orphan lynx rehabilitation could also contribute to genetic exchanges if orphans would be switched between populations.[101] Furthermore, although reintroductions may work with zoo-born animals,[142] carnivore translocation and reintroduction programs using wild-caught (including rehabilitated) animals are in general more successful than those using captive-bred animals.[89,143-146] Thus, orphaned lynx could be valuable in the framework of translocation programs in Europe.

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Pathologies resulting from domestic cat (*Felis catus*) predation on cottontail rabbits (*Sylvilagus* spp.) in Colorado, USA

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ABSTRACT: Predation by domestic cats (*Felis catus*) is a major cause of admission to wildlife rehabilitation centers and represents almost a third of all intakes of cottontail rabbits (*Sylvilagus* spp.) to the Colorado Wild Rabbit Foundation. Here, we describe the outcomes for 681 cat-caught cottontail rabbits received at our facility during the four-year period from 2017 through 2020. We review causes of death for which cats were directly or indirectly responsible, as well as underlying conditions that may have precipitated predations. We also describe common injuries inflicted by cats, useful clinical signs, and any treatments we have found effective in rehabilitating these patients.

KEY WORDS: cat predation, cottontail, domestic cat, *Felis catus*, predation, *Sylvilagus*, wildlife rehabilitation.

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Introduction

Predation by domestic cats (*Felis catus*) is a major cause of admission to wildlife rehabilitation facilities, and cottontail rabbits (*Sylvilagus* spp.) are some of the most frequently affected species.[1,2] Cat predation represents the largest single category (30%) of intakes to the Colorado Wild Rabbit Foundation (CWRF).

Patients received at our facility originate primarily from an urban/suburban environment, with cat victims typically brought directly to us by the cat owner or by a local resident who witnessed the predation. Occasionally, our patients come from rural areas. The region we serve includes most of the northern Denver, Colorado, USA metropolitan area, east of the Continental Divide, including the city of Denver and its suburbs, up to the Wyoming border. Approximately 85% of our patients are desert cottontail rabbits (*Sylvilagus audubonii*), 13% are eastern cottontails (*Sylvilagus floridanus*), and 2% are mountain cottontails (*Sylvilagus nuttallii*).

Most cat victims are young rabbits,[3] but occasionally even adults are preyed upon. Outcomes are generally poor,[1,2] and at our facility 63% do not survive. However, not all of the deaths in this study of cat-predated cottontail rabbits were the direct result of cat-inflicted injuries; underlying medical conditions and rehabilitation constraints also

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contributed. In this retrospective study, we examined the medical records of 681 cat-predated patients received at CWRF from 2017 through 2020 in order to better understand the pathology of cat predation on cottontail rabbits. The purpose of this study was three-fold: (1) to document the magnitude of the problem, including intakes and outcomes; (2) to classify direct and indirect causes of death in order to identify factors that need to be addressed to improve outcomes; and (3) to focus on the directly cat-caused injuries, including associated clinical signs and treatments that we have found to be effective. This study shows that while the overall survival of this cohort was low (37%), improved diagnosis and treatment of not only cat-caused injuries but also predisposing medical conditions, increased wildlife rehabilitation capacity, and better rehabilitation protocols could increase survival.

Materials and Methods

For this study, we reviewed the patient records of all cottontail rabbits received at CWRF during the four-year period from 2017 through 2020 that specified "Cat Attack" as the cause of admission. "Cat Attack" included rabbits known to have been predated by a cat as well as those strongly suspected to have been predated based on the proximity of a cat to the patient, all according to finder reports. In addition, we included patients with injuries consistent with a cat predation and unlikely to have had other causes. All individuals in this study either died (or were euthanized) in our care, were dead upon arrival at our facility, or were successfully released back into their habitats according to established criteria.

Individuals who did not survive to release were grouped into the following five categories based on the probable cause of death: Cat-caused Injuries; Predisposing Conditions; Nosocomial Disease; Age/Capacity; and Unknown. Probable cause of death was established from patient records including daily care sheets, gross necropsy findings, and any diagnostic testing that had been performed.

The "Cat-caused Injuries" category included individuals that died or were euthanized directly due to cat-inflicted injuries. We considered an injury to be cat-inflicted if it involved large avulsions or punctures to or partial eviscerations of vital organs that were unlikely to have had other causes, and where no obvious predisposing conditions such as unrelated diseases or other trauma were found.

The "Predisposing Conditions" category included individuals with conditions that were unlikely to have been directly caused by a cat, or if we could not be sure that they were caused by a cat. These conditions probably would have been fatal, and the cat only indirectly contributed to the rehabilitation outcome. Frequently encountered underlying conditions included blindness or partial (one eye) blindness in the absence of trauma consistent with a cat predation; advanced infectious disease (e.g. severe *Taenia pisiformis* cysticercosis, pneumonia, coccidiosis); orphaning/emaciation; spinal injuries; and fractures. For some of these injuries, especially spinal injuries and fractures, it was difficult to distinguish between cat-caused and predisposing: for this study, we classified them as "Predisposing Conditions."

The "Nosocomial Disease" category included cat-predated individuals that died from conditions acquired during the rehabilitation process. We considered medical conditions to be nosocomial if they were not directly caused by a cat and if clinical signs were first seen after the patient had been in our care for at least five days. We considered conditions in which signs were seen prior to five days as having been acquired in the wild, and these cases were thus classified as "Predisposing Conditions." Nosocomial conditions consisted mostly of gastrointestinal (GI) diseases, which are common in young rabbits, the most frequent cat victims. Euthanasia cases due to rare injuries such as fractures and spinal injuries sustained while handling the patient or while the patient was caged were also included here.

While we made our best attempt to determine whether a cause of death was "Cat-caused," "Predisposing Conditions," or "Nosocomial Disease," there is some uncertainty in this analysis. We estimate that the uncertainty is within 5% of each reported ratio in the tables below. Some ambiguity in the data is unavoidable. For instance, major abdominal injuries caused by a cat could leave underlying GI diseases undetectable; in this case, the death would have been classified as "Cat-caused," but should more accurately have been classified as "Predisposing Conditions." Similarly, clinical signs of disease that appeared six days post-intake were classified as "Nosocomial Disease;" however, it is entirely possible that the disease was present at intake and festered, undetected, until that time. Ultimately, we have concluded that this study paints an accurate picture of the various risks and their magnitudes posed to cat-predated rabbits entering rehabilitation.

The "Age/Capacity" category included cat-predated individuals that were healthy at intake but were euthanized on arrival because they were too young to successfully rehabilitate (in our experience) or because our facility had reached capacity limits. We followed an established ranking for capacity euthanasia that was primarily based on age, with younger age of the rabbit (requiring more and longer care along with lower chances of survival) being the primary consideration. Neonates (individuals less than six days old) were always euthanized.

The "Unknown" category included individuals for which we were unable to determine the probable cause of death.

For the third part of our study, we selected some representative images from the medical records of our patients, including some from prior to 2017, which depict common cat-caused injuries. We reviewed the associated clinical signs, treatments, and outcomes. Where necessary, we highlighted specific lesions or pathologies.

Results and Discussion

Magnitude of the Problem

During the four-year study period, 681 cottontail rabbits were received at CWRF due to cat interactions, representing 30% of all intakes, the single largest category (Table 1). Other common reasons for intake included orphaning (19%), nest destruction/displacement (15%), illness/disease (15%) and dog predations (10%); less common reasons included hit by car, bird predation, and entrapment.

Of the cat-predated patients, most (n = 426, 63%) died or were euthanized, while 255 (37%) were released back into their habitat. The annualized percentage information in Table 1 shows the consistency of the cat problem in the Denver, Colorado metropolitan area, including admissions and outcomes, throughout each of the four years of this study. These numbers indicate that free-roaming cats are a large and persistent problem, and that despite improvements in our cottontail rehabilitation protocols,[4] outcomes for cat victims have not substantially changed. While we have increased successes for our non-cat predation patients through improved husbandry and disease control,[4] most deaths of cat victims were due to either severe traumatic injuries or advanced predisposing conditions (see Sections II and III). Improvements in outcomes for cat-predation patients would require significant veterinary intervention, which was not available at our facility for the duration of this study.

TABLE 1. Cottontail rabbits admitted to the Colorado Wild Rabbit Foundation due to domestic cat interactions and their outcomes.

YEAR	NUMBER INTAKES	NUMBER CAT-CAUGHT	% CAT-CAUGHT	NUMBER CAT-CAUGHT DIED	% CAT-CAUGHT DIED	NUMBER CAT-CAUGHT RELEASED	% CAT-CAUGHT RELEASED
2017	827	238	29%	148	62%	90	38%
2018	515	171	33%	115	67%	56	33%
2019	453	135	30%	79	59%	56	41%
2020	441	137	31%	84	61%	53	39%
Total	**2,236**	**681**	**30%**	**426**	**63%**	**255**	**37%**

TABLE 2. Classification of causes of death for cottontail rabbits that died at the Colorado Wild Rabbit Foundation after domestic cat interactions.

YEAR	NUMBER CAT-CAUGHT INTAKES	NUMBER CAT-CAUGHT DIED	NUMBER/% CAT-CAUSED INJURIES	NUMBER/% WITH PREDISPOSING CONDITIONS	NUMBER/% FROM NOSOCOMIAL DISEASE	NUMBER/% DUE TO AGE/ CAPACITY	NUMBER/% UNKNOWN
2017	238	148	68/46%	32/22%	20/13%	23/16%	5/3%
2018	171	115	58/50%	23/20%	16/14%	7/6%	11/10%
2019	135	79	40/51%	4/18%	7/9%	4/5%	14/18%
2020	137	84	48/57%	16/19%	9/11%	7/8%	4/5%
Total	**681**	**426**	**214/50%**	**85/20%**	**52/12%**	**41/10%**	**34/8%**

Note that the percentages died and released in Table 1 are based on the number of cat-caught rabbits, not the total number of intakes. The decrease in the number of patients in the study after 2017 reflects capacity limitations at our facility. See Paul and Friend (2020)[3] for a breakdown of age categories and species received at our facility.

Classification of Causes of Death

Table 2 shows the probable causes of death of the cat-predated patients in our study, grouped according to criteria defined previously. This table shows that only half of the patients (50%) that did not survive died directly from cat-inflicted injuries. We further describe some of these injuries in Sect. III. The other half of the cat-predated non-survivors died from a combination of predisposing conditions (present prior to the cat predation) and rehabilitation-related factors; these deaths were indirectly related to the cat predation.

Note that Table 2 covers only deceased patients, in contrast to Table 1, which covers the entire cohort in our study. For instance, while 50% of deaths were directly due to cat-inflicted injuries (214 out of 426 in Table 2), these deaths represent the outcomes for 31% of all cat-predated patients (214 from Table 2 out of 681 from Table 1).

While cottontail rabbits are most vulnerable to cat predation when young,[3] any debilitating injury or disease[5] can leave individuals of all ages susceptible to predation. (See Paul and Friend (2020)[3] for a study of how age relates to vulnerability to cat predation, for the three species of cottontail rabbits received at CWRF.) In this study, 20% of the cat-predated rabbits that died had a predisposing medical condition that may have left them vulnerable and may have resulted in death even without the cat interaction. One underlying disease that is worth noting here is coccidiosis,[4] which frequently affects recently weaned rabbits. This disease appears to make the rabbits especially vulnerable to cat predation at an age when they are typically able to escape.[3]

Notably, 12% of the non-surviving cat-caught patients (the "Nosocomial Disease" category) appeared to recover from their cat-inflicted wounds but subsequently died in captivity, often from GI diseases, respiratory infections, or captivity-related trauma. Whether all of these cases were truly nosocomial or whether some were present before the cat interaction, they may indicate a need for better rehabilitation protocols such as prophylaxis and treatments for common rabbit diseases, stress reduction, and infection control.

The "Age/Capacity" category shows that a sizable portion (10%) of cat-caught patients that died were healthy at intake and may have survived had they been able to stay in their habitat. In our experience, rabbits less than approximately six days old at intake (neonates) do not survive the weaning stage in rehabilitation and therefore we no longer attempt to rehabilitate them: these were euthanized upon arrival at our facility. In addition, when our facility reaches capacity, younger rabbits that require labor-intensive hand-feeding are euthanized.

In this "Age/Capacity" category, we mostly saw rabbits whose nest had been discovered by a free-roaming cat and therefore could not be safely left to be cared for by their mothers. While every effort was made to work with the finder to keep these individuals in their natural habitat, once a cat has discovered a nest, the infants (unweaned individuals) remain vulnerable unless the cat can be prevented from re-visiting the nest. This is often impossible because the cat's owner is unknown or is unwilling to keep their cat contained, or a feral cat may be difficult to catch. The proportion of "Age/Capacity" euthanasia cases decreased after 2017, because we referred more neonatal patients directly to veterinarians for euthanasia; these individuals were not included in our cohort.

Finally, for 8% of our cat-caught patients that did not survive, we could not determine a cause of death, often because we were unable to perform a necropsy.

The numbers in Table 2 indicate that in order to increase the survival of cat-caught rabbits in rehabilitation, several factors need to be addressed: better treatments for cat-caused injuries, including greater levels of veterinary support, including surgery; better diagnosis and treatment of diseases and injuries, including those acquired during rehabilitation; increased rehabilitation capacity; and better protocols for rearing neonates. It is also worth noting the importance of necropsies for understanding why patients are dying in rehabilitation. It is easy to assume a cause based on the reason for intake (cat predations in this study), when other factors may be more significant; hence the classifications in Table 2.

In Sect. III, we describe common cat-caused injuries. Other conditions affecting wildlife in rehabilitation included in Table 2 have been described elsewhere. For instance, Cockram et al. (2021)[5] review common issues affecting wildlife patients, including injuries, diseases, neonates, and captive rearing. Perry et al. (2020)[6] discuss capacity limitations faced by wildlife rehabilitation facilities.

Common Cat-Inflicted Injuries

Often, even severe cat-caused injuries are not immediately fatal, and some can easily be missed on an initial exam.[2] As prey animals, cottontail rabbits are expert at hiding any distress; cat victims that appear externally unharmed at intake may die over the course of several days due to internal injuries or infections. Since cats can cause a number of different injuries, and since the rabbit may also have had an underlying condition that made it vulnerable to predation, clinical signs can be quite varied. Often, wildlife rehabilitation facilities have limited access to advanced diagnostics (e. g., radiographs or clinical laboratory tests), so knowing the types of injuries that cats commonly inflict, along with (typically subtle) clinical signs, can inform treatment decisions. When potentially fatal injuries such as punctures to vital organs or partial eviscerations are diagnosed at intake, limited resources often mean that euthanasia is the only feasible treatment. Necropsies can clarify the cause of death if a rabbit dies of unknown causes, and we often find injuries post-mortem that point to a cat predation, even when no such history was available at intake and no external injuries were found.

Below, we provide short descriptions of some common cat-inflicted injuries that we have encountered at our facility, along with pertinent clinical signs and any treatments we have found to be effective. Ideally, every cat-predated patient should be seen by a veterinarian and an appropriate treatment plan prescribed. However, this may not always be feasible in a rehabilitation setting. Nonetheless, any rabbit with a known or suspected cat interaction should be given systemic antibiotics, even if no injuries are visible.[1] If a cat-predated patient is not prescribed antibiotics (in our case, often due to an unknown history), the risk of infection is high;[7] see Sect. III.c.2 for our experience with this. We recommend working with a veterinarian to develop a protocol for cat-predated patients. Also, it is important to release survivors only after they are old enough to be able to evade a repeat encounter with a cat—usually when the rabbit reaches a minimum of 220 g of body weight.[3]

In the following sections, we describe general treatments that we, as rehabilitators, have found to be helpful. We give some examples of cases, including observed clinical signs and underlying diagnosed injuries. While we depict common injuries, we have by no means presented an exhaustive compilation. Cats often inflict injuries to provoke a reaction from their prey, rather than to quickly kill them—the so-called "play" interaction.[8] Thus, injuries can affect any body part to varying degrees, and often multiple injuries are present, sometimes inflicted over a period of hours or days.

III.a Initial Exam and Clinical Signs

Some cat-caused injuries may be seen easily during an initial exam (such as partial eviscerations that extend through the skin, as shown in Fig. 1, or avulsions, illustrated in Fig. 2), but in older, fully furred individuals, injuries are often difficult to see due to dense fur, minimal bleeding, and the nature of the injury. For example, Fig. 3 shows multiple puncture wounds and a partial evisceration of the small intestine through the abdominal wall that were hidden under the skin and not apparent at intake. In the case of hidden injuries due to a cat predation, behavioral signs of pain or distress become important indicators.

In our experience, clinical signs associated with cat-inflicted wounds depend on the location and severity of the injury, and whether infection has set in. Anorexia and a reluctance to move are general features of an ill animal. Dyspnea may indicate a chest/lung injury or infection. Daily weight loss despite good appetite, continuing for three or more days, is often indicative of infection.

Given the stoic nature of rabbits, close attention should also be paid to subtle signs such as posture, facial expressions associated with pain, and piloerection. Such observations should be made regularly and may provide evidence of serious injuries, especially if still apparent after a day or two and after the administration of pain medication. With abdominal injuries, we often see a hunched, "puffed up" appearance (front and hind legs close together with piloerection) and partially closed eyes, similar to what has been described in domestic rabbits[9] (*Oryctolagus cuniculus*). This appearance can also indicate GI disease such as coccidiosis.[4] Rabbit-specific pain scales have been developed for domestic rabbits[10] and should be investigated for use

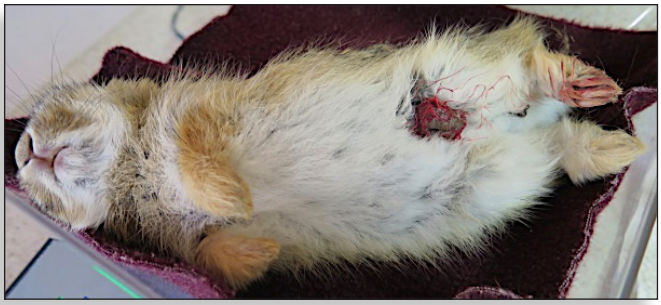


FIGURE 1. Cat-inflicted partial evisceration of intestine through the abdominal wall and skin, easily visible on initial exam.



FIGURE 2. Cat-inflicted avulsion, easily visible on initial exam.



FIGURE 3. Cat-inflicted puncture wounds and partially eviscerated intestine, visible only after removal of skin during necropsy.



FIGURE 4 (Bottom right). Cat-inflicted avulsion on the back.

in cottontail rabbits.

Rabbits with degloving wounds (Sect. III.b), a frequent injury inflicted by cats, may not show any clinical signs other than the wounds themselves. Their behavior may be normal, including appetite, feces production, weight gain, and activity; these cases often resolve well. Similarly, a rabbit with an abscess (Sect. III.c.4), especially when the abscess is localized, may not show any clinical signs other than a lump under the skin that increases in size over time.

III.b Degloving Wounds/Avulsions

III.b.1 Description

The most easily visible cat-caused injuries include degloving wounds/avulsions, often to the hindquarters (Fig. 2), back (Fig. 4), and hind legs, especially around the ankle (Fig. 5). These may be small and localized, or extend over a considerable surface area. The wounds are often partially covered with fur and may appear much smaller than they actually are. Usually, only superficial layers of skin are involved (Fig. 4), but occasionally muscles, tendons, or bones are exposed (Fig. 5).

III.b.2 Treatments for Avulsions

Unless comprising an extended surface area, cat-caused degloving wounds usually heal well in these species with minimal intervention. We have seen good results with once-a-day topical application of silver sulfadiazine (SSD) or manuka honey for 1–3 days, in addition to systemic antibiotics. Ankle and leg wounds, even with exposed tendons or bone, can heal well but are prone to infection and must be monitored closely. Even here, we have found that topical application of SSD for several days is usually all that is needed. We rarely see infections in rump or back deglovings. If the wound is infected, SSD may be more effective initially and could then be followed by application of honey, if needed. In our experience, flushing the wound is not necessarily beneficial, unless the wound is heavily contaminated. When enough skin is present, suturing or stapling the wound can be considered; however, cottontail skin is fragile, and these closures can easily tear. Bandaging is not practical in these species as bandages will promptly be removed by the rabbit. Therefore, wounds are usually left open and care must be taken that any bedding or food items do not contaminate the wound. Linens such as pillow cases or towels for bedding, leafy greens such as kale or lettuce, and hand-picked, long-bladed grass are preferable to hay, kibble, mowed grass or other small-particle items. The two rabbits shown in Fig. 4 and 5, despite severe wounds, displayed normal behaviors, recovered from their injuries with this minimal treatment, and were released.

III.c Punctures/Bite Wounds

III.c.1 Description

Some of the most common cat-inflicted wounds we diagnose are punctures, presumably from cat bites. They may not be visible during an external exam, but they should always be suspected in conjunction with cat predations. Punctures can cause extensive damage to the underlying tissue, including vital organs, and can result in serious infections. Often these distinctive wounds can be seen during necropsy once the skin is removed (Fig. 6), but since the skin of cottontails heals quickly, sometimes only the underlying damage is visible. Cats frequently target the neck, chest, and abdomen, but any body part can be punctured. Punctures can penetrate internal organs; we often see damage to the liver (Fig. 7), cecum (Fig. 8), intestines (Fig. 9), and lungs (Fig. 10). Other organs that may be punctured include the skull (Fig. 11) and stomach (Fig. 12).

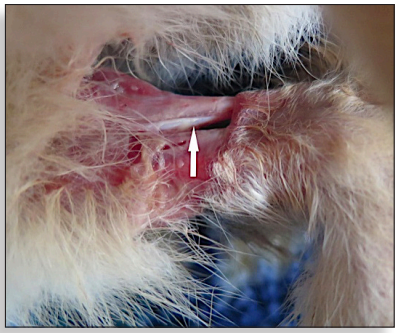


FIGURE 5. Exposed tendon from cat-inflicted avulsion on the ankle.

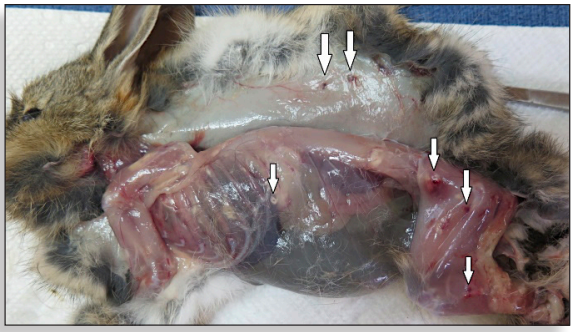


FIGURE 6. Multiple cat-inflicted puncture wounds visible under the skin during necropsy.

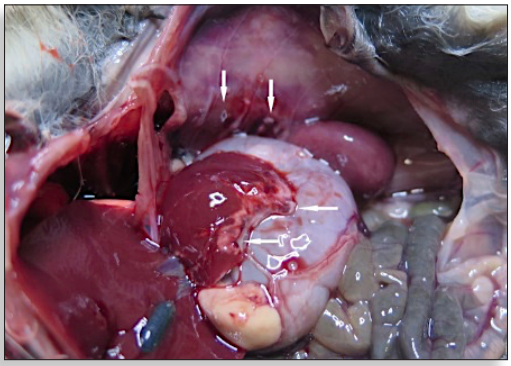


FIGURE 7. Cat-inflicted liver punctures. Note signs of necrosis/infection on edge of liver lobe.

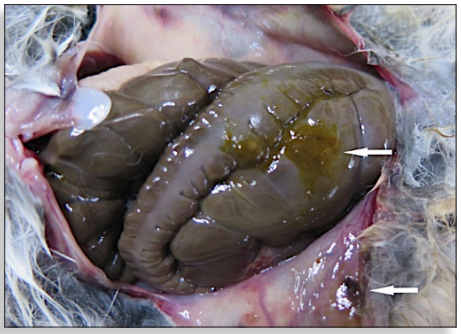


FIGURE 8. Cat-inflicted cecum puncture. Note fecal matter from cecum adhered to puncture wound on underside of skin.



FIGURE 9. Cat-inflicted punctured large intestine.

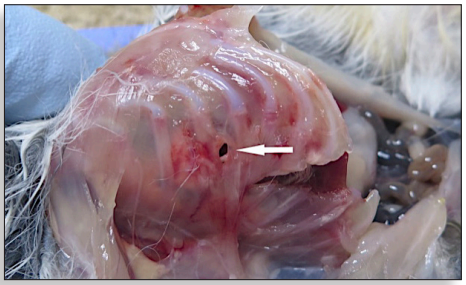


FIGURE 10a. Cat-inflicted chest wall puncture.

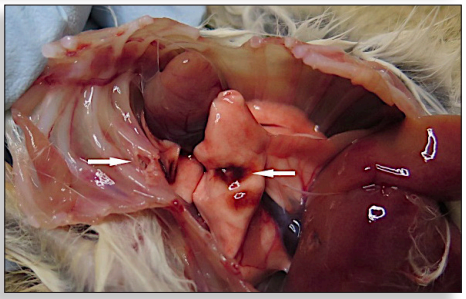


FIGURE 10b. Lung puncture associated with chest wall puncture in Fig. 10a.

III.c.2 Widespread Infections Resulting from Puncture Wounds

Untreated cat-inflicted puncture wounds may result in widespread infections, such as peritonitis, polyserositis (Fig. 13), chest/lung infections (Fig. 14), or septicemia. We typically saw such infections in patients that arrived at our facility dead or dying, where necropsies revealed partially healed puncture wounds indicating the predation occurred several days prior. We also occasionally discovered these types of infections in patients with an unknown history who were not prescribed antibiotics at intake; these patients often died within the first 3–10 days in care.

For example, the rabbit in Fig. 15 was admitted with no history of a cat predation and thus had not been prescribed antibiotics. Three days after intake, it became clear that the rabbit was deteriorating and it was euthanized. The behavioral signs most noticeable were a stiff posture, the inability or reluctance to ambulate, and a facial expression (note partially closed eyes) suggestive of severe pain (Fig. 15a). This facial expression was consistent with what Banchi[9] describes as indicating abdominal pain in domestic rabbits; on necropsy, we discovered the rabbit suffered from severe peritonitis/polyserositis (Fig. 15b).

III.c.3 Treatments for and Prevention of Widespread Infections

Our older protocols specified antibiotic treatment only for patients with a known history of a cat predation and associated injuries. Under this protocol, some of our patients died from infections that were consistent with an untreated cat predation. As mentioned previously, necropsies of these patients often revealed peritonitis or polyserositis (Fig. 13 and 15), probably due to cat-caused punctures into the abdominal cavity that were not detected at intake. In the six cases that we submitted for culture, all came back positive for *Pasteurella multocida*. *Pasteurella multocida* is a common pathogen in cat saliva[11] and is the most common cause of infected cat-bite wounds in humans.[12]

Similarly, we often found chest cavity and lung infections (Fig. 14) under this old protocol, again probably due to cat-caused punctures into the chest cavity. We also saw such widespread infections, both abdominal and thoracic, in confirmed cat-predated patients that died despite antibiotic therapy; some of these patients were known or suspected to have been repeatedly predated by a cat for several days prior to intake, and their infections were presumably

too advanced to respond to our therapy. We subsequently changed our protocol to administer antibiotic therapy to suspected as well as known cat-predated patients, even if no injuries were found at intake. Since adopting this more aggressive protocol, we rarely see these infections. Note that the data in this study (Tables 1 and 2) were collected after this protocol change.



FIGURE 11. Cat-inflicted skull puncture.

A cat predation should always be considered in young patients with an unknown history, especially those that recently left the nest; direct questioning of the finder related to a possible cat interaction should be part of the intake protocol. In summary, many puncture wounds will heal successfully with systemic antibiotic therapy; therefore, it is important to administer such therapy, or definitively rule out a cat predation.

III.c.4 Abscesses Resulting from Puncture Wounds

While abscesses rarely present at admission, they can form at puncture sites even with the administration of systemic antibiotics. They are especially common around the neck (Fig. 16) and shoulders, but can also form in joints (Fig. 17) and pretty much anywhere else on or in the body. These abscesses may be localized and encapsulated (walled off from surrounding tissue), or they may spread to adjacent tissue, as seen in Fig. 16b. The rabbit depicted in Fig. 16 was euthanized 16 days after intake, after the failure of repeated attempts to successfully treat the abscess (including flushing and various antibiotic therapies—see below). The rabbit in Fig. 17 was euthanized nine days after intake; it displayed a persistent limp and poor weight gain despite systemic antibiotic therapy.

Sometimes abscesses emerge after the completion of antibiotic treatment (typically 5–7 days at our facility); this may be due to the time it takes for the abscess to become apparent, or because the antibiotics were suppressing but not eliminating the growth of bacteria. It is therefore important to carefully monitor cat-predated patients for abscesses for several days post-antibiotic treatment before releasing them. For example, the rabbit shown in Fig. 18 appeared completely healthy—it exhibited good weight gain and normal activity—but a few days after completion of antibiotic treatment and just prior to planned release, a lump on the neck appeared (seen in Fig. 18). This abscess was localized and encapsulated and was successfully treated as described below.

III.c.5 Treatments for Abscesses

Treatments for abscesses vary with the type of abscess. In our experience, a localized abscess can often be resolved by lancing and flushing, followed by a daily application of manuka honey into the abscess capsule until healed. Careful palpation of the



FIGURE 12. Cat-inflicted stomach puncture with milk seepage into abdominal cavity. Note that the curdled appearance of the milk indicates that this injury may have occurred quite some time before death.



FIGURE 13. Polyserositis after suspected cat bite, without antibiotic treatment.

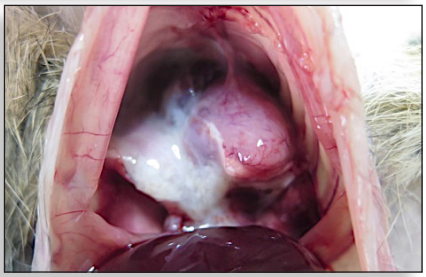


FIGURE 14. Chest/lung infection after suspected cat bite, without antibiotic treatment.





FIGURE 15a (above). Stiff posture and partially closed eyes of rabbit prior to euthanasia.

FIGURE 15b (left). Same rabbit at necropsy, showing polyserositis.



FIGURE 16a. Cat-caused neck abscess undergoing treatment.



FIGURE 16b (far right). Necropsy of same rabbit, showing the abscess having spread to surrounding tissue including the shoulder and the front leg.

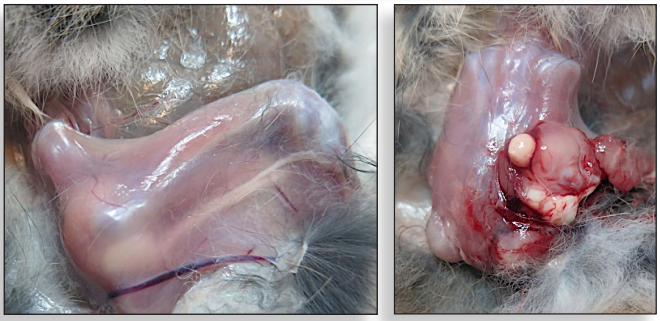


FIGURE 17a. Cat-caused abscess in the hip joint seen during necropsy. **FIGURE 17b (above right).** Same abscess, opened.



FIGURE 18. Cat-inflicted abscess on neck, with no clinical signs other than a lump on the neck.

swelling to see if it is attached to underlying tissue can be useful to determine if the abscess is localized, but it can often be difficult to tell if an abscess has spread. We have found that persistent weight loss (or poor weight gain in young rabbits) over a period of several days may be an indication of disseminated infection. Abscesses that have spread into underlying tissue are difficult to treat, and a veterinarian should be consulted. A different antibiotic may be tried or euthanasia should be considered. For domestic rabbits, the recommended treatment for abscesses is complete surgical excision of the entire abscess capsule, when possible.[13]

III.d Eviscerations/ Partial Eviscerations

III.d.1 Description

Partially eviscerated or herniated organs are also a frequent injury caused by cats; we suspect these are caused by a cat "clawing" the victim, rather than due to a bite. In contrast to puncture wound patients, these individuals usually die or are euthanized before obvious infections can set in. Organs frequently involved include the intestines (Fig. 19 and 20), cecum (Fig. 21), spleen (Fig. 22), and lung (Fig. 23). Often, the affected organs will be pulled through the abdominal or chest wall but remain under the skin, so the injury cannot easily be detected externally. Depending on the size of the injury, it can sometimes be felt as a lump under the skin with careful palpation. Fig. 20 shows a partially eviscerated small intestine that was pulled through the abdominal wall but not the skin; it was discovered by palpating, then wetting the surrounding fur. Another example can be seen in Fig. 24; while this rabbit appeared unwell at intake, we did not detect any obvious injuries during its initial exam. As seen in Fig. 24a, the rabbit exhibited a hunched posture, reluctance to move, and piloerection, which we now often associate with abdominal injuries or disease (as also noted in Sect. III.a). This rabbit died one day after intake, also with part of its small intestine pulled out of the abdominal cavity but hidden under the skin (Fig. 24b). Similarly, Fig. 25 shows a rabbit with its bladder pulled through the abdominal wall but not the skin. This injury also was not apparent at intake, but became visible as the bladder filled up over the course of a day or two, at which point the rabbit was euthanized.

Occasionally, organs will be herniated into a different body cavity. For example, the rabbit in Fig. 26 presented with dyspnea that rapidly worsened despite oxygen therapy, and it was therefore euthanized shortly after intake. As is apparent in Fig. 26, a portion of the small intestine was herniated through the diaphragm into the chest cavity and compromised the breathing process.

III.d.2 Treatments for Eviscerations

Some of the above cat-inflicted injuries potentially could have been treated surgically if discovered in a timely manner, as are similar injuries in dogs and cats.[14] At our facility, surgical intervention was not feasible, and all of these patients died or were euthanized. Research is needed to see if surgical repair could be successful in similar cases.

Conclusion

Cat-caught wildlife, especially cottontail rabbits, can account for a large proportion of intakes at wildlife rehabilitation facilities,

and comprised almost a third of our intakes during this study. Outcomes are generally poor. While cats were directly or indirectly responsible for most of the deaths in this study, it is important to recognize that just undergoing the rehabilitation process presents an additional risk to patients, although it is unclear whether this risk represents an increase over what may occur naturally in the wild. While the overall proportion of cat-predated patients in this study that survived to release was low, there were effective treatments for a number of injuries and many patients fully recovered.

Most of the deaths and injuries documented here could have been prevented if stronger restrictions were placed on free-ranging domestic cats, both owned pets and feral animals. Since cats have been shown to bring home only about a quarter of their victims, leaving half at the site of capture and consuming the rest,[15] the magnitude of the problem is likely much larger than that described here.

The burden placed on wildlife rehabilitators and veterinarians, in terms of cost, time, and effort spent treating these patients, as well as the emotional toll of witnessing suffering, is substantial. Thus, we believe the problem of free-roaming cats should be addressed. According to Trouwborst et al.,[16] cats are an invasive species and have no place in our ecosystems.

We hope that this compilation of information will be useful to the wildlife rehabilitator or veterinarian when deciding what actions or further diagnostics may be warranted for their cat-predated patients. For patients that don't survive, necropsies are an important component for developing future treatment protocols.

Disclaimer

The authors received no financial support from any manufacturer or organization mentioned or cited in this paper for the research, authorship, and/or publication of this article, and assert that no conflicts of interest are present. The authors affirm that all animals enrolled in this study received the highest standards of rehabilitation care, conforming to ethical guidelines of the Colorado Wild Rabbit Foundation, the International Wildlife

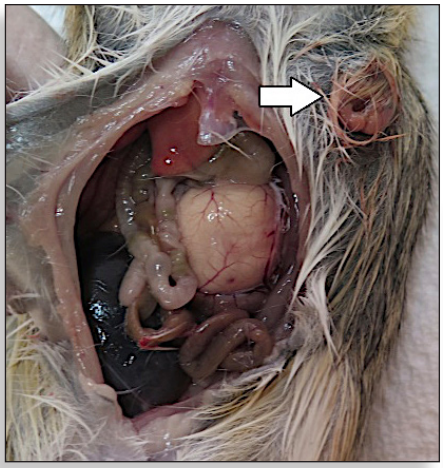


FIGURE 19. Cat-inflicted partial evisceration of the small intestine through the abdominal wall and skin.

FIGURE 20. Cat-inflicted partial evisceration of the small intestine through the abdominal wall but not the skin.





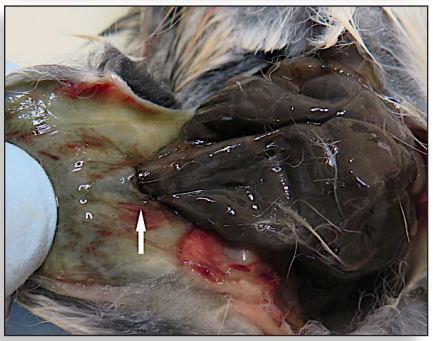


FIGURE 21a (above left). Cat-inflicted partial evisceration of the cecum through the abdominal wall. Note how this injury could easily have been missed during an initial exam.
FIGURE 21b (above right). Same injury as it appeared on necropsy.

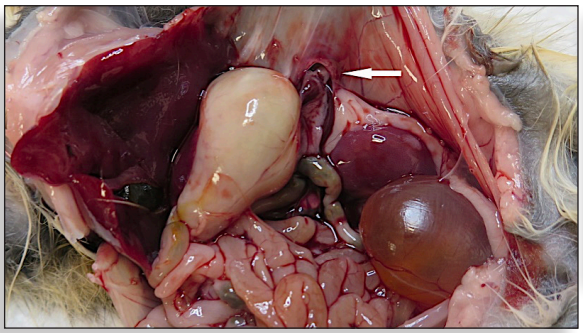


FIGURE 22. Cat-inflicted partial evisceration of the spleen through the abdominal wall.

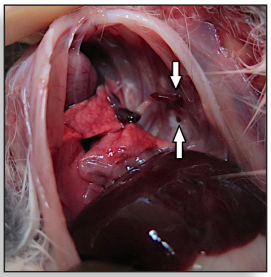


FIGURE 23. Cat-inflicted partial evisceration of torn lung tissue through the chest wall.



FIGURE 24a. Cat-predated rabbit displaying the hunched, "puffed" appearance often associated with abdominal injuries.

FIGURE 24b. Same rabbit during necropsy, showing partial evisceration of the intestine through the abdominal wall.

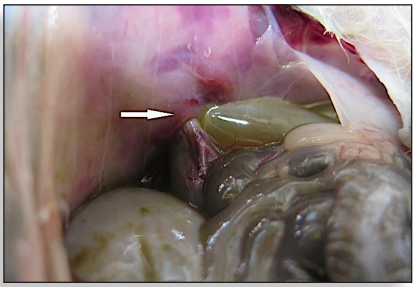




FIGURE 25a. Cat-inflicted evisceration of the bladder through the abdominal wall but not the skin.



FIGURE 25b. Bladder after removal of skin during necropsy



FIGURE 26. Intestines herniated through the diaphragm into the chest cavity after a cat predation.

Rehabilitation Council, and the National Wildlife Rehabilitators Association; all interactions with these animals were in accordance with the relevant local, state, National, and international laws, rules, treaties, and regulations for such interactions.

About the Authors

Gabriele C. Paul has been involved in wildlife rehabilitation since 2007, and has focused on lagomorph rehabilitation since 2013. She is the co-founder and Director of the Colorado Wild Rabbit Foundation. Gabriele has a master's degree in biology from the University of Colorado and is a Certified Wildlife Rehabilitator (CWR). She is licensed by the state of Colorado for the rehabilitation of small mammals.

Daniel G. Friend has been involved in lagomorph rehabilitation since 2010, and was a founding Director of the Colorado Wild Rabbit Foundation in 2013, in which he maintains an active role. He recently retired as a research physicist (Cornell University, AB and University of Colorado, PhD) and continues active leadership roles in several domestic and international physics-focused organizations.

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CONTINUED FROM PAGE 6

returned to the Northwestern Hawaiian Islands as part of the Center's partnership with NOAA Fisheries, utilizing resources in the area to identify seals in need, rescue and rehabilitate them, and give them a second chance at life.

Confiscated Wildlife Training in Malaysia

KOTA KINABALU, MALAYSIA *(July 28, 2022)*—A recent training in Sabah helped frontline staff to identify, rescue and care for trafficked animals when they are seized alive.

The International Fund for Animal Welfare (IFAW), with support from WWF–Malaysia and in collaboration with the Sabah Wildlife Department, ran the four-day focused training session (July 25–28) in Kota Kinabalu, Sabah. Attendees were frontline officers and government officials involved in live animal seizures and confiscations. The multi-billion dollar illicit trade in wild animals includes smuggling for the exotic pet business, as well as for wildlife body parts.

Sabah is the location of one of the world's oldest rainforests, and the home to orangutans, clouded leopards, proboscis monkeys, elephants, and many other species notably threatened by wildlife trafficking.

Illegal wildlife trade efforts often focus on wildlife products, while specific challenges related to live animal seizures are rarely addressed.

Lois Lelanchon, IFAW Programme Manager, Wildlife Rescue, said, "It is vital that we provide the resources needed by frontline officers to enable them to adequately deal with live animal seizures, which can present unique challenges in terms of biosafety, public safety, and animal welfare. However, along with these challenges come opportunities, as we are talking about live animals. Trafficked species are often classified as threatened, and could be rehabilitated and released to the wild to play a critical role in conservation and species survival."

Launched by Sabah Wildlife Department Director, Augustine Tuuga, the training involved advice on handling and care of confiscated wild animals until they can be transported to a suitable care facility. The course has also introduced participants to new genetic traceability and forensic tools as well as covering subjects such as species identification, animal health checks, relevant local and international legislation, and zoonotic disease risk. Training objectives include ensuring the safety of personnel alongside the seizure/confiscation chain, reducing biosafety risks, safeguarding animal welfare, and minimizing animal die-offs.

This latest training was provided as part of the project TRIPOD (Targeting Regional Investigations for Policing Opportunities & Development). It is a follow-up to a training session held in the area last month by Freeland to help local enforcers find and dismantle criminal networks that target Sabah's biodiversity to feed illicit wildlife supply chains globally.

Additional TRIPOD training courses and networking events will be held in Indonesia, in the Philippines, and at the sub-regional level in the coming months. TRIPOD is also creating a comprehensive "toolkit" for frontline officers to support their counter-trafficking efforts.



PHOTO © OREGON STATE UNIVERSITY. CC BY-NC-ND 2.0.

African elephants (*Loxodonta africana*), common victims of illegal wildlife trafficking.

New Facility for Prerelease Sea Turtles in Persian Gulf

ABU DHABI, UNITED ARAB EMIRATES *(December 7, 2022)*—The Department of Culture and Tourism–Abu Dhabi (DCT Abu Dhabi) has signed a Memorandum of Understanding (MoU) with the Environment Agency–Abu Dhabi (EAD) to create a pre-release turtle rehabilitation area at Louvre Abu Dhabi in the waters surrounding the museum. The project supports the last step of the rehabilitation cycle before the marine animals are released back into

the sea. It is an extension of the EAD's Wildlife Rescue Program in partnership with The National Aquarium, intended to fulfill the country's conservation efforts in preparing the animals for release into Abu Dhabi's waters in 2023.

HE Al Geziry, Director General of Tourism, said, "The collaboration of government departments, environmental groups, and leading academics to work towards a common goal is a powerful formula for facilitating positive conservation outcomes." The facility will be overseen by the EAD and run by The National Aquarium.

Fire Destroys Red Creek Wildlife Center Clinic Building

SCHUYLKIL, PENNSYLVANIA, USA *(December 9, 2022)*—A fire in the main clinic at Red Creek Wildlife Center in Pennsylvania killed 41 animals residing at the center. Local news has reported that estimated monetary damages will exeed $50,000. The fire began at an electrical outlet strip on Monday, December 5th. Posting on Facebook, the center reports that they are hoping to have a temporary clinic open by the end of December.

Wildlife Rehabilitation Documentary Winning Global Accolades

NEW DELHI, INDIA *(December 13, 2022)—All That Breathes*, Shaunak Sen's documentary film that first debuted at the Sundance Film Festival at the beginning of 2022, has continued to garner awards after its first Grand Jury Prize at Sundance, including best documentary at Cannes Film Festival and Best Feature and Best Director at the International Documentary Association Awards, among others. It's currently being discussed as a likely contender in this winter's Academy Awards as the Oscar's Best Documentary. The film features Nadeem Shehzad and Mohammad Saud, founders of Wildlife Rescue in New Delhi and long time IWRC members, as well as their employee, Salik Rehman. Over the course of the documentary the audience gets to know the wildlife of New Delhi and is treated to a first-hand seat in the rehabilitators' discussions on the challenges of their work and its place in the world.



PHOTO © ADOLFO FELIX ON UNSLASH. CC BY-NC-ND 2.0 LICENSE.

Loggerhead turtle (*Caretta caretta*).

Corporate nonprofit partnership supports wildlife care in New South Wales and beyond

SYDNEY, AUSTRALIA (August 31, 2022)—Everbridge, a global leader in critical event management and public warning software, is celebrating three years of collaboration with WIRES (Wildlife Information Rescue and Education Services). WIRES volunteers use Everbridge's xMatters digital service availability solution to coordinate wildlife rescues.

Lucy Clark, Emergency Response Manager for WIRES notes, "Access for rescue teams was extremely difficult in the immediate aftermath, and we needed to focus on 24/7 phone support for people dealing with displaced wildlife in addition to urgent logistical support for our volunteers. Many animals in care needed to be evacuated. Without Everbridge working away in the background, this task would have been impossible. Hundreds of exhausted animals were rescued, including orphaned joeys, wombats and bandicoots, echidnas, and many waterlogged birds. We believe that with our coordinated emergency response efforts and our sophisticated Everbridge software, we provided the best possible outcomes for our precious wildlife. We are so grateful for your support and state-of-the-art technology. Together we can achieve extraordinary things to ensure more animals get the second chance at life in the wild that they deserve." ■

SELECTED ABSTRACTS

What do animals learn during anti-predator training? Testing for predator-specific learning in ‘alalā (*Corvus hawaiiensis*)

AL Greggor, B Masuda, RR Swaisgood. *Behavioral Ecology and Sociobiology*, 23 November 2022; 76(165)

Despite the growing use of conservation breeding and translocations in conservation, many translocation efforts fail due to predation post-release. Released animals often lack appropriate behaviors for survival, including anti-predator responses. Anti-predator training—a method for encouraging animals to exhibit wariness and defensive responses to predators—has been used to address this challenge with varying degrees of success. The efficacy of anti-predator training hinges on animals learning to recognize and respond to predators, but learning is rarely assessed, or interventions miss key experimental controls to document learning. We present an experimental framework for designing anti-predator training that incorporates suitable controls to infer predator-specific learning and illustrate their use with the critically endangered Hawaiian crow, ‘alalā (Corvus hawaiiensis). Our training aimed to increase anti-predator behavior towards a natural predator, the Hawaiian hawk, ‘io (*Buteo solitaries*). In addition to running live predator training trials, we included two control groups, to determine if responses could otherwise be due to accumulated stress and agitation or to generalized increases in fear of movement. We could not verify that the training induced anti-predator learning because responses were similar across all experimental groups. Therefore, without these control groups, we may have wrongly concluded that predator-specific learning occurred. Additionally, despite generations in human care that can erode anti-predator responses, ‘alalā showed high levels of predatory wariness during baseline assessments. We discuss the implications of a learning-focused approach to training for managing endangered species that require improved anti-predator competence and the importance of understanding learning mechanisms in diagnosing behavioral problems.

Using wildlife rehabilitator surveys to identify threats: a case study of koalas in Victoria, Australia

KR Ashman, DJ Watchorn, and DA Whisson. *Australian Zoologist*, 2022; 42(1):130–145. https://doi.org/10.7882/AZ.2021.027

Identifying threats and their regional occurrence across a species’ range is increasingly valuable for prioritising threat-specific interventions and achieving effective conservation outcomes. We surveyed registered wildlife rehabilitators to identify (i) threats faced by the koala across Victoria and (ii) their perceptions on koala population trends and potential threat mitigation actions. Wildlife rehabilitators identified habitat loss, fragmentation, and degradation as the biggest threat to koalas, while vehicle collisions, heatwaves and wildfire were also identified as key threats. Accordingly, reducing the clearing of native vegetation was considered the most effective threat mitigation action, while creating of wildlife corridors, planting of more food trees, and educating communities living in koala occupied areas were also considered appropriate mitigation strategies. Finally, 89% of wildlife rehabilitators believed that koala numbers are declining in their region.

Hacked kestrels (*Falco tinnunculus*) show similar patterns of post-fledging food dependency as wild reared birds: implications for best practice in release management of orphaned raptors

N Thavarajah and M Fenkes. *Wildlife Rehabilitation Bulletin*, 2022;40(1):1–7. https://doi.org/10.53607/wrb.v40.243

One of the challenges of wildlife rehabilitation is ensuring that rehabilitated animals have the required characteristics for survival after release. This is especially the case for orphaned animals that normally develop survival skills during a prolonged period of parental care. For raptors, this is called the post-fledging dependency period (PDP), where parents provide nutritional support to juveniles whilst they develop the physiological and behavioural characteristics required to successfully hunt prey. Orphaned raptors can be rehabilitated and released using a method termed “hacking,” a type of “soft-release” where fledglings are released from a nest box, which they learn to associate with food. This method gives the birds an opportunity to develop prey capture skills, whilst continued nutritional support is provided by rehabilitators at the box. Here, we used a hacking method to rehabilitate and release 15 orphaned kestrels (*Falco tinnunculus*) and observed the pattern of return to the hacking box. Of the released birds, 80% returned to the hack site for food at least once. The average number of days birds returned to the box was 12.67 ± 8.76, and there was a clear trend towards a gradual decrease in return rate (number of visits to the box per day) over time. Our observations are comparable to patterns of PDP in wild-reared kestrels and we therefore suggest that orphaned kestrels can be successfully rehabilitated in this way.

Social integration of translocated wildlife: a case study of rehabilitated and released elephant calves in northern Kenya

SZ Goldenberg, SM Chege, N Mwangi, I Craig, D Daballen, I Douglas-Hamilton, N Lamberski, M Lenaipa, R Lendira, C Lesowapir, *et al. Mammalian Biology*, 2022. https://doi.org/10.1007/s42991-022-00285-9

Conservation translocations have the potential to strengthen populations of threatened and endangered species, but facilitating integration of translocated individuals with resident populations remains a substantial challenge. Developing functional social relationships like cooperative partnerships or establishing clear dominance hierarchies may be critical to integration of released individuals. Developing such relationships has not received much attention in translocation

research, especially for long-lived, socially complex animals for which establishment and navigation of social environments is often a lengthy process that requires sustained monitoring to understand. Here, we present a case study of the social associations of African savannah elephant (*Loxodonta africana*) calves that have been rehabilitated and released into a fenced wildlife sanctuary in northern Kenya with a resident population of elephants. We use focal follows of interactions pre-release and GPS tracking post-release to quantify social associations of calves with each other and with resident elephants at the release site. We demonstrate how this approach supports translocation monitoring by capturing temporal trends in social patterns within and between release cohorts and among released elephants and wild elephants already resident at the site during a transitional soft release period. Our results show that initial post-release social behavior of rehabilitated calves is related to histories of interaction with familiar individuals and cohort membership and that released calves increased their associations with residents over time. This information provides new behavioral insights for guiding elephant release projects, like the strength of relationships within and among release cohorts, the time to integration with the resident population, and the occurrence and increased incidence of societal fission–fusion. Further, this study provides an example of the utility of animal behavior research to achieve and assess progress towards conservation objectives, and to develop monitoring tools for conservation managers.

Morbidity and mortality of free-ranging American black bears (*Ursus americanus*) undergoig rehabilitation in eastern Tennessee, USA, 1996–2021

JD Sheldo, C Cordero-Aponte, V Reibel, CD Blair, X Zhu, R Gerhold, A Cushing, EC Ramsay, D Dodd, and M Dennis. *J Wildl Dis*, 2022; 58(3):575–83. https://doi.org/10.7589/jwd-d-21-00191

Free-ranging American black bears (*Ursus americanus*) often share habitat with humans and domestic animals, predisposing them to anthropogenic conflicts. Rehabilitation under professional care is a management option for orphaned, injured, and/or ill bears. Across several southeastern states, rescued bears are assessed and treated at the University of Tennessee and rehabilitated at Appalachian Bear Rescue (ABR). Records from 1996–2021 showed 337 bears (170 males, 166 females, 1 unknown) from nine states were admitted to ABR. Three bears were admitted twice, resulting in 340 admissions (42 neonates <3 mo old, 206 cubs 3–12 mo, 87 yearlings 1–2 yr, and 5 adults >2 yr). Bears presented as orphans (58%), malnourished (24%), injured or ill (12%), or confiscated/other (6%). Individuals were returned to the wild (85%); died or were euthanized (12%); or were placed into professional care (3%). Of released bears, 195 had complete medical records available for evaluation; 31% were healthy upon intake while the remaining were treated successfully for malnutrition and internal parasites (49%), orthopedic (9%) and soft tissue injuries (5%), or other diseases (5%). Causes of death determined during necropsies performed (n=30) were classified as trauma (50%), developmental (13%), undetermined (13%), malnutrition (13%), infectious or inflammatory (7%), and toxicosis (3%). Despite the lack of maternal care and high prevalence of malnutrition and trauma, most bears recovered to release with appropriate husbandry and medical care. This study provides a foundation for research to further improve care of rehabilitating black bears.



PHOTO © JITZE COUPERUS. CC BY-NC-ND 2.0 LICENSE.

American black bear (*Ursus americanus*).

To the rescue—Evaluating the social-ecological patterns for bird intakes

R Andrade, HL Bateman, KL Larson, C Herzog and JA Brown. *Urban Ecosystems*, 2022; 25:179–92. https://doi.org/10.1007/s11252-021-01135-1

Animals from urban areas are regularly brought into wildlife rehabilitation centers, providing untapped potential data records to inform management of wildlife species. Although rescues may be considered a wildlife stewardship behavior, not all 'rescues' may be warranted. Some animals are more likely to be brought into a rescue center than others, suggesting that human drivers underlying wildlife rehabilitation efforts are important to understand for urban conservation efforts. Literature has primarily focused on understanding the ecological drivers and implications of wildlife rescues.

Our study is the first to investigate both the social and ecological drivers of bird rescues using census, household survey, and intake data. In Phoenix metropolitan area, Arizona, USA in 2017–2018, we found doves and common species were sent to the center most often. Altricial species (helpless at hatching) and young birds were more likely to be brought to the center, perhaps due to perceptions of young animals as vulnerable. We found rescues came from neighborhoods with higher incomes and residents with pro-ecological worldviews, perhaps reflecting a perceived responsibility for wildlife. Conversely, few rescues came from neighborhoods with a high percentage of Hispanic/Latinx residents, who often feel more interdependent with nature. Neighborhoods with greater numbers of rescues were more likely to have residents participating in yard stewardship activities as compared to neighborhoods with fewer rescues. Our findings are relevant to understanding drivers of wildlife stewardship actions and for intake centers who wish to reduce the occurrence of people bringing in wildlife that do not need to be rescued. ■

TAIL ENDS



Harley, you *know* what it does to me when you look at me like that.

Western Grebes in mating dance.
(Aechmophorus occidentalis)

PHOTO © TEDDY LLOVET. CC BY-SA 2.0.

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.

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

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

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The blue-and-white swallow (*Pygochelidon cyanoleuca*), a Texas species and proposed addition to the MBTA list of protected birds.

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