

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:

Mitred conure (*Psittacara mitratus*). Native to Chile, Bolivia, Peru. Naturalized flocks are found in California, Florida, and Hawaii.

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ON THE COVER:

Chinese leopard cat (*Prionailurus bengalensis chinensis*), one of the 42 subspecies widely distributed throughout Southeast Asia.

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INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

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

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EDITORIAL

Human–Wildlife Coexistence

Human and wildlife interactions are never far from my mind. This year I've found myself considering our intricate relationships whether I'm perusing a local social media site or traveling to distant continents.

At home in Oregon, I've been watching the conversations on the social media platform NextDoor around black bears (*Ursus americanus*) in the Eugene South Hills. We've reached the time in the year where bears, recently out of hibernation, are looking to replenish calories, finding easy pickings in unsecured garbage cans. Fortunately, for each person who asks "I saw a black bear, who do I call?", there are fifteen people responding with helpful tricks to keep bears and humans safe without the need to call any external agency. I've been encouraged by this peer level human–wildlife interaction education.

In March, I was lucky enough to attend the first International Conference on Human–Wildlife Conflict and Coexistence. Human–wildlife interaction happens in all sorts of places and with all sorts of species, but some interactions seemed to get more attention than others at the conference, especially elephants and large cats. There is no doubt these high impact interactions need attention, but practitioners were keen to discuss wider-ranging interactions, from reptiles and small rodents to ungulates. It was obvious that we need to identify the role of conflict mitigation for species and communities of all sizes. Wildlife rehabilitators have a critical role in this discussion.

In a second big travel event this year I visited New Zealand, a place where human–wildlife interactions can be infamous. I found it disconcerting to be walking in the remote Fjordlands and encounter poison warning signs and bait stations for introduced possums, ferrets, and weasels. But just as condors seem to rebound in the southwest US when lead is limited, so in New Zealand do birds like takahē (*Porphyrio hochstetteri*) and hihi (*Notiomystis cincta*) thrive where cats, rats, and other predators have been excluded via physical or chemical means. It is quite something to visit a 500-acre (200-hectare) native species reserve completely enclosed with predator exclusion fencing and double door access.

Unfortunately, humans intentionally introduced most of these problem species, although some like rats and mice were unintentionally brought to the island, coming ashore via docked ships. Possums were brought from Australia for fur production, rabbits for food and "to remind British settlers of home," weasels and ferrets to predate the rabbits run amok, and so forth. Now citizens are trying to rectify the situation yet again.

We often see human–wildlife interactions as one-way events: cars injuring squirrels at a busy city intersection, elephants eating a human's corn field. But in reality these instances are part of a tangle of interactions stretching in time and space. So it is in New Zealand. As a short term tourist I see the poison warning signs, the campsites filled with rabbits, cats, ferrets, and mallards, and the well-guarded native species reserves. But the full story is only experienced by the humans and wildlife of New Zealand, both working to persist in their environment over the course of centuries.

Before we can make pronouncements, we need to understand that full story along with the conservation, welfare, and OneHealth implications of actions and inaction. Wildlife rehabilitators navigate the tricky patterns of human–wildlife conflict every day, weaving together the needs of the entire community with all the tools in their kits. The world owes wildlife rehabilitators a great deal of gratitude for this constant and often fruitful effort to improve the welfare of the wildlife and humans within our communities.

—Kai Williams
Executive Director

North Carolina Red Wolf Population Grows

EAST LAKE, NORTH CAROLINA, USA *(May 11, 2023)*—The Red Wolf Recovery Program this week announced the birth of a new litter of wild red wolf puppies, three females and two males. These pups, along with a cross-fostered male pup born at Point Defiance Zoo & Aquarium in Tacoma, Washington, will join the Milltail Pack in Alligator River National Wildlife Refuge in Eastern North Carolina. This will bring the pack number to 13 wolves; impressive growth considering the pack last year saw the first red wolf litter born in the wild since 2018.

"This is extraordinary news for red wolves in the wild. This family group is now a large, fully-functioning pack with these new pups and the yearlings," said Ben Prater, director of Defenders of Wildlife's Southeast Program. "We are so grateful for the FWS biologists that made this happen. We're hopeful this is a sign of things to come in the species recovery."

In addition to the Milltail family group, two 4-pup litters each reside in acclimation pens with their parents and will be released in the coming weeks. With these litters and additional releases of captive-bred wolves, the wild population could total 35–37 by the end of May. Thanks to Defenders' legal action that compelled the USFWS to release more red wolves into the wild, the wild population now stands to quadruple in just two years.



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Red wolf *(Canis rufus).*

Trialing Vaccine in Wild Koalas

NEW SOUTH WALES, AUSTRALIA *(May 16, 2023)*—A chlamydia vaccine developed in 2020 is now being trialed in wild koalas. The koalas are captured, vaccinated, held for observation, and then released back to their capture location with an identifying marker. Most chlamydia medicines do not work on koalas given their unique stomach enzymes, so progress with this vaccine is very exciting. According to the Associated Press, approximately 80% of koalas are likely infected with chlamydia.

Florida Wildlife Hospital Receives Help to Rebuild after Hurricane Ian

VENICE, FLORIDA, USA *(March 30, 2023)*—The Wildlife Center of Southwest Florida has been busy working to recuperate after Hurricane Ian. Executive Director Pamela DeFouw notes that fiscal and in-kind support from Florida Power & Light Company (FPL) provided much-needed aid. Senior Environmental Specialist Brian Fox worked to restore power and remained to volunteer further. A news release from FPL quotes Fox, "I knew from past experiences these facilities don't get as much attention after storms compared to other organizations or charities, so this became a personal concern of mine."

The article continues with DeFouw noting, "It was amazing the support we got to take care of the influx of animals," adding that her volunteers and staff are also appreciative. "It brought a lot of us closer together and really shows the strength of the center itself."

Eastern Washington Rehabilitators Call for More Volunteers

PULLMAN, WASHINGTON, USA *(May 2, 2023)*—Eastern Washington has seven permitted wildlife rehabilitators. The community needs more wildlife rehabilitators, transporters, and center volunteers. "We do what we can, but we don't have enough volunteers here or enough paid staff here to go out and collect wild animals," said Marcie Logsdon, a wildlife veterinarian at Washington State University. "We, for the most part, rely on the public

and good Samaritans to bring them to us." In an interview with radio station KUOW, she notes that the long distances between animals and rehabilitation centers in the large state exacerbate the challenges of supporting wildlife.

Fish and Wildlife agents are involving partners, such as skilled wildlife rehabilitators, that bring the possibility of rewilding or repatriation to the table. The conclusion to this case, and a similar earlier apprehension, will unfold over the next few years.

PHOTO © SOCALPARROT. USED WITH PERMISSION.



Amazon parrot (*Amazona*) in rehabilitation at SoCal Parrot Rescue, San Diego, CA.

Confiscated Parrots Hatched in Airport

MIAMI, FLORIDA, USA *(May 25, 2023)*—In Miami earlier this spring, a person was apprehended with 29 smuggled Amazon parrot eggs. They were discovered when the eggs started pipping in their carryon luggage while transiting the airport. The three hatchling red-lored and 21 yellow-naped Amazons were immediately taken to the Rare Species Conservatory Foundation where 24 have been successfully raised. USFWS was able to apprehend and prosecute the smuggler. The parrots will likely be moved to SoCal Parrot Rescue in southern California while long term plans for their welfare are explored.

HPAI Deaths in New England Seals

MEDFORD, MASSACHUSETTS, USA *(March 14, 2023)*—Over 330 New England harbor and gray seal deaths were associated with HPAI (Highly Pathogenic Avian Influenza) in the summer of 2022, according to Cummings School of Veterinary Medicine at Tufts research conducted in collaboration with the Tufts Wildlife Clinic and other area centers.

In a university press release, co-author Wendy Puryear notes, "We have a better resolution and greater depth of detail on this virus than before because we were able to sequence it and detect changes almost in real time. And we have pairings of samples, sometimes literally from a bird and a seal on the same beach."

The clinic has been conducting avian influenza surveillance on birds and some mammals since January 2022, shortly after this strain of avian influenza took a trans-Atlantic journey from Europe into the US. Through this testing, the team found a wide range of flu viruses, including at least three strains that crossed the Atlantic, and they witnessed consistent waves of infection in birds.

At the same time, in collaboration with NOAA's Greater Atlantic Region Marine Mammal Stranding Network, they were able to screen nearly all seals that came through the network, whether or not the animal appeared sick. The stranding network is composed of experts from state and federal wildlife and fisheries agencies, nonprofit rehabilitation and response facilities, aquariums, and academic institutions who respond to strandings.

"Because of the genetic data that we gathered, we were the first to see a strain of the virus that's unique to New England. The data set will allow us to more meaningfully address questions of which animals are passing the virus to which animals and how the virus is changing," said fellow co-author Kaitlin Sawatzki.

CITES Celebrates 50 Years

WASHINGTON DC, USA *(March 3, 2023)*—The Convention on International Trade in Endangered Species of Wild Fauna and Flora (or CITES) was opened to the world's governments for signature on 3 March, 1973 in Washington, DC, at the end of the Plenipotentiaries Conference hosted by the United States of America. This meeting became known as the "World Wildlife Conference."

Since then, it has grown in its membership from the original 10 Parties to 184. These Parties to the Convention continue to work to ensure that the world's animals and plants will not be driven to extinction by regulating international wildlife trade so

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Challenges faced in rehabilitating orphaned leopard cats (*Prionailurus bengalensis*) in Western Assam, India

Daoharu Baro,[1] Bhaskar Choudhury,[1] Aftab Ahmed,[1] Abhishek Narayanan,[1] Panjit Basumatary,[1] Nazrul Islam,[1] and Ashraf NVK[1]

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ABSTRACT:

The leopard cat (*Prionailurus bengalensis*) is one of the most widely distributed small cat species in the world. For the current study, 15 leopard cat kittens were hand raised between 2015 and 2021, and the challenges faced in rehabilitating the species were evaluated. During the hand-raising phase, 73% (11/15) of the leopard cat kittens survived, while four died. The average weight gain of the kittens was 10.5 (±1.05) g per day during the milk-dependent period and 14.7 (±1.24) g per day after the introduction of solid food. At the age of 6–7 mo, they were soft released at an appropriate site by first holding them in situ in an acclimatization cage for an average of 20 days. In the absence of radio transmitters, an attempt was made using camera traps to monitor the dependency of the released cats on the supplementary food being kept in the cage. However, no post-release photos of the cats were captured, as the cats did not come back to the cage and showed no fidelity, either to the acclimatization cage or to the food being provided. Post-release monitoring via radio or satellite telemetry would have provided information on the survival and spatial ecology of the individuals. For future studies, we recommend including this approach while hand-raising and releasing leopard cats back into the wild.

KEYWORDS: hand-raised, leopard cat, post-release monitoring, *Prionailurus bengalensis*, rehabilitation.

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Introduction

The leopard cat (*Prionailurus bengalensis*) is a widespread species found in most of the Indian subcontinent, Southeast Asia, China, the Korean Peninsula, and the Russian Far East.[1] In India, leopard cats are found in two distinct populations, one in the southern Western Ghats and the other in the Himalayas/Northeast India.[2] The small cat occurs in a broad spectrum of habitats, including tropical rainforests, shrub forests, open grasslands, and plantations.[1] Studies indicate that leopard cats can thrive on human-modified landscapes and have moderate dietary flexibility. Leopard cats mainly prey on murids (i.e., rodents) and other small mammals but can also take a variety of other prey like reptiles, amphibians, birds, and insects.[3] Their prey preference, like other carnivores, is thus dependent largely on prey availability and competition with sympatric

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FIGURE 1. Leopard cat kitten in rehabilitation.

predators.[4] While the trade for skin and bone, the pet trade, and retaliatory killing are threats to the species outside its range in India,[5] habitat fragmentation and, to an extent, hunting are also major threats to the populations in India. Though not as adapted as the jungle cat (*Felis chaus),* leopard cats are also known to use human-modified landscapes for their life sustenance activities, including breeding and reproduction.[6,7] These human-modified landscapes can provide two types of dens: natal dens, sites where altricial kittens are born and nurtured for 2–3 wk until they are mobile, and auxiliary dens, secondary sites where the young can safely be hidden, especially when the mother is away.[8] However, this adaptive strategy of the mother also puts the kittens in jeopardy of being located by humans, particularly when the mother leaves the den. Though small cats are known to reject their kittens during the neonatal period due to physical, biological, or physiological inabilities to successfully rear them,[9] the reason for the presentation of kittens at the rescue center is the unwanted intervention of misinformed villagers picking up the kittens.[10] In such cases, all attempts are made to reunite the kittens with the mother. When attempts at reunion fail, the kittens are either taken to lifetime care centers like zoos or inducted into a holistic rehabilitation program to pursue a return-to-the-wild option.

The International Fund for Animal Welfare (IFAW) and Wildlife Trust of India (WTI) operate a Mobile Veterinary Service (MVS) unit at the Bodoland Wildlife Transit Home, Charaikhola, Kokrajhar, Assam, India. The unit is a satellite station of the Centre for Wildlife Rehabilitation and Conservation (CWRC), Kaziranga National Park, a joint facility established by IFAW and WTI in collaboration with the Assam Forest Department. The CWRC and its allied MVS units, like the one at Kokrajhar, assist the forest department in responding to wildlife emergencies that include wildlife displacements of various kinds. The main focus of the mobile veterinary unit is to provide optimum veterinary care to the displaced animal, address its welfare needs, and eventually return it back to the wild using scientific methods.

Rescue history

Between January 2015 and May 2021, the MVS station handled 15 leopard cat kittens from various parts of Western Assam. Eight of these kittens were admitted as individuals (Fig. 1), while seven were presented in litters of two or three individuals. On arrival, they were checked for injury and other physiological parameters. Preliminary treatments for dehydration were provided, and the kittens were kept in a plastic basket in preparation for a possible reunion with the mother. In all the cases except one (where the mother was confirmed dead), the team attempted to reunite the kitten with the mother by placing the kitten at the site of rescue for 24 hr. If the mother is close, the cries of the kittens are enough to attract the mother back. Camera traps were set up to record the mother's return. Having failed to reunite, the kittens were hand-raised for release back to the wild. All the kittens were estimated to be older than 2 wk of age (eyes open, able to ambulate) except for two kittens less than 2 wk old (eyes closed).

Methods

The entire process of nursing, release, and post-release monitoring was conducted according to the guidelines outlined in the IFAW–WTI protocol on small carnivore rehabilitation.[11]

Housing

For about the first month post-admission, the kittens were held in a medium-sized cage (L 4 ft × H 3 ft × W 3 ft) to facilitate close observation and care. Due to their ease of cleaning and disposable nature, soft blankets were provided as a substrate inside the cage. The hollow of a tree trunk was placed inside the cage and used as a refuge den. The cage with all its furnishings was kept in a well-ventilated small animal nursery room. After a month, the kittens were shifted to the outdoor enclosure (L 22 ft × H 10 ft × W 11 ft) when they were estimated to be about 2–3 mo of age or weighed over 1 kg. This was designed to give sufficient space for mobility, overall bone and muscle development, and gradual reduction of human contact to avoid habituation.[12] Tree branches,

tree stalks, and a refuge den provided furnishings. The enclosure was situated at a remote location with minimal human exposure.

Feeding

The kittens were bottle-fed in the ventral position to avoid aspiration. A nursing kit meant for small animals was used. For the first 24 hr of admission, the kittens were fed fluids (Ringer's lactate mixed with 25% dextrose). The kittens were fed every 2–3 hr (around eight feedings/day), and the volume fed for the entire day equaled 12–18% of their body weight as per available literature.[9] Unavailability of a suitable commercial milk replacer was the biggest challenge for the authors in the rehabilitation of the rescued kittens. This lack of milk replacer in the local market made cow's milk the next best option. (However, with increased demand and supply in the growing pet market, commercial milk replacers are now being used for all newly rescued kittens.) Cow's milk was fed till the age of weaning (8 wk). The milk was first boiled, then cooled and fed when it was lukewarm (20–30°C). Bottles and nipples were thoroughly washed and sterilized before every feeding. To encourage defecation and urination, anal stimulation using wet cotton was done after every feeding.[13] Milk was slowly tapered off from bottle to pail while being supplemented with egg yolk for additional protein and fat; eventually, milk and supplements were replaced by solid foods completely. Visceral organs (liver), small bones, and large muscles of chicken, lamb, and pork were given for natural supplementation of essential nutrients. Meat was provided in a quantity limited to about 20% of the body weight once a day without following any definite time frame to prevent the development of food anticipatory behavior.

Behavioral enrichment

Once the kittens were weaned, live prey in the form of rodents and young chickens were provided to them twice a week to provide opportunities for honing their hunting skills. The cats, at the age of 3 mo onward, gradually learned to stalk the prey animals swiftly, capture and kill them, and skin and devour them. By this time, human contact was completely removed, and only remote feeding was done. A remote camera was placed to record the hunting behavior. The animals were considered to be fit for release into the wild only after they learned to skillfully hunt the given prey. Kittens of similar age groups were kept together in the same enclosure to avoid boredom and encourage social learning. Though the kittens were initially reluctant to interact with each other, they soon started to use the same refuge den after spending around a week of time together.

Veterinary care

Upon admission, an oral electrolyte solution (FDC Ltd., India) was offered for mild to moderately dehydrated kittens, and a Ringer's lactate solution (Parenteral Pvt. Ltd., India) was given intravenously in severe cases. Constipation is a common digestive problem during hand rearing with the new milk formula/diet.[14,15] Digestive stimulants, Digyton drops (Himalaya, India) at 4–5 drops, twice a day after food, were given orally to prevent flatulence. Periodical deworming was done with Albendazole at 10 mg/kg body weight or a combination of Praziquantel and Fenbendazole tablets given orally following stool examination. Extra vitamins and supplements (Ostopet, Virbac, India, and Zipvit, Intas, India) were prescribed for the kittens to prevent vitamin deficiency and ensure proper bone health and growth. Kittens were vaccinated with a modified live vaccine, Feligen® CRP (Virbac, India), to protect against the diseases caused by feline calicivirus, feline viral rhinotracheitis, and panleukopenia virus. They received their first dose at an age of around 8–10 wk and a booster dose at 4–5 mo of age. A complete

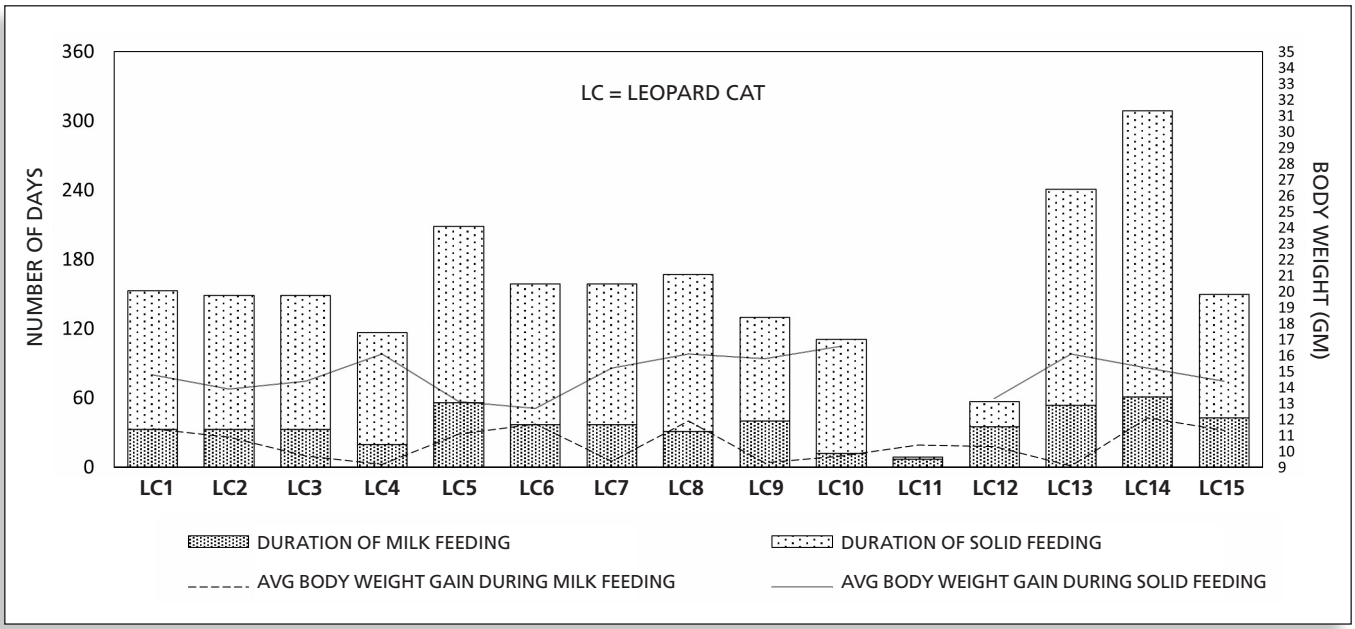


FIGURE 2: Duration of milk and solid feeding versus bodyweight gain of leopard cats.

blood count and serum chemistry were examined for each individual before releasing them back into the wild.

Acclimatization and release

A suitable release site was selected after careful consideration of habitat suitability, threats, availability of prey, and proximity to the original capture/rescue site. All the cats above 5 mo of age, weighing close to 2 kg and above, were taken to the release site for acclimatization through temporary accommodation. In situ acclimatization is essential to develop the released individual's fidelity/philopatry to the release site and consequently prevent or minimize sudden post-release dispersal. A soft release by in situ acclimatization also helps in the gradual familiarization of the released individuals to the release site and the reduction of dependence on humans. At the release site, the cats were kept in a medium-sized welded mesh cage (L 4 ft × H 3 ft × W 3 ft) for varying periods (7–30 days) to become acclimatized to the wild environment. Daily they were given adequate water and food. Human exposure was kept to a minimum. After the acclimatization period was over, the door was kept open for the animals to move out into the wild. Supplementary food was continued in the cage for a week to support the cats till they could get established at the new site.

Post-release monitoring

In the absence of radio or GPS collars, post-release monitoring of the released cats was done using a series of camera traps set near the feeding area and probable trails. Camera traps were placed near the cage door as well as nearby trails to record the moving out and returning of the cat to the cage to see if they were still returning to the cage for food. Due to the lack of financial support, radio transmitters and other active transmission devices could not be used. All the animals were microchipped before release to verify the individual identity in times of opportunistic recapture or death. Secondary information also gathered were impression pads in the sand near the enclosure site.

Results

Seventy-three percent (11/15) of the leopard cats admitted for hand raising survived. One kitten died 9 days post-admission, due to poor body condition and health leading to secondary infections, and three kittens died 2 mo, 4 mo, and 5 mo post-admission, respectively. The cause of death for two cats was attributed to canine distemper virus (CDV), as ascertained by necropsy findings and a PCR test from brain, lung, and spleen samples. *Pasteurella* spp. were isolated from the lung samples of the fourth animal. The remaining 11 cats that survived were acclimatized and released. On average, the released kittens spent about 178 days (111–309 days) from admission to release. The average weight gain of the kittens was 10.5 (±1.05) g per day during the milk-dependent period and 14.7 (±1.24) g per day after the introduction of solid food (Fig. 2).

Upon release, the cats stayed inside the cage for a while even after the doors were left open, and gradually moved out to explore the nearby areas before taking off into the wild. None of the released cats were captured in the camera traps after the initial release implying that the cats did not return to the cage after release. The camera trap photos showed other animals such as mongooses and rodents feeding on the supplementary food inside the cage, but there were no indications of the cats' presence even after 15 days of the camera trap. No other evidence, including footprints, was recorded after release.

Challenges and Discussion

Limited literature is available on the milk composition of leopard cats or specific *Prionailurus* spp., but the literature available on a closely related species from the genus *Felis* indicates that cat milk is low in sugar content relative to fat and protein.[16,17,18] In contrast to cow's milk, a commercial kitten milk replacer is highly suggested for leopard cat kittens.

Mortality due to infectious disease is a concern during the nursing period. All the cats were vaccinated during the hand-raising phase for feline infectious diseases but not against CDV (canine distemper virus). Two leopard cats died of CDV. Canine distemper virus primarily affects canids and presents in the form of dysfunction of multiple systems, including the gastrointestinal, respiratory, immune response, and central nervous systems.[19] Many authors have documented clinical disease or seroprevalence of CDV in felids as well. At least in two (*Panthera* and *Lynx*) of the 42 extant felid species, distemper disease and associated mortality have been recorded.[19,20,21,22] Additionally, antibodies towards CDV (seroprevalence) have been detected in those species of wild felids including leopard cats (genus *Prionailurus*).[23,24,25] However, the death of two leopard cats in Assam due to CDV could be the first record of mortality in *Prionailurus* indicating the species' susceptibility to the virus in the wild. Vaccination is an option, but the availability of a feline-specific killed vaccine in the local market is limited. The present condition, using a modified live vaccine (MLV) to protect against feline calicivirus, viral rhinotracheitis, and panleukopenia virus, did not show any adverse reaction after administration. Use of Feligen® CRP vaccine in tigers and lions is also reportedly safe, with the exception of abortion in one lioness, potentially caused by the incorrect use of the feline panleukopenia virus modified live vaccine.[26] However, more elaborate research is needed on its use in the leopard cat. Following the use of an MLV in the kittens, two black-footed cat (*Felis nigripes*) kittens and their dam were found to have an outbreak of herpes and calicivirus.[27] Although unable to definitively prove that the disease observed in these cases was caused by the MLV, temporal and circumstantial evidence suggested that this was the case. Recombinant or killed vaccines could have been the safest choice for use in cats, but they are comparatively rarer in the market.

Successful learning of hunting skills is one of the indicators of fitness for release back to the wild. The success story of the hand-raised orphan cheetah (*Acinonyx jubatus*) was well-documented.[28]

The leopard cats were trained by being introduced to various dead and live prey animals, including poultry, rabbits, and wild prey before release, with minimal human exposure. All the cats in the present study were released in a protected area that already had an unknown population of leopard cats. There is no information available on the number of days or weeks they should be held and the size of the enclosure that should be used. In our case, the period of acclimatization for the leopard cats (7–30 days) might have been too short for the development of site fidelity as evident from the fact that none of the cats returned to the enclosure post-release. Moreover, a large enclosure encompassing the key microhabitat of the leopard cat in the wild for acclimatization would have not only provided ample opportunities for leopard cats to explore and hide, but also permitted holding them for a longer period.

It can be safely assumed that leopard cats survived for the initial few weeks post-release, as the team did not record or receive any report of any mortality of a leopard cat in the vicinity. In the absence of radio transmitters, camera traps were deployed near the enclosure to monitor the cats' presence post-release. The absence of camera trap photos only showed that the cats did not develop any site fidelity despite being kept in the cage at the same location for an average of 20 days. However, site fidelity was noticed in the reintroduced cheetah through a GPS collar in Liwonde National Park, Malawi.[29] It is not often feasible to cover all areas with camera traps, and thus, post-release monitoring with camera traps has its limitations. To record concrete evidence of the survival of such hand-raised felids in the forest, a radio telemetry or satellite approach would be more appropriate.

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Case study: Cross-fostering an endangered San Joaquin kit fox pup (*Vulpes macrotis mutica*) orphaned due to sarcoptic mange

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Introduction

The San Joaquin kit fox (*Vulpes macrotis mutica*) is a small canid endemic to the Central Valley of California, USA. It is a federally-listed endangered and state-listed threatened species primarily due to habitat loss and degradation as a result of anthropogenic development, thus concerted efforts are made to protect as many remaining individuals as possible.[1] San Joaquin kit foxes (hereafter, "kit foxes") are born altricial in January to March and depend on maternal care until they are fully weaned at around 8 wk.[2,3] Kit fox pups remain dependent on adult provisions until they are about 4 mo old when they are capable of hunting on their own and foraging for prey, which primarily includes rodents and insects.[4,5] Kit fox pups become fully independent and disperse from their natal range when they are about 5 mo old.[6] Dependent kit fox pups that do not have the care of an adult family member will likely perish without human intervention, which often involves raising them individually in captivity.[4] Raising wildlife in captivity may be less than ideal as facilities must have adequate space, proper permits,

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ABSTRACT: The San Joaquin kit fox (*Vulpes macrotis mutica*) is an endangered canid endemic to Central California, USA. San Joaquin kit foxes living in urban areas are susceptible to a fatal skin disease called sarcoptic mange. Advanced cases require hospitalization until the individuals recover and can be released. In spring 2022, a young San Joaquin kit fox pup was hospitalized for sarcoptic mange. The pup was determined to be orphaned and fated for a life in captivity due to his young age and lack of conspecific caretakers. Concurrently, a family group consisting of an adult female San Joaquin kit fox and three pups was also hospitalized for sarcoptic mange. Cross-fostering was successfully implemented in captivity by introducing the orphaned pup into the family group, and all were released together after recovery. Following releases, the orphan and his foster family appeared healthy and demonstrated natural behaviors, at least till the pups reached independence, implying successful cross-fostering and reintroduction. This case study constitutes the third instance of cross-fostering San Joaquin kit fox pups.

KEYWORDS: California, canids, captive rearing, husbandry, orphaned wildlife, sarcoptic mange, urban wildlife, veterinary medicine, wildlife conservation.

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and financial means to house animals, which is particularly involved for endangered species.[7,8] Rehabilitated wildlife also tends to have varying post-release survival rates between 11% and 53%.[7,8] Post-release survival rates for inexperienced orphans are likely lower due to the inopportunity to learn proper social skills from their family group, which could result in an increased risk of habituation to humans and inappropriate responses to conspecifics and predators.[9]

Cross-fostering is an option occasionally employed to rear orphaned young in the wild with unrelated conspecifics, which allows them to learn natural behaviors that increase their chances of survival and eventual reproduction.[10,11] Cross-fostering has proven successful in other canid species, including red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), and red wolves (*Canis rufus*).[11,12,13] Canids are generally behaviorally adaptable, and females of many species will allonurse or even adopt young of related or unrelated individuals of the same social group to assist kin, spread energetic costs of rearing across more individuals, and maximize survivorship of young.[2,7,14,15,16] In kit foxes, related adult females have been documented allonursing and co-rearing pups in the same den.[16,17] Additionally, young female kit foxes that have not dispersed from their natal range have been known to adopt and raise the subsequent litter after the mother died.[18]

Two successful instances of kit fox pup reintegration and cross-fostering from a single litter are described in Cypher et al.[7] In this case, six pups whose mother had died when they were 3 wk old were captured and reared together in captivity until they were 10 wk old. Four of these pups were successfully released into a den with the biological father and an unrelated female, and the remaining two pups were integrated into an unrelated family group that consisted of a mated pair with their two pups of similar age. The survival rate for all six pups was higher than the estimated survival rate for wild kit fox pups raised normally, and the orphaned pups demonstrated natural behaviors, including the ability to find food and shelter. Here we present the third documented attempt at cross-fostering kit foxes in Bakersfield, California.

Background

The city of Bakersfield is located in the southeastern San Joaquin Valley of Central California. Bakersfield is a heavily developed city with a population of nearly 380,000 people and is surrounded primarily by agriculture, with natural habitat including saltbush scrub (*Atriplex* spp.), grassland, and riparian areas on 25–30% of its boundary.[19] Bakersfield has historically supported a stable population of kit foxes that have been studied extensively for their value as successful urban-adapted yet endangered canids. Urban kit foxes occur in higher densities than non-urban kit foxes and are observed in many urban land uses, though they prefer undeveloped lots or open, landscaped lots such as school campuses; and dens may be constructed in culverts, pipes, rubble piles, or under infrastructure.[10,19,20] Many Bakersfield residents who observe kit foxes have a greater knowledge and appreciation for them and express support for their conservation.[21]

Since 2013 the Bakersfield kit fox population has been severely afflicted by sarcoptic mange, a skin disease caused by an infestation of the parasitic mite *Sarcoptes scabiei,* which is fatal for kit foxes.[22,23] Since the start of the sarcoptic mange epizootic, kit fox abundance in Bakersfield has declined by nearly 70%.[24] Transmission occurs via direct contact with infectious mites on another fox or possibly by environmental transmission in dens.[15,25] Affected kit foxes exhibit degradation of the epidermis as mites burrow into the skin, causing pruritus, dermatitis, erythema, lichenification, crusting, darkened skin, alopecia, and eventual death unless medical intervention is provided.[22] Affected kit foxes may also present with lethargy and emaciation, often appearing outside of dens during daylight in exposed locations, and may not respond to human presence.[22] A majority of sarcoptic mange cases in kit foxes are reported by concerned members of the public, allowing affected individuals a chance at treatment. A single dose of the topical acaricide selamectin (Revolution®, Zoetis, Florham Park, NJ, USA) can effectively treat mild infestations (i.e., initial infection where <25% of an individual's body demonstrates hair loss and crusted skin) and provide protection from infestation for up to 28 days, and an acaricidal flumethrin collar (Seresto®, Bayer, Shawnee Mission, KS, USA) can provide protection for up to 5 mo for individuals of appropriate body condition to wear a collar.[22,26,27] If a kit fox exhibits moderate to severe signs of sarcoptic mange (i.e., hair loss and crusted skin over >25–50% of its body, emaciation, dehydration, lethargy, open wounds), it is transported to the California Living Museum Zoo wildlife rehabilitation center (CALM). At CALM, kit foxes receive extensive treatment over the course of at least 4 wk, including multiple doses of selamectin, antibiotics for secondary infections, subcutaneous fluids to address dehydration, and any other necessary care.[22] Kit foxes are released at their original capture site once their appropriate treatment courses have been completed. All kit fox trapping, handling, and collaring procedures follow guidelines for the use of wild animals in research described by the American Society of Mammalogists and are conducted in accordance with conditions and protocols established in permits from the US Fish and Wildlife Service and Memoranda of Understanding from the California Department of Fish and Wildlife.[18]

A kit fox pup is orphaned due to sarcoptic mange.

On 12 April 2022, a concerned business manager at Bakersfield Renewable Fuels, a large industrial refinery, reported two distressed kit fox pups to the Endangered Species Recovery Program (ESRP). The pups were without an adult and approaching employees and heavy equipment during daylight hours. On the day of the initial report, we placed a trail camera (Black Flash digital cameras, Cuddeback, Green Bay, WI, USA) at either entrance of the suspected natal den that was within a 70 m culvert adjacent to a railroad. We baited one of the cameras with a punctured can of cat food and several drops of scent lure (Carman's Canine Call, Minnesota Trapline Products Inc., Pennock, MN, USA). We collected the cameras and reviewed the images the following

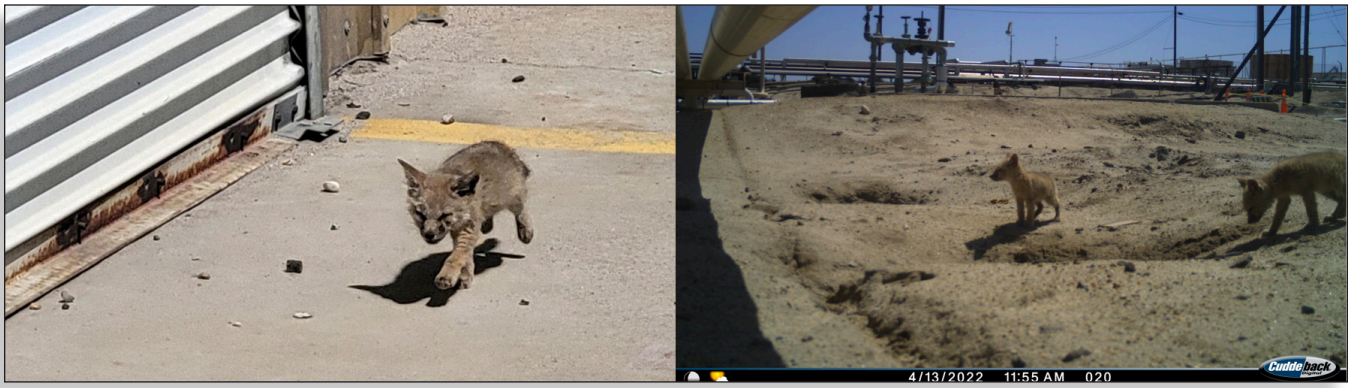


FIGURE 1. San Joaquin kit fox (*Vulpes macrotis mutica*) pups were observed with sarcoptic mange at a local business in Bakersfield, California, USA in April 2022. The left image was captured by the reporting party, and the right image was captured by a trail camera on 13 April 2022.

day along with images provided by the reporting party and determined the pups had advanced sarcoptic mange and that there was at least one adult kit fox in the area (Fig. 1). We left cameras in place to determine if any other kit foxes were visiting the natal den and placed live-traps (wire-mesh box, double-door collapsible traps, 25.4 x 25.4 x 121.9 cm, Tomahawk Live Trap, Hazelhurst, WI, USA) in the vicinity to be monitored during business hours. Traps were baited with a bowl of water and a mixture of wet cat food, hot dogs, and sardines and covered with canvas tarps for camouflage and protection. One of the pups was captured in a trap near the natal den the following morning and the other was observed drinking from a nearby water source and was opportunistically hand-captured. Both pups were immediately transported to CALM for assessment and medical treatment (Fig. 2). The pups were both males, estimated to be 4–6 wk old, and exhibited severe signs of sarcoptic mange with darkened skin, eyes crusted shut, lesions, and crusting on face and legs. They were also dehydrated, cold, and lethargic. Despite supportive care and initiation of medical treatment, one pup died in care overnight.

We left the traps open one additional night in an attempt to capture other kit foxes still in the area that might need treatment for sarcoptic mange, particularly an adult caretaker for the pups. While an adult male was captured with mild signs of sarcoptic mange, there was insufficient evidence demonstrating that he was the biological father, and the pups did not appear fully weaned. Thus, we treated him with selamectin, fitted him with a flumethrin collar, and released him at his capture location. We collected the two cameras left at the natal den six days after they were originally deployed. Apart from the sick pups, four other kit foxes appeared in images: the adult male we had previously captured, a second adult, and a pup with an adult that we presumed was its parent. This pup was captured in only one image and appeared slightly larger and in better physical condition than the sick pups, so we concluded that they were likely from a neighboring litter as this area supports multiple kit fox family groups. We then set additional traps for four days in attempts to capture these other individuals, although no additional kit foxes were captured. Two baited cameras were then deployed for an additional 11 days at the natal den following this trapping effort. Other baited cameras were deployed nearby on 5 May 2022 for five days in continuing attempts to capture images of kit foxes that could be siblings or part of the family group. Kit fox activity on cameras decreased over time, and no other sightings were reported. We attempted one final trapping effort for two days starting 5 May 2022 at a location nearby the natal den, though no kit foxes were captured. Therefore, we deduced that the two pups likely did not have a definitive conspecific caretaker, and their mother either abandoned them because they were sick, or had recently died from sarcoptic mange.



FIGURE 2. Two young kit fox pups with sarcoptic mange were captured on 14 April 2022.

The absence of a family group for the surviving pup had us

concerned for his post-release survival. While minimal human contact is routinely provided when kit foxes are in rehabilitation, due to his young age and poor condition this pup was hand-nursed for several days following admission into care. Caretakers also needed to ensure the pup was getting the proper nutrition, warmth, rehydration, and treatment needed to make a full recovery. Additionally, field cameras and other recent reports indicated that coyotes and bobcats (*Lynx rufus*), both of which are kit fox predators, frequented the area.[1] Because it seemed unlikely that this pup would be able to provision himself or avoid predators and other dangers on his own, the decision to place the pup into a permanent captive home was considered.

Another kit fox family is captured for sarcoptic mange treatment.

On 11 May 2022, four wk after the orphaned pup was captured, a concerned employee at Norris Elementary School reported a family of sick-looking kit foxes that consisted of an adult female and at least two pups. The school is in a quiet area of town surrounded by residential neighborhoods and is located 0.3 km from the urban edge of Bakersfield and about 8 km away from Bakersfield Renewable Fuels. The kit foxes were regularly observed on campus, particularly during and immediately after student mealtimes, and were known to be denning under a row of portable classrooms. The adult female had reportedly ventured into an occupied classroom before quickly running out, and this family of kit foxes did not seem to be afraid of humans. After reviewing photos taken by the reporting party, it was apparent that the adult kit fox had advanced sarcoptic mange and would need to be captured.

We surrounded the portable classrooms with traps, and two pups displaying early signs of sarcoptic mange were captured within one hr. The pups were estimated to be 12 wk old and presented with minimal flaking and crusted skin and they were transported to CALM. The traps were left open and monitored during the day to target the adult female and any additional pups, including one pup that was observed from a distance while processing the first two pups for transport to CALM. We set two unbaited cameras nearby to assist in the detection of additional littermates and adult family members.

The following morning a third pup was captured, exhibiting more severe signs of sarcoptic mange than the first two pups. This pup was also transported to CALM and united with its two presumed siblings following an examination and initial treatment. We rebaited traps with McDonald's fast food (hamburgers or chicken nuggets) in an attempt to entice the adult female to enter a trap; she was captured the following morning and transported to CALM. Anthropogenic food may be used as bait in the urban environment as a familiar food item for trap-shy animals where it is crucial we have the animal in hand.

Images from the cameras revealed no additional kit foxes had visited, so we collected the traps, though we left the cameras in place and added a scent lure to the ground below the cameras to attract any additional kit foxes that may be in the area. Cameras were deployed for an additional three nights with no other kit foxes observed, and no additional reports of sick kit foxes were made from the school or surrounding neighborhood. We felt confident that all kit foxes in the immediate vicinity had been captured, so we collected the cameras accordingly.

Upon examination at CALM, the adult female was emaciated, dehydrated, and had extensive hair loss and thickened, crusted skin over her entire body. She had enlarged mammae, so we concluded that she was the mother of the three captured pups and gave her the unique number identifier F7416. In efforts to reduce the stress of being held in captivity and ensure socialization continued with reduced attention on humans, the three pups and the adult female were housed together in the same enclosure while they underwent treatment. As soon as F7416 was reunited with the three pups at CALM, the pups immediately became vocal, and F7416 sniffed each one individually. Despite her poor physical condition, F7416 proceeded to feed each of the pups out of the bowl of meat product provided to them. These behaviors reinforced our decision to have placed all four individuals together during the course of their treatment despite F7416's guarded prognosis of survival.

The orphaned kit fox pup is introduced to the family group.

F7416 and her pups showed improving conditions after one wk of treatment, so a meeting was arranged with representatives at the California Department of Fish and Wildlife (CDFW) and CALM to discuss the possibility of integrating the orphaned pup into F7416's litter while in captivity. After careful consideration, it was unanimously decided the orphaned pup should be allowed an opportunity to live its life in the wild, especially since the orphan continued to display an aversion to human presence despite being in care for four wk.

On 31 May 2022, nearly 7 wk after the orphan was captured and 3 wk after the family group was captured, the orphan and the family group were moved into adjacent outdoor enclosures. The enclosures were separated by chicken wire fencing (1.27 × 7.62 cm), allowing for safe contact that would provide a minimal risk of injury. The outdoor enclosures had the added benefit of minimal human activity where both groups could experience natural sounds and weather, and engage in natural behaviors such as digging and running. CALM personnel directly observed the initial introductions so that staff could intervene and separate the kit foxes if introductions went poorly (e.g., the kit foxes appeared to be in extreme duress, acted aggressively, attempted to get away, cowered, or became injured).

Positive behaviors were displayed immediately by the orphaned pup including squealing vocalizations and repeated attempts to get closer to the other kit foxes. Positive behaviors were also exhibited by the family group including curiously watching the orphaned pup and attempting to engage in play through the fence (Fig. 3). The kit foxes were left in their respective enclosures overnight to further acclimate, observe, and interact with each other.

Given the positive behaviors observed in both groups, the orphaned pup was allowed supervised access into the adjacent pen with F7416 and her three pups the following day. The orphaned pup quickly approached F7416, and she displayed similar dominant behavior as she did with her pups that included a gaping mouth and slight growl, though she was mostly indifferent towards the orphaned pup.

Within the first day, the pups were all playing together. The orphan became more confident when approaching F7416 for direct contact and she accepted him as she did her own pups (Fig. 4). After their integration, all the kit foxes were fed together, and no negative behaviors were observed. Considering this a success, the orphaned pup was left with the F7416 and her pups continuously. The kit foxes were closely monitored for 1 wk following the introductions. During this time, all kit foxes continued to exhibit normal behaviors, with the only notable behavior being the orphaned pup seemed bolder and displayed more assertiveness towards food which may have been attributed to him being at CALM for the longest amount of time.



FIGURE 3. Kit fox F7416 and one of her pups investigating the fence line of the adjacent pen containing an unrelated orphaned San Joaquin kit fox pup at the California Living Museum in Bakersfield, CA, USA on 31 May 2022.



FIGURE 4. Kit fox F7416 and an orphaned pup that was cross-fostered into her litter nestled together at the California Living Museum in Bakersfield, CA, USA on 1 June 2022, while receiving treatment for sarcoptic mange.

The cross-fostered pup was released with the family group following recovery from sarcoptic mange.

On 8 June 2022, 8 wk after the orphaned pup was captured, we prepared all five kit foxes for release at the site of F7416's natal den at Norris Elementary School where the family group was captured 4 wk earlier. Each kit fox received a final dose of selamectin, and all four pups had hair and tissue samples taken for genetics, received ear tags with unique number identifiers, and were uniquely marked with black nontoxic dye (Nyanzol-D; Albinal Dyestuff, Inc., Jersey City, NJ USA) to identify individuals on camera or from a distance. We also fitted a VHF/GPS radio collar (Advanced Telemetry Systems, Isanti, MN, USA) with a flumethrin insert onto F7416 for telemetry tracking. We placed each kit fox in individual travel kennels for safety while being transported from CALM to the release site.

Releasing kit foxes near or after dark is preferable as they are nocturnal, and it helps to diminish disorientation after being held in captivity for a period of time. The foxes were scheduled to be released at sunset.[1]

We placed the kennels directly in front of the portable buildings under which the natal den was located. We opened the kennel holding F7416 first so that she might help orient the pups as they were released, and then simultaneously opened the doors to the other kennels shortly after. As the pups saw each other and F7416, they all rushed towards F7416 with their ears tucked back, bodies low to the ground, and tails wagging (Fig. 5). Despite his observed confidence in captivity, the orphaned pup, given unique number identifier M7470, was the most reluctant to leave the kennel and required the most encouragement, including tilting the kennel forward and gently tapping on the back. Once he saw the other kit foxes playfully running around the portables, he quickly joined



FIGURE 5. Adult female kit fox F7416 (far right, collared), one of her pups (far left), and an orphaned pup cross-fostered into her litter (center, lateral dye marking) were released on 8 June 2022 at the capture location of F7416 and her litter in Bakersfield, CA, USA, following their recovery from sarcoptic mange.



FIGURE 6. Cross-fostered kit fox pup M7470's last appearance on a trail camera on 13 July 2022 in Bakersfield, CA, USA.

them, though he was observed lingering outside the portables and sniffing the environment more so than the others, who had all eventually retreated under the portables. This was not unexpected behavior as the release site was a novel location for M7470.

Post-release monitoring

We tracked F7416 regularly and ran field cameras for a number of weeks following the release to monitor the family's survival and verify that M7470 had stayed with his foster family. We provided a total of 7.5 kg of dog kibble (Purina ONE SmartBlend Natural Dry Dog Food) over the course of six wk to assist F7416 in transitioning back to providing food for her pups, especially with the added burden of an additional pup. The family was provided food, and F7416 was tracked to underneath the portables or nearby on a biweekly basis until 28 June 2022, after which her collar signal was not heard again.

We placed two unbaited cameras on 24 June 2022 facing two entrances to underneath the portables that the kit foxes had been observed using. These cameras were deployed for one wk and regularly captured all five kit foxes. Kit fox activity was mostly limited to after dark, and both F7416 and two of the pups appeared with prey items or trash on at least one occasion. F7416 last appeared on camera on 29 June 2022. Another camera was placed on the more extensively used entrance under the portables on 8 July 2022 and was baited in hopes of locating F7416. The camera was deployed for 1 wk but captured significantly less kit fox activity though all four pups appeared on camera, as well as five raccoons (*Procyon lotor*) and two domestic cats (*Felis catus*).

During this time, we examined fresh kit fox scat at the site that contained numerous insect parts, indicating that the pups were at least successfully foraging for insect prey despite F7416's absence. M7470 last appeared on camera on 13 July 2022, about 5 wk after his release, and appeared healthy (Fig. 6). Additionally, two baited field cameras were placed in locations surrounding the school on 27 July 2022 for one wk, to further assess sarcoptic mange occurrence in the area, and two of F7416's biological pups were detected. Neither F7416 nor M7470 visited these cameras.

Discussion

There is considerable evidence for successful cross-fostering in canids and other species particularly when it occurs at a very early age, such as within 2 wk of birth.[9,11,28] As they become older, animal offspring become more recognizable to parents.[11] This may be due to developmental milestones that appear as juveniles age such as vocal cues and scent glands.[11] The ability to recognize kin and the motivation to persecute unfamiliar conspecifics influences the success of cross-fostering in species.[11,29] In this case study, the orphaned kit fox was nearly 11 wk old when he was accepted into the foster family. As compared to more social canids, kit foxes do not form hierarchical groups or partake in cooperative hunting, have low-to-no retention of adult offspring in the group, rarely interact with members of their group outside of breeding season, and exert dominance or territory maintenance mostly through indirect means such as scent marking as opposed to agonistic interactions.[17,30,31] This lack of intensive social hierarchy may have facilitated the acceptance of an older pup into the family group.

Despite the stress of being held in captivity and recovering from disease, the foster family and the orphaned pup readily accepted each other. The urban setting in which these kit foxes lived may have further contributed to the acceptance of an additional pup by the mother kit fox, who was also presumably a single parent at the time of her capture. Urban environments offer plentiful cover in the form of anthropogenic structures as well as consistent and abundant kit fox prey.[32] Kit foxes and other canid species may be more tolerant of additional group members if resources are abundant.[16,26,33,34,35] The natal den of the foster family was on an elementary school campus where maintained green spaces support abundant prey such as rodents and insects, and anthropogenic food and food waste are frequently dropped or left out. The campus also includes a large sports field, a water catchment basin, and portable units, all of which are favored micro-landscapes for denning and foraging by kit foxes in the urban environment.

Post-release monitoring showed that all kit foxes had stayed at the natal den at least through June, when kit fox pups typically

become independent of their parents. All of the kit foxes appeared healthy and were exhibiting normal behaviors that included capturing prey and limiting most activity to after dark. Because the elementary school is fenced in, the natal den was protected from high-speed vehicles, the number one cause of mortality for kit foxes in urban areas, and kit fox predators such as coyotes, bobcats, and free-ranging dogs (*Canis familiaris*) were mostly excluded.[19] Human activity after dark was also limited, allowing the kit foxes to engage in nightly activities without direct human interference. All pups further remained in the area at least through mid-July, which is the peak time of year for dispersal, despite the mother kit fox disappearing at the end of June. GPS data indicated F7416 was crossing a four-lane road and venturing into the urban fringe where predators such as coyotes and bobcats are more likely to reside.[19] F7416 presumably died as a result of predation since no kit fox remains were observed in the roadway after extensive searching throughout her home range. It is encouraging that M7470 was documented alive and healthy 5 wk after his initial release with the foster family, demonstrating he had accepted his foster family and natal range, and the family had accepted him at least through dispersal age.

A number of behavioral traits should encourage the survival and future reproductive success of the kit foxes involved in this cross-fostering event including behavioral plasticity, tolerating some human handling and presence, lack of intense social hierarchy, access to abundant resources, and innate and learned behaviors in the urban environment alongside conspecifics. This case study demonstrates that cross-fostering kit foxes has the potential to be a successful management tool for rescuing orphaned pups as well as in increasing population numbers or genetic diversity. Observations from this case study suggest kit foxes can be successfully cross-fostered at least until they are 3 mo old, and mother kit foxes can be accepting of additional pups even under stressful circumstances. Additionally, only minimal provisioning and monitoring following a cross-fostering and release event may be required as individuals readily demonstrate the ability to find resources and survive. This is ideal as the less interaction the foxes have with humans, the less likely they are to become habituated to human presence. Because this is only the third cross-fostering event attempted for San Joaquin kit foxes, further observations would allow for a more defined cross-fostering protocol for future incidences.

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that it is legal, sustainable, and traceable.

CITES Secretary-General Ivonne Higuero noted,

> We are at a crucial moment confronting a crisis of rapid biodiversity loss, changing climate and rising pollution on our planet. For the last half a decade, CITES Parties and stakeholders have been building partnerships to support the conservation of our wildlife. Those partnerships must be continued and strengthened to address our environmental challenges and allow us to achieve our shared vision to change our relationship with nature and not ask from it more than it can give us. Washington D.C. is the birthplace of CITES, and there is no more fitting place to renew our commitment and embark on the next 50 years of our work.

The official World Wildlife Day 2023 event in Washington, DC was co-organized between the United States Fish and Wildlife Service (USFWS) and CITES Secretariat, in partnership with the United Nations Development Programme (UNDP), the International Fund for Animal Welfare (IFAW), Jackson Wild, and the National Geographic Society. This unique partnership aims to define the issues that are facing our wildlife, and to encourage society at large to take part in a transformation towards a healthier planet for the benefit of all.

UNDP's new Nature Pledge reflects the organization's commitment to support some 140 countries in meeting ambitious targets under the new Global Biodiversity Framework. "We stand at a pivotal moment for people and planet," UNDP Administrator Achim Steiner said. "We can achieve the transformational change we need only through partnerships with governments, key partners like CITES, indigenous peoples and local communities, civil society, women and young people, and the private sector. At this global inflection point, partnerships can't settle for the ordinary."

A live event on March 3rd showcased partnership stories from around the world that made a difference for conservation, featuring stories from the Caribbean, Malaysia, Namibia, Nepal, Singapore, and the USA. It also explored how more funding could be attracted to wildlife conservation from private sources. Lisa Samford, Executive Director of Jackson Wild, notes, "Our aim is to inspire action necessary to protect and conserve wildlife, and these stories do exactly that."

500+ Bats Fly Free

OMAHA, NEBRASKA, USA *(May 8, 2023)*—Nebraska Wildlife Rehab receives hundreds of bats every winter, found hibernating in human dwellings. Like many wildlife centers, albeit usually in smaller numbers, the center cares for the bats over the winter and releases them in mid spring. The Nebraska center released their 2022/23 overwintered bats May 8th, the 14th year they've done a public bat release. The event was combined with educational activities regarding bats.

Wildlife Center Legacy of Mississippi Rehabilitator

COLDWATER, MISSISSIPPI, USA *(May 1, 2023)*—Mississippi Wildlife Rehabilitation is an ongoing legacy of Valery Smith. On April 23rd Valery Smith, 77, died from cancer, but the center she created in 1995 will continue to thrive. The DeSoto Times-Tribune reports that the Mississippi Wildlife Rehabilitation center was the first permitted avian center in Mississippi.

World Wildlife Fund Features Belize Center

BELIZE CITY, BELIZE *(May 17, 2023)*—A recent World Wildlife Fund story featured Belize wildlife rehabilitation center Wildtracks. The article focused on their manatee rehabilitation work, although the center also cares for primates.

Co-founder Zoe Walker discussed with the World Wildlife Fund the different players required for manatee success. "It takes a team of people across Belize, whether it's the Fisheries Department, whether it's the people who rescue the manatees or us doing the rehabilitation or the protected-area managers who are making sure the areas are safe for manatees."

In April, Wildtracks won the Belize Fund for a Sustainable Future grant to support their holistic manatee work that meets the grant's three objectives of strengthening management capacity, increasing knowledge and capacity for manatee rehabilitation, and ensuring that rescued manatees have a positive impact on the wild population.

Utah Wildlife Center Looks for New Home

OGDEN, UTAH, USA *(May 10, 2023)*—The Wildlife Rehabilitation Center of Northern Utah is looking for a new facility location. Their 13-year location on Ogden city land comes to an end this September. The center will need to temporarily close to new attendance as they prepare to vacate and continue their search for a new location.

Wildlife Rescue App Available in Eastern Australia

HOBART, TASMANIA, AUSTRALIA *(April 4, 2023)*—Residents in three eastern Australia states—Queensland, New South Wales, and Tasmania—now have access to a wildlife rescue app that connects finders with the nearest wildlife carer. The app was developed from a partnership between IFAW and the New South Wales Wildlife Council.

Albino Echidna Admitted to WIRES

NEW SOUTH WALES, AUSTRALIA *(May 11, 2023)*—An albino echidna presumably hit-by-car came into care at a WIRES facility in New South Wales in May. The small monotreme was released back to the wild after a few days of monitoring. A video of the release was posted on Facebook. This is the second albino echidna spotted this fall. ■

SELECTED ABSTRACTS

Molecular surveillance of potential SARS-CoV-2 reservoir hosts in wildlife rehabilitation centers

Mena J, Hidalgo C, Estay-Olea D, Sallaberry-Pincheira N, Bacigalupo A, Rubio AV, Peñaloza D, et al. *The Veterinary Quarterly* 2023:43(1):1–10. https://doi.org/10.1080/01652176.2023.2164909.

The COVID-19 pandemic, caused by SARS-CoV-2 infection, has become the most devastating zoonotic event in recent times, with negative impacts on both human and animal welfare as well as on the global economy. Although SARS-CoV-2 is considered a human virus, it likely emerged from animals, and it can infect both domestic and wild animals. This constitutes a risk for human and animal health including wildlife with evidence of SARS-CoV-2 horizontal transmission back and forth between humans and wild animals.

Using blood lead concentrations of wildlife sentinels to identify environmental risk factors of lead exposure for public health and wildlife rehabilitation efforts

Imagawa M, Rushing M, Carter A, Schott R, Berman JD. *Ecotoxicology* 2023;32:357–69. https://doi.org/10.1007/s10646-023-02642-x.

Lead poisoning remains a persistent health issue for both humans and wildlife, despite strides to reduce lead contamination in the environment. Using Geographic Information Systems (GIS), this study explores the associations between blood lead levels (BLLs) in wildlife sentinels and possible built environment lead exposure risk factors in the Minneapolis–Saint Paul, Minnesota urban area. Results show a high level of heterogeneity in animal BLLs (n = 472) across our urban environment and suggest that each kilometer increase in road density is associated with a 17.07% (95% CI: 1.48%, 35.05%) increase in BLL in our study species of Virginia opossums and eastern gray squirrels, and a 14.28% (95% CI: 1.16%, 29.09%) increase in BLL of rock pigeons. For squirrels and opossums, we see an additional 5.72% (95% CI: 0.59%, 10.85%) increased risk of BLL for every 1,000 people per square mile. The relationship between animal sentinels and environmental hazards can give us an insight into the potential lead exposure risks for humans. The use of wildlife sentinel data to explore environmental risk factors supports a One Health approach to better address public health questions and aid in wildlife rehabilitation related to residual lead poisoning from ambient environmental exposures.



PHOTO ©WRCM. CC BY 2.0 LICENSE.

Opossum (*Didelphis virginiana*) patients seen at the Wildlife Center of Minnesota, 80% come in having lead, with 50% having lead at a toxic level.

Two decades of wildlife rehabilitation in Greece: Major threats, admission trends and treatment outcomes from a prominent rehabilitation centre

Vezyrakis A, Bontzorlos V, Rallis G, Ganoti M. J Nat Conserv. 2023;73:126372. https://doi.org/10.1016/j.jnc.2023.126372.

The ultimate goal of wildlife rehabilitation centres is to release wild animals back into the wild, after providing care and treatment according to protocol. The data collected during the process, though, can be an invaluable resource of information, and act as a proxy of the anthropogenic impact on wild populations. They can even help to propose mitigation and conservation measures that could reduce pressure on wildlife. In the current study, we analysed the records of ANIMA, a prominent wildlife rehabilitation centre in Athens, Greece, over a 17-year study period. Using a database of 54,445 animals representing 353 species from 104 families, we draw connections between the magnitude of admission causes and their predicted outcomes based on the animals admitted. We found that while many animals that are admitted as orphans or after living in captivity have good chances of being released, that is not the case for victims of electrocution or domestic animal attacks. Illegal shooting is clearly present in our data and seems to also affect wild populations negatively. We highlight the importance of wildlife rehabilitation centres' data towards understanding and defining human impact on wildlife, the importance of communicating the results to policymakers for biodiversity conservation, and even proposing possible management directions. In that context, we also urge for more population monitoring field studies, so that admission data can be accurately

combined and make meaningful predictions for the status of wild populations.

Rapid consumption of kelp crab: implications for sea otters in Washington state

Johnson CJ, Hale JR, Tinker MT, Foster EU, Samhouri JF, Shelton AO, Laidre KL. *Northwestern Naturalist.* 2023;104(1):48–67. https://doi.org/10.1898/NWN20-07.

As animal populations approach environmental carrying capacity, competition for food increases, generally leading to decreased individual energy intake rate. Energy-intake rate can therefore be used as one metric of population status relative to carrying capacity. Focal observations of sea otter (*Enhydra lutris*) foraging behavior have been used throughout their range to estimate energy-intake rates and infer population status. In Washington state, previous research has demonstrated that handling times for kelp crabs (*Pugettia* spp.) by sea otters are 1.5 to 2 times faster than those observed in California and British Columbia, resulting in higher energy-intake rate estimates for sea otters in Washington. We investigated potential causes for the difference in handling time by: (1) comparing sea otter handling times of kelp crab and non-kelp crab prey items in Washington, California, and British Columbia; (2) comparing the handling times of kelp crabs by a subset of sea otters in California, which are kelp crab specialists (2003–2012, n = 244 kelp crab captures) to those of sea otters in Washington (2015–2018, n = 541 captures) and British Columbia (2013–2017, n = 359 captures); and (3) comparing the biomass-to-width ratios of kelp crabs from Washington and California. We did not observe consistent differences between regions in sea otter handling times of non-kelp crab prey. Mean sea otter handling time of small kelp crabs (carapace ≤1 sea otter paw width) in Washington (32.7 s) was significantly faster than in British Columbia (52.0 s, $P < 0.0001$) and all of California (40.6 s, $P < 0.0001$), but was not significantly different from that of kelp crab-specialist sea otters in California (31.7 s, $P = 0.313$). Mean sea otter handling time of large kelp crabs (≥1 sea otter paw) in Washington (64.7 s) was significantly faster than in British Columbia (87.7 s, $P= 0.003$), in all of California (104 s, $P < 0.0001$), and in the subset of kelp crab-specialist sea otters in California (91.6 s, $P = 0.007$). Kelp crabs in Washington had a larger biomass-to-width ratio than kelp crabs in California: in Washington, a kelp crab with a 20-mm maximum carapace width had a 3.8% greater predicted biomass than a kelp crab in California of the same width, and a 27.1% greater biomass for a 60-mm carapace. Our results suggest that sea otters in Washington are kelp crab specialists with behavioral differences allowing them to consume kelp crabs faster, a difference that may affect the inference of sea otter population status from energy-intake rates in Washington.

Epidemic versus endemic West Nile virus dead bird surveillance in California: changes in sensitivity and focus

Foss L, Feiszli T, Kramer VL, Reisen WK, Padgett K. *PLOS ONE*. 2023;18(4):e0284039. https://doi.org/10.1371/journal.pone.0284039.

Since 2003, the California West Nile virus (WNV) Dead Bird Surveillance Program (DBSP) has monitored publicly reported dead birds for WNV surveillance and response. In the current paper, we compared DBSP data from early epidemic years (2004–2006) with recent endemic years (2018–2020), with a focus on specimen collection criteria, county report incidence, bird species selection, WNV prevalence in dead birds, and utility of the DBSP as an early environmental indicator of WNV. Although fewer agencies collected dead birds in recent years, most vector control agencies with consistent WNV activity continued to use dead birds as a surveillance tool, with streamlined operations enhancing efficiency. The number of dead bird reports was approximately ten times greater during 2004–2006 compared to 2018–2020, with reports from the Central Valley and portions of Southern California decreasing substantially in recent years; reports from the San Francisco Bay area decreased less dramatically. Seven of ten counties with high numbers of dead bird reports were also high human WNV case burden areas. Dead corvid, sparrow, and quail reports decreased the most compared to other bird species reports. West Nile virus-positive dead birds were the most frequent first indicators of WNV activity by county in 2004–2006, followed by positive mosquitoes; in contrast, during 2018–2020 mosquitoes were the most frequent first indicators followed by dead birds, and initial environmental WNV detections occurred later in the season during 2018–2020. Evidence for WNV impacts on avian populations and susceptibility are discussed. Although patterns of dead bird reports and WNV prevalence in tested dead birds have changed, dead birds have endured as a useful element within our multi-faceted WNV surveillance program.

Wildlife emergency response services data provide insights into human and non-human threats to wildlife and the response to those threats

Camprasse E, Klapperstueck M, Cardilini A. *Diversity* 2023;15(5)683. https://doi.org/10.3390/d15050683.

Our transformation of global environments into human-dominated landscapes has important consequences for wildlife. Globally, wildlife is interacting with humans or impacted by human activities, which often results in negative outcomes such as population declines, disruption of social bonds, biodiversity loss, imperilment of threatened species, and harm to individual animals. Human and non-human threats to wildlife can be challenging to quantify and tend to be poorly understood especially over large spatial scales and in urban environments. The extent to which such damage is mitigated by reactive approaches (e.g., wildlife rescue) is also not well understood. We used data from the main state-based Wildlife Emergency Response Services (WERS) in Victoria, Australia to address these issues. The data, which describe tens of thousands of cases of threats to wildlife annually over a ten-year period, allowed a detailed

characterization of the type and extent of threats in the state. We identified the main common and threatened species impacted by various threats and showed that the vast majority of them were anthropogenic (e.g., vehicle collisions, cat attacks, and entanglements). The extent to which different taxonomic groups and species were impacted by various threats differed and threats were dependent on locations. The Greater Melbourne area was identified as a hotspot for threats to wildlife. The WERS was able to source service providers for thousands of animals annually, facilitating their assessment, release into the wild and rehabilitation. However, every year, thousands of animals died or were euthanized and thousands more were left unattended. WERS case reports are increasing and there is a growing service–demand gap. Whilst studies reporting on the demand and response of WERS are rare, situations in other parts of Australia and the world might be similar. This highlights the urgent need to understand and mitigate human and non-human threats to wildlife, particularly in urban environments, where the rate of biodiversity loss is high. We discuss opportunities and barriers to doing so.

Differences in mortality of pre-weaned and post-weaned juvenile European hedgehogs (*Erinaceus europaeus*) at wildlife rehabilitation centres in the Czech Republic

Kadlecova G, Rasmussen SL, Voslarova E, Vecerek V. *Animals*. 2023;13(3):337. https://doi.org/10.3390/ani13030337.

Previous research from several European countries has indicated that the European hedgehog (*Erinaceus europaeus*) is in decline. Wildlife rehabilitation centres contribute toward the protection of debilitated hedgehogs, including the young. Based on data from 27 wildlife rehabilitation centres, the mortality rate and the release rate of juvenile hedgehogs were evaluated depending on whether they were from normally timed litters (admitted from April to September) or from late litters (admitted from October to March). A total of 4388 juvenile European hedgehogs were admitted to wildlife rehabilitation centres in the Czech Republic from 2011 to 2020. The number of post-weaned young from late litters admitted (28%) did not differ from the number of pre-weaned young from late litters (29%). Where the outcome was known, young from late litters had the highest mortality rate (46%) in the year of admission. The release rate was the highest in post-weaned young from normally timed litters (86%). Further research should focus on the definition of optimal care and treatment of the underlying causes for admission of juvenile hedgehogs. The reproductive strategy (the timing of litters) of European hedgehogs under the climatic conditions of the Czech Republic affects the chance of survival of young at wildlife rehabilitation centres and likely also in the wild.

West Nile virus eco-epidemiology and climate change

Heidecke J, Schettini AL, Rocklöv J. *PLOS Climate*. 2023;2:e0000129. https://doi.org/10.1371/journal.pclm.0000129.

West Nile virus (WNV) is an arbovirus with a wide geographical distribution. It is maintained in an enzootic bird-mosquito cycle and exhibits regular zoonotic transmission to humans, to whom it can cause West Nile fever and neuroinvasive disease. Over the last decades, WNV has emerged as a serious health threat with profound impacts on animal and human health. It is broadly accepted that climate change impacts the transmission of WNV through multiple pathways via its impacts on vectors, the pathogen, hosts, and the environment. Although some clarity has been established, the outcomes of these climate-driven processes are yet to be better understood before they can fully benefit tailored prevention and control measures. This review focuses on the eco-epidemiology of WNV and how it is impacted by climate change through an integrative lens. We discuss the role of eco-epidemiological modeling in knowledge generation and highlight the importance of adopting an interdisciplinary and transdisciplinary One Health approach for improved surveillance, data collection, modeling, and translation of outcomes into actionable policy and control.

DNA metabarcoding-based evaluation of the diet of big brown bats (*Eptesicus fuscus*) in the mid-atlantic region

Deeley S, Kang L, Michalak P, Hallerman E, Ford WM. *Northeastern Naturalist*. 2023;29(4):454–73. https://doi.org/10.1656/045.029.0405.

High-throughput DNA sequencing can generate large genetic datasets in a cost-effective manner. Although the diet of *Eptesicus fuscus* (big brown bat) has been studied widely in natural and rural systems using visual identification of prey items in feces, our aim was to more completely assess diet using a metabarcoding approach across a wide urban–natural landscape gradient in the mid-Atlantic region. Concordant with our expectations and previous big brown bat diet studies from visual identification, we observed a high abundance of Coleoptera (beetles) relative to other insect orders. Although a possible improvement over visual techniques for studying food habits, we suggest caution in interpreting metabarcoding results in diet studies. We noted observations of environmental or contaminant taxa within these data, and designed a stringent filtering method that we used to eliminate these taxa, but that also removed previously documented prey taxa from our dataset.

Intralipid emulsion therapy for the treatment of suspected toxicity in 2 avian species

Schmidt LK, Keller KA, Tonozzi C, Brandão J, Christman J, Stern WA, et al. *J Avian Med Surg*. 2023;36:394–399. https://doi.org/10.1647/21-00057.

Intravenous lipid emulsion (ILE) therapy has shown promise as a treatment option for a variety of lipophilic toxins. Two birds presented for suspected ingestion of a toxic substance. A blue-and-gold macaw (*Ara ararauna*) presented after chewing a block of bromethalin rodenticide without overt clinical signs at the time of presentation. Additionally, a free-ranging bald eagle (*Haliaeetus leucocephalus*) was found weak

and depressed near a municipal landfill after presumptive ingestion of pentobarbital. Both birds were treated with ILE therapy for potential intoxication without any adverse events. The macaw was clinically normal after three days of hospitalization and at a one-week reevaluation. The eagle was transferred to a rehabilitation center after markedly improved mentation and strength and was released seven days later. Clinicians should consider ILE therapy for the treatment of lipophilic toxicities; however, monitoring is recommended for persistent lipemia and other adverse effects that have been reported in the veterinary literature.

Host, environment, and anthropogenic factors drive landscape dynamics of an environmentally transmitted pathogen: Sarcoptic mange in the bare-nosed wombat

Ringwaldt EM, Brook BW, Buettel JC, Cunningham CX, Fuller C, Gardiner R, Hamer R, Jones M, Martin AM, Carver S. *J Anim Ecol*. 2023;92(6):1–16. https://doi.org/10.1111/1365-2656.13960.



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Wombat (*Vombatus ursinus*) with sarcoptic mange.

Introduction: Understanding the spatial dynamics and drivers of wildlife pathogens is constrained by sampling logistics, with implications for advancing the field of landscape epidemiology and targeted allocation of management resources. However, visually apparent wildlife diseases, when combined with remote-surveillance and distribution modelling technologies, present an opportunity to overcome this landscape-scale problem.

Materials & Methods: Here, we investigated dynamics and drivers of landscape-scale wildlife disease, using clinical signs of sarcoptic mange (caused by *Sarcoptes scabiei*) in its bare-nosed wombat (BNW; *Vombatus ursinus*) host. We used 53,089 camera-trap observations from over 3261 locations across the 68,401 km^2 area of Tasmania, Australia, combined with landscape data and ensemble species distribution modelling (SDM). We investigated: (1) landscape variables predicted to drive habitat suitability of the host; (2) host and landscape variables associated with clinical signs of disease in the host; and (3) predicted locations and environmental conditions at greatest risk of disease occurrence, including some Bass Strait islands where BNW translocations are proposed.

Results: We showed that the Tasmanian landscape, and ecosystems therein, are nearly ubiquitously suited to BNWs. Only high mean annual precipitation reduced habitat suitability for the host. In contrast, clinical signs of sarcoptic mange disease in BNWs were widespread, but heterogeneously distributed across the landscape.

Discussion: Mange (which is environmentally transmitted in BNWs) was most likely to be observed in areas of increased host habitat suitability, lower annual precipitation, near sources of freshwater and where topographic roughness was minimal (e.g. human modified landscapes, such as farmland and intensive land-use areas, shrub and grass lands). Thus, a confluence of host, environmental and anthropogenic variables appear to influence the risk of environmental transmission of *S. scabiei*. We identified that the Bass Strait Islands are highly suitable for BNWs and predicted a mix of high and low suitability for the pathogen.

Conclusions: This study is the largest spatial assessment of sarcoptic mange in any host species, and advances understanding of the landscape epidemiology of environmentally transmitted *S. scabiei*. This research illustrates how host–pathogen co-suitability can be useful for allocating management resources in the landscape.

Osteology of the pelvic limb of nine-banded armadillo, *Dasypus novemcinctus linnaeus*, 1758 applied to radiographic interpretation

Machado FP, Dornelles JEF, Rausch S, Oliveira RJ, Portela PR, and Valente ALS. *Braz J Develop*. 2023;9(5):14686–709. https://doi.org/10.34117/bjdv9n5-013.

In South Brazil, where the Pampa biome is predominant, nine-banded armadillos are frequently found injured or even dead at margins of roads and highways, which has contributed to the increasing number of specimens in admission to wildlife rehabilitation centers. Osteological studies are limited and normal skeleton morphology information is need for radiographic recognition in wildlife medicine. The objective of this work was to present the morphology of the bones from the pelvic limbs of *Dasypus novemcinctus*, pointing out their topographical characterization and how they can be seen in radiographic images. Pelvic limbs of twelve dead nine-banded armadillo specimens from different age categories were used. The carcasses underwent radiological examinations using digital processing and practical plans for the clinical routine of small animals. From each radiographed individual osteological preparation was carried out using conventional anatomical techniques.

Photographic records of bones were made considering views of anatomical importance to the study. All bone components of the pelvic limbs showed characteristics favorable to the species' lifestyle and habits reinforcing evolutive morphoplasticity. Some bone injuries were unable to be clearly recorded through radiographic images because peculiar anatomical characteristics and limited mobility in some joints did not allow executing positioning as done in the dog or cat. Presence of a synsacrum, a great third trochanter, a well-structured leg with tibia and fibula similar in size and thickness, and the complex sesamoid elements on feet suggest the specialization in shifting body weight to the pelvic limb while using the forelimbs to dig. The study provided a radiographic protocol including suitable positioning from practical execution by wildlife veterinarians that work in rehabilitation centers.

Admittance to wildlife rehabilitation centres points to adverse effects of climate change on insectivorous bats

Salinas-Ramos VB, Tomassini A, Ferrari F, Boga R, and Russo D. *Biology*. 2023;12(4):543. https://doi.org/10.3390/biology12040543.

Climate change is exerting a broad range of (mostly adverse) effects on biodiversity and more are expected under future scenarios. Impacts on species that deliver key ecosystem services, such as bats, are especially concerning, so their better understanding is key to preventing or mitigating them. Due to their physiological requirements, bats are especially sensitive to environmental temperatures and water availability. Heatwave-related mortality has been reported for flying foxes and, more anecdotally, other bat species. For temperate regions, to date, no study has highlighted an association between temperature extremes and bat mortality, mostly due to the difficulty of relying on data series covering long timespans. Heatwaves may affect bats, causing thermal shock and acute dehydration so that bats may fall from the roost and, in some cases, are rescued by the public and brought to wildlife rehabilitation centres (WRCs). In our work, we considered a dataset spanning over 20 years of bat admittance to Italian WRCs, covering 5,842 bats, and hypothesized that in summer, the number of admitted bats will increase in hotter weeks and young bats will be more exposed to heat stress than adults. We confirmed our first hypothesis for both the overall sample and three out of five synurbic species for which data were available, whereas hot weeks affected both young and adults, pointing to an especially concerning effect on bat survival and reproduction. Although our study is correlative, the existence of a causative relationship between high temperatures and grounded bats is still the best explanation for the recorded patterns. We urge such a relationship to be explored via extensive monitoring of urban bat roosts to inform appropriate management of bat communities in such environments and preserve the precious ecosystem services such mammals provide, especially insectivory services.

Wildlife conservation and preserving biodiversity: impactful opportunities for veterinarians?

Cerda JR, Webb TL. *J Am Vet Med Assoc.* 2023;261(7):1–7. https://doi.org/10.2460/javma.23.02.0094.

The world is losing wildlife species at an unprecedented rate. Habitat destruction, overexploitation, and pollution are the leading causes of biodiversity decline. As a threat multiplier, climate change exacerbates these processes as demonstrated by the death of several billion wild animals in the last few years from wildfires, floods, heat waves, and other natural disasters. In the face of these challenges, veterinarians have unique and important skill sets to contribute to wildlife conservation and the preservation of biodiversity at many levels. Veterinarians can organize and train to mobilize wildlife extraction, rescue, and rehabilitation units during natural disasters as well as build relationships with rehabilitators to provide their services for general wildlife rehabilitation needs. They can work in transdisciplinary teams to provide veterinary expertise for ecosystem health and rewilding projects. They can become sustainability champions by providing pollinator and wildlife friendly habitats at their clinics and reducing clinic waste and energy consumption, and they can engage in science communication and advocacy. When provided with the necessary information, resources, and action items, veterinarians can increase their positive impact and personal well-being through purposeful, value-driven, community-building efforts to support wildlife conservation and biodiversity.

Morphologic and genetic analysis of *Synhimantus* (*Synhimantus laticeps*) from a long-eared owl (*Asio otus*)

Lopes C, Santos-Silva S, Nunes C, Mendes S, Costa C, Brazio E, Coutinho T, Rodrigues FT, Mesquita JR, Coelho AC. et al. *Pathogens*. 2023;12(5):717. https://doi.org/10.3390/pathogens12050717.

The long-eared owl (*Asio otus*) is a medium-sized owl species that is well-distributed in almost all of the territories in Portugal. Nematodes were found in the oral cavity of a long-eared owl (*A. otus*) admitted to CRASSA (Wildlife Rehabilitation Centre of Santo André). During a physical exam and stabilization of the bird, five nematodes were collected. The worms were examined and measured under light microscopy, and photos were taken. After a morphological analysis was conducted, all the nematodes (five females) were identified as *Synhimantus laticeps*. Two specimens were subjected to molecular analysis, which confirmed the result. This study provides a combined morphological and genetic approach to *S. laticeps*. To the authors' best knowledge, this is the first report including genetic sequencing of *S. laticeps* in a long-eared owl (*A. otus*) from Portugal. ■

TAIL ENDS



What, am I supposed to dance or something?

Crimson-backed sunbird
Leptocoma minima
IUCN Red List–Least Concern, Population Trend – Stable

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

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

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

Kieran Lindsey, Editor
jwr.editor@theiwrc.org

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

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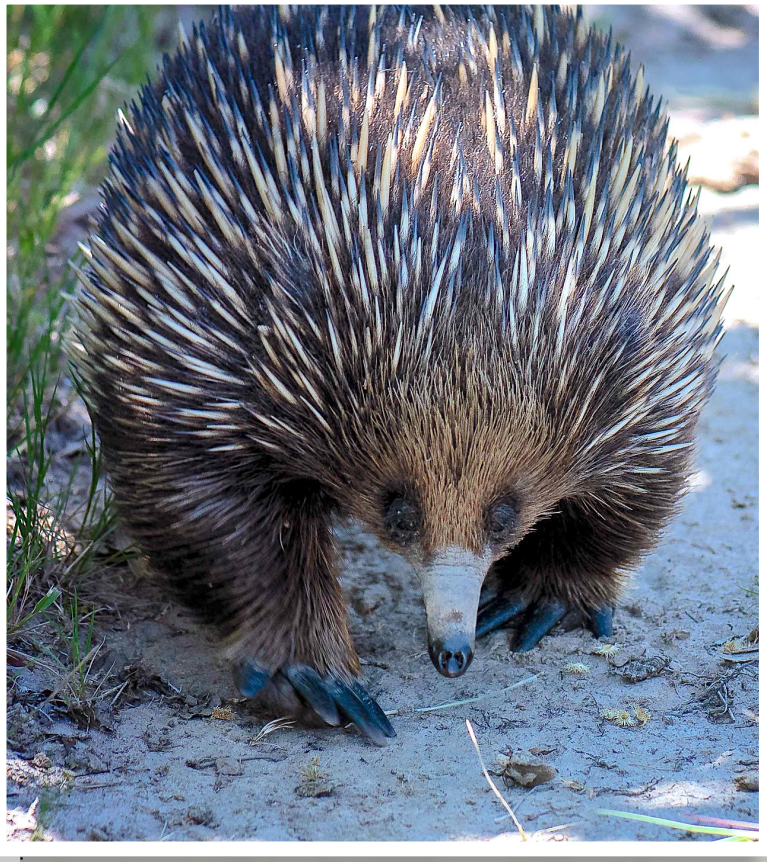


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Echidna (Tachyglossidae family).



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