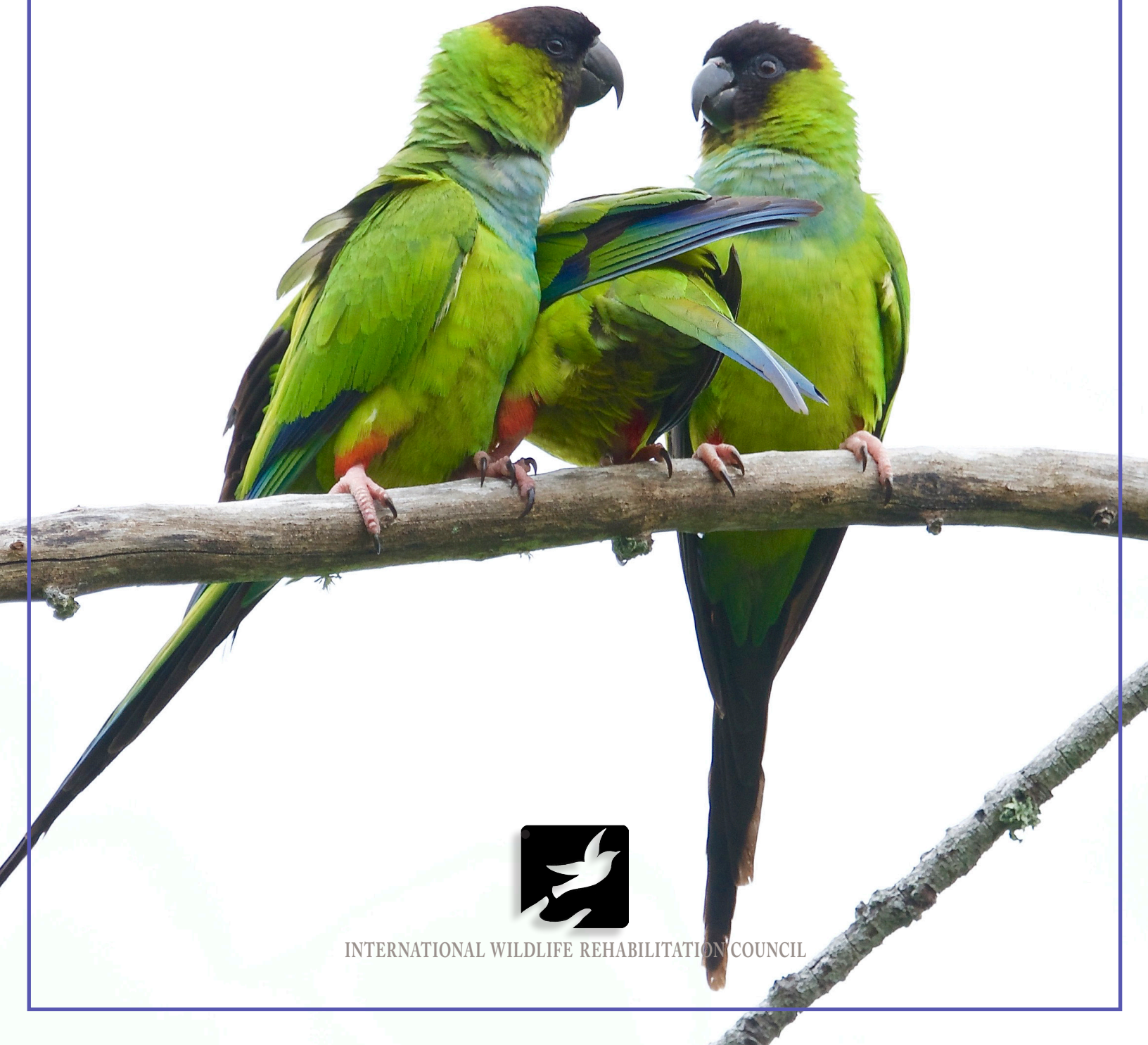
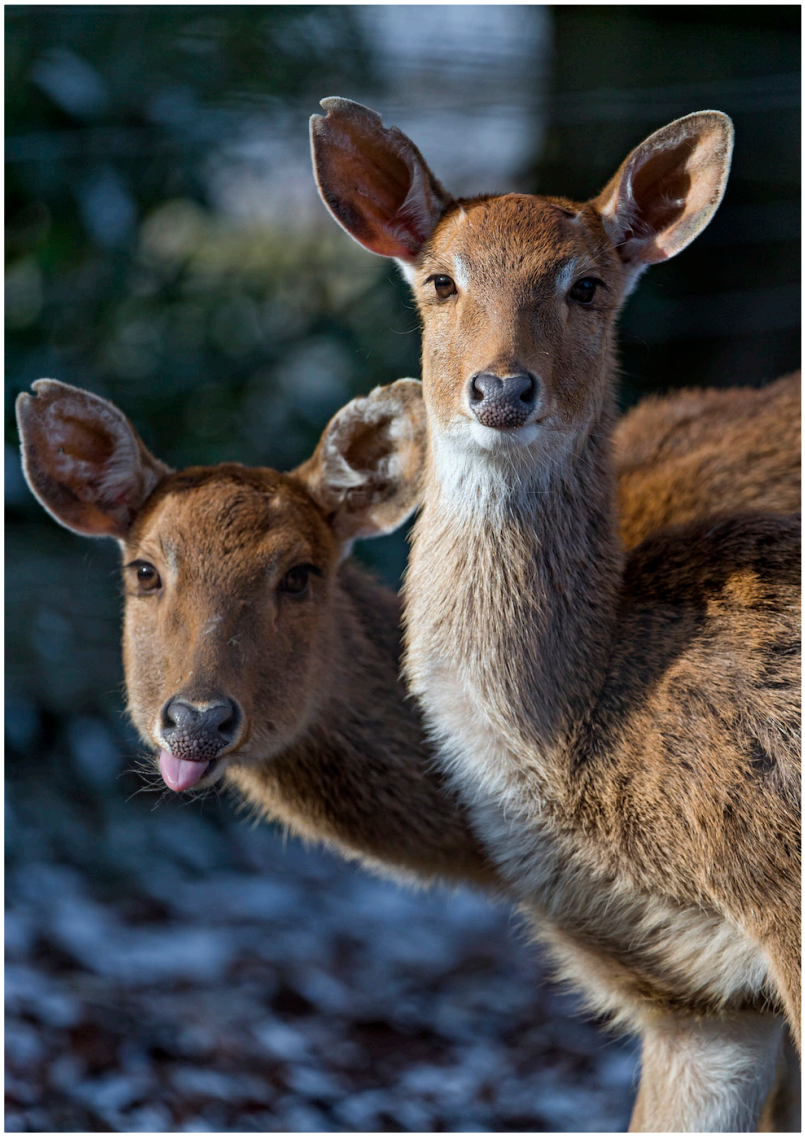
JOURNAL OF WILDLIFE REHABILITATION

Volume 41, Number 2, 2021



INTERNATIONAL WILDLIFE REHABILITATION COUNCIL

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



ON THE COVER:

Nanday parakeet trio (*Aratinga nenday*).
PHOTO ©OHFALCON72. CC BY-NC-SA 2.0.

LEFT:

Myanmar's endangered Eld's deer *(Rucervus eldii).* (See Ranger Awards, page 6).
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IWRC

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

Resilience

I am intrigued by organizational culture. Lately I have been mulling over how values and the resulting organizational culture affect employee resilience, both in and out of the workplace. The last year has required quite a lot of resilience from all of us. I believe that organizations that value trust and collaboration, and see employees as fully realized individuals—not just cogs in the workplace—have higher percentages of resilient employees. Not having the time to do original research in this area, I went to Google to see if this theory was supported by literature.

While I didn't find my exact hypothesis stated and tested, I found evidence that satiated my curiosity. Both scholarly and business articles suggested the culture/resilience relationship, although most focused directly on organizational rather than individual resilience. *Trust, collaboration, responsive, empowered,* and *safe* were all terms that I saw repeatedly in my cursory research. *Communication* was also front and center in the literature; this is certainly part of IWRC's culture.

The IWRC cultivates a culture of flexibility, teamwork, and balance—although thinking of our literature deadline marathons, we need continuous improvement on this last value. As an organization we have settled into this culture, at first by chance and intuition. However, over time and with reflection, we have begun to cultivate these values with strong intentionality, to the degree that it's part of the question set for potential new hires and is included in orientation briefings. It wasn't until this last year that I began to clearly see the link between our culture and our resilience. How were we able to navigate work and life challenges without entirely losing our way, individually or collectively? I believe that it is one part luck and three parts culture. We have been lucky to have a passionate, tenacious and flexible staff. At the same time, we have built a culture that promotes individual as well as organizational resilience by acknowledging that we are not superhumans, and provides us the space to recover and recharge. Our culture of trust and teamwork allowed staff to acknowledge our limits and facilitated responsibility shifts to allow healing. We have drawn heavily on this strategy of mutual support with the recent challenges, and rather than the marginally functioning org you might have expected to see in 2020, we've been able to meet those challenges head on and exceed expectations.

Our board member Jayanthi Kallam also embodies these values, and was able to build resiliency by buttressing her organization's employees during the pandemic. In fact, it was a recent conversation with her that sent me on this organization–culture thought path. Jay is Executive Director of the Avian and Reptile Rehabilitation Centre in Bengaluru, India. In Spring of 2021 India was hit exceptionally hard by COVID-19 at a time when things seemed to be shifting more positively in other countries. Jay saw it as her duty not only to ensure that her staff was healthy and able to work, but also that their families remained safe during this emergency. She sent out a clear message that the organization is committed to the safety of the staff and their families over and above any operational objectives for the duration of the pandemic. One of the outreach coordinators was reassigned to a new Employee Support Coordinator role with responsibility to provide support for employee's families, be it procuring medicines and in some cases meals, updating employees on the latest Covid-19 guidelines, scheduling vaccination appointments, or assisting in finding hospital beds. She reports that setting the safety of employees as the primary goal did not impact the operations of the organization but instead had the opposite effect of aligning all the employees towards the organization's mission. The staff bonded

CONTINUED NEXT PAGE

Wildlife Heroes Podcast Initiative

SYDNEY, AUSTRALIA *(May 12, 2021)*—Season 2 of the Wildlife Heroes podcast dropped this May. The Foundation for National Parks & Wildlife (FNPW) teamed up with environmental podcast maker and former ABC RN producer Gretchen Miller to create the Wildlife Heroes podcast, which launched in 2020.

Season 1 of Wildlife Heroes, Caring for Carers, started a mental health conversation to support our volunteers to look after themselves and each other. Throughout the season wildlife carers and mental health experts shared stories and perspectives about climate worry, personal well-being, community conflict, catastrophic events, and supporting others.

Season 2, One Animal at a Time, explores the tremendous role of wildlife rehabilitators in conservation, and why rescuing one animal at a time is important and valuable to the conservation of Australian species.

The podcast forms part of a broader mental health support program that FNPW is rolling out through its Wildlife Heroes project. It is funded through the Wildlife Rescue and Rehabilitation Initiative of the Australian Government, and the NSW Government through its Environmental Trust.

Intake Volumes Continue to Increase

CANADA AND USA *(May 2021)*—One year into the COVID-19 pandemic and wildlife rehabilitation intakes continue to increase across several localities.

Wildlife Rehabilitation and Release in Grass Valley, CA reported to The Union that they hit capacity this spring, but are triaging intakes per a cooperative arrangement with Gold Country Wildlife Rescue.

Le Nichoir in Quebec saw increases last year but 2021 is seeing increases above the already high numbers.

Last year, centers in Illinois, Virginia, and New Jersey also reported upticks in calls and admissions according to The Revelator. The Spokane Spokesman-Review reports that some wildlife centers in Washington saw a 25% increase in call volume. Aggregate data from WRMD shows US caseloads to have increased 5% in 2020.

New International Award Highlights Rangers

INTERNATIONAL *(April 7, 2021)*—The very first winners of the 2021 International Ranger Awards, presented by the International Union for Conservation of Nature (IUCN) and World Commission on Protected Areas (WCPA), were announced April 7 in a virtual ceremony. These new awards recognise individuals and ranger teams that have gone above-and-beyond the call of duty to protect wildlife and support local communities. The awards,

Editorial

CONTINUED

over the new safety initiatives, looking out for each other and extending the same care and compassion to each other as they would to the animals in their care. The collective focus on employee and family safety prevented compassion fatigue at an individual level, as everyone felt reassured that they were not alone. This reinforced their bonds, making the team stronger and empowering the organization to be more confident and resilient in the face of challenging situations. I predict that this work will not only protect these individual families, but create a stronger organization for years to come.

I tend to think of my human resource management decisions as being a very small part of my work at IWRC. But on reflection, seemingly small HR choices dictate organizational culture, and are foundations for mission success, stagnation, or failure.

—Kai Williams
Executive Director



The endangered Siamese crocodile *(Crocodylus siamensis Schneider 1801).*
PHOTO © CHRISTOPHE FRANCEY. CC BY-NC-ND 2.0 LICENSE.

established with the support of the International Ranger Federation, Conservation Allies, and Re:wild (formerly Global Wildlife Conservation), complement the existing and ongoing range of awards offered to rangers around the world.

"Rangers are at the very heart of conservation," said Kathy MacKinnon, chair of the IUCN World Commission on Protected Areas. "The stories of the winners of the new International Ranger Awards illustrate the scope and breadth of their work. Rangers protect wildlife and important natural habitats, they work with communities to address conflicts with wildlife and support conservation-based livelihoods, they collect scientific data, and serve as educators and communicators introducing young people and the broader public to the wonders of nature. Whether employed in a protected area or a community-managed reserve, rangers are critical to our global conservation efforts, helping to stem biodiversity loss and protect the important ecosystems that serve as natural solutions to climate change and other global challenges. WCPA is delighted to be a partner in delivering these new awards, which recognise their vital work."

This year's 10 winners included eight individual rangers and two ranger teams, selected from among 113 nominations from 43 countries. These nominations totalled 630 rangers: 68 individual nominations and 45 team nominations. All of the winners are rangers in protected and conserved areas and are residents of the countries in which they work. A further 19 rangers and teams have been recognised with special commendations.

The winners of the 2021 International Ranger Awards are:

- **Anety Milimo (Zambia)**: a research technician and field ranger in Mosi Oa Tunya National Park;
- **Aung Zaw Myint (Myanmar)**: a ranger in Chathin Wildlife Sanctuary in Myanmar;
- **Bénévoles au sein de l'Aire Protégée (Madagascar)**: a young volunteer ranger team protecting Menabe Antimena Protected Area from forest fires;
- **Chhay Reap Community Crocodile Wardens (Cambodia)**: a team of Indigenous rangers protecting critically endangered Siamese crocodiles in Southern Cardamoms National Park;
- **Giorgi Abramishvili (Georgia)**: a senior ranger in Batsara-Babaneuri Protected Areas;
- **Mahindra Giri (India)**: a range officer with the Uttarakhand Forest Department in Rajaji Tiger Reserve;
- **Ninfa Carianil (Colombia)**: a ranger in Águila Harpía ProAves Reserve in the Colombian Amazon;
- **Offossou d'Andous Kissi (Côte d'Ivoire)**: a ranger in charge of community outreach for the Comoé National Park;
- **Sathish Sundaram (India)**: a forest ranger with the Tamil Nadu Forest Department in Gulf of Mannar Marine National Park;
- **Sergey Erofeev (Russia)**: the deputy director of conservation in Altai State Biosphere Reserve.

Summary citations of the winners can be found on the Re:wild website.

The applications for the awards were reviewed by a panel of experts from IUCN-WCPA, the International Ranger Federation, Re:wild, and Conservation Allies. Each nominee was evaluated based on their commitment and dedication to a protected or conserved area; service to or by local communities when resolving threats affecting protected areas; valour in the face of overwhelming challenges or grave threats; impact of their contribution; and leadership to resolve extraordinary situations or crises.

Mike Appleton of Re:wild notes, "As well as recognising the winners and helping the places where they work, these awards will also help raise the profile of rangers as responsible, accountable professionals doing vital work on behalf of us all. We are delighted to announce that the launch of the next round of awards will be announced later this year."

Municipalities Update Regs to Allow Wildlife Rehabilitation

CANADA AND USA *(April 2021)*—This spring sees several municipalities looking to update ordinances to allow wildlife rehabilitation. Webster Groves, Missouri is looking to change legislation via City Council Bill 9149 in order to allow wildlife rehabilitation by legally permitted individuals. In April, Norfolk County, Ontario changed zoning regulations to allow site specific wildlife rehabilitation by permitted individuals.

Phasing Out Lead Ammunition in UK

LONDON *(March 23, 2021)*—The UK government is considering a ban on lead ammunition under a new chemical regulation system, UK REACH. The Environment Agency together with the Health and Safety Executive have started a two-year process to review the evidence, conduct a public consultation and propose options for restrictions.

UK Environment Minister Rebecca Pow notes that "addressing the impacts of lead ammunition will mark a significant step forward in helping to protect wildlife, people, and the environment."

Research by the Wildfowl and Wetlands Trust (WWT) shows that between 50,000 to 100,000 wildfowl die in the UK each year due ingesting lead from used pellets. Despite being highly toxic, wildfowl often mistake the pellets for food. A further 200,000 to 400,000 birds suffer welfare or health impacts, and animals that predate on wildfowl can also suffer.

WWT Ecosystems Health & Social Dimensions Manager Dr. Julia Newth states, "Conservationists, including WWT, shooting organisations and game meat retailers have recognised the toxic risks from lead ammunition to people and the environment. Regulation of its use in all shooting, wherever this may happen, is very much needed as soon as possible to protect human and animal health and to enable us to move towards a greener and safer future."

Lead ammunition can also find its way

CONTINUED ON PAGE 32

A comparison of two psittacine rehabilitation facilities and implications for conservation planning

Patricia J. Latas, DVM,[1] Nikki Buxton,[2] and Brooke Durham[3]



Red-lored parrot *(Amazona autumnalis).*
PHOTO © BELIZE BIRD RESCUE.

Introduction

In their native geographical ranges, psittacines are impacted by human incursion, habitat degradation, loss of native food and nesting, polluted water sources, poaching, hunting, and harassment and cruelty from the human population.[1] Consequences of human-associated captivity include malnutrition; cage injury; parasitic, fungal, bacterial, and viral amplification; and community-acquired infections.[2] Wild parrots in captivity also reflect the socio-economics of the human captors.[3-4] Wild urban parrots suffer stress from general urbanization but are protected from human and other animal depredations[5,6] and urban species have adapted completely to city life.[7-11] Urban psittacines rarely suffer from infectious disease, trafficking, harassment or socio-economic factors[12] but may have illness and injury reflecting urban hazards, such as window and vehicle collisions.[13]

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[1]Wild Parrot Coalition and SoCal Parrot, Tucson, AZ USA. [2]Belize Bird Rescue, Roaring Creek, Cayo District, Belmopan, Belize. [3]SoCal Parrot, Jamul, CA USA

ABSTRACT:
Parrots are charismatic members of any ecosystem in which they are found. Consequently, psittacines are presented to wildlife rehabilitators due to anthropogenic impact, natural disaster, and trafficking confiscation. Here we compare mortality, morbidity, disposition, and life history from psittacines admitted to two facilities: Belize Bird Rescue, a "soft release" rehabilitation facility returning native, captive and confiscated psittacines to the wild; and SoCal Parrot, a "hard release" facility limited to naturalized psittacines of southern California, USA, where all patients are wild and have been for many generations. We hypothesized that the two populations would differ, with wild natives being more biodiverse, healthier, and suffering less anthropogenic impact than naturalized urban psittacines; and that the reasons for admission, disposition, and survival to release would be more favorable to the native populations. We found, however, that urban birds are more diverse, healthier, and suffer less from negative human–wildlife interactions. We also found that "soft release" and prolonged care before and after resulted in high survival rates and successful releases. The findings may serve to guide for early decision-making in rehabilitation of wild psittacines, depending on type of population and release methods. We also suggest implications of wildlife rehabilitation of psittacines toward conservation of threatened and endangered species.

KEYWORDS: *Amazona, Aratinga,* Belize Bird Rescue, *Brotogeris,* confiscations, *Eupsittula,* ex-captives, parrots, *Pionus, Psittacara*, psittacines, SoCal Parrot, *Thectocercus.*

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In this comparative study, we examine two different psittacine populations: one from Belize Bird Rescue (BBR), a wildlife rehabilitation facility returning native wild, confiscated, or ex-captive psittacines to the wild; and SoCal Parrot (SCP), a wildlife rehabilitation facility limited to the naturalized psittacines of southern California, USA, where all patients are completely wild and have been for many generations. Our purpose was to understand the differences and similarities between native and naturalized parrots in rehabilitation, and here we compare admissions, mortality, morbidity, disposition, and life history data collected from each.

We suspected that there would be differences: hypothesizing that wild native psittacines would be more biodiverse, healthier, and suffering less anthropogenic impact than naturalized urban psittacines; that they would be more "wild" and less habituated to humans; and that the reasons for admission, disposition, and survival to release would be more favorable in the native populations. We were intrigued to find that native birds at BBR are less diverse, less healthy, and more habituated to humans, and yet likely to achieve favorable outcomes with successful release to the wild. Although admissions to rehabilitation are primarily due to direct anthropogenic impact on both, urban birds are more diverse, healthier, "wilder" and less accepting of human care, and suffer less from direct human–wildlife interactions of captivity. We also found that capability for "soft release" and prolonged care before and after release results in high survival rates and successful release.

We hope the findings will be useful as guidelines for early decision-making and care in the wildlife rehabilitation of wild psittacines and subsequent parsimonious allocation of resources, depending on the type of population and methods for release; and to practical application for conservation efforts.

Methods

The web-based database wrmd.org (https://www.wrmd.org/) was used to collect data from 2008–2020 for seven species of native psittacines at BBR (n = 824) and nine species of naturalized psittacines (n = 613) from SCP. A total of 16 species were examined: red-lored parrot *Amazona autumnalis* (RLPA); yellow-headed parrot *Amazona oratrix* (YHPA); white-fronted parrot *Amazona albifrons* (WFPA); red-crowned parrot *Amazona viridigenalis* (RCPA); lilac-crowned parrot *Amazona finschi* (LCPA); northern mealy parrot *Amazona farinosa* (MEPA); yellow-lored parrot *Amazona xantholora* (YLPA); white-crowned parrot *Pionus senilis* (WCPA); olive-throated parakeet *Eupsittula nana* (OTPA); red-masked parakeet *Psittacara erythrogenys* (RMPA); mitred parakeet *Psittacara mitrata* (MIPA); blue-crowned parakeet *Thectocercus acuticaudatus* (BCPA); nanday parakeet *Aratinga nenday* (NAPA); and *Brotogeris* spp. (BROT). Large-bodied species (*Amazona* spp.) and small-bodied species (the remainder) were included in this comparison because of interesting differences in presentation, care, prognosis and prediction of outcomes, and in the hope of establishing guidelines for the contrasting early decision-making differences for the large-bodied versus small-bodied birds.

Species

The species included in this comparison from each facility were selected based on several criteria. Birds selected from BBR were species native to Belize; birds from SCP were naturalized species, derived from wild-caught flocks documented for up to five decades in Southern California. SCP only admits wild psittacines for rehabilitation and release; the birds are not ex-captives or escaped pets. BBR and SCP shared two species in common (RLPA and YHPA). Large-bodied species (*Amazona* spp.) and small-bodied species (the remainder) were both included in this comparison because of interesting differences in presentation, care, prognosis, and prediction of outcomes.

Age distribution

To simplify varying criteria used by multiple individual caregivers to judge the age of admitted birds, age categories were divided into four groups: Obvious adults, Obvious nestlings, Juveniles, and Unknown.

Reasons for admissions

There were many reasons for admission. To compare them, categories were simplified with the knowledge that in doing so there would be overlap and possible loss of both precision and accuracy; yet the categories would still offer useful information. Individual medical records were scrutinized, and a subjective judgment rendered. Broad categories included: Unknown, Fledglings, Non-traumatic, and Traumatic. Healthy Fledglings were considered to be birds on the ground that were neither ill nor suffering trauma, and thus a natural fledging event. Trauma was defined as visual or palpable evidence of traumatic injury, imaging, post-mortem discovery, or veterinary records. Non-traumatic categorization was based on subjective entry of "sick" or "ill" or "ill thrift" etc. as entered into the admissions records or veterinary records.

Disposition

The wrmd.org database provides several categories for the final disposition of animals: Pending (including birds not ready for release at the time of writing and non-releasable residents and transfers); Released, where birds were released to the wild; Euthanized within the first 24 hr; DOA (dead on arrival); Died within the first 24 hr; Euthanized after the first 24 hr and in the course of rehabilitation; and Died after the first 24 hr during the rehabilitation process. Percentage of all birds surviving rehabilitation, total mortality (the percentage of birds that died overall), and the mortality not including the first 24 hours (which represents the mortality during rehabilitation) were calculated from the data.

Trauma by species and type of injury

Details of traumatic injuries impact early decision-making and resource allocation, and are therefore important to document and categorize. Traumatic injury was compared between species for each facility. Injuries were broadly grouped into subjective categories and/or etiologies knowing that overlap was likely in most cases.

Subjective judgment was used to decide which category fit best for each case when categorizing vehicle collision, other collisions (windows, walls, etc.), witnessed predator attack, projectile injury, or burns (chemical, electrical, and thermal). Fractures were further delineated by subjective grouping to anatomical regions of most obvious or most significant impact, which included: head injury, fractures of the upper extremity (wing), and fractures involving any part of the lower extremity (hips, legs, toes). Witnessed or documented traumas were grouped into Anthropogenic (collisions, vehicle collisions, projectile injuries) and Non-anthropogenic (predator attacks, falls from nest).

Parasites

Internal and external parasites were detected by methodologies including fecal floatation, fecal and oral direct smears, visual evaluation, and medical records, and included tapeworms, nematodes, bot flies, mites, and lice.

Body weight

Practicalities and expedience often precluded the ideal situation of recording body weights for individuals over the duration of captivity. Collecting the weight at intake, especially of wild adults, is important, as it may be the only sample available for a given individual. Initial weight and, where available, adult weight closest to release date, initial nestling weight, and juvenile weight at admission were recorded and grouped by species and age category.

Origins

Birds from BBR were divided into several broad categories: Ex-captive birds that were given up voluntarily; Confiscated poaching victims and at-risk chicks removed by authorities from exposed or known poaching nests; Known wild birds; and Unknown origin. Birds from SCP were 100% wild birds and grouped as: Non-injured fledgling; Obvious trauma; sick, ill, or other Non-traumatic admission; and Unknown, which included many birds transferred from shelters or other local animal facilities for which the original reason for admittance was not recorded.

Results

Species

Samples included 16 species of psittacines representing a wide geographic and taxonomic diversity. Birds from BBR were seven species native to Belize in three genera (*Amazona, Pionus, Eupsittula*); SCP birds included nine species from five genera (*Amazona, Psittacara, Thectocercus, Aratinga, Brotogeris*) of naturalized psittacines originally from Mexico and Central and South America. Red-lored parrots (RLPA, *Amazona autumnalis*) and yellow-headed parrots (YHPA, *Amazona oratrix*) were common to both facilities. Figure 1 shows simple pie charts representing the percentage of each species

TABLE 1. Number of admissions for each species, and the total admissions per year from 2008–2020.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Belize Bird Rescue (BBR)													
OTPA	2			2	4	9	8	8	13	7	13	10	7
WFPA	1	9	1	6	13	23	33	27	51	26	32	22	22
RLPA	3	9	10	10	7	32	36	19	23	15	29	20	21
YHPA			3	4	1	5	25	25	22	13	40	23	27
MEPA	1		1	1	1		3	5	1	1	1		
YLPA		4				2	1	4		1		1	1
WCPA		1		1		3		7	5	1	1	2	3
Total	**7**	**23**	**15**	**24**	**26**	**74**	**106**	**95**	**115**	**64**	**116**	**78**	**81**
SoCal Parrot													
RCPA							7		54	72	92	61	68
LCPA							1		11	10	17	7	9
RLPA							1		1	1	2	2	2
YHPA									1	2	2	1	1
RMPA							3		30	22	24	19	24
MIPA							1	1	4	5	13	12	12
NAPA									4	3			1
BCPA									1	2		4	
Brot									4		2		
Total							**13**	**1**	**110**	**117**	**152**	**106**	**117**

Abbreviation key: The following are used to denote the species described in all figures and tables: BBR: Belize Bird Rescue; SCP: SoCal Parrot; red-lored parrot *Amazona autumnalis* (RLPA); yellow-headed parrot *Amazona oratrix* (YHPA); white-fronted parrot *Amazona albifrons* (WFPA); red-crowned parrot *Amazona viridigenalis* (RCPA); lilac-crowned parrot *Amazona finschi* (LCPA); northern mealy parrot *Amazona farinosa* (MEPA); yellow-lored parrot *Amazona xantholora* (YLPA); white-crowned parrot *Pionus senilis* (WCPA); olive-throated parakeet *Eupsittula nana* (OTPA); red-masked parakeet *Psittacara erythrogenys* (RMPA); mitred parakeet *Psittacara mitrata* (MIPA); blue-crowned parakeet *Thectocercus acuticaudatus* (BCPA); nanday parakeet *Aratinga nenday* (NAPA); and *Brotogeris* spp. (BROT).

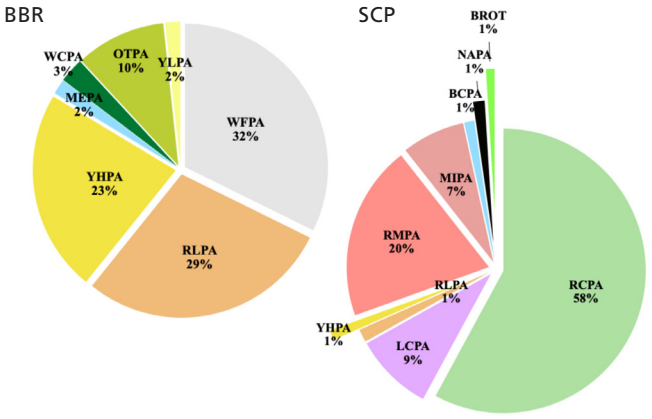


FIGURE 1. Percentage of total admissions represented by each species. The pie charts for Belize Bird Rescue (BBR) and SoCal Parrot (SCP) show the percentage of the total admissions for each species. White-fronted parrots (WFPA), red-lored parrots (RLPA) and yellow-headed parrots (YHPA) accounted for 84% of all admissions. At SCP, red-crowned parrots (RCPA) and red-masked parakeets (RMPA) were the most numerous with 78% of total admissions.

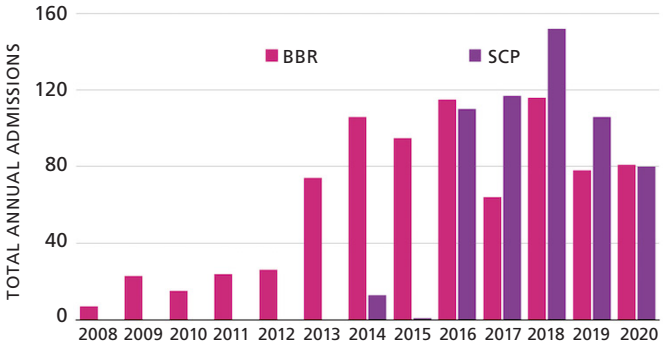


FIGURE 2. Total number of admissions over time. This bar chart compares the total number of birds in this study admitted annually. Records for BBR started in 2008, and SCP began in 2014. Belize began a campaign for licensure of native parrot species and increased awareness of the legalities of ownership in 2013, and the admissions grew accordingly. Major operations at SCP were begun in 2016, reflected by the influx of admissions starting in 2016. The large number of admissions in 2018 were due primarily to RCPA which apparently underwent a boom in population that year.

Abbreviation key: Red-lored parrot *Amazona autumnalis* (RLPA); yellow-headed parrot *Amazona oratrix* (YHPA); white-fronted parrot *Amazona albifrons* (WFPA); red-crowned parrot *Amazona viridigenalis* (RCPA); lilac-crowned parrot *Amazona finschi* (LCPA); northern mealy parrot *Amazona farinosa* (MEPA); yellow-lored parrot *Amazona xantholora* (YLPA); white-crowned parrot *Pionus senilis* (WCPA); olive-throated parakeet *Eupsittula nana* (OTPA); Red-masked parakeet *Psittacara erythrogenys* (RMPA); mitred parakeet *Psittacara mitrata* (MIPA); blue-crowned parakeet *Thectocercus acuticaudatus* (BCPA); Nanday parakeet *Aratinga nenday* (NAPA); and *Brotogeris* spp. (BROT).

admitted over the years for each facility. Figure 2 shows the total number of birds admitted over time for each facility. Records for BBR started in 2008, and for SCP began in 2014. Belize began a campaign for licensure of native parrot species and increased awareness of the legalities of ownership in 2013, and the admissions grew accordingly. Major operations at SCP were begun in 2016, reflected by the influx of admissions starting in 2016. The large number of admissions in 2018 was due primarily to RCPA chicks, which apparently underwent a boom in population that year. Table 1 shows the numbers of each species admitted over the years, as illustrated in Figure 3.

Age distribution

Despite admissions resulting from diverse situations, age distribution was considered valuable as a tool to understand breeding cycles and phenology, especially as these parameters are not well-known in most of the taxa included in this study. Age category data are shown in Table 2 for adults, juveniles, and nestlings in each species for both facilities, and illustrated as percentage of total admissions in the accompanying pie charts of Figure 3a. The expertise and experience of admitting personnel varied, and finer categories were lumped into less precise categories. The "unknown" category represents birds which were in transition from juvenile to adult but ascribed to neither, and are over-represented at BBR because of murky background, inadequate history, or misleading statements by owners relinquishing them. At BBR, OTPA, WFPA, and RLPA accounted for most of the juveniles; YHPA (n = 115) nestlings represented 52% of all nestlings due to active removal of at-risk chicks from vulnerable nests to be reared in the facility. Most adults were RLPA (49%, or 145 of 298). Juveniles were the most common recorded age group at SCP (n = 274) with RCPA the majority at 72% (197 of 274).

Reasons for admissions

As shown in Table 2, and illustrated in the pie charts of Figure 3b, most birds were admitted to BBR (86%) as non-traumatic, sick or ill confiscated, ex-captive, or at-risk nestlings. In contrast, at SCP 42% of admissions were traumatic injuries, 29% for uninjured, healthy fledglings, and 8% for non-traumatic admissions; of those, a total of 13 birds, or 2% of all admissions, were subjectively described as "ill."

Disposition

The disposition, or final outcomes, for BBR and SCP are included in Table 2. Pie charts in Figure 3c show 66% of birds from BBR were released to the wild compared to 49% released from SCP. SCP released 57% of the Amazon species and 23% of the parakeet species. BBR released 68% of the parrot-type species and 53% of the parakeets.

Examination of the historical records showed that SCP maintained a greater number of non-releasable birds in earlier years, but as release criteria were solidified (via improved decision-making as to early euthanasia), the number of Pending Dispositions declined.

The birds currently Pending include many birds from the early days. Pending includes both non-releasable birds and those still in rehabilitation at the time the data was summarized. SCP had higher percentages of euthanasia, DOA, and deaths in the first 24 hr and after, compared to BBR.

Overall, 65% of BBR and 49% of SCP were released by the end of 2020. Personal communication from both facilities speculate that 60% of birds from 2020 are currently in rehabilitation, which could raise the percentages of release to approximately 75% for BBR and nearly 60% for SCP.

Mortality and Survival

Mortality and survival data from Table 2 allow comparison of both facilities in Figure 4a for percent survival (the percentage of admissions that lived), percent total mortality (percentage of all admissions that died or were euthanized), and mortality following the first 24 hr (percentage of all admissions that died or were euthanized within the first 24 hr post-admission). In this way, the deaths occurring before rehabilitation had begun can be separated from those during rehabilitation. BBR had the highest survival rates overall, at 92%, and mortality following the first 24 hr at 6%. SCP survival was lower, at 78%, reflecting higher mortality in the first 24 hours (22%). After the first 24 hr, the percentage of mortalities at SCP occurring during rehabilitation dropped to 8%. More birds arriving at SCP than at BBR were in critical or moribund condition, and required immediate euthanasia or died in spite of treatment before true rehabilitation could begin.

Traumatic Injuries

Data in Table 3 show the total number of birds in each category for which different causes of trauma were known, for each facility. In Figure 4b, the etiology of traumatic injuries is compared by both total number and percentage of each type of the known causes of trauma. Only 24% (12 of 89) of trauma cases at BBR had a known cause, and most of those were ascribable to window collisions, followed by predation or vehicle collision. At SCP, 73 of 180 (41%) causes were known and included predation, projectile injury, burns, vehicle collisions, and miscellaneous collisions. SCP had about twice as many traumatic patients as BBR, at approximately 75% of the number of total admissions.

From medical records, we found that the body regions in which traumatic injuries occurred are predictive as to outcome. Birds with severe head trauma and receiving appropriate treatment often survived to release, but those with injuries to the wings (no matter how trivial) usually resulted in euthanasia due to unlikely chances of success in the wild. Records also showed that those with projectile injuries from Table 3 (12 of 17, or 71% fatal at SCP, 0% released; 33% were fatal at BBR) often failed to return to the wild.

Parasites

Data from Table 3 show the number of recorded incidents of parasites (external and internal) found on patients from BBR and SCP.

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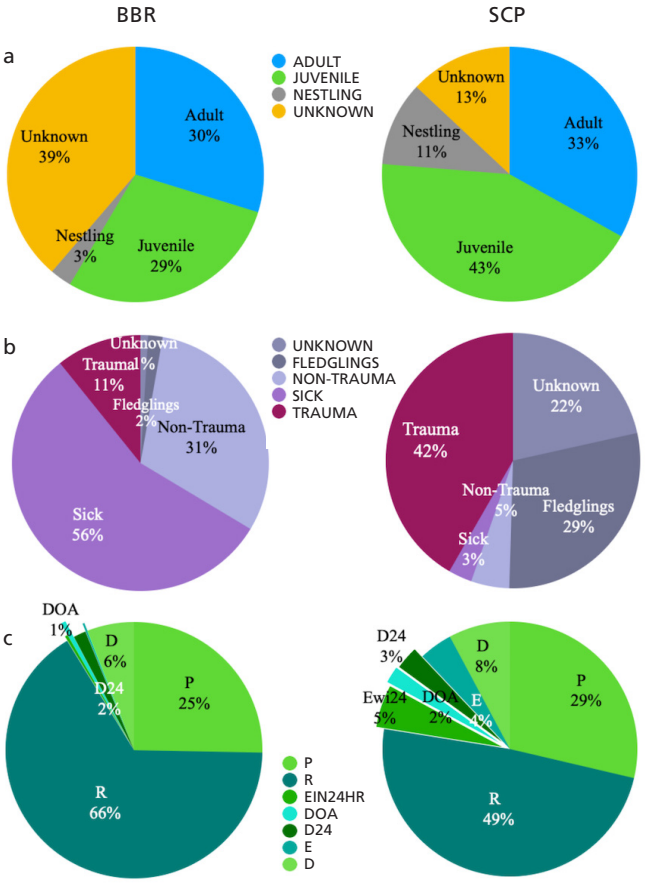


FIGURE 3. Age, reasons for admission, and disposition as percentage of total admission over all years.

Figure 3a. *Percentage of total admissions over all years for the age groups categorized as adults, juveniles, nestlings, and unknown.* At BBR, there are a large number of cases for which the age category was either not recorded or unknown; which usually included birds which were in transition from juvenile to adult but ascribed to neither.

Figure 3b*. Percentage of all admissions for non-traumatic reasons, traumatic injury, admission of healthy and uninjured fledglings; and unknown reason.* Non-traumatic or ill birds made up 87% of the admissions at BBR. Traumatic injury accounted for 42%, and healthy fledglings 29% of all admissions at SCP.

Figure 3C*. Disposition, or outcome, of birds.* Categories include: Pending (birds not ready for release at the time of this writing and non-releasable residents); Released; Euthanized in the first 24 hr; Dead-on-arrival; Died within the first 24 hr; Euthanized after the first 24 hr and in the course of rehabilitation; and Died after the first 24 hr.

Abbreviation key: n = total; A = obvious adult; J = obvious fledgling or flighted juvenile; N= unflighted nestling; U = unknown age; Unknown = reason for admission unknown or not recorded; Fledglings = healthy, non-injured in the process of fledging; NonTrauma = admitted without obvious physical signs of trauma and/or overt illness; Trauma = evidence of traumatic injury; P = pending, including not ready for release at time of this writing and non-releasable residents; Ein24 = euthanized within first 24 hr of admission; DOA = dead-on-arrival; D24 = Died during first 24 hr post-admission; E = Euthanized after first 24 hr; D = died after first 24 hr; Survive = percentage of all birds that lived; Mortality = percentage of all birds that died or were euthanized; after 24 hr = percentage of birds that died or were euthanized after 24 hr and during rehabilitation.

TABLE 2. Age, reason for admission, disposition, and survival and mortality data for each species.

		AGE DISTRIBUTION				REASON FOR ADMISSION						
	n	A	J	N	U	Unknown	Fledglings	NonTrauma	Trauma	P	R	Ein24
BBR												
OTPA	84	41	12	11	25	2	12	28	39	13	45	2
WFPA	266	93	58	1	57	3	0	245	24	61	186	1
RLPA	235	57	32	0	145	2	0	218	18	71	152	0
YHPA	188	13	115	5	53	0	0	181	5	55	123	0
MEPA	13	4	1	1	7	0	0	13	0	3	10	0
YLPA	14	6	3	0	4	1	3	9	1	2	10	0
WCPA	24	15	0	3	7	0	0	21	2	4	19	0
Total	**824**	**229**	**221**	**21**	**298**	**8**	**15**	**715**	**89**	**209**	**545**	**3**
SCP												
RCPA	355	88	201	26	40	53	76	13	53	72	209	21
LCPA	55	23	26	1	5	9	23	2	22	15	30	5
RLPA	9	4	4	0	1	1	2	0	6	7	2	0
YHPA	7	5	1	1	0	1	1	0	5	4	0	0
RMPA	122	56	28	22	14	20	12	12	62	44	42	3
MIPA	44	16	10	6	11	7	11	6	14	23	16	1
NAPA	8	15	15	15	15	1	0	0	7	5	0	1
BCPA	7	6	1	0	0	0	0	0	7	3	1	2
Brot	6	6	0	0	0	1	0	1	4	3	0	0
Total	**613**	**219**	**286**	**71**	**86**	**93**	**125**	**34**	**180**	**176**	**300**	**33**

Age categories were: Obvious adults, Obvious juveniles, Nestlings, and Unknown. Unknown included birds in transition from juvenile to adult but ascribed to neither. The expertise and experience of admitting personnel varied, and finer categories were lumped into less precise categories. Reasons for admission were grouped into Unknown; healthy, unharmed Fledglings; Non-traumatic reasons; and admissions due to Traumatic injury. Dispositions comprised Pending (including birds not ready for release at the time of this writing and non-releasable residents), Released, Euthanized in the first 24 hr, Dead-on-arrival, Died within the first 24 hr, Euthanized after the first 24 hr in the course of rehabilitation, and Died after the first 24 hr. The final columns show the percentage of birds that survived, total mortality, or the percentage of birds that died overall, and the mortality not including the first 24 hr (which represents the mortality during rehabilitation).

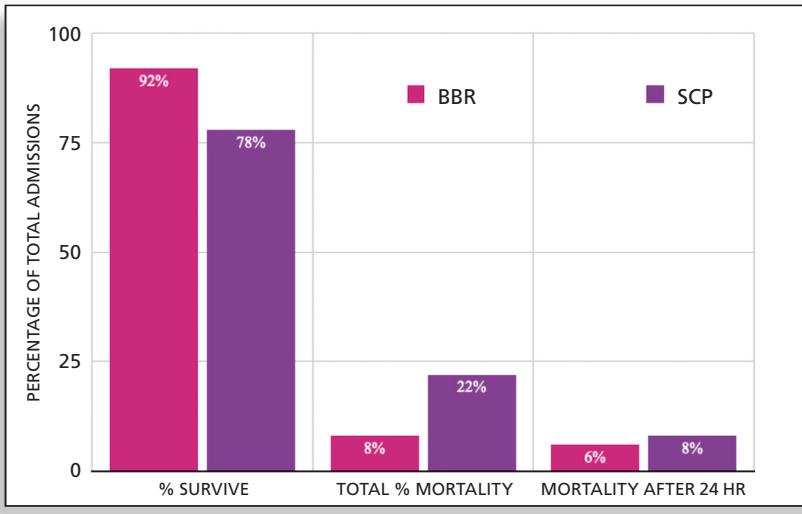


FIGURE 4. Mortality and survival after the first 24 hr post-admittance. Deaths occurring before rehabilitation has begun are separated from those during rehabilitation. The bars show that more birds arriving at SCP were in critical or moribund condition than at BBR, and required immediate euthanasia or died in spite of treatment before true rehabilitation began.

DISPOSITION				SURVIVAL AND MORTALITY		
DOA	D24	E	D	Survive	Mortality	After 24 h
4	5	2	14	70	30	20
1	5	0	12	93	7	7
0	1	0	11	95	5	5
0	1	0	9	95	5	5
0	0	0	0	100	0	0
0	1	0	1	86	14	7
0	0	0	2	96	4	8
5	**13**	**2**	**49**	**92**	**8**	**6**
2	9	16	26	79	21	12
0	1	1	3	82	18	7
0	0	0	0	100	0	0
0	0	0	3	57	43	43
9	4	8	12	70	30	16
1	2	0	1	87	13	2
0	1	1	1	63	37	3
0	1	0	0	57	43	0
1	0	0	2	50	50	33
13	**18**	**26**	**48**	**78**	**22**	**8**

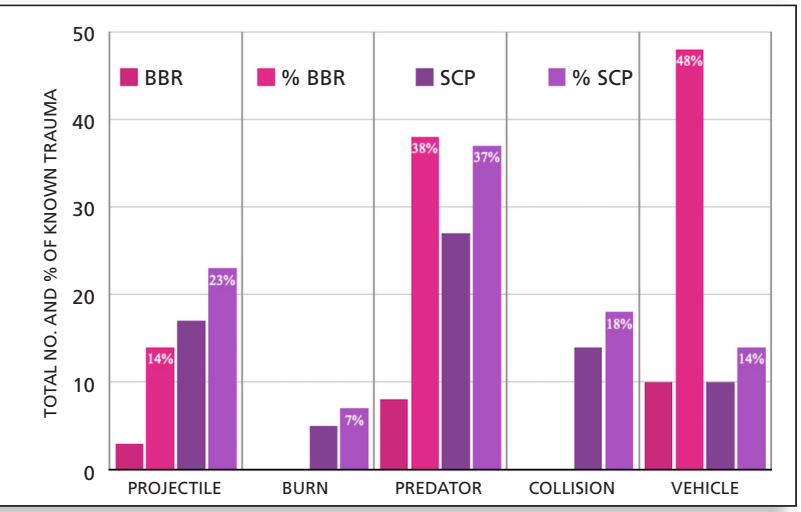


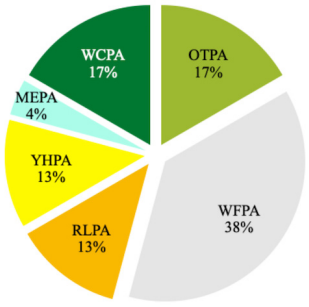
FIGURE 4B. Etiology of traumatic injury, compared by total number and percentage of each type of known cause of trauma. Of trauma cases at BBR, most were ascribable to predation or vehicle collision. Origins for traumatic injury at SCP included Predation, Projectile injury, Burns, Vehicle collisions, and miscellaneous Collisions.

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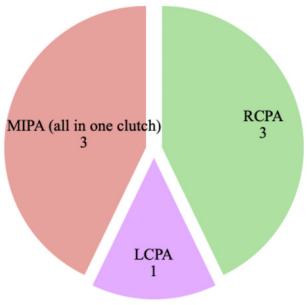
There are a total of 24 entries (3% of all admissions) of parasitism at BBR. In Figure 5a, the pie chart shows the percentage of those parasites found in each species at BBR, where 38% of the parasites (n = 9 instances) were from WFPA, with five other psittacine species accounting for the remaining 62%. Figure 5b shows the percentage for the total number of birds of each species at BBR from which parasites were detected. For example, 24% of WCPA had parasites, but only 5% of WFPA were parasitized even though they were responsible for 38% of all parasite incidents. At SCP (Figure 5c), three RCPA, one LCPA, and a clutch of three MIPA were parasitized with mites, for only 1% of the total admissions.

Body Weight

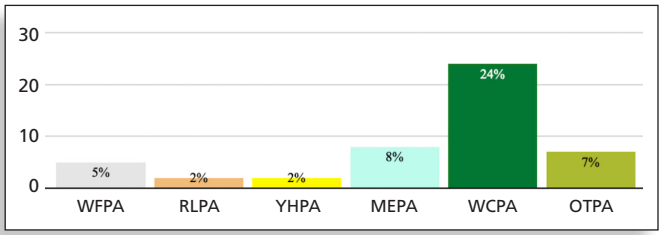
Body weight is an important parameter for assessment, determining age category, and prognostication. There are times when the weight at the initial examination may be the only opportunity to record the body weight for an individual. Recording sequential entries during the course of rehabilitation is ideal, but unlikely for most rehabilitation facilities. In Table 4, weights are recorded and standard deviation calculated according to initial weight at admission for all age groups, and for known adults, known juveniles, and known nestlings. Any particular individual may represent an entry into the calculations for all levels, if admitted as a nestling and released as an adult. Figure 6a compares weights of known adults, in ascending order, for both facilities. They can roughly be grouped into birds less than 100 grams, 100–200 grams, 300–350



5a. BBR: Percent of all parasites found per species.



5c. SCP: Total individuals admitted with mites.



5b. BBR: Percent of each species admitted with parasites.

FIGURE 5. Parasites.

Figure 5a. *Percentage of parasites recorded for each species.* For example, WFPA were responsible for 38% of all parasite incidents. ***Figure 5b.*** *Percentages of each species diagnosed with parasitism.* For example, 24% of WCPA had parasites; 5% of WFPA were parasitized but had the most diverse parasite populations.

TABLE 3. Trauma types and parasites. Parasites were most numerous and diverse at BBR. Of all admissions, 3% had some internal or external parasitism. At SCP the only parasites recorded were poultry mites, and of the 7 cases, 3 were chicks from the same clutch.

	PROJECTILE	BURN	PREDATOR	COLLISION	VEHICLE	PARASITES	% WITH PARASITES
BBR							
OTPA	0	0	2	0	9	4	7
WFPA	2	0	2	0	1	9	5
RLPA	1	0	0	0	0	3	2
YHPA	0	0	1	0	0	3	2
MEPA	0	0	0	0	0	1	8
YLPA	0	0	0	0	0	0	0
WCPA	0	0	3	0	0	4	24
Total	**3**	**0**	**8**	**0**	**10**	**24**	**3**
Total known n=81	**4**	**0**	**0**	**12**	**4**		
SCP							
RCPA	5	2	14	6	3	3	1
LCPA	2	2	0	0	2	1	2
RLPA	0	0	1	1	1	0	0
YHPA	1	0	1	0	0	0	0
RMPA	9	1	5	5	4	0	0
MIPA	0	0	1	1	0	3	7
NAPA	0	0	1	0	0	0	0
BCPA	0	0	2	0	0	0	0
Brot	0	0	2	1	0	0	0
Total	**17**	**5**	**27**	**14**	**10**	**7***	**1**
Total known n=73	**23**	**7**	**37**	**5**	**14**		

*7 of 7 individuals; 3 were in the same clutch.

grams, and 400–600 grams. Figure 6b compares weights in each age group for the facilities, with most species showing overlap of standard deviation, suggesting that body weight does not necessarily indicate age category. Initial weight at first examination for each species is compared to the overall mortality of each in Figure 6c. The column below each species is the difference in the overall mortality and the species mortality. Although the smaller-bodied birds appear to have higher-than-overall mortality, more sensitive analysis is needed to determine significance.

Origins

Birds from BBR originated from several broad categories: ex-captive birds that were given up voluntarily; confiscated birds, including known poaching victims and at-risk chicks removed by authorities from exposed or known poaching nests; known wild birds; and those of unknown history (Table 5). In Figure 7a, the pie chart represents the percentage of total admissions in each category; Figure 7b shows the number from each category of birds in each species. Most admissions originated from trafficking or pet trade: 85% of all birds at BBR came from ex-captive situations or confiscations and only 13% were known to have come from the wild. The top three species (WFPA, RLPA, and YHPA) accounted for 74% of the pet trade-related and confiscations. All birds from SCP (100%) were of wild origin, and no birds originated from any other activity.

Seasonality

Table 6 shows total admissions for each month over all the years, for each facility. Not unexpectedly, breeding season was the time of greatest admissions for both facilities.

Admissions by month shown in Figure 8 coincided with peak breeding seasons for the species involved. May through August were the busiest months, with BBR peaking in May–June as WFPA and RLPA chicks were admitted along with at-risk nestling YHPA; and at SCP the June–July peak coincided with the nesting season of the most numerous admissions, the RCPA.

At both facilities, *Amazona* spp. nestlings first appeared in April and June, fledging by early August. At SCP, RMPA and MIPA nestlings arrived in August–October with most fledging

in September.

At BBR, the earliest nestlings to be admitted were OTPA in March and the latest were also OTPA, in December. May was the most active month for nestling admissions and consisted of *Amazona* spp., WFPA, RLPA, and YHPA. This might represent a distinct nesting season in May–June for them, and year-round nesting in OTPA.

Discussion

In conclusion, successful return rates (60–70% percent released) of rehabilitated wild psittacines to the wild from both facilities are very good, regardless of origin or release situation. However, rehabilitation success of urban, non-native, and non-invasive naturalized species differed in some surprising ways from that for species within their native ranges.

SCP represented the greatest taxonomic diversity, with nine species from five genera from diverse endemic ranges. BBR included six species in three genera, several having small geographic ranges within Belize.

Native psittacines from Belize presented for rehabilitation originated primarily from confiscated or ex-captive populations; and suffered the widest diversity of maladies, from trauma to infectious disease and poor husbandry. Poor health results from many human-related issues with the native psittacines of Belize, due to ingrained cultural practices associated with poaching and pet-keeping. Along with poached nestlings and juvenile and at-risk chicks, at minimum 85% of the psittacines for rehabilitation at BBR represented victims of the pet trade. Ex-captive and confiscated psittacines, which often suffered from poor welfare, contributed to the majority of ill-thrift and sick birds admitted over the years. As might be expected, chicks associated with trafficking and the pet trade (confiscations, at-risk chicks, and voluntary relinquishment of illegal pets) are often in poor health; but with appropriate care, time, and soft release the birds can be successfully released to the wild.

In contrast, the highly urbanized southern California flocks, wild for decades, had very few parrots admitted, other than healthy fledglings, for any reason except obvious trauma (only 2% of admissions over six years were categorized as "sick"). The urbanized non-native parrots of Southern California admitted to rehabilitation are healthier than their native counterparts that are admitted to care in Belize.

Trauma is a serious factor in urban psittacine rehabilitation. Injuries are often catastrophic and preclude release, resulting in lower release rates, immediate euthanasia and DOA, and higher mortality within the first 24 hours following admission. Morbidity of the injury was less important than the body region in which it occurred. For example, most birds with severe head trauma can recover and be released, even when presented as obtunded or paralyzed; but serious fractures of the flight apparatus preclude release and necessitate euthanasia. Projectile injuries are catastrophic

TABLE 4. Body weights in grams and standard deviation (sd). Calculated from records of: initial weight at admission; for known adults; for known juveniles; and for known nestlings. Any particular individual may represent an entry into the calculations for all levels, if admitted as a nestling and released as an adult.

	INITIAL WT	SD	A	SD	J	SD	N	SD
BBR								
OTPA	65	9	73	8	63	8	60	11
WFPA	158	46	200	36	156	30	123	49
RLPA	314	119	341	132	295	76	250	67
YHPA	396	105	453	101	347	84	325	79
MEPA	572	121	627	11	463	16	0	0
YLPA	143	35	159	1	149	86	8	30
WCPA	164	21	177	34	163	16	0	0
SCP								
RCPA	257	40	290	30	249	29	201	66
LCPA	272	36	292	37	272	32		
RLPA	319	27	360		305	15		
YHPA	432	31	432	31	400		20	
RMPA	158	24	165	19	141	26	158	21
MIPA	187	32	206	37	172	23	177	16
NAPA	140	11	140	11				
BCPA	160	25	178					
Brot	63	15	63	15				

TABLE 5. Origins of birds at BBR. Categories: ex-captive birds that were given up voluntarily; confiscated poaching victims and at-risk chicks removed by authorities from exposed or known poaching nests; known wild birds; and unknown source.

BBR	EX-CAPTIVE	CONFISCATED	WILD	UNKNOWN
OTPA	20	16	45	0
WFPA	110	106	43	6
RLPA	110	100	14	4
YHPA	51	131	1	0
MEPA	9	4	0	1
YLPA	7	3	3	1
WCPA	10	12	1	0
Total	**317**	**372**	**107**	**12**

TABLE 6. Number of each species admitted for each month from each facility 2008–2020.

MONTH	1	2	3	4	5	6	7	8	9	10	11	12
BBR												
OTPA	5	2	5	4	14	21	9	7	5	3	3	4
WFPA	3	8	13	10	53	67	37	14	20	22	4	11
RLPA	10	16	15	8	44	38	32	16	19	12	9	16
YHPA	8	5	7	41	76	19	9	3	2	8	1	8
MEPA	1	2			2		2		1	2		3
YLPA		1	1		2	3		2	4		1	
WCPA				2	4	9	5	2		1		
Total	**27**	**34**	**41**	**65**	**195**	**157**	**94**	**44**	**51**	**48**	**18**	**42**
SCP												
RCPA	10	9	10	9	9	104	125	25	19	9	9	8
LCPA	3	3	1	2	1	18	12	7	2	2	2	1
RLPA	1					2	2		2	1		1
YHPA					2		4		1			
RMPA	6	9	15	5	4	3	1	27	34	10	5	3
MIPA	3	1			3	1	1	12	11	5	1	5
NAPA					1		1	2		2	1	
BCPA				1			3	3	1			
Brot				1	3		1	1				
Total	**23**	**22**	**26**	**18**	**23**	**128**	**150**	**77**	**70**	**29**	**18**	**18**

and fatal for both facilities, suggesting that these types of injuries should be considered for euthanasia early in the decision-making process. Having an indication of the general outcome related to traumatic injuries can inform intelligent decision-making regarding welfare of the patient, chance for successful release, and allocation of resources.

BBR is a soft-release facility and can maintain care for adult ex-captives and chicks for extended periods of time; where SCP is hard-release for wild birds only. Successful candidates for release must be ready for the hardships. Catastrophic injuries plus "hard" release situation require euthanasia more often than "soft" release situations (total euthanasia is 10% of all admissions at SCP, compared to <1% at BBR), and a higher mortality rate (euthanasia + Died + DOA) of 22% versus 8% for BBR).

Soft release in-situ at BBR allows higher survival and release rates, where ex-captive native birds can explore and adapt to wild conditions at their own pace. Even with many birds having spent years in captivity or suffering severe debilitating injury, the chances for successful return to the wild are good. In contrast, the harsh reality of urban living in Southern California requires instant adaptation to freedom, which in turn requires full health and functionality at release. "Hard release" at SCP, where birds need to be able to survive without human intervention immediately on release, influences decision-making, especially related to catastrophic trauma. Euthanasia is often the first choice if birds are determined to have little chance at successful release within the normal annual cycle when flock roosts are assembling (at the end of the nesting and fledging timeframe). The decisions made at admission include prognosis for successful release, and birds suffering severe and potentially long term disability are euthanized early in the rehabilitation process.

Parasites in the native psittacines at BBR reflect the diverse parasitic fauna in-situ in Belize, as well as parasites common to pets or poultry that are acquired and amplified during captivity. In contrast, only poultry mites (commonly found on native and non-native avifauna, pets, and poultry species in Southern California) were discovered on the urban birds. More specific and intensive examination and testing for parasites, in both facilities, will be of interest and is recommended for future data collection.

Body weight is an important and easy measurement. Monitoring individual weights over time during rehabilitation is considered best practice, but in reality it may be impractical to do so. In this study we compiled and analyzed the available data according to species and age categories. In many avian species, weight can be used to determine age category; in our analysis, body weight was not useful for distinguishing adult from juvenile or nestling. It is not advisable to use weight to assign age category to birds for which it is not known.

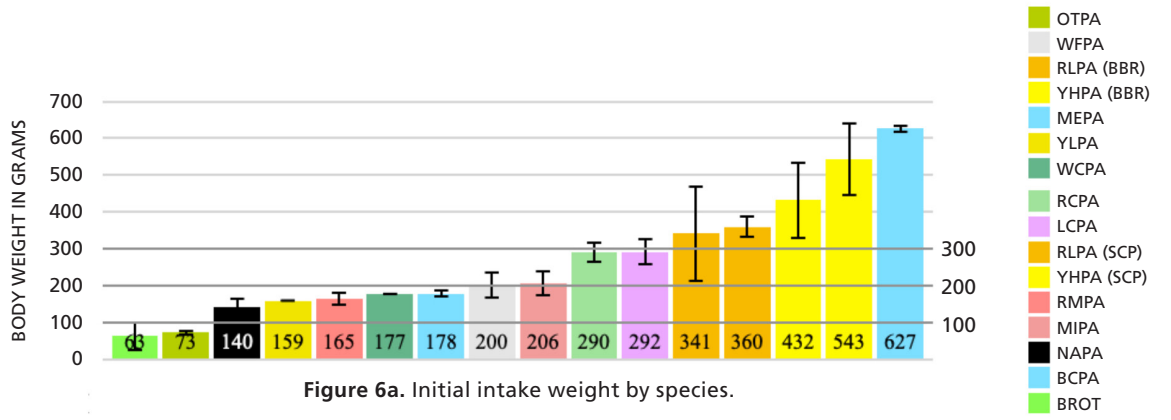


Figure 6a. Initial intake weight by species.

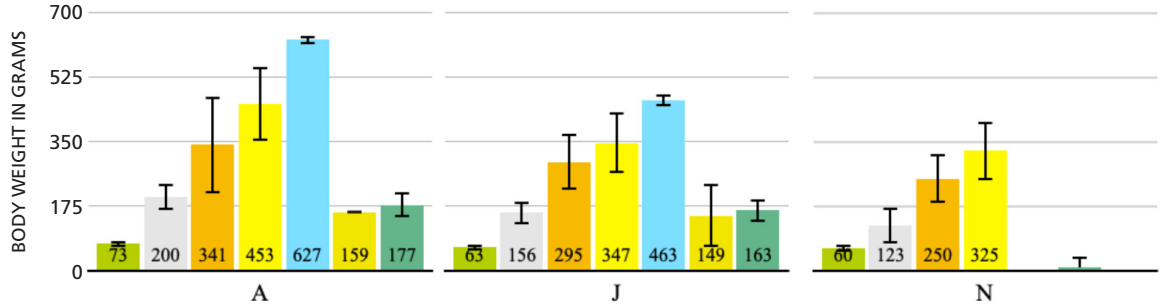


Figure 6b. BBR age groups.

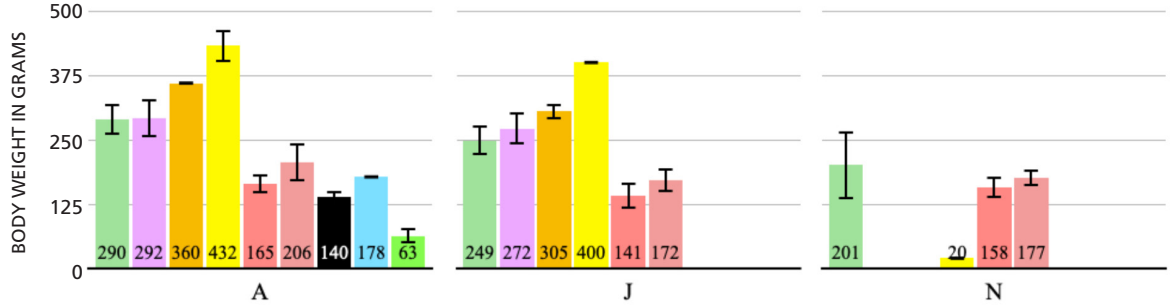


Figure 6b. SCP age groups.

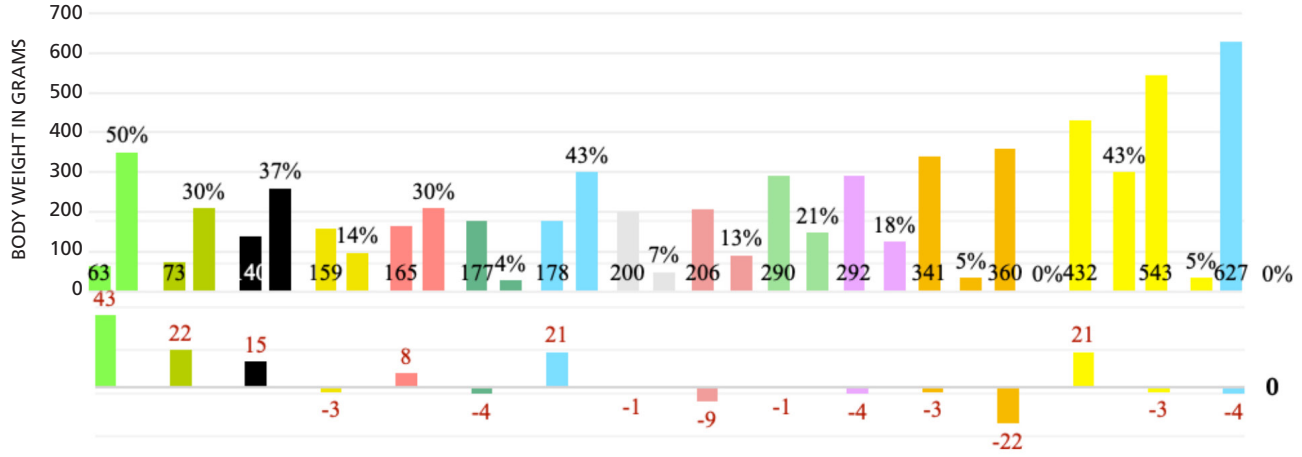


Figure 6c. Comparison between initial intake weight and mortality, all species.

FIGURE 6. Comparisons of body weights.

Figure 6a. *Compares weights of known adults, in ascending order, for both facilities.* The error bar represents +/-1 sd. They can roughly be grouped into birds less than 100grams, 100–200 grams, 300–350 grams, and 400–600 grams. ***Figure 6b.*** *Compares weights in each age group for the facilities.* The error bar represents +/-1 sd. Most species show overlap of standard deviation between the age groups, suggesting that body weight does not necessarily indicate age category. ***Figure 6c.*** *Compares body weight at initial examination with the overall mortality for each species.*

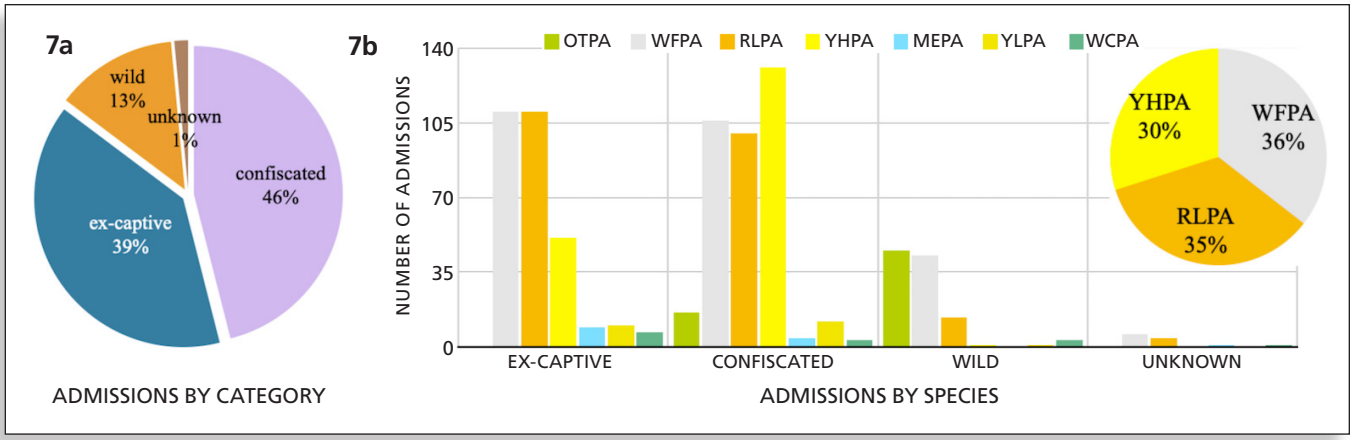


FIGURE 7. Origins of birds admitted to BBR.

Figure 7a. *Percentage of total admissions by category*: ex-captive birds that were given up voluntarily; confiscated birds, including known poaching victims and at-risk chicks removed by authorities from exposed or known poaching nests; known wild birds; and those of unknown source.

Figure 7b. *Number of birds per species by origin.* Most admissions originated from trafficking or pet trade activities. The most numerous species, WFPA, RLPA, and YHPA, are also the most numerous entries for the ex-captive and confiscated categories.

The hypothesis that small-bodied birds have a higher mortality rate needs to be investigated further. Our data suggests that it may be so, but more detailed analysis is required to determine the significance of body size. For practical rehabilitation purposes, we suggest that subjective judgment and triage regarding resource allocation to catastrophic or critical cases in small psittacines is necessary.

Seasonality is roughly equivalent to that of the same species that have been observed in the wild.[14-18] Knowing the first appearance, peak numbers, and final appearance of nestlings and juveniles over the season can improve planning and preparation. Adult admissions correspond to nest-searching, nestlings admissions correspond with nesting activity, and juvenile peak periods occur during fledging. Most (85%) psittacines at BBR represent victims of the pet trade, and as might be expected, admission of chicks associated with trafficking and the pet trade (confiscations, at-risk chicks, and voluntary relinquishment of illegal pets) reflected seasonal breeding period. Psittacines in Southern California also face pressure from poaching (a single bird was recorded as a victim of human "depredation"), but SCP only accepts wild birds and does not have any data to monitor seasonality of the pet trade.

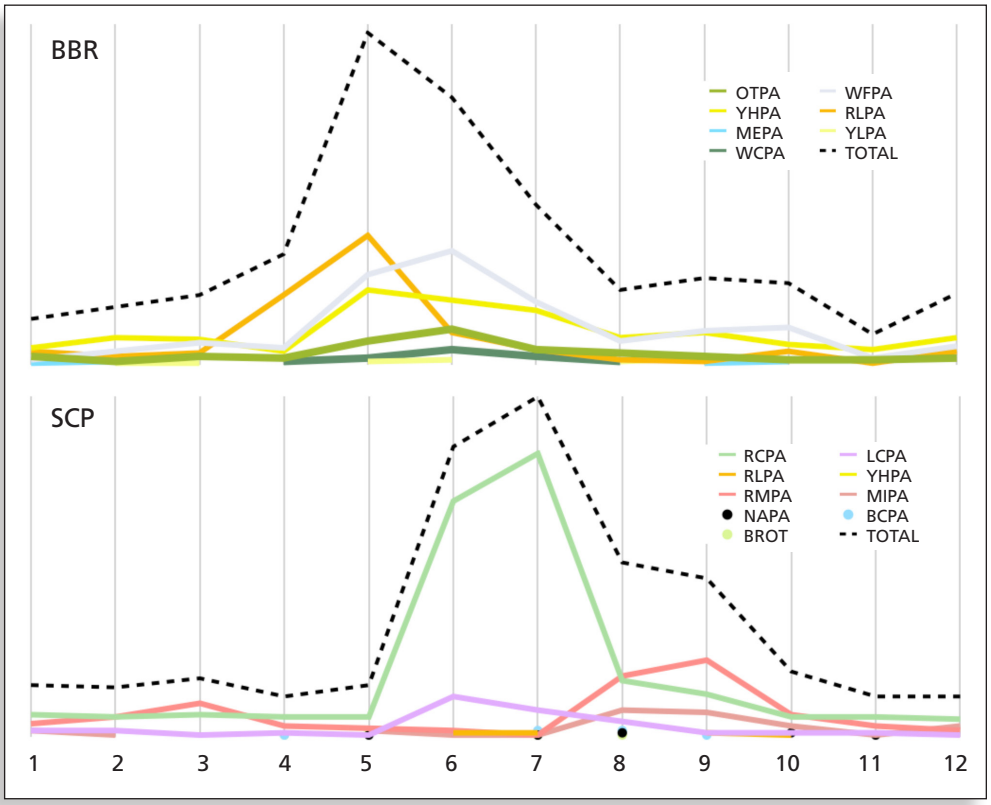


FIGURE 8. Monthly admissions. The line graphs show total admissions for each month over all the years, for each facility. Peak numbers coincide with breeding seasons of the most common species. May through August were the busiest months for both, with BBR peaking in May–June as WFPA and RLPA chicks were admitted along with at-risk nestling YHPA, and at SCP the June–July peak coincided with the nesting season of RCPA. The second "bump" August–September represents the second-most numerous influx and consists of RMPA chicks.

Anthropogenic impact resulting from the urban habitat is the cause of most admissions to SCP. Large numbers of healthy, unharmed fledglings are "rescued" by the public, simply because nests are in urban areas and many people see and have access to the youngsters learning to fly. Public interaction with wild psittacines

is closely related to the breeding season for both facilities, when nestlings and fledglings are collected for both the pet trade and for rehabilitation and eventual release to the wild. For the urban birds at SCP, intense public education has been responsible for decreasing admissions of unharmed juveniles, which in turn has freed resources for use for injured and ill birds.

In Belize, wildlife laws and increasing public awareness of parrot welfare have increased the number of ex-captives and confiscated chicks. Neonates and juveniles are vulnerable to illegal trade in Belize, and the population of confiscated birds, at-risk chicks, and ex-captive adults are all the result of this activity. Trafficking is the most important problem facing psittacines in Belize, with injury and disease rates and general condition of the birds negatively affected and requiring extended timeframes and expense for appropriate and successful release.

Implications for Conservation Planning

The serious anthropogenic impact on psittacines worldwide is demanding creativity and evidence-based planning for reintroductions and supplementation of existing populations. Parrots that have completed successful rehabilitation offer cost-effective and important resources. Confiscated chicks at risk of poaching can be successfully reared in a rehabilitation facility to be released to the wild.

Ex-captives need long-term care (often years) and multiple screening if they are to be considered for any translocation/repopulation beyond local soft-release, but a facility that can provide this support such as BBR is ideal. Soft release and long-term care at the BBR resulted in lower mortality and higher release rates for all species, in spite of the captive/confiscated origins of the majority. Such situations are ideal for localized, in-situ psittacine release. Birds enter the wild in good physical condition, are familiar with the ecosystem, and have the opportunity to return for "help" when needed (which they do! Pers. comm. Nikki Buxton, 2020).

Urban populations are the healthiest potential source for translocations but may be limited to translocations within ecologically similar urban areas. Non-releasable wild birds from these populations might be a healthy and epigenetically fit source for breeding if appropriate, and large-area sanctuaries with minimal human interference could be provided for life-long care.

Acknowledgements

We would like to extend our sincere and grateful thanks to the many volunteers, donors, and staff that made this work possible. Without them, many psittacines would suffer and die without care and would never see freedom to thrive again in the wild. The wild parrots deserve our gratitude and affection, as they have taught us much about resiliency, compassion, adaptability, and the joy of being wild. We would also like to acknowledge Racheal Avilla and Devin Dombrowski, the developers of WRMD Wildlife Database, for their help, advice, and support with data acquisition.

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Brooke Durham is the Executive Director of SoCal Parrot, an organization devoted to the rescue, rehabilitation, and release of the naturalized wild psittacines of Southern California. She is also the Executive Director of REP for Wildlife, and sits on the Board of Directors of the International Wildlife Rehabilitators Council.

Nikki Buxton is the founding and ongoing Director of Belize Bird Rescue, Belize's only multi-species avian rescue and rehabilitation centre, which admits many species of native wildlife, ex-captives and confiscated animals. Nikki has been managing Belize Bird Rescue since its inception in 2004. Although the Centre works with every species of indigenous birds, her passion will always be for the parrots.

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Red-lored parrot being released after successful rehabilitation *(A. autumnalis).*

Characterizing trends in human–wildlife conflicts in the American Midwest using wildlife rehabilitation records

Rachel B. Long,[1¤] Kristi Krumlau,[2] and Anna M. Young[1]

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Great horned owl caught in farm fence *(Bubo virginianus).*

Introduction

Interactions between humans and wildlife have become more frequent as a consequence of encroachment, resulting in an increase in the likelihood of human–wildlife conflict events and zoonotic disease transmission.[1,2] Human–wildlife conflicts—negative interactions between humans and wildlife that pose a real or perceived threat to either party[3]—are substantial causes of wildlife mortality and population decline, and manifest differently across taxa and anthropogenic contexts.[4,5] Examples of conflicts demonstrated to significantly impact wildlife populations include vehicle strikes,[6,7] mid-flight collisions with windows,[8] domestic cat predation,[9] and anthropogenic sources of ecological contamination.[10,11]

Quantifying causes of morbidity and mortality in wildlife populations is often difficult, as there are significant logistical challenges associated with *in situ* studies of wildlife health.[12,13] It can also be challenging to navigate the behavioral biology of wild populations in a minimally invasive manner; high stress events and capture myopathy can be significant welfare risks to surveys of live individuals.[14] Continued innovation of methods that can be used to identify threats to wildlife health with fewer logistical and welfare challenges is necessary.[13]

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ABSTRACT Human–wildlife conflict is difficult to measure, but the analysis of records from wildlife rehabilitation facilities has shown potential as a technique for characterizing human impacts on wildlife. To examine the value of wildlife rehabilitation records for characterizing local human–wildlife conflicts and prevalence of select wildlife diseases, we reviewed 45,668 records representing over 280 species admitted to a wildlife rehabilitation facility over a 10-year period (2005–2014). We identified the most frequently recorded causes of admission for commonly admitted species, and evaluated how causes of admission may vary across taxa throughout the year. Our analyses support the value of wildlife rehabilitation facility data for characterizing some pressures from human–wildlife conflict and select disease trends for certain taxa, as well as utility for informing topics to emphasize in local conservation education efforts. For example, orphaned neonatal wildlife accounted for the largest proportion of admissions to this facility, and highlights an opportunity for conservation education regarding when wildlife is truly orphaned and requires professional intervention. Additionally, domestic dog attack cases accounted for a proportion of admissions comparable to that of domestic cat attacks, demonstrating a need for the conversation surrounding the impact of domestic pets on local wildlife to expand to include dogs in addition to cats.

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The analysis of records from admissions to wildlife rehabilitation facilities has potential to be a useful technique for characterizing human–wildlife conflicts and disease trends that may be impacting local wildlife, as this method would not be as subject to the challenges of assessing wildlife health in the field as described by Ryser-Degiorgis[13] and Spalding and Forrester.[12] Additionally, there are an impressive number of wildlife rehabilitation facilities located around the world–for example, there are currently over 60 wildlife rehabilitation organizations located in the state of Ohio,[15] over 330 wildlife rehabilitation carers in Australia as of 2000,[16] and over 65 wildlife rehabilitation facilities in the United Kingdom.[17] These facilities each frequently admit hundreds to thousands of animals annually—uniquely positioning them to assess pressures faced by their respective local species.[16] The studies to date from wildlife rehabilitation institutions have focused primarily on identifying common causes of morbidity and mortality for specific taxa, including raptors,[18-20] reptiles,[21] and black cockatoos,[22] as well as comparing rehabilitation outcomes,[20,23] causes for admission across taxa, and causes for admission across ecological niches.[24] A broader analysis of wildlife rehabilitation records could be ideal for identifying human–wildlife conflicts of particular significance for conservation, such as the recent study that used these records to demonstrate the impact of domestic cat predation on a variety of native species.[25] Analyses that span longer time periods could also provide insight regarding how causes of morbidity and mortality may fluctuate seasonally—valuable information for epidemiological studies of disease and human–wildlife conflicts,[26,27] as well as conservation education efforts. One such study on Australian wildlife found that admissions peaked in the spring and summer during breeding seasons.[28]

The purpose of this study was to examine the value of wildlife rehabilitation facility admissions records for informing understanding of local human–wildlife conflicts and wildlife disease trends by 1) identifying the top reasons for admission to this facility, 2) examining how occurrences as measured by admitted cases may fluctuate monthly and across taxa, and 3) analyzing trends in commonly admitted disease cases. This information could have direct implications for wildlife rehabilitators and conservation educators, as well as offer information relevant to human and domestic animal health.[12,16,29]



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Great blue heron (Ardea herodias) caught on a fishing line. Fortunately, this bird was successfully rescued and rehabilitated.

Materials and methods

This study utilized records from admissions to a wildlife rehabilitation facility, but did not involve direct interaction with or experimental manipulation of live animals. As such, IACUC approval was not required. However, the permission of the wildlife rehabilitation facility to utilize these records for the purposes of this study was sought and granted.

Study Area

We utilized records from admissions to a wildlife rehabilitation facility veterinary hospital in central Ohio, United States of

America. This facility was located in a suburban context, with urban and rural areas in near proximity. Animals were regularly admitted from all three contexts, though most frequently from urban and suburban areas. Most admissions (>70%) originated from the county in which this facility was located and the six immediately surrounding counties (Franklin, Licking, Delaware, Union, Madison, Fairfield, Pickaway). Animals were also admitted from more distant regions of Ohio; at least one animal was admitted to this facility from 74 of the 88 counties in Ohio during the span of this study.

Admission records databases

We reviewed records spanning a 10-year period (2005–2014), which included 45,668 individuals from over 280 species, including rabies vector species. Each individual admitted to this facility had been assigned a unique record entry, regardless of life stage or being admitted with conspecifics at the same intake event. The records included both animals that were alive on presentation to the hospital as well as animals that were dead on arrival. Admissions records had been recorded in a Microsoft Access database from 2005–2012, and in the Wildlife Incident Log/ Database and Online Network (http://www.wild-one.org) database from 2013–2014. The two databases differed in how information was recorded, so consolidation of all records in the time span of this study necessitated standardization to facilitate analysis across the 10-year period.

Taxonomic group categorizations

We assigned each case to one of eight taxonomic groups: mammals, reptiles, amphibians, water- fowl, water/shorebirds, raptors, gallinaceous birds, and songbirds+. We assigned all mammalian, reptilian, and amphibian species to their respective taxonomic categories. We assigned orders Anseriformes, Podicipediformes, and Gaviiformes to the waterfowl taxonomic group, orders Pelecaniformes, Gruiformes, Ciconiiformes (excluding vultures), and Charadriiformes to the taxonomic group of water/shorebirds, the orders Falconiformes, Accipitriformes, Strigiformes, and vulturine Ciconiiformes to raptors, and the order Galliformes to gallinaceous birds. We categorized all passerines and other small bodied terrestrial birds, namely the orders Piciformes, Caprimulgiformes, Apodiformes, and Columbiformes, into the Songbirds+ taxonomic group. We classified records where species was not identified as unknown.

Cause of admission categorization

Information in the records regarding the circumstances that led to an animal being admitted to this wildlife rehabilitation facility was documented according to what was stated by the individuals admitting the animal to the facility and/or derived from physical examinations by a veterinarian upon admission. Causes for admission were numerous and there was variation in how the causes were documented in the records, so to facilitate analysis we created a categorization system that involved assigning each case a broad cause of admission category and a specific subcategory. The broad cause of admission categories we created for the purposes of this study were modelled after the "circumstance" categories utilized by the WILD-ONe database system. We divided some of these categories into multiple categories (ex: we divided WILD-ONe's "Collision" category into the broad categories of "Collision with Non-moving Object" and "Collision with Moving Object") to enable us to analyze groups of similar specific causes for admission with more precision. Our list of specific cause of admission categories was formulated based on the more detailed information contained in records related to the circumstances that led to an animal being admitted. These lists of broad cause of admission categories and specific cause of admission subcategories were then applied to all records across both the Microsoft Access and WILD-ONe databases resulting in 83 broad categories and 20 subcategories (S1 Table). If an animal was admitted with multiple injuries, we assigned its cause of admission based on the primary reason the animal was brought to the wildlife hospital. If an animal was admitted with both a disease and an injury—for example, a raccoon (*Procyon lotor*) that had been struck by a vehicle but also exhibited signs of canine distemper virus—we categorized the animal with the cause of admission categories corresponding to both the source of its injury and its disease to ensure that disease occurrences were represented appropriately. This dual categorization was only necessary for 14 cases.

While most records explicitly stated the reasons that individuals were admitted to the hospital and cause for admission categories were assigned accordingly, there were records where the circumstances that resulted in an animal's injucorrectry were either unknown by the individual who admitted the animal, or were not recorded. In unknown cases, it was possible in many instances to reasonably assign a cause for admission based on corroborating information and/ or findings from physical examinations—an approach also utilized by other facilities.[30] A frequently encountered example of this involved animals that had been found by the side of a road, but had not been observed or recorded being hit by a vehicle. If a record in this instance contained at least two other items of information (fractures, abrasions, contextual information, etc.) that would implicate a car strike, we assigned the individual the broad category of "Collision with Moving Object" and specific subcategory of "Hit by Vehicle." If a record stated an individual was "found by road" but there was not sufficient information to implicate a car strike, we assigned the broad category of either "Unknown" if no other relevant information was included, or "Injury Unspecified Cause" and the appropriate subcategory if at least one injury was noted.

For the purposes of this study, causes of admission considered to be human–wildlife conflicts involved animals being admitted due to an adverse direct interaction with a human (ex: vehicle strikes, lawn mowing equipment strikes, or intentionally inflicted trauma) or an adverse indirect interaction with a human or a human-associated phenomenon (ex: window strikes or domestic

pet attacks). There are many reasons that wildlife may become orphaned, ranging from misinformed human interferences, the caregiving parent(s) becoming deceased due to a human–wildlife conflict, predation, etc.; the reason neonates become orphaned is rarely known unless the event was directly observed. We have chosen to include animals with the "orphaned" cause of admission designation to be part of the conversation regarding local human–wildlife conflict as it is postulated by wildlife rehabilitators that a noteworthy portion of neonate and juvenile animals admitted as orphans were likely not truly orphaned.

While the prevalence of some diseases can be exacerbated by human influence, such as how close contact with infected individuals at bird feeders or contact with contaminated bird feeders contributes to the spread of mycoplasmal conjunctivitis in finches,[31] diseases are considered separately from human–wildlife conflicts.

As this wildlife rehabilitation facility is a non-profit organization that relies largely on donations/grants to operate, and as such has limited resources to dedicate to diagnostic testing, some disease cases were identified based on a syndromic approach, where a presumed diagnosis is made based on clinical signs, relevant history, and/or response to treatment. Mycoplasmal conjunctivitis and avian botulism are two examples of diseases in this study where cases were typically identified using this approach, as they have very characteristic clinical signs. Suspected West Nile virus cases were at times presumed based on a syndromic approach, but were typically also supported via serum antibody blood tests as resources allowed. However, it was not indicated in this data set which cases were confirmed and which were not. While this approach is certainly not without limitation and possibility for error, it is common in wildlife rehabilitation facilities across the United States due to similar resource constraints, and does have some merit; syndromic surveillance for WNV was recently described as still potentially conferring value to WNV surveillance efforts.[32]

Suspected canine distemper virus cases in mesopredator species such as raccoons were typically confirmed via serum antibody tests. Rabies testing was pursued in mentally inappropriate mesopredators when there was a known situation where another animal or a human may have been exposed.

Data analysis

To examine how human–wildlife conflict as measured by admissions to this facility may vary seasonally and across taxonomic groups, we assessed changes in mean cases admitted per month via Chi-squared tests. We also described the total number of each taxonomic group admitted, the top 20 species admitted, the top five broad causes for admission, the top five specific causes for admission, and the top three specific causes for admission for each taxonomic group.

To characterize the most common causes for admission to this wildlife rehabilitation facility, we first identified the top four specific causes for admission. For each of the top four specific causes, we assessed the number of cases admitted, the percentage

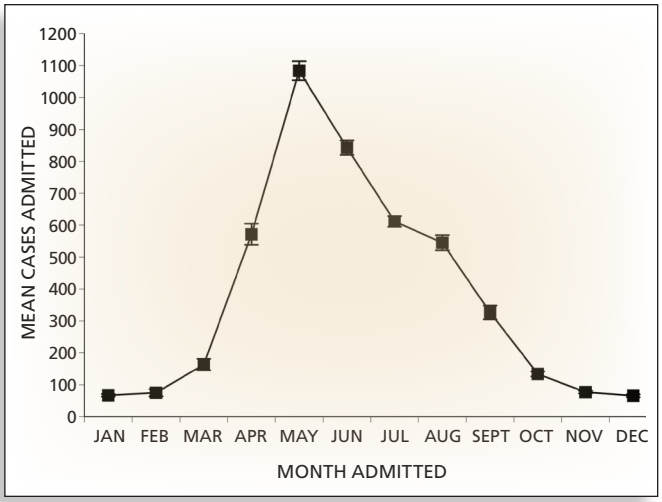


Fig 1. The mean ± SE cases admitted per month to the wildlife rehabilitation facility from 2005–2014.
https://doi.org/10.1371/journal.pone.0238805.g001

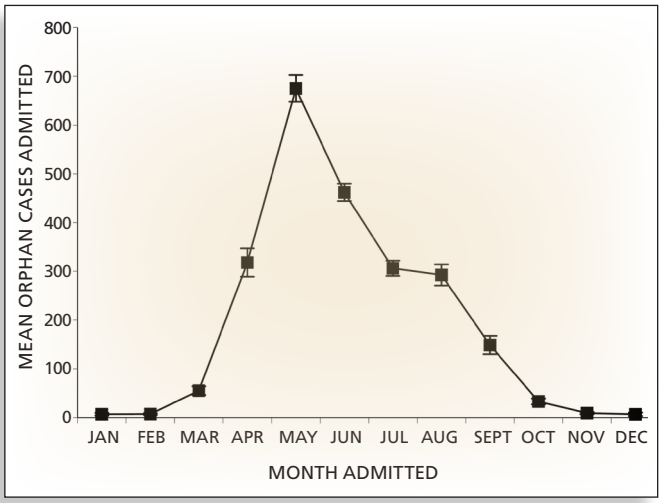


Fig 2. The mean ± SE orphaned cases admitted per month to the wildlife rehabilitation facility from 2005–2014.
https://doi.org/10.1371/journal.pone.0238805.g002

that those cases constituted of all cases admitted to the facility, the taxonomic groups affected, and how mean cases per month fluctuated with Chi-squared tests. For one of the top four specific causes for admission, vehicle strikes, we utilized average daily traffic volume data[33] for the county where this facility was located to evaluate the contribution of monthly and annual changes in traffic volume to trends in vehicle strike cases with linear regression tests.

To examine the potential of wildlife rehabilitation records to contribute to disease monitoring, we assessed the number of cases admitted for five diseases of particular importance to the wildlife rehabilitation facility–canine distemper virus, West Nile virus, avian botulism, mycoplasmal conjunctivitis, and rabies. We identified the species that were affected by each of these five diseases, as well as the percentage of all cases admitted that these diseases constituted. For the most represented of the five diseases, canine distemper virus, we also analyzed fluctuations in mean cases per month and in total cases per year via Chi-squared tests as it was

TABLE 1. The total number and percentage of all admitted cases represented by each taxonomic group, and the total number and percentage of all admitted cases represented by the top 20 most frequently admitted species.
https://doi.org/10.1371/journal.pone.0238805.t001

SPECIES	TOTAL ADMITTED
MAMMALS (43 spp.)	**24815 (54.5%)**
Eastern cottontail rabbit (*Sylvilagus floridanus*)	10715 (23.5%)
Eastern grey squirrel (*Sciurus carolinensis*)	4831 (10.6%)
Raccoon (*Procyon lotor*)	3192 (6.8%)
Virginia opossum (*Didelphis virginiana*)	3105 (6.8%)
Big brown bat (*Eptesicus fuscus*)	417 (0.91%)
Striped skunk (*Mephitis mephitis*)	407 (0.89%)
Eastern chipmunk (*Tamias striatus*)	373 (0.82%)
SONGBIRDS+ (135 spp.)	**13111 (28.7%)**
American robin (*Turdus migratorius*)	2708 (5.9%)
House sparrow (*Passer domesticus*)	1945 (4.3%)
European starling (*Sturnus vulgaris*)	1443 (3.2%)
Mourning dove (*Zenaida macroura*)	1307 (2.9%)
House finch (*Haemorhous mexicanus*)	626 (1.4%)
Northern cardinal (*Cardinalis cardinalis*)	561 (1.2%)
Common grackle (*Quiscalus quiscula*)	417 (0.91%)
Goldfinch (*Spinus tristis*)	398 (0.87%)
Rock pigeon (*Columba livia*)	386 (0.85%)
WATERFOWL (25 spp.)	**4898 (10.8%)**
Mallard (*Anas platyrhynchos*)	3192 (6.9%)
Canada goose (*Branta canadensis*)	1184 (2.9%)
RAPTORS (22 spp.)	**1704 (3.7%)**
Red-tailed hawk (*Buteo jamaicensis*)	537 (1.2%)
Cooper's hawk (*Accipiter cooperii*)	397 (0.87%)
REPTILES (29 spp.)	**641 (1.4%)**
WATER/SHOREBIRDS (13 spp.)	**230 (0.51%)**
AMPHIBIANS (12 spp.)	**98 (0.22%)**
GALLINACEOUS (6 spp.)	**56 (0.12%)**

the only disease with a degree of representation in the records that facilitated meaningful analysis (n>100 cases across 10 years).

Results

Admissions over time and across taxa

A total of 45,668 cases were admitted to this wildlife rehabilitation facility from 2005–2014, with a mean of 4,562.7 ± 226.51 cases admitted annually. Of these records, 98% contained sufficient information to be included in some level of analysis and 92% contained sufficient information to be assigned a broad and specific cause of admission category. Total admissions varied across all 10 years ($\chi^2_9 = 112.44$, $P < 0.001$), ranging from 4,105 to 4,848.

TABLE 2. The five most frequently assigned broad causes for admission, and the two most frequently assigned specific causes for admission corresponding to each.
https://doi.org/10.1371/journal.pone.0238805.t002

CAUSES OF ADMISSION	TOTAL ADMITTED
ORPHANED	**23201 (50.6%)**
Orphaned	23201 (50.6%)
DOMESTIC ANIMAL INTERACTION	**8286 (18.1%)**
Cat Attack	4491 (9.8%)
Dog Attack	3755 (8.2%)
COLLISION WITH MOVING OBJECT	**3932 (8.6%)**
Hit by Vehicle	3418 (7.5%)
Hit by Lawn Equipment	415 (0.9%)
INJURY UNSPECIFIED CAUSE	**1519 (3.3%)**
Bone Fracture	556 (1.2%)
Wounds/Abrasions	184 (0.4%)
COLLISION WITH NON-MOVING OBJECT	**1180 (2.6%)**
Collision with Building/Window	1057 (2.3%)
Collision with Natural Object/Structure	86 (0.2%)
OTHER BROAD CAUSE OF ADMISSION	**7613 (16.7%)**
Other Specific Cause of Admission	8454 (18.5%)

The mean cases admitted each month fluctuated throughout the year ($\chi^2_{11} = 3467{:}74$, $P < 0.001$). More cases were admitted from May through August than October through March, with May being the peak month for total cases admitted (1,083.5 ± 89.29). The month with the fewest mean cases admitted was December (65.9 ± 13.29); (Fig. 1).

Of the eight defined taxonomic categories, mammals were the most frequently admitted, representing over half of all cases (Table 1). Of the 20 species most frequently admitted, seven were mammals, with the eastern cottontail rabbit (*Sylvilagus floridanus*) accounting for nearly one-fourth of all admitted cases. Songbirds+ also accounted for a notable percentage of cases admitted, followed by waterfowl, raptors, and reptiles. Water/shorebirds, amphibians, and gallinaceous birds accounted for only a small portion of all cases admitted, 0.4% collectively.

The top five most frequently assigned broad causes for admission categories account for 83.5% of all cases admitted, and the top five most frequently assigned specific causes for admission subcategories account for 81.5% of all admitted cases (Table 2). The most assigned broad category and specific subcategory was "Orphaned", encompassing just over half of all cases admitted. Domestic animal interactions were the second most frequent cause of admission at nearly one in five of all cases admitted; within this broad category, both cat and dog attacks each accounted for close to a tenth of all cases admitted. Collisions with moving objects constituted nearly a tenth of all cases admitted, with vehicle strikes accounting for most of these incidents.

TABLE 3. The top three specific causes of admission for each taxonomic group, with total count and percentage of taxon individuals admitted due to each cause, release rate, and mortality. https://doi.org/10.1371/journal.pone.0238805.t003

TAXON	TOP SPECIFIC CAUSE OF ADMISSION		2ND SPECIFIC CAUSE OF ADMISSION		3RD SPECIFIC CAUSE OF ADMISSION	
MAMMALS	Orphaned	13627 (54.8%)	Dog Attack	3272 (13.2%)	Cat Attack	2513 (10.1%)
SONGBIRDS+	Orphaned	6199 (47.4%)	Cat Attack	1805 (13.8%)	Collision with Building/Window	886 (6.8%)
WATERFOWL	Orphaned	2968 (60.6%)	Hit by Vehicle	706 (14.4%)	Bone Fracture	95 (1.9%)
RAPTORS	Hit by Vehicle	436 (25.6%)	Orphaned	179 (10.5%)	Collision with Building/Window	130 (7.6%)
REPTILES	Hit by Vehicle	232 (36.2%)	Orphaned	106 (16.5%)	Dog Attack	29 (4.5%)
WATER/ SHOREBIRDS	Hit by Vehicle	35 (15.2%)	Orphaned	27 (11.7%)	Bone Fracture	24 (10.4%)
AMPHIBIANS	Hit by Lawn Equipment	14 (14.3%)	Bone Fracture	7 (7.1%)	Cat Attack	6 (6.1%)
GALLINACEOUS	Orphaned	30 (53.6%)	Hit by Vehicle	10 (17.9%)	Dog Attack	4 (7.1%)

The most frequently observed specific causes for admission varied across taxonomic groups (Table 3). Being orphaned was the most frequent reason for admission for mammals, songbirds+, waterfowl, water/shorebirds, and gallinaceous birds, and the second most common reason for raptors and reptiles. Vehicle strikes were the top cause of admission for raptors, reptiles, and amphibians. Domestic animal attacks were either the second or third top cause for admission of mammals, songbirds+, reptiles, and gallinaceous birds. Collisions with buildings/ windows were the third most recorded cause of admission for songbirds+ and raptors. Amphibians were most frequently admitted due to lawn mower strikes.

Top causes of admission

We further examined the top four identified specific causes of admission to the wildlife rehabilitation facility: orphaned, dog attacks, cat attacks, and vehicle strikes.

Orphaned

A total of 23,201 neonate and juvenile individuals were admitted as having been orphaned, constituting 50.8% of all cases admitted during the study period, a large proportion of admissions during the spring and summer months (Figs. 1 and 2), and one of the top three specific causes for admission for seven of the eight taxonomic groups (Table 3). The mean orphan cases varied significantly across months (χ^2_{11} = 2727:59, P < 0.001), with the peak month being May and the month with the fewest cases being January (Fig. 2). The total orphan cases also varied annually (χ^2_9 = 337:05, P < 0.001), with the most admitted in 2010 and the fewest admitted in 2007.

Domestic animal attacks

A total of 4,491 individuals were admitted due to being attacked by a cat, and 3,755 individuals were admitted due to a dog attack. Cat attacks and dog attacks account for comparable percentages of all cases admitted to the wildlife rehabilitation facility (9.8% and 8.2% respectively). The three taxonomic groups most impacted by cat attacks were mammals (2,593 cases), songbirds+ (1,805 cases), and waterfowl (64 cases), collectively representing 69 species. Mammals (3,262 cases), songbirds+ (403 cases), and reptiles (29 cases) were most impacted by dog attacks. Cat attacks impacted 1,413 more songbirds+ individuals than dog attacks, and dog attacks impacted 682 more mammals than cat attacks. The mean cases of cat attacks χ^2_{11} = 361:99, P < 0.001) and dog attacks (χ^2_{11} = 323:10, P < 0.001) varied across months. The peak month for mammal cases admitted due to either cat or dog attacks was May, and the peak month for songbirds+ cases admitted due to either cat or dog attacks was June. The months with the fewest dog attack or cat attack cases admitted were December and January (Fig. 3). The total cases of dog attacks (χ^2_9 = 45:5, P < 0.001) and cat attacks (χ^2_9 = 91:63, P < 0.001) also differed annually, with peak admission for dog attacks occurring in 2013, peak admissions for cat attacks occurring in 2009, and the fewest cases of either cat or dog attacks being admitted in 2005.

Vehicle strikes

Vehicle strikes represented 8% of all cases admitted to the wildlife hospital. Diverse taxa were admitted due to vehicle strike cases, with Canada geese (*Branta canadensis*), Virginia opossums

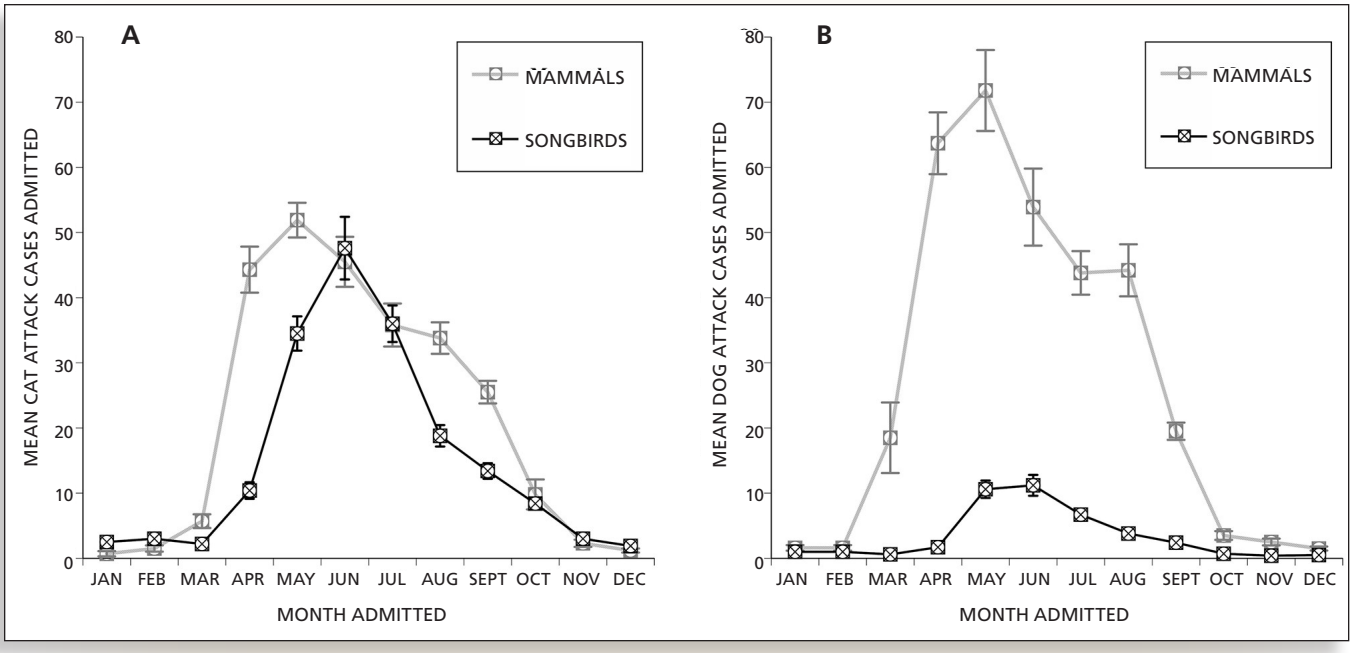


FIG 3. A) The mean ± SE cat attack cases per month, and B) mean ± SE dog attack cases per month admitted to the wildlife rehabilitation facility from 2005–2014 for the top two most impacted taxonomic groups: Mammals and songbirds+.
https://doi.org/10.1371/journal.pone.0238805.g003

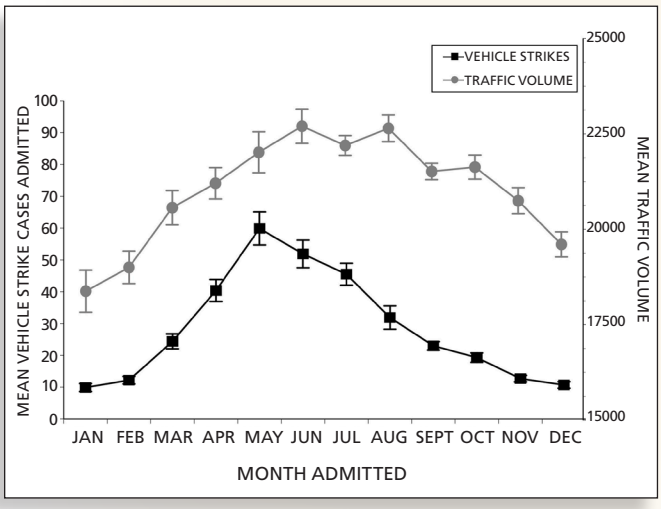


FIG 4. The mean ± SE vehicle strike cases admitted per month to the wildlife rehabilitation facility per year from 2005–2014.
https://doi.org/10.1371/journal.pone.0238805.g004

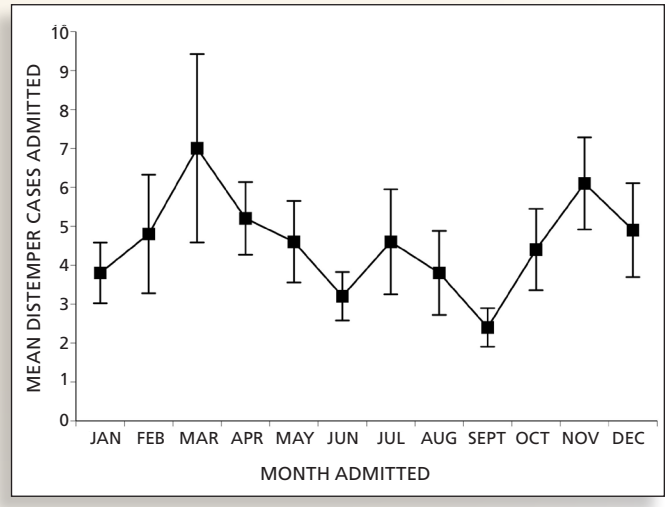


FIG 5. The mean ± SE cases of canine distemper virus admitted per month to the wildlife rehabilitation facility from 2005–2014.
https://doi.org/10.1371/journal.pone.0238805.g005

(*Didelphis virginiana*), eastern cottontail rabbits, mallards (*Anas platyrhynchos*), and eastern gray squirrels (*Sciurus carolinensis*) being the five most admitted species. The mean vehicle strike case admissions varied significantly across months (χ^2_{11} = 115:48, P < 0.001), and the total cases differed annually (χ^2_9 = 34:38, P < 0.001). The peak month for cases admitted due to vehicle strikes occurred in June, and the month with the fewest vehicle strike cases was January (Fig. 4). The peak month for mean daily traffic volume in Franklin County, Ohio, USA was June, and the month with the lowest mean daily traffic volume was January (Fig. 4). A strong linear relationship was found between mean daily traffic volume per month and mean monthly vehicle strike cases admitted ($F_{1,10}$ = 13.63, P = 0.004, R^2 = 0.577), but not between mean annual traffic volume and total annual vehicle strike cases admitted ($F_{1,10}$ = 0.416, P = 0.539, R^2 = 0.056).

Disease

Recorded disease cases accounted for 1,018 (2.23%) of cases admitted from 2005–2014. Canine distemper virus (family Paramyxoviridae, genus *Morvillivirus*) was the most commonly recorded disease state of cases admitted from 2005–2014, with 520 (94%) cases observed in raccoons (*Procyon lotor*) and 30 (5.5%) cases observed in striped skunks (*Mephitis mephitis*). The mean cases of canine distemper per month exhibited some fluctuation (Fig. 5), but not to a statistically significant degree (χ^2_{11} = 3:63, df = 11, P < 0.979). However, across all 10 years there was a fluctuation

in total cases admitted annually for both raccoons (χ^2_9 = 182:77, df = 9, P < 0.001) and skunks (χ^2_9 = 34, df = 9, P < 0.009) with peak years in 2008 for raccoons and 2009 for skunks. Mycoplasmal conjunctivitis (*Mycoplasma* spp.) accounted for 8% of all disease cases admitted and largely impacted house finches and goldfinches (89% collectively). West Nile virus (family Flaviviridae, genus *Flavivirus*) was recorded for 6% of all disease cases, avian botulism (*Clostridium* spp.) accounted for 4%, and other miscellaneous disease states accounted for 28%. A total of three individuals, all big brown bats (*Eptesicus fuscus*), tested positive for rabies (family Rhabdoviridae, genus *Lyssavirus*), accounting for 0.3% of disease cases admitted, and 0.007% of all cases admitted to the wildlife rehabilitation facility during the examined time period.

Discussion

Overall trends

Our study demonstrates the value of wildlife rehabilitation records for characterizing local human–wildlife conflicts and potentially select disease trends, as well as how occurrences may fluctuate seasonally and impact taxa differently. While our analysis is most directly applicable to the region where this wildlife rehabilitation facility is located, we believe this technique can be applied in other regions as well. A similar study in Australia found that car strikes, dog and cat attacks, and orphans were also top reasons for admissions, although they additionally found entanglement and disease to be highly prevalent.[28]

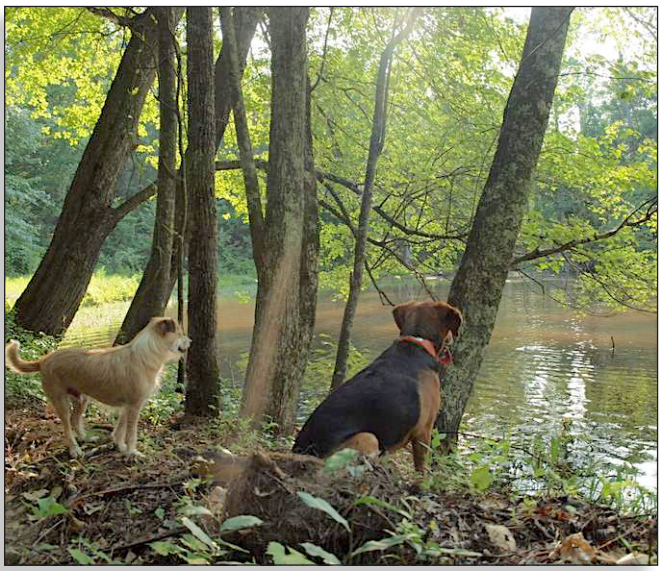


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A wood duck, alarmed by the appearance of domestic dogs, fakes a distracting injury to protect her four ducklings, who swim away. Dog attacks appear to exert pressure on wildlife comparable to cats.

Using the records, we were able to identify what are likely some of the predominant types of human–wildlife conflicts in the central Ohio region, including domestic animal attacks, vehicle strikes, lawn mower strikes, and collisions with buildings, and how they impact taxa differently. It is likely that wildlife rehabilitation facilities have a greater monitoring capacity for some taxa more than others; mammals, songbirds+, and waterfowl constituted the majority of admissions to this facility. It should be noted that distinctive species or subgroups within the taxonomic categories utilized in this study may experience human–wildlife conflict differently; here we focused on broad trends, future studies are needed to tease apart which threats may apply more to specific species or taxonomic subgroupings. Additionally, this facility primarily depends on the public to bring in animals they find, which results in the predominantly admitted species being those that are more frequently seen by people, and those that non-professional individuals are willing to attempt to handle. However, meaningful trends were still able to be discerned for some of the taxa that were admitted, such as mammals being more likely to be admitted due to domestic dog attacks than cat attacks. These findings also suggest utility for future studies that examine how human–wildlife conflicts may vary or be experienced differently by taxonomic groups more specific than those examined in this study.

It was also found that other forms of human–wildlife conflict, such as vehicle strikes, impacted a larger assortment of taxonomic groups. Vehicle strikes were one of the top three specific causes of admission for five of the eight taxonomic groups utilized in this study (Table 3). This suggests that ongoing study and education is needed regarding vehicle strike deterrents such as wildlife-friendly driving practices.

Top causes of admission

Orphaned. Orphaned neonates and juveniles were a primary cause of admission for seven of the eight taxonomic groups admitted, accounting for the largest source of admissions to this facility (Table 2) and highlighting the ongoing need for public education regarding legitimately orphaned wildlife. Orphaned wildlife admissions have constituted a predominant cause for admission in other wildlife rehabilitation facilities as well.[19,34] This facility has protocols to help screen for neonatal wildlife that may not actually be orphaned, but they mostly entail conversational questioning, and are dependent on the honesty and existing knowledge of the members of the public presenting the animals to the hospital. Thus, increasing the rigor and/or consistency of these screenings may be useful to some degree, but increasing public understanding of topics such as the biology of local neonatal wildlife, how to discern whether found neonates are legitimately orphaned, and local resources that can be contacted for assistance would likely be the more ultimate solution.

Domestic animal attacks. Domestic animal attacks demonstrated significant month-to-month fluctuations, likely corresponding with seasonal changes in the biology of local wildlife related to habitat use,[35,36] breeding seasons,[37] migration,[37,38] and range size.[39,40] Domestic animal attack cases may also exhibit this seasonality, as during the months of April–August in the northern hemisphere domestic animals maintained as household pets may be more likely to spend more time outside and thus have a greater likelihood of encountering wildlife. The seasonal influx and thus increased density of migratory songbird species may



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Virginia opossum (*Didelphis virginiana*). The species is a familiar one at rehabilitation facilities throughout its range, often victim of anthropogenic injuries.

also be a contributing factor. A similar trend in seasonal rates of domestic cat attacks on wildlife was also reported for another U.S. wildlife rehabilitation facility's records.[25] This highlights a time of year where it is particularly important to emphasize supervising pets outdoors to decrease the frequency of domestic animal attacks on wildlife.

A similar study that was broader in region, including all North America WILD-ONe data but focusing on cat–wildlife conflicts over a shorter period of time, also determined domestic pet attacks to be a top reason for admission at 14%, comparable to our finding of 18% for this Ohio facility. Unlike our study, they found that birds presented to the facility due to a cat attack more than other taxa, but similarly the species most commonly admitted for cat attacks were the eastern cottontail rabbit, American robin, and eastern gray squirrel.[41] This suggests that our findings are representative of national trends for at least domestic felid attacks.

Our study also suggests that the current conversation regarding the impact of domestic animal attacks on wildlife needs to expand. We found evidence for the previously demonstrated magnitude with which domestic cat predation impacts songbird and mammalian taxa,[9,25,42] but our findings also illuminate that in terms of total cases admitted, dog attacks exert pressure comparable to cats. It should be noted that cats are primarily predating taxa that are typically considered of higher conservation concern, namely songbirds. Although none of the species in this study were threatened or endangered, many admitted songbird species are protected under the Migratory Bird Treaty Act. However, dogs are impacting small mammals to an extent that is of notable concern from an animal welfare standpoint, and they could pose a conservation threat in regions where endangered small mammals are more prevalent than in central Ohio. While it has been previously suggested that dog attacks may have a noteworthy impact on wildlife populations,[43,44] we provide evidence that dog attacks are another source of anthropogenic pressure on wildlife that should be addressed in wildlife education efforts and accounted for in conservation decision-making for songbird and mammalian taxa.

Vehicle strikes. Our findings suggest that changes in traffic volume throughout the year are not the primary driver of the fluctuations observed in vehicle strike cases. While a relationship was found between traffic volume and vehicle strikes across months within a mean year, this was not the case across years. It is likely that seasonal changes in wildlife dispersal, migration, and behavioral biology contribute more significantly to vehicle strikes than the fluctuations in traffic volume recorded in this area. These findings support the relevance of vehicle strikes as a significant source of morbidity and/or mortality in wildlife,[45,46] as well as the need for additional study regarding effective wildlife/vehicle strike prevention measures such as wildlife crossing structures or warning signage for motorists.[47] Additionally, these findings lend support to the value of incorporating mitigation techniques such as wildlife crossing structures into roadway preconstruction planning,[47] as well as heightened education efforts during times of the year where changes in wildlife behavioral biology may contribute to increased likelihood of vehicle strikes.

Disease. While the mean canine distemper virus cases admitted per month were not found to fluctuate to a statistically significant degree, there was fluctuation in total raccoon and skunk canine distemper cases admitted annually from 2005–2014. These species are known reservoirs of canine distemper virus in this region.[48-50] An increase in admissions of both species due to canine distemper may suggest an increase in overall prevalence of canine distemper cases during those years. This facility also admitted a noteworthy number of cases of Mycoplasma conjunctivitis, an ocular infectious disease primarily affecting finch species that was first observed in Ohio in 1994,[31,51] throughout the examined time period. These findings, in conjunction with other recent work that has observed annual fluctuations in West Nile virus cases admitted to a Minnesota wildlife rehabilitation facility[32] and characterized European hedgehogs as a natural reservoir for some coronaviruses via surveillance testing of admissions to a facility in northern Italy,[52] may implicate value for wildlife rehabilitation admissions for disease monitoring. However, additional research is needed which compares wildlife records and monitored wildlife population disease prevalence before conclusions can be drawn.

It should be noted that resources available for diagnostic testing and relatively low rates of diseased individuals being admitted may limit the ability of wildlife rehabilitators to discern small fluctuations in disease occurrences locally,[27] and diseases that do not show obvious clinical signs will be underrepresented in this dataset. However, in the event of significant spikes in disease prevalence in local populations, wildlife rehabilitation facilities would be among the first to detect it via abnormal increases in cases admitted, potentially such as those observed in canine distemper cases admitted in 2008 and 2009. This would corroborate speculation in other literature regarding the potential value of wildlife rehabilitation records for wildlife disease monitoring.[19,27,53]

While rabies is one of the diseases of greatest public health concern, it was only confirmed in three cases out of over 45,000 admitted across 10 years. This could be due to the public being less likely to approach animals exhibiting signs that can be associated with rabies, but is also likely a reflection of the low prevalence observed in this region.[54]

Implications for human–wildlife conflict monitoring and conservation education

While wildlife management challenges are multifaceted, wildlife rehabilitation facilities could feasibly serve as one piece of the puzzle by contributing information regarding human–wildlife conflict and some disease trends in urban and suburban areas broadly, or more specifically by taxon. A standardized system of record keeping would optimize the potential effectiveness of rehabilitators as a resource in this way. Progress has been made with the creation of standardized national databases such as WILD-ONe (http://www.wild-one.org/), Wildlife Rehabilitation MD (http://wrmd.org/), and state-specific online databases, but there is a need for cohesiveness between organizations and public health agencies regarding data collection.[53] Some of the most significant challenges for wildlife health surveillance are related to the lack of confirmed cases, underreporting of confirmed cases, and lack of infrastructure to facilitate assembling records for surveillance.[55] An increase in federal financial support of wildlife rehabilitation facilities could enable increased staff power, resources for disease-related diagnostics, and a cohesive nationwide database. This infrastructure would facilitate more uniform, cohesive monitoring of human–wildlife conflicts and disease occurrences nationally and internationally, and potentially enable wildlife rehabilitation facilities to contribute to monitoring of these trends on both local and global scales. Additionally, our findings highlighted several needs for public education outreach efforts—namely, the impacts of both domestic cat and dog predation on wildlife, how to recognize when neonatal wildlife is truly orphaned and resources to contact for professional intervention, time periods throughout the year when different human–wildlife conflicts are most likely to occur, and affected wildlife taxa. The identification of such trends and subsequent development of relevant public outreach campaigns has been shown to contribute to wildlife population recovery and maintenance,[43] and our findings suggest that wildlife rehabilitation facilities are uniquely positioned to contribute to these efforts.

Supporting information

S1 Table. All broad and specific causes for admission. A complete list of the broad specific causes for admission and the corresponding specific causes for admission that were used to categorize the admissions records from a wildlife rehabilitation facility in the Midwest, USA.

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into the wider environment and the food chain, posing a risk to people if they eat contaminated game birds. Studies have also found that lead poisoning caused lowered immune systems in wild birds, potentially aiding the spread of diseases such as avian influenza.

Condors to Soar Again in Northern California

KLAMATH, CALIFORNIA USA *(March 23, 2021)*—For the first time in 100 years, the endangered California condor will return to the Pacific Northwest. Once on the brink of extinction, this iconic species has made significant steps towards recovery. In late March, the U.S. Fish and Wildlife Service, National Park Service, and the Yurok Tribe announced a final rule that will help facilitate the creation of a new California release facility for the reintroduction of condors to Yurok Ancestral Territory and Redwood National Park, the northern portion of the species' historic range. The facility will be operated by the Northern California Condor Restoration Program, a partnership between Redwood National Park and the Yurok Tribe.

The rule will designate the condors affiliated with this program as a nonessential, experimental population under the Endangered Species Act. This status will provide needed flexibility in managing the reintroduced population, reduce the regulatory impact of reintroducing a federally listed species, and facilitate cooperative conservation.

"The California condor is a shining example of how a species can be brought back from the brink of extinction through the power of partnerships," said Paul Souza, Regional Director for the U.S. Fish and Wildlife Service's California–Great Basin Region.

Over twelve years, the Yurok Tribe has led this effort and completed tremendous legwork to prepare for the return of condors to the region. Extensive environmental assessments, contaminant analyses, and community sessions were just a few of their tasks. The Tribe completed the process because the condor is irreplaceable to their sacred cultural landscape. Pending completion of the facility, the anticipated release of condors would be Fall 2021 or Spring 2022.

"The reintroduction of the condor is one component of this effort to reconstruct the diverse environmental conditions that once existed in our region. We are extremely proud of the fact that our future generations will not know a world without prey-go-neesh," said Joseph L. James, Chairman of the Yurok Tribe.

California condors prehistorically ranged from California to Florida and, more recently, from western Canada to northern Mexico. By the mid-1900s, populations had drastically declined due to poaching and poisoning. In 1967, the California condor was listed as Endangered. In 1982, only 23 survived worldwide. By 1987, all remaining wild condors were placed into a captive breeding program, an intensive recovery effort to save them from extinction.

As a result of conservation partnerships and intensive captive breeding and reintroduction efforts, there are now over 300 California condors in the wild in California, Arizona, Utah and Baja, California. However, the bird is still listed as Endangered, and lead poisoning (largely caused by ingesting lead shot or fragments of bullets when feeding on carcasses) is one of the specie's primary threats.

The final rule exempts most incidental take of condors within the nonessential experimental population, provided the take is unintentional and not due to negligent conduct. Although the rule exempts most incidental take, certain activities are prohibited within 656 feet (200 meters) of an occupied nest.

These include habitat alteration (e.g., removing trees, erecting structures, altering the nest structure or perches near the nest) and significant visual or noise disturbance (e.g., tree-felling, chainsaws, helicopter overflights, concrete cutters, fireworks, or explosives). Two exemptions are emergency fuel treatment activities by federal, state, tribal, or local government agencies to reduce the risk of catastrophic wildfires and responses to wildfire or other emergencies.

Wildlife Rehabilitation Org Funds Wildlife Disease Research

NEW SOUTH WALES, AUSTRALIA *(February 1, 2021)*—WIRES is funding research at University of Sydney School of Veterinary Science to better understand and manage wildlife diseases. The $200,000 two-year grant will support initiatives to improve disease diagnosis in native wildlife and ultimately improve long-term outcomes.

Disease outbreaks and resurgence are becoming more common due to the combination of climate change, unprecedented bushfires, and long-term drought.

"Wildlife carers often rescue animals suffering from disease and rely on veterinary advice to best treat and manage such animals while in care," said Leanne Taylor, CEO of WIRES. "More research into wildlife diseases is greatly needed, particularly now with so many species moving to endangered status. We look forward to working with the University of Sydney School of Veterinary Science team to gain better insights into diagnosis and treatment for our native animals."

The first phase of the project will be surveying wildlife carers and veterinarians on common diseases impacting wildlife in care that require better treatments or have indeterminate causes.

University of Sydney research lead Professor David Phalen from the School of Veterinary Science said, "The funding from WIRES will ultimately result in a marked reduction in illness and improved chances for a successful release and long-term post-release survival for any species of birds, mammals, and reptiles that are brought into care." Lorikeet paralysis syndrome and wombat road deaths are among subjects of research that will receive funding.

Phalen and his team previously uncovered and prevented ongoing poisoning in eastern grey kangaroos (iron poisoning from feeding on limited vegetation) and barn owls (poisoned eating rodents that had consumed rodent bait). Professor Phalen was also on a committee organised by Wildlife Health Australia to develop evidence-based wildlife feeding guidelines for the public, following the 2019-20 bushfire season. ■

TAIL ENDS



Walter's snuck off to the bazaar again. He really struggles with family gatherings.

Ring Tailed Lemur
Lemur catta Linnaeus 1758

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INSTRUCTIONS FOR AUTHORS

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

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

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

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MANUSCRIPT Manuscripts should be MS Word documents in either PC or MAC platform (*no PDF files*).

Manuscript should be typed in Times Roman, 12 pt., double-spaced throughout with one-inch margins.

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

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

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

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

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



Swainson's thrush (*Catharus ustulatus*), rescued from a locked storage shed in North Dakota.

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