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Ensuring proper placement of proapatagial tags on vulture wings: an anatomy lesson

Report on an ongoing international survey of psittacine-focused rehabilitation practices

One million species? A review of the Global Assessment report by the IPBES and what it means

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:

New Zealand kaka (*Nestor meridionalis*) on New Zealand's Sanctuary Mountain Maungatautari, Pukeatua, Waikato, New Zealand. PHOTO © STEVEN DOSREMEDIOS. CC BY-NC-ND 2.0.

RIGHT:

Surf scoter (*Melanitta perspicillata*), among the rocks in Pillar Point, California. PHOTO © JASON CROTTY. CC BY-SA 2.0 LICENSE.



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Small Steps, Global Vision

IWRC has long been framed by two elements of our service, education and international outreach. We reaffirmed these principles during a high level discussion of IWRC's primary objective at the November 2018 board meeting. The discussion was the start of a series of conversations around IWRC's strategy—vision, mission, values, strategic objectives—that we've been having this year.

Our strategic plan for most of the twenty-teens was to ensure IWRC was a healthy modern nonprofit; running in the black; in compliance with relevant government laws; and able to fulfill program services within a reasonable timespan. Queue a sudden realization last year that we had met the goals of that strategic plan (although of course maintaining all three goals are perennial tasks). But it was time to consider our future goals.

I was extremely excited that the board reaffirmed our focus as an international nonprofit. IWRC has had global members and provided courses in multiple countries for many years, long before my tenure on staff. But I've always felt that our provision of courses and resources outside of North America lacked structure. The slightly haphazard approach of providing one-off trainings as requested has served us well and allowed us to spread education to those who requested it and were prepared to do

a good amount of organizational work. But what about the people who need these resources and don't know about them, or cannot afford them? What about ongoing resources after a class in the form of member services? What about getting the vast wealth of international rehabilitation knowledge and resources shared with our existing network?

You already know (I hope!) that we are working to provide additional content, such as the revised Nutrition text, new courses, disaster preparedness resources, and more. But we also have the opportunity to broaden the access to our materials and improve the way they are delivered (such as interactive online classes).

As we move towards 2020, we'll have more information on our strategic plan. I'm writing this in June, where the plan is a moderately robust draft. I especially cannot wait to share our articulation of IWRC's values with you—they may not be the most important part of the plan, or even new, but I love how they encompass IWRC, from the membership, to the board, to the staff.

As Adam noted in the June 2019 Newsletter: "we will take small steps at first, but we are moving forward and we will of course keep you updated as we progress."

—Kai Williams
Executive Director

"Brat" Mountain Lion Released

WETMORE, Colorado, USA (June 3, 2019)—

Wet Mountain Wildlife Rehabilitation Center and Colorado Parks and Wildlife released several overwintered mammals June 3rd, including a mountain lion who had made the news in November 2018 for being taken from a snowbank and then fed bratwurst.

Alberta Bear Cubs Released

CALGARY, California, USA (June 20, 2019)—On June 20, the government safely released the two bears the Cochrane Ecological Institute's wildlife rehabilitation facility received in summer 2018. A team of veterinarians, provincial wildlife biologists and Fish and Wildlife officers worked together with the institute to coordinate the bears' release.

weight at the rehabilitation facility to be safely released.

Jason Nixon, Minister of Environment and Parks, states, "The Government of Alberta is committed to a wildlife rehabilitation process that considers the well-being of individual animals, ecological balance and the safety of Albertans. Alberta's wildlife rehabilitation protocols are guided by compassion and the best available scientific research; which clearly indicates that the

Kay McKeever (1924–2019)

Kay McKeever was a pioneer in the care and rehabilitation of wild owls.
Obituary on page 23

Gary Bogue (1938–2019)

Gary Bogue founded the country's first wildlife rehabilitation hospital.
Obituary on page 24

The ministry will continue monitoring the rehabilitated bears to ensure their return to the wild is successful. The bears must be able to forage on their own, socialize appropriately with other bears, and be unlikely to be involved in a human-bear conflict.

Climate Change Partial Cause of Seabird Die-off

SEATTLE, Washington, USA (May 29, 2019)—A mass die-off of seabirds in the Bering Sea may be partially attributable to climate change, according to a new study published May 29 in PLOS ONE by Timothy Jones of the citizen science program COASST at University of Washington, Lauren Divine from the Aleut Community of St Paul Island Ecosystem Conservation Office, and colleagues. The birds appeared to have died from the effects of starvation.

In the current study, Jones and colleagues documented a four-month-long die-off of puffins and a second species, the crested auklet, on St. Paul Island, one of the Pribilof Islands in the southern Bering Sea, about 300 miles east of the mainland. Beginning in October 2016, tribal and community members recovered over 350 severely emaciated carcasses, mostly adults in the process of molting, a known nutritional stressor during the avian life cycle. A reduction in food resources before entering molt may have prevented many birds from surviving, the authors suggest. Using wind data to model beachings, they calculated between 3,150 and 8,500 birds could have died in the event. Tufted puffins comprised 87% of this total, or 40–100% of the Pribilofs Islands' population, making it

PHOTO © COLORADO PARKS AND WILDLIFE SE DIVISION



Mountain lion kit, "Brat," when rescued sick from the public in Colorado, November 2018. It was released as an adult from Wet Mountain Wildlife Rehabilitation Center June 3, 2019.

Prior to their release, both bears were examined by veterinarians from the University of Calgary, and it was determined that they were healthy and ready to re-enter the wild. The bears are about 16 months old—and by six months, black bears are self-sufficient to reintegrate into their original habitat. The bears have gained enough

sooner young bears are released from captivity after becoming self-sufficient, the better off they will be in the long term. This is a decision that has been made with the best interests of both young bears in mind."

The bears were fitted with radio collars and Alberta Environment and Parks will monitor their reintegration into the wild.

highly likely that affected birds originated from colonies throughout the Bering Sea. In comparison, puffins have made up less than 1% of recovered carcasses in the region in prior years.

The authors suggest that climate-driven shifts in prey abundance and/or distribution, combined with the onset of molt, may have caused this puffin die-off, and note that further climate variability in this region is probable. Further research and observation will show whether seabirds can remain resilient in an increasingly variable environment.

Divine adds: “This paper is a successful application of citizen science in the real world. Island residents collected

Appeals for the Ninth Circuit has for the third time remanded to the lower court a Resource Conservation Recovery Act (RCRA) Citizens Suit controversy for further review. The RCRA aims to reduce hazardous waste and ensure waste is appropriately handled.

The plaintiffs complain that the Forest Service’s management of spent lead ammunition in Arizona’s Kaibab National Forest is endangering wildlife, especially certain scavenger species that ingest lead ammunition left behind in animal carcasses by hunters. At this time no one is in charge of removing spent ammunition. The *Yale Journal on Regulation* puts forth three resolutions: “Theoretically, the For-

plaintiffs were in fact seeking an advisory opinion from the court, an action it could not take. The Ninth Circuit reversed those decisions, and now directs the lower court to determine whether the Forest Service has an obligation as a landowner and property manager to regulate disposal of hazardous waste.

Knowledge of Predators Provides Measure of Safety

SYDNEY, Australia (May 15, 2019)—Exposing vulnerable species like the bilby to an environment with predators before releasing them into the wild could help improve the species’ ultimate survival, new research by University of New South Wales ecologists has shown.

In their study—published in the *Journal of Applied Ecology*—the ecologists compared the behaviour and subsequent survival of two groups of bilbies from different scenarios: a group that had been deliberately exposed to feral cats, and a group that had not come into contact with predators before.

The study is the first experimental test of predator exposure that shows how the fate of animals that are introduced into a predator-rich environment could be improved by prior experience living with predators.

The team—from UNSW, Arid Recovery and UCLA—conducted the experiment in the Arid Recovery Reserve, a 123 km² network of fenced exclosures in arid South Australia. Several locally extinct species have recently been re-introduced into the Reserve, including the vulnerable greater bilby. In 2016, the Reserve had a population of about 500 bilbies.

“The reserve is divided into paddocks, and we conducted the experiment in three paddocks: the predator-free paddock, the predator-exposed paddock, and the release site,” says lead author Aly Ross, a PhD candidate at the Centre for Ecosystem Science at UNSW.

Bilbies from the predator-exposed paddock had been living with five feral cats in the two years leading up to the experiment, while bilbies from the predator-free

CONTINUED ON PAGE 25



The bilby (*Macrotis lagotis*). Australian study has shown that pre-release predator exposure to feral cats and foxes can show survival benefits after release.

high quality data in real time and provided COASST with a detailed context for their analysis. Without the positive and mutually beneficial relationship built over years of collaboration, this massive die-off of tufted puffins would have gone unreported in the scientific community.” Via [Newswise](#).

Federal Landowner Responsibility Towards Toxic Waste

SAN FRANCISCO, California, USA (May 30, 2019)—The U.S. Court of

est Service could address the spent lead ammunition problem by either (1) removing the lead bullets left on Forest Service land, (2) requiring hunters to do so, or (3) prohibiting the use of lead bullets.”

The current inaction is alleged to violate RCRA because the Forest Service is creating or contributing to the creation of an imminent and substantial endangerment to human health or the environment in the forest.

The lower court first dismissed the case for lack of standing, and then because the

A review of vulture wing anatomy and safe propatagial tag application methods, with case studies of injured vultures

Margaret T. Hirschauer,¹ Kerri Wolter,¹ and Neil A. Forbes²

PHOTO © RICHARD TOWELL. CC BY-NC-ND 2.0 LICENSE.



Lappet-faced vulture (*Torgos tracheliotos*). See what this show-off is wearing, page 35.

Introduction

Propatagial (wing) tags have been applied to the study of birds for well over 50 years.¹ The advantages of propatagial tags are clear: these highly-visible tools allow for individual identification, contributing incredible data for studies of ecology and behavior with conservation applications. However, several concerns have been raised with propatagial tags across several bird taxa, ranging from issues with the tags themselves, i.e. tag loss and fading numbers (in vultures)² to issues with bird behavior and health, i.e. initial discomfort including excessive preening and pecking at the tag (in ruddy ducks *Oxyura jamaicensis*),³ reluctance to fly, abrasion of the skin, feather wear, weight loss, changes in social and breeding behaviors³ (in common eiders *Somateria mollissima*),⁴ reproductive success (in magnificent frigatebirds *Fregata magnificens*),⁵ increased predation, and even increased mortality.¹

The use of propatagial tags on large-bodied raptors, specifically vultures, is not novel. In South Africa, several organizations—including several conservation groups and universities—undertake propatagial tagging. VulPro is a vulture conservation organization based in the North West Province that has been applying propatagial tags to vultures since its beginnings in 2007. The organization conducts in-situ and ex-situ conservation actions focusing on species in southern Africa, namely the cape vulture (*Gyps coprotheres*), African white-backed vulture (*Gyps africanus*), lappet-faced vulture (*Torgos tracheliotos*), white-headed vulture (*Trigonoceps occipitalis*), and hooded vulture (*Necrosyrtes monachus*). Propatagial tags have proven to be a large aspect of successful monitoring in all facets of the organization's efforts, in particular rehabilitation, conservation breeding for reintroduction programs, and wild colony monitoring.

¹VulPro NPO, Plot 121 Bookenhoutkloof Road, North West Province, South Africa.

²Vulture Alliance, Vulture Alliance, c/o International Centre for Birds of Prey, Newent, Gloucestershire, UK

ABSTRACT

Propatagial tags are implemented across the globe in many bird taxa for ornithological research and conservation programs. This marking method is a critical component in research efforts, but evidence suggests they have negative effects on behavior, reproduction, and survival. Several vultures (n=8) in South Africa were recovered with improperly placed propatagial tags between 2010 and 2018, requiring removal of the tags and rehabilitation. We review the critical elements in vulture wing anatomy with photographs of a Cape vulture (*Gyps coprotheres*) cadaver wing. The only safe placement for propatagial tags lies within a triangular area in the propatagium with dimensions 10 cm x 8 cm x 5 cm. We provide measurement guidelines for tag placement in reference to key points in the wing, as well as photographs and descriptions from case studies of improper (n=5) and proper (n=1) tag placement. We illuminate the importance of understanding wing anatomy and proper tag placement before undertaking this invasive procedure, in aims to reduce the likelihood of tag-related injuries and mortalities in these imperiled species.

KEYWORDS: ligament, marking, propatagial tag, propatagium, re-sighting, tendon, vulture, wing anatomy, wing tag.

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VulPro continually adapts their tagging methods to improve the health of individuals tagged.⁶ Other vulture researchers in southern Africa have addressed the various styles and implementation of propatagial tags in literature.^{7,8} Sweeney et al. similarly addressed several concerns in North American black vultures (*Coragyps atratus*) and turkey vultures (*Cathartes aura*) including tag retention, social behaviors, flight and foraging abilities, and body condition, ultimately reporting no adverse effects.⁹ Similar findings of no negative effects were reported for breeding behaviors in other raptors (golden eagles *Aquila chrysaetos*,^{10,11} and American kestrels *Falco sparverius*¹²).

A review of propatagial tag use in literature concludes that the benefits of propatagial tags generally outweigh the concerns,¹ and this is also true when focusing strictly on vultures.⁷ However, Calvo and Furness¹ report that out of 65 articles reviewed which implemented propatagial tags, only 9.2% (six articles) noted, or tested for, adverse effects. These studies and reviews assume propatagial tags are correctly applied. Vulture wing anatomy, in reference to propatagial tags and proper propatagial tag placement, has been explicitly discussed in the literature.^{7,13} However, these discussions are often cursory, or when providing detail, do so without reference to images or specific anatomical structures of concern such as ligaments or tendons.

We review the proper placement of propatagial tags on large vultures by indicating a clear safe area for tagging, through both measurements and images of a Cape vulture cadaver wing, and elaborate on the critical tendons and ligaments to avoid when piercing the propatagium. We also provide case studies from five vultures which were fitted with propatagial tags located outside of the safe area and were subsequently collected for rehabilitation.

There are several types of tags used on large raptors and vultures around the world. In southern Africa, two main types are used: either A) a single-sided, hard cattle ear tag style, or B) a wrap-around soft PVC streamer style tag.^{6,8} The safe zone discussed in this paper can and should be used with both tag styles.

Wing Anatomy

The propatagium, or elastic membrane extending between the shoulder and carpus, forms the leading edge of the wing and is vital for aerodynamics required for flight. The soft tissue spanning between the radius / ulna and humerus where propatagial tags are applied extends from the leading edge and encompasses the entire wing. This region is not simply skin, but contains vital tendons and ligaments, with feather follicles and blood vessels distributed throughout (Fig. 1).

To determine the piercing placement on the propatagium, it is critical to ensure that 1) the application site is not directly puncturing any tendon, ligament, feather follicle, or blood vessel, and 2) the pin and outer diameter of the tag applicator (Fig. 2) do not touch or rub on any of these elements during any stage of wing movement. It is possible to visualize and feel feather follicles and blood vessels, as the skin on even large birds is relatively thin; if surgical alcohol is applied to the ventral aspect of the propatagium,

these structures can be readily seen through the skin.

Some structures, such as the thicker *Ligamentum propatagialis pars longus* located along the leading edge, are easily felt. The wing needs to be extended and the anatomical structures and landmarks need to be located and assessed (Fig. 3). We also provide measurement guidelines to ensure that wing structures which cannot easily be felt are also avoided (Fig. 4).

There is a triangular safe area for the application of tags approximately 10 cm x 8 cm x 5 cm (Fig. 4). This safe zone begins no less than 2.5 cm from the leading edge of the wing and 2.5 cm distal to a line drawn between the elbow joint and bend in the leading edge of the propatagium (when the wing is flexed). In other words, when placing a propatagial tag the pin must sit at least 2.5 cm distal to the bend in the leading edge of the propatagium created when the wing is folded.

These measurements provided, and our cadaver example, refer to a Cape vulture wing. Measurements can be transferred to other comparably large vultures—i.e. lappet-faced vulture, African white-backed vulture, white-headed vulture, griffon vulture (*Gyps fulvus*)—but should be assessed for smaller species such as the hooded vulture or Egyptian vulture (*Neophron percnopterus*). Tags placed within the highlighted safe area allow for the avoidance of all tendons, ligaments, and bones at all stages of wing movement. The areas should still be thoroughly investigated for feather follicles and blood vessels before piercing.

Ligamentum propatagialis pars longus, the ligament running along the leading edge of the propatagium, is relatively thick and can be easily felt with the hand. *M. extensor carpi radialis* is a tendon which runs along the length of the radius just in front of the bone (Fig. 3). Both *Ligamentum propatagialis pars brevis* and *Ligamentum limitans cubiti* transect the propatagium between the elbow joint and the leading edge, but are thinner than *Ligamentum propatagialis pars longus*, and more easily missed if a thorough investigation is not conducted (Fig. 3).



FIGURE 1. A ventral view of an open propatagium, taken from the right wing of a Cape vulture cadaver. The elbow joint is in the lower right corner of the photo. Ligaments, tendons, bone, and feather follicles are all visible, with the safe zone outlined in black.



FIGURE 2. A ventral view of the open propatagium showing the circular rear of the wing tag pin (placed in an incorrect position), which must not rub on any vital structures.

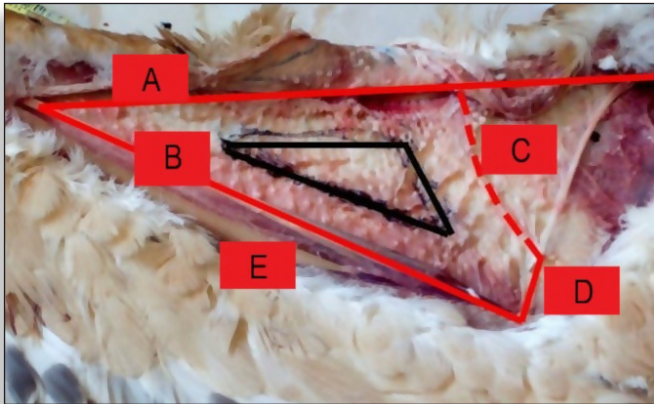


FIGURE 3. A ventral view of an open propatagium on the right wing, showing the vital structures and tendons (highlighted in red) which must be considered when placing a propatagial tag: A) *Ligamentum propatagialis pars longus*, B) *M. extensor carpi radialis* (running in parallel to the radius and ulna bones), C) *Ligamentum limitans cubiti*, D) *Ligamentum propatagialis pars brevis*, and E) radius (bone). The only acceptable safe area for placing a propatagial tag is highlighted in black.

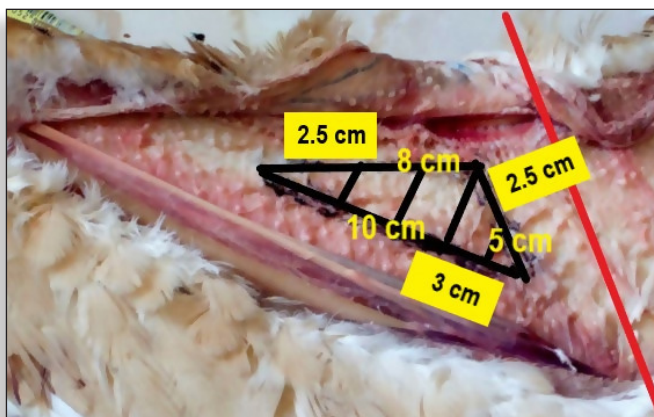


FIGURE 4. A ventral view of the safe area for wing tag placement in Cape vultures: with the right wing extended, a line perpendicular to the extended wing is determined from the elbow joint (bottom of photo) to the bend in the leading edge of the propatagium (top of photo; see red line). The safe area commences 2.5 cm distal (towards the carpus) from this line. The cranial limitation of the safe area is 2.5 cm caudal to (behind) the leading edge of the wing, and the caudal extremity of the safe area is 3 cm cranial to (in front of) the radius.

Case Studies

At the time of publication, eight vultures have been admitted to VulPro's rehabilitation facility with improperly placed propatagial tags. Some vultures were grounded from other threats and injuries (i.e. broken wings from power line collisions), while some were recovered on the ground, weakened at least in part due to improper tagging. We elaborate on each of these cases below in order to visually demonstrate the damage caused and to show what an improperly placed tag can look like when fitted on a bird. Our aim is to illuminate these cases to ideally avoid these situations altogether, or to help identify these cases so the tags can be removed.

Case 1: Tag applied when too young, too close to elbow joint, caudal to safe zone.

This vulture was admitted to VulPro as a fledgling juvenile (within the first year of life). Its propatagial tags had been placed too close to the elbow joint. The bird had also been tagged when it was too young, with the result that the skin around the piercing site had expanded, leaving a gaping hole (Fig. 5). Individuals should not be tagged until at least four months of age, or when all flight feathers are fully developed and the bird is practicing flapping for its first flight.⁶

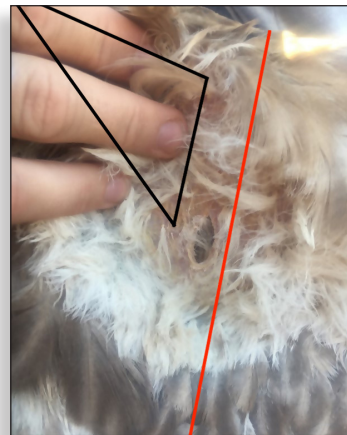


FIGURE 5. Case 1. This fledgling's propatagial tag has been removed, showing a ventral view of the resulting hole much larger than the tag applicator pin. The safe area is outlined in black; the perpendicular line from the bend in the leading edge of the propatagium to the elbow is shown in red.

Case 2: Tag applied too close to three tendons / ligaments, proximal to safe zone.

This vulture was admitted to VulPro with a tag applicator almost touching the *Ligamentum propatagialis pars brevis* 'D' as well as *Ligamentum limitans cubiti* 'C' (see Fig. 3) as shown in Figures 6 and 7.



FIGURE 6. Case 2. A ventral view of the open propatagium. The black dot represents the placement of the tag in Case 2, proximal to the safe zone.

FIGURE 7. A ventral view of the tag placement in Case 2, too proximal to the body, nearly touching *Ligamentum propatagialis pars longus*. Notice the placement of the tag in relation to the bend in the leading edge of the propatagium (directly under or slightly proximal to the bend). The safe area is outlined in black. The perpendicular line from the bend in the leading edge of the propatagium to the elbow is shown in red.



Case 3: Tag applied too close to the elbow joint, proximal and caudal to the safe zone.

This vulture was admitted to VulPro with a tag placed too close to the elbow joint, *Ligamentum limitans cubiti* 'C' and *Ligamentum propatagialis pars brevis* 'D' (see Fig. 3; Figures 8 and 9). Tags placed in this area of the propatagium are not visible when the bird is resting with wings folded, as they are folded into the body (Fig. 10, above right).



FIGURE 8. A ventral view of the open propatagium. The black dot represents the tag placement of the bird in Case 3, proximal and caudal to the safe area.

FIGURE 9. A ventral view of the tag in Case 3, placed too caudal and proximal to the safe area. The safe area is outlined in black. The perpendicular line from the bend in the leading edge of the propatagium to the elbow is shown in red.

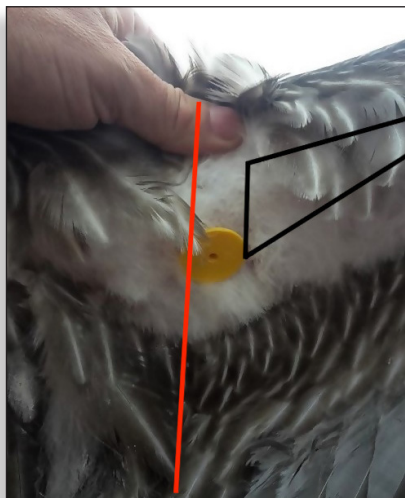


FIGURE 10. A dorsal view of the tags from Case 3, with a placement too caudal and proximal to the safe area. The tags are not visible when the bird is resting with wings folded, as the face of the tags are folded in towards the body.

Case 4: Tag applied too close to tendon, proximal to the safe area.

This vulture was admitted to VulPro with a tag placed proximal to the safe area, nearly touching ligaments 'C' and 'D' (see Fig. 3, Fig. 11). The tag was visible when the bird folded its wings, yet it did not lay flat on the dorsal side of the wing. It stuck out at an angle from the bend in the elbow (Fig. 12).



FIGURE 11. A ventral view of the open propatagium. The black dot represents the placement of the tag in Case 4, proximal to the safe area.



FIGURE 12. A dorsal view of the tag placement in Case 4, directly under the bend in the leading edge of the wing, proximal to the safe area, and too close to ligaments. The result is a tag which sticks out at an angle when the wing is folded closed.

Case 5: Tag applied too close to leading edge, medial and anterior to the safe area, very close to the *Ligamentum propatagialis pars longus*.

This vulture was admitted to VulPro with a tag placed too close to the leading edge, anterior to the safe area (Fig. 13). Tags placed closer than 2.5 cm from the leading edge risk damaging the *Ligamentum propatagialis pars longus*. Tags placed here tend to flip forward, with the tag pin moving toward the ventral side of the body (Figures 14 and 15). This results in a tag flipping over onto the ventral aspect of the wing, simultaneously pulling the pin against the *Ligamentum propatagialis pars longus*, risking damage to the ligament. In most cases tags placed in this position are semi- or totally illegible in the field.



FIGURE 13. A ventral view of the open propatagium. The black dot represents the tag placement in Case 5, too close to the leading edge, cranial to the safe area, touching and impeding movement of *Ligamentum propatagialis pars longus*.



FIGURE 14. Tagging too close to the leading edge of the wing, as in Case 5, not only risks damaging the propatagial ligament, but also risks the tag rotating forward and flipping over onto the ventral surface of the wing. In this dorsal view, you can see the tag pin has rotated, and the tag flipped over the leading edge of the wing. The pin now rests on the leading edge.

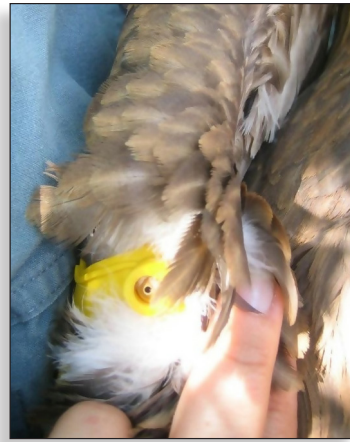


FIGURE 15. A dorsal view of wings folded with the tag placement from Case 5. Note how the tag pin is on the leading edge. This often causes the tag face to stick out from the body at a 90-degree angle, making it difficult to read.

Case 6: Tag properly placed inside safe area.

For proper tag insertion, each wing should be extended and thoroughly investigated, surgical alcohol or a similar disinfectant applied to both dorsal and ventral surfaces of the propatagium, and the tag placed no less than 2.5 cm distal to a line drawn from the elbow joint to the bend in the propatagium (when wing is folded, Fig. 16). When the tag is placed inside the safe area it will not interfere with the fold in the propatagium when the bird is at rest and it will lay flat along the dorsal surface of the wing (Fig. 17).



FIGURE 16. A dorsal view of a vulture wing when extended. The wing has been investigated for vital structures and is ready for tag application. This shows the proper placement of a propatagial tag, at least 2.5 cm distal from the line drawn from the bend in the propatagium (when the wing is folded) to the elbow joint (red line).



FIGURE 17. When properly applied, a propatagial tag will not interfere with the bend in the leading edge of the propatagium and the tag will rest flat on the dorsal surface of the wing.

Discussion and Management Implications

Vulture populations across Africa are in dramatic decline and are at risk of extinction.¹⁴ Conservation efforts will be critical to their continuing survival and there is no question that propatagial tags can contribute positively to these efforts. However, the improper placement and application of these tags has the potential to injure vultures, on occasion with lethal consequences. VulPro has recovered eight vultures grounded and unable to fly due to discomfort or injury from misplaced propatagial tags. This is an unacceptable and avoidable threat to endangered and critically endangered vulture populations. There is a safe method and safe region to place propatagial tags to avoid these negative consequences.

As seen in Case 1, there is an appropriate age and size at which propatagial tagging should be undertaken. Birds should be at least four months of age, with fully developed flight feathers. Behaviorally, they should be flapping in preparations for flight. This is a critical stage in which tagging from a wild nest may not be possible, as there is the risk that young birds will attempt flight before they are ready. Only experienced practitioners should undertake wild fledgling tagging. We recommend only tagging Cape vulture fledglings that weigh more than 5.5 kg, and African white-backed vulture fledglings that weigh more than 3.5 kg.

Even with safe placement and application of propatagial tags, VulPro has begun to note skin irritation on the ventral surface of the wing. Most vultures do not show this irritation response to tags. However, with a few individuals, this irritation is so severe that feathers are missing, and the skin is abraded and reddened. We suspect this abrasion, caused even when the tag is applied within the safe zone, may have been the cause of failure in some releases. VulPro has started to remove propatagial tags and apply leg bands as visual identifiers and will monitor the release of individuals after this change to determine its effects.

We have provided the photos and case studies above because we believe it is critical that all people placing propatagial tags on birds have an understanding of the vital elements for flight located within the wing, how and where to conduct safe propatagial tag placement, and finally, what properly and improperly placed tags look like on a bird's wing while at rest and moving. It is suggested that all persons applying propatagial tags should be trained and licensed to do so, and that a web-based or online database of tags inserted, including the tagger's identification, be maintained. If misplaced tags are found, corrective training can be provided for the tagger.

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Dallas Zoo, Detroit Zoological Society, DHL Supply Chain, Fresno Chaffee Zoo, Gauntlet Conservation Trust, GH Braak Trust, Hans Hoheisen Charitable Trust, Jacksonville Zoo and Gardens, Lomas Wildlife Protection Trust, LUSH, Max-Planck-Gesellschaft, Natural Encounters Inc., Prince Bernhard Nature Fund, Reeder Conservation Fund, Rufford Foundation, Sacramento Zoo, The Hawking Centre UK, The Tusk Trust, World of Wings Bird of Prey Centre in Scotland, Zeiss South Africa, ZKTeco, and Zoo Atlanta.

About the Authors

Maggie Hirschauer started working with raptors in 2008, conducting rehabilitation and education programs in Indiana. She later volunteered with raptor rehabilitation efforts in Kentucky, then moved on to her master's research in 2014 addressing VulPro's Cape vulture conservation breeding and reintroduction program. She was a part of VulPro's propatagial tagging, GPS tracking, conservation breeding, and rehabilitation efforts until 2017. She currently lives in Montana where she continues to help injured raptors and conducts mountain lion and butterfly conservation studies.

Kerri Wolter founded VulPro, a non-profit vulture conservation organization, in 2007. She currently manages VulPro's facility with over 200 non-releasable vultures, including a conservation breeding and supplementation program for critically endangered species, a rehabilitation facility which helps up to 90 vultures each year, and an internationally recognized research program which monitors the health of wild populations across southern Africa. Kerri has placed propatagial tags on over 1,000 vultures and GPS tracking devices on over 200. She has published protocols on proper handling, housing, tagging, breeding, and management of several old-world vulture species.

Neil Forbes, BVetMed DipECZM (avian) FRCVS, gained RCVS Specialist status in zoo and wildlife medicine (avian) in 1992, followed by FRCVS in exotic bird medicine (1996) and Diploma of the ECZM (1997). Neil has lectured on the international avian medicine circuit, authored papers in peer-reviewed international journals, and written or contributed to textbooks. Neil is a past President of the European College of Zoological Medicine and the European Board of Veterinary Specialization, taught avian medicine at Bristol Univ. Vet School from 2000–2010, and headed Great Western Exotic Vets clinical referral service from 2004–2017. In 2017 Neil was instrumental in setting up the Vulture Alliance, a charitable organization which aims to bring a new skill set to bear on the global vulture population crisis, training vets and rehabilitators in rehabilitation, orthopedic surgery, and captive breeding of conservationally-sensitive species.

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Rescue, rehabilitation, and release of psittacines: an international survey of wildlife rehabilitators

Patricia J. Latas¹



African grey parrot (*Psittacus erithacus*). Left: Mitred Parakeets (*Psittacara mitratus*).

Introduction

Parrot rehabbers work in areas of agriculture, logging, and commercial and residential development; activities which result in habitat degradation and fragmentation and the likelihood of encountering injured and orphan psittacines. Many work with authorities responsible for confiscating illegally trafficked birds.

Methods

The online platform Survey Monkey was used to reach wildlife rehabilitators around the globe and included responses from the Neotropics, African nations, Australasia, North America, and Europe. The survey opened in November 2018, and is still open to participation, but analysis includes responses collected up to April 2019. Two-hundred-thirty-seven participants were contacted directly, via membership lists and cooperation with international, regional, local, and individual organizations in geographic areas known to have wild psittacines: the Neotropics, African nations, Australasia, North America, and Europe. Of those, 34 responded to the survey.

Respondents were given the option of anonymity and follow-up was only possible if contact information was granted. Diverse urban, rural, non-native, and native species were included, depending on geographic location. Questions included qualitative and subjective topics and options for respondents to comment on details or add their own observations. One respondent per facility filled in the survey. The survey text is available in Appendix 1. An active, open link may be found here: <https://www.surveymonkey.com/r/ZGGXBT>. Results were tabulated and presented in graphical form (see Figures 1–6).

¹Awe Pono Avian Health, 7223 E. Camino Valle Verde, Tucson, AZ USA and SoCal Parrot, Jamul, CA, USA

ABSTRACT: Psittacines are the most common birds reported in legal and illegal wildlife trade. Wildlife rehabilitators are called upon to assist in the care and appropriate release of diverse parrot species in diverse habitats. The problems and issues related to wild psittacine rehabilitation reflect universal issues in wildlife rehabilitation; however, parrots require specific training and represent a high-visibility, highly emotive and charismatic group of birds prone to significant wildlife trafficking. The online platform Survey Monkey was used to reach wildlife rehabilitators around the globe and included responses from the Neotropics, African nations, Australasia, India, North America and Europe. The survey was intended to explore the extent of wildlife rehabilitators' role in wild parrot rescue, rehabilitation, and release, and ultimately to be used to prepare options, guidelines, and plans for psittacine rehabilitation and release to the wild. Out of 237 rehabilitation centers contacted, 34 responded.

Based on survey results, human impact is the primary cause for presentation of psittacines to a rehabilitation facility. Reports of non-traumatic, non-anthropogenic illnesses varied between regions.

KEYWORDS: Psittacines, wildlife rehabilitation, wild parrot rehabilitation, orphan parrot, anthropogenic impact, psittacine health

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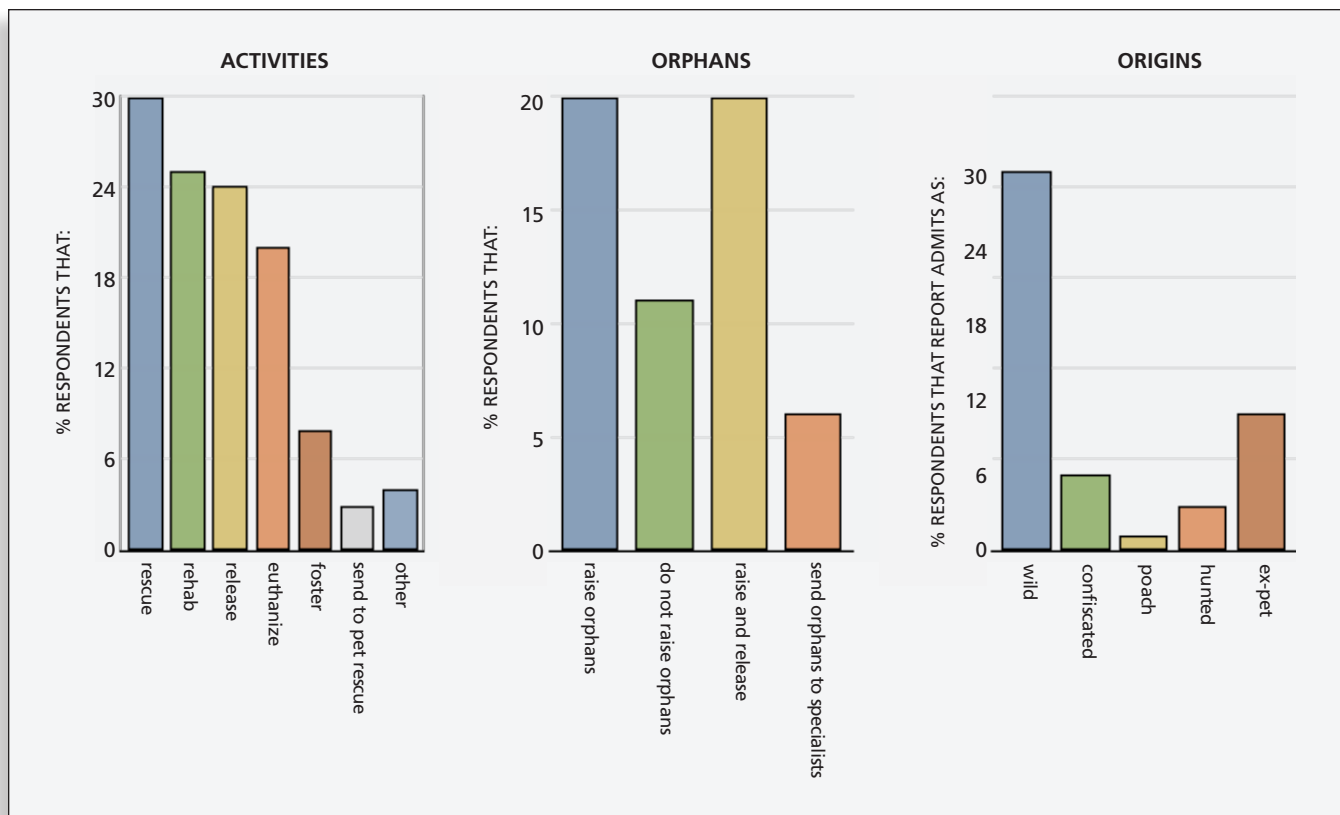


FIGURE 1. Types of activities reported by respondents working with orphaned psittacines, and origin of psittacines admitted to the facility, represented by the percentage of all respondents in the survey.

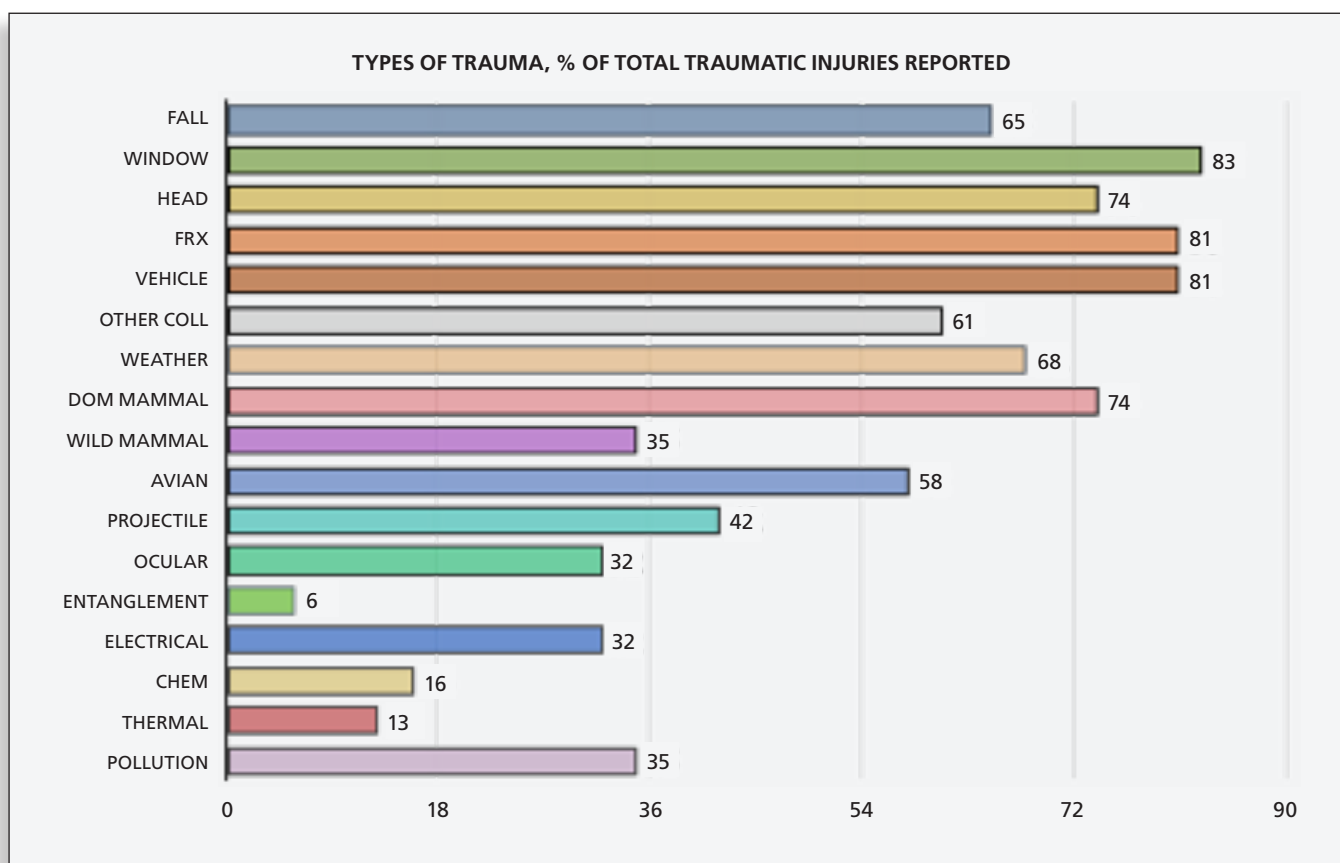


FIGURE 2A. Reasons for admissions (trauma), as reported on the survey by types of injury.

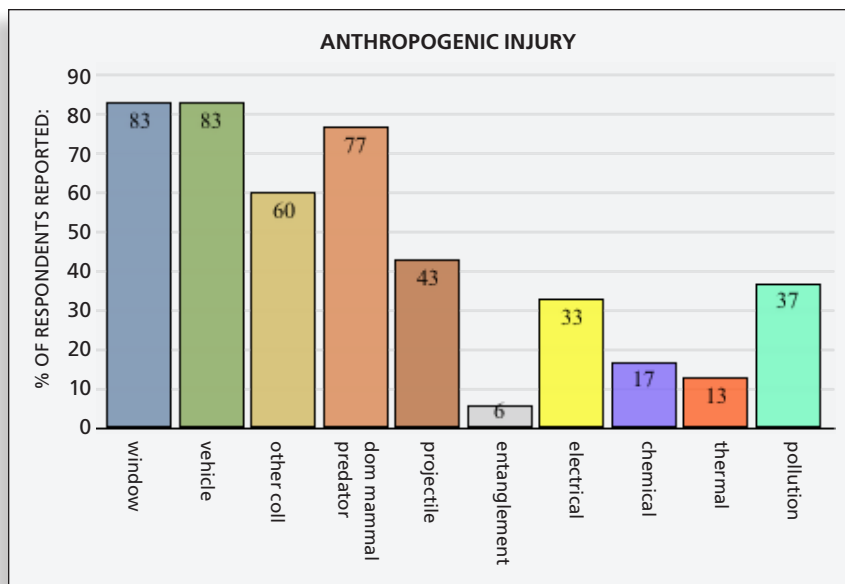


FIGURE 2B. Reasons for admissions (anthropogenic), as reported on the survey by types of injury.

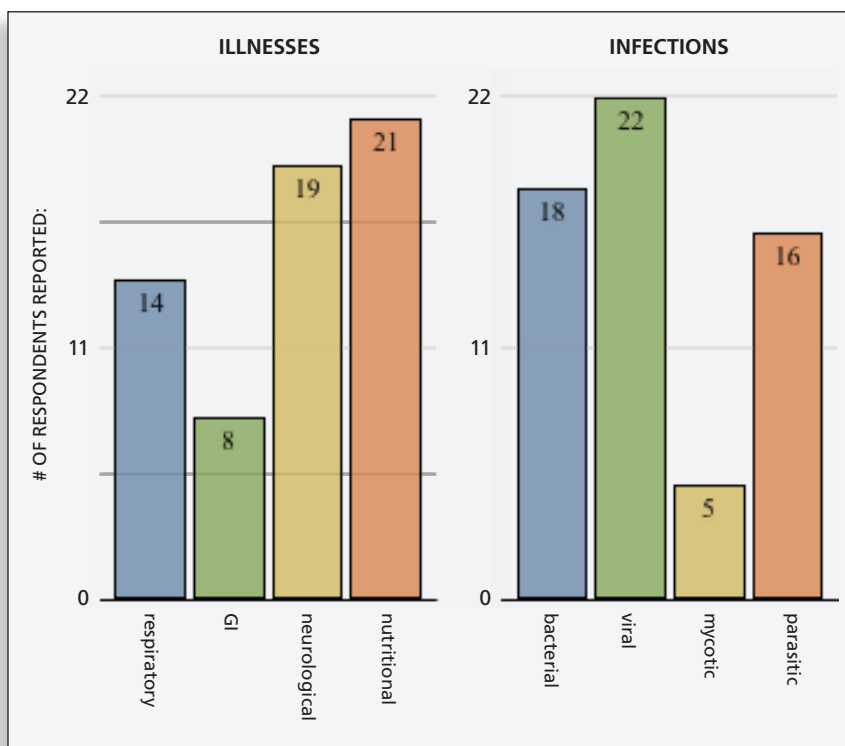


FIGURE 3. The number of respondents reporting non-traumatic categories related to respiratory, GI, neurological, nutritional illness, and perceived or documented infections.

Results

The majority of wildlife rehabilitator respondents ($n=30$) who work with wild psittacines engage in rescue, rehabilitation, and release of the birds. Where it is legal to do so, most raise orphans for release to the wild. Most psittacine intakes are wild birds, or, to a much lesser extent, ex-pets. Few facilities collaborate with authorities to take confiscated birds (see Fig. 1 for graphical representation of these results).

Respondents reported intakes of 60 species of psittacines,

and several responded with generalities such as “all native species in Australia” or “parrots in Florida” (see Appendix II). The common and scientific names for those species can be found in Appendix III. The psittacine species presented for intake represent native, endemic, naturalized, or invasive populations from Indo-Malaysian, Australasian, African, Neotropical, European, and North American regions.

Anthropogenic trauma is the most common source of injury, regardless of geographic region (Figs. 2A and 2B). It was left to the respondents to define their interpretations of trauma, but comments included phrases “lacerations”, “bruising”, “fractures” and other common language indicating physical forces applied to the body of the bird. The top 3 types of trauma, reported by the majority of responding rehabilitators worldwide (70%, $n=21$), were: window strike (83%, $n=27$), vehicle collision (81%, $n=27$), and predation by domestic mammals (74%, $n=24$). Respondents also reported miscellaneous fractures and head injury, likely from non-witnessed collisions. Anecdotally, the comments indicated that cats were the most likely domestic predator involved. Likely non-anthropogenic trauma included weather ($n=23$), fall injuries ($n=22$), and avian depredation ($n=19$).

Broadly-interpreted categories of perceived or documented illness, where trauma was not observed, are represented in Figure 3. Approximately 60% of respondents reported nutritional ($n=21$) and neurological ($n=19$) problems in their patients, likely reflecting the number of orphans and trauma victims. Geographical location showed some impact on reported illness (Fig. 4). Respiratory and GI issues were mainly reported from the Australasian rehabilitators. Suspect viral infections (Psittacine Feather and Beak disease) dominated Australian reporting, but overall 65% ($n=22$) reported viral, 53% ($n=18$) reported bacterial, 47% ($n=16$) reported parasitic, and 15% ($n=5$) reported mycotic infections. However, the majority of respondents also

reported that they do no diagnostic testing (Fig. 6) so many of these diagnoses are based on experience and physical examination only.

About 44% ($n=17$) of respondents reported that they had isolation capability; intensive care ($n=10$), hospitalization ($n=16$), and pediatric ($n=11$) capability (Fig. 5).

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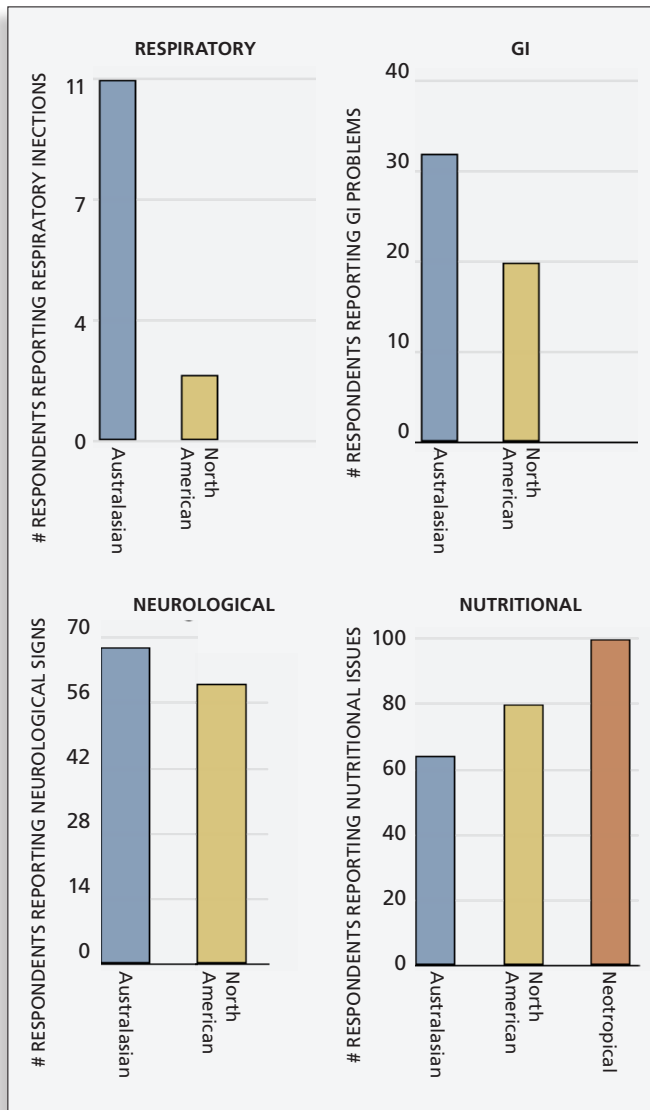


Figure 4. Illnesses reported by geographical location.

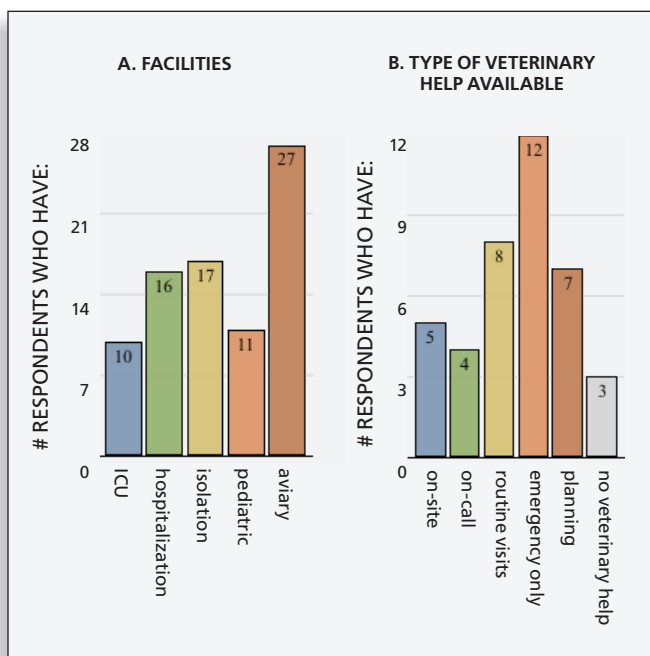


FIGURE 6. (A) Although 47% of rehabilitators were involved with diagnostics of parrots in their care, more than half did no diagnostic work. **(B)** In-house diagnostic work included fecal analysis, blood work, and necropsies; **(C)** clinical pathology (combined blood counts and chemistries) and radiology were the most common diagnostics done outside of the facility.

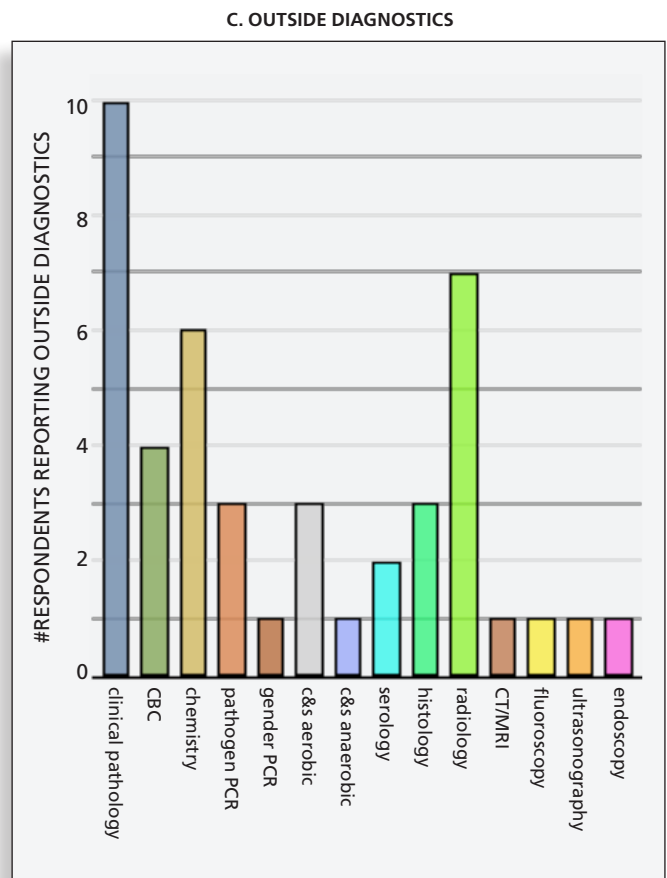
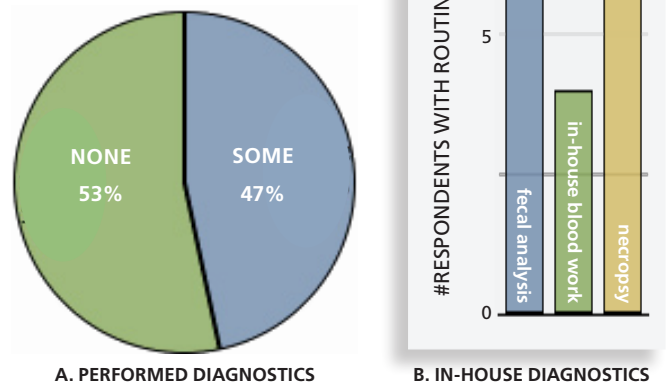


FIGURE 5. (A) Facilities available to rehabilitators and **(B)** types of veterinary assistance available to them. Most were able to care for injured and ill patients, but less than half could offer intensive care or isolation. The majority had at least emergency veterinary care available, but some did not have any veterinary help at all.

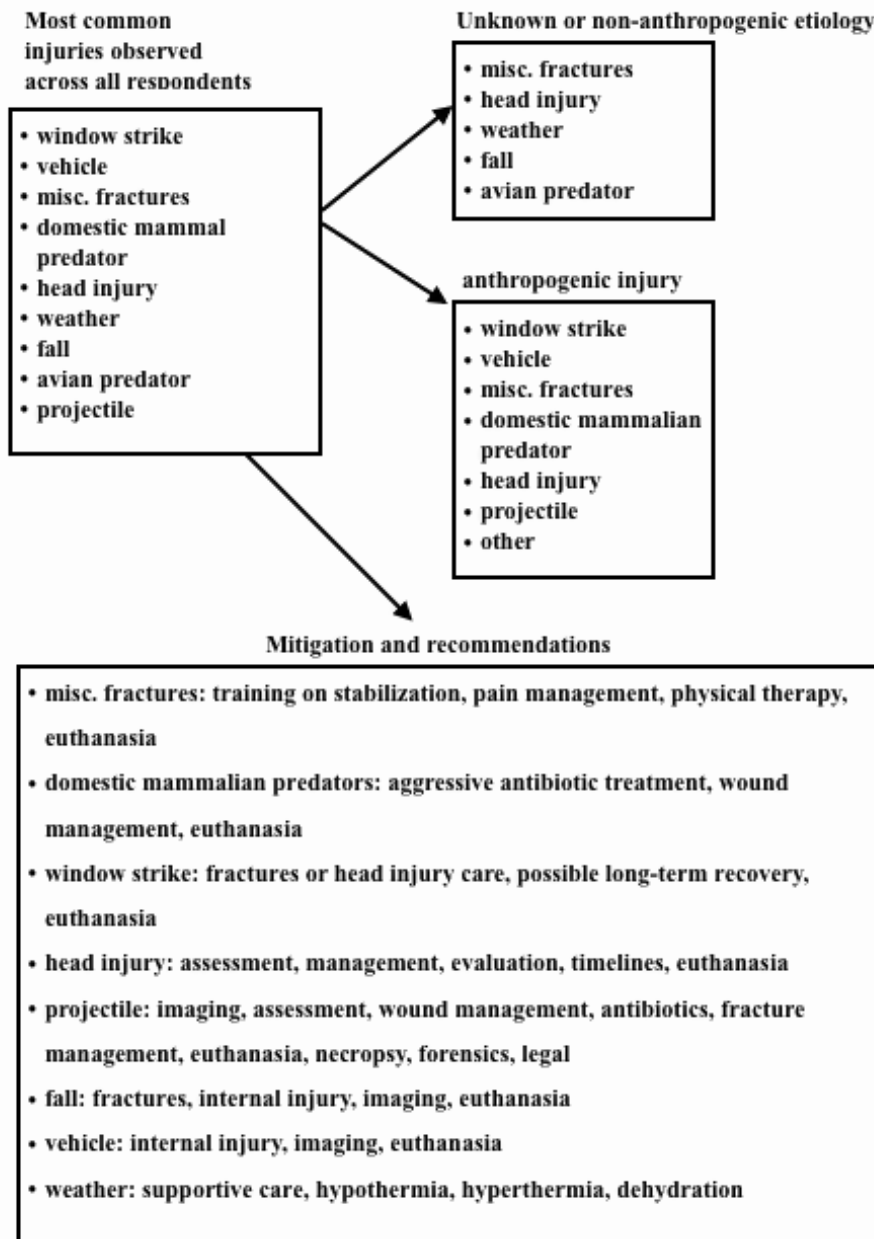


FIGURE 7. A flow chart illustrating injury, anthropogenic etiology, and mitigation recommendations.

Regarding veterinary involvement, 10% (n=3) of respondents report they have no veterinary contact, 48% (n=16) use emergency veterinary services when birds require veterinary care, 29% (n=10) make routine appointments as needed, 16% (n=5) have an on-call veterinarian, 13% (n=4) have an on-site veterinarian available, and only 19% (n=7) reported using veterinarians in planning (Fig. 5). About half (n=18) report that no diagnostics are performed on their patients (Fig. 6). About a third use in-house fecal analysis and necropsy, 8% (n=3) send out bacterial culture and sensitivities, and only 8% (n=3) use pathogen identification PCRs. Many comments indicated the prohibitive costs of diagnostic testing, imaging, and veterinary services. Most comments made it clear that rehabilitators understand the value of diagnostics but are frustrated by unavailability or expense.

Discussion

The purpose of this survey was to understand related issues and thereby make recommendations to assist successful rehabilitation of psittacines. Continuing education for multiple fractures, internal injuries, head trauma, and euthanasia procedures would be appropriate preparation for the psittacine rehabilitator. Easily available and economical diagnostics, advanced planning, and preparation would improve identification and care for non-traumatic illnesses. Rehabilitators need training in simple and inexpensive testing which can be made available with minimal equipment, such as in-house fecal testing or collection of samples, and collection of samples on PCR cards for archiving or eventual testing. Microbiological diagnostics need to improve for proper identification of pathogens and to identify and prevent antibiotic resistance. PCRs need to be more available, affordable, and practical (at present, there are portable PCR machine prototypes being developed for field use). Training and equipment for basic in-house screening of disease could improve care, treatment, disposition, and eventual success of release to the wild, and in addition prepare for isolation and communicable disease. Formal isolation, treatment, and hospitalization facilities are needed in situ with some form of veterinary involvement. Financial constraints need to be acknowledged and addressed.

Conclusions

Anthropogenic damage

The results of this survey illustrate serious human impact on wild psittacines. Human impact is the primary cause for presentation of psittacines for intake at rehabilitation facilities. Anthropogenic damage to avian, and specifically to parrot populations, is only now attracting academic research interest,⁹⁻¹⁴ and wildlife rehabilitators are the “first responders” in this tragedy.

More and improved veterinary involvement

Wildlife rehabilitation organizations, individual rehabilitators and facilities, and the veterinary community must improve contact, communications, assistance, education, and training in all directions by actively seeking gaps in knowledge, bridging those

gaps, and developing diverse and transparent networking. Communication and contact between rehabilitators and veterinarians need to be bilateral and facilitated. More wildlife-educated veterinarians need to be involved with planning and implementation of psittacine rehabilitation. More veterinary involvement is essential, with proper compensation or subsidy.

More veterinary involvement in psittacine rehabilitation and release was indicated, and should include planning, training, and availability. Veterinarians can bring skills from their avian medicine and wildlife medicine training, and clinical and practical experience to the rehabilitation of wild psittacines that will facilitate higher success rates and higher quality of care. In turn, veterinarians stand to gain by becoming educated in the needs of wildlife rehabilitation medicine and specifically to psittacine rehabilitative medicine. A flow chart may help in determining what injuries may result from anthropogenic vs. non-anthropogenic or unknown-etiology injuries; and mitigation, treatment and preparation for planning (Fig. 7).

Financial considerations

Funds must be made available to improve diagnostics, care, and education. As an example, in one organization each parrot costs approximately \$150 for veterinary testing and care, spends a minimum of 90 days in rehabilitation for a total \$1,350 for boarding (estimated at standard \$15 per day), and requires \$50 transportations costs, for a total of \$1,550 per bird, and usually \$400–\$500 pro-bono veterinary care per month (confidential personal communication). If there are only 100 intakes per year, that equals \$155,000 for the organization, the entire cost being borne by donors and volunteers with no additional government funding; and possibly \$6,000 expenses absorbed by a veterinarian. Rehabilitation communities and veterinarians do not have the resources to bear the financial burden of proper care.

Collaboration to help trafficking victims

If frequent collaboration with law enforcement confiscation authorities, wildlife rehabilitators, and veterinarians involving confiscated parrots is to be successful, monetary support of proper and adequate diagnostics, imaging, and veterinary care is mandatory. Governments need to assist wild parrots from trafficking and not assume that voluntary organizations will shoulder the responsibilities.

When parrots are confiscated, there is an immediate need to find captive husbandry resources. A proactive collaboration agreement between rehabilitators and authorities would be one way to facilitate more timely response. A natural match would be collaboration between governmental organizations involved with confiscation and wildlife rehabilitators with the knowledge and skills to do just that.^{15–16} Collaboration with authorities responsible for confiscation of trafficked birds would be a natural fit for many rehabilitation facilities, if accompanied by concurrent infusion of funds to support the operations. Staff, training, planning, and physical operations are already in place and could relieve economic, environmental, training, and personnel problems. Funding agreements need to be part of any collaborative agreement if the process is to be sustainable over any length of

time. Highest standards of care, health, welfare, well-being, and successful release of wild psittacines require significant financial backing, but are beneficial to healthy environments and thereby beneficial to a nation as a whole. In addition, clarification of standards and regulations regarding rescue, rehabilitation, and release of psittacines in non-endemic areas would be essential.

The demand for psittacine rehabilitation will only increase with the ongoing rise in animal trafficking, expanding human settlements, increasing human populations, and emerging wildlife disease related to environmental stress. Wildlife rehabilitators, whether located in urban centers or in deeply remote regions, will be expected to assist in recovery, care, release, and protection of wild parrots. Every effort, from financial, training, and veterinary access to policy-making, must be maintained at the highest standards. The fate of 398 species, 111 (28%) listed as globally threatened by ICUN, and 56% (n = 222) of which are in decline,⁷ depends on many members of a united team. Rehabilitators must be ready to shoulder part of this responsibility.

The wildlife rehabilitation community needs to prepare a front-line defense against the extirpation of diverse psittacine species. Examination of these survey results may assist in needs planning and development of best practices and highest standards of care to ensure successful release of healthy parrots into appropriate habitats.

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Appendix I. Survey

Wild Psittacine Rescue, Rehabilitation and Release Survey

<https://www.surveymonkey.com/r/ZGGXBT>

This survey is meant to help the Veterinary Section of the Working Group for Psittaciformes of the International Ornithological Union understand the extent of wildlife rehabilitators' role in wild parrot rescue, rehabilitation, and release. Urban and native species are included, depending on geographic location. The survey hopes to assist needs assessment and to better prepare options, guidelines and plans for psittacine rehabilitation and release to the wild. If you wish to leave contact information, please use the space in Question 1 or message privately. Thank you for your time and care.

Appendix II. Species Mentioned in Survey

Author's note: the following are comments taken directly from the survey results, spelling not corrected. A list with common and scientific names may be found in Appendix III.

Neotropics

Amazonas amazonica, *A. farinosa*, *A. autumnalis*, *A. severus*, *Ara ararauna*, *Ara macao*, *Aratinga Weddellii*, *Pionites melanocephalus*, *Brotogeris cyanopectus*, *Pionus menstruus*, *Pionus sordidus*.

Yellow-headed Amazon, Red-lored Amazon, Yellow-lored Amazon, White-fronted Amazon, Northern Mealy Amazon, White-crowned Parrot, Olive-throated Parakeet.

All parrot species of Bolivia, among those as principal: blue-fronted amazons, canary winged parakeets, red and green macaws, blue and gold macaws, chestnut fronted macaws, dusky headed parakeets, white eyed parakeets, mitrate parakeets, monk parakeets, blue headed parrot, blue winged parrotlet, peach fronted parakeet, blue throated macaw.

North America

Note: There are 18 and possibly more species of psittacines in Florida, and at least 13 species of naturalized psittacines in California.¹⁷⁻²²

love birds, budgies, monk parrots

Myiopsitta monachus

Quaker parrot, red-masked parakeet

Macaws. Quakers.

RMPA, MIPA, various Amazons Florida

RCPA, LCPA, RLPA, YHPA, RMPA, MIPA, NAPA, BCPA, WWPA, YCPA.

Europe

Ring-necked parakeets

Africa

Grey headed parrots, Lillian's lovebirds, African Grey parrots

Indo-Malaysian

Rose-ringed Parakeet, Alexandrine Parakeet, Plum-headed Parakeet, Blue winged Parakeet

Australasian

Note: There are 40 species of parrots and 14 species of cockatoos in Australia.²³

all native birds

Sulphur crested cockatoos, galah (Rose breasted cockatoo), rosella, lorikeet (rainbow, musk, purple crown), corellas (long and short billed), red rumped grass parrot

Parrots and lorikeets

Adelaide rosella, Eastern rosella, galah, Sulphur crested cockatoo, Little corella, Long billed corella, Rainbow lorikeet, Musk lorikeet

Lorikeets, Cockatoos, galahs, corellas

corellas, galahs, major mitchells, lorikeets, weiros (cockateils) budgerigars, port lincoln

Any and All

Galah, Cockatoo, Rainbow and Musk Lorikeet

All that are found of the east coast of Australia.

lorikeets (rainbow/musk etc), Eclectus. Others.

Sulphur crested cockatoo, Rainbow Lorikeet

rainbow lorikeet sulphur crested cockatoo

All native species to Australia

King parrot, crimson rosella, rainbow lorikeet

Lorikeets, galahs, cockatoos, corellas, crimson rosella, all Australian native parrots

Rainbow lorikeets Sulphur Crested Cockatoos

Australian King Parrot, Sulphur-crested Cockatoo, Galah, Long-billed Corella, Little Corella, Eastern Rosella, Crimson Rosella, Rainbow Lorikeet, Scaly-breasted Lorikeet, Musk Lorikeet

rainbow lorikeet

sulphur-crested cockatoo, eastern rosella, yellow rosella, galah, red-rumped parrot, Australian king parrot, rainbow lorikeet, little corella

Appendix III.

Common and Scientific names of birds mentioned by respondents

Taxonomy according to Handbook of the Birds of the World Alive.²³

New World Origin

Orange-winged Amazon (*Amazona amazonica*)

Southern Mealy Amazon (*Amazona farinosa*)

Northern Mealy Amazon (*Amazona guatemalae*)

Turquoise-fronted Amazon (*Amazona aestiva*)

Yellow-headed Amazon (*Amazona oratrix*)

Red-crowned Amazon (*Amazona viridigenalis*)

Red-lored Amazon (*Amazona autumnalis*)

Lilac-crowned Amazon (*Amazona finschi*)

White-fronted Amazon (*Amazona albifrons*)

Yellow-lored Amazon (*Amazona xantholara*)

Chestnut-fronted Macaw (*Ara severus*)

Blue-and-yellow Macaw (*Ara ararauna*)

Scarlet Macaw (*Ara macao*)

Blue-throated Macaw (*Ara glaucogularis*)

Dusky-headed Parakeet (*Aratinga weddellii*)

Nanday Parakeet (*Aratinga nenday*)

White-winged Parakeet (*Brotogeris versicolurus*)

Yellow-chevroned Parakeet (*Brotogeris chiriri*)

Cobalt-winged Parakeet (*Brotogeris cyanopectus*)

Jamaican Parakeet (*Eupsittula nana*)

Peach-fronted Parakeet (*Eupsittula aurea*)

Blue-winged Parrotlet (*Forpus xanthopterygius*)

Monk Parakeet (*Myiopsitta monachus*)

Black-headed Parrot (*Pionites melanocephalus*)

Blue-headed Parrot (*Pionus menstruus*)

Red-billed Parrot (*Pionus sordidus*)

White-crowned Parrot (*Pionus senilis*)

Blue-crowned Parakeet (*Psittacara acuticaudatus*)

Mitred Parakeet (*Psittacara mitratus*)

Red-masked Parakeet (*Psittacara erythrogenys*)

White-eyed Parakeet (*Psittacara leucophthalmus*)

Psittacines in Florida

Indo-Malaysian

Plum-headed Parakeet (*Psittacula cyanocephala*)

Malabar Parakeet (*Psittacula columboides*)

Alexandrine Parakeet (*Psittacula eupatria*)

Rose-ringed Parakeet (*Psittacula krameri*)

African

Rosy-faced Lovebird (*Agapornis roseicollis*)

Nyasa Lovebird (*Agapornis lilianae*)

Grey Parrot (*Psittacus erithacus*)

Brown-headed Parrot (*Poicephalus cryptoxanthus*)

Australasian

Cockatiel (*Nymphicus hollandicus*)

Galah (*Eolophus roseicapilla*)

Major Mitchell's Cockatoo (*Cacatua leadbeateri*)

Long-billed Corella (*Cacatua tenuirostris*)

Western Corella (*Cacatua pastinator*)

Little Corella (*Cacatua sanguinea*)

Sulphur-crested Cockatoo (*Cacatua galerita*)

Australian Ringneck (*Barnardius zonarius*)

Crimson Rosella (*Platycercus elegans*)

Pale-headed Rosella (*Platycercus adscitus*)

Eastern Rosella (*Platycercus eximius*)

Western Rosella (*Platycercus icterotis*)

Red-rumped Parrot (*Psephotus haematonotus*)

Budgerigar (*Melopsittacus undulatus*)

Musk Lorikeet (*Glossopsitta concinna*)

Purple-crowned Lorikeet (*Glossopsitta porphyrocephala*)

Rainbow Lorikeet (*Trichoglossus moluccanus*)

Australian King-parrot (*Alisterus scapularis*)

Eclectus Parrot (*Eclectus roratus*)

Kay McKeever (1924–2019)

From the Owl Foundation:

We wanted to inform all of our supporters of the sad news that one of our founders, Kay McKeever, passed away April 4. Following is her obituary:

Katherine (Kay) McKeever died April 4, 2019, aged 94, at Albright Manor in Beamsville, Ontario, after years of declining health.

Kay was born in Vineland, Ontario, on October 16, 1924, the third child of Muriel and Roger Clarke, who took up summer fruit farming in Vineland Station at the end of World War I. The family lived in Ottawa in winter, and Kay was schooled in Ottawa, Vineland, and Beamsville. As a child, Kay loved the outdoors and animals, domestic and wild. In high school she excelled in athletics and English. She worked on the farm in summer and figure skated in winter, performing in exhibition skating.

Kay graduated from high school during World War II and enlisted in the Women's Division of the RCAF, drawing maps for pilots serving in the Pacific. She was disappointed the RCAF did not allow women to fly planes, which she wanted to do. While on service she met Robert Colbran to whom she was married from 1945–1948.

After the war, Kay's mapping skills landed her a job with Photographic Survey Corp. in Toronto. She joined a group that bought a war surplus airplane and achieved her ambition of becoming a pilot. While at PSC, she met Don MacFadyen, a flight instructor and night intruder pilot during the war, who worked for PSC in South America. Kay and Don married in 1950. They lived in Toronto and Brazil and had two children. They collected rocks, minerals and gemstones for which Kay designed settings later sold in Canada.

Kay returned to Canada in 1956 with the children while Don was still in Brazil, settling in Richmond Hill. Not one to sit still, she built a large garden, returned to figure skating, and enjoyed annual canoe trips. She was an avid reader and

fan of classical music.

Kay's second marriage ended in the early 1960s. She returned to Vineland, designing and building a house for herself beside her parent's home. Kay also designed homes for friends, producing detailed house plans. She returned to her early love of wild animals, and her dogs were joined by orphaned raccoons, flying squirrels, exotic owls, and the first orphaned wild owl.

Kay's mother introduced her to Larry McKeever, a widowed electrical engineer and a naturalist and conservationist of many years. They married in 1967, and this time the marriage would last. They built a house in Peterborough and lived there until Larry's retirement. Kay grew more serious about rehabilitation of injured raptors and conservation.

In 1970, they returned to Kay's house in Vineland to expand their raptor rehabilitation work. Kay became a pioneer in the care and rehabilitation of wild owls. Her dedication, aviary designs, and many contacts led to increasing recognition.

Kay started speaking to groups about owls and her work. Audiences found her not only an expert on owls, but an entertaining speaker. She was soon in demand by many organizations.

In 1975, Kay and Larry established a charitable organization (now called The Owl Foundation). Larry's pension allowed them to remain around-the-clock volunteers in their project for decades. Through their commitment, and later with the help of other volunteers and staff, they built an institution in which thousands of birds of prey have been helped and returned to the wild.

In the 1970s, Kay found that, in the right conditions, non-releaseable wild owls would breed in captivity and produce young that could be trained and



Kay McKeever launched the Owl Rehabilitation Research Foundation, now The Owl Foundation, in 1975 with her husband, Larry.

released. She began to use non-releaseables as foster parents for wild orphans. Kay considered her success in breeding most native owl species of Canada one of her most important achievements.

Kay's manual on the care and rehabilitation of owls, first published in 1979, attracted professional interest from around the world. She became a widely recognized authority on owls, speaking at conferences and contributing to scientific and lay publications. Kay also wrote two books for children based on true stories of owls in her care.

Kay and Larry were ardent advocates for conservation, and in the 1980s began an ambitious ongoing restoration project, planting native tree species on the land that held the family farm, creating a natural oasis in an agricultural landscape.

Kay and Larry received many awards from rehabilitation, veterinary, conservation and other organizations. Kay received the Lifetime Achievement Award of the U.S. National Wildlife Rehabilitators Association, and was made a member of the Order of Canada in 1986. Kay was an inspiration to many people, and a friend and mentor to other rehabilitators.

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Gary Bogue (1938–2019)

GARY BOGUE—BELOVED CONTRA COSTA TIMES WILDLIFE, PET COLUMNIST

From the San Francisco Chronicle

By Megan Cassidy

Gary Bogue was set to accept a plum job at an ad agency upon college graduation more than five decades ago, when he happened upon a small natural history museum while on a walk in Walnut Creek.

Before the end of the hour, an employee persuaded Bogue to spend his weekends volunteering there. By the end of the month, he had ditched the advertising plans altogether, opting instead to become a recreation assistant for the city.

The choice touched off a lifetime of pioneering work in wildlife rehabilitation as well as education, and spending 42 years as a wildlife and pet columnist for the Contra Costa Times.

Bogue, whose legacy includes founding the country's first wildlife rehabilitation hospital and inspiring the creation of Tony La Russa's Animal Rescue Foundation, died Thursday in his Benicia home. He was 81.

"He taught certainly a whole community, if not a whole world, how to respect and live with the natural world around them," said Bogue's wife, Lois Kazakoff, who retired from The Chronicle in May after 26 years at the newspaper.

Bogue became the Alexander Lindsay Junior Museum's curator in 1967, and remained there until 1979 when he left to join the Contra Costa Times. He retired from the Times in 2012 and later wrote seven books on wildlife.

He developed the idea of the museum's wildlife rescue center in 1970 after people in the neighborhood started bringing in injured wildlife. The museum is now known as the Lindsay Wildlife Experience.

"He went out and he raised money to put together kind of a hospital, so that they would try to patch up the animals, and then put them back out into the environment," Kazakoff said. "So you



Gary Bogue founded the country's first wildlife rehabilitation hospital.

weren't creating pets, you were helping wildlife."

The work helped create a worldwide model, as well as offshoot products. For one, Kazakoff said, the employees noticed several people bringing in orphaned fawns, but the fawns would become sick if they were fed cow's milk.

Because other groups were beginning to start wildlife rehabilitation units, Bogue figured there may be a market for a product that resembled doe's milk. He approached Foremost Dairies in Oakland, which performed a chemical analysis and created formula with off-the-shelf ingredients.

"And then they found out that there was so much interest in it, they actually created a formula product that you can order online, just like any other baby's formula," Kazakoff said.

As a writer, Bogue developed a reputation as the "Ann Landers of California wildlife," as he was described in a 2004 profile in the New York Times.

In his daily Contra Costa Times column, Bogue fielded reader questions like "Why is my cat acting weird?" or "Why is this bird flying into my window?" said Lisa Wrenn, who was Bogue's editor for 20 years.

Readers delighted in Bogue's unconventional style, and with his experience

at the museum he could speak authoritatively about pets and wild critters alike.

"He found a way of connecting with the community," Wrenn said, noting that in a pre-internet era there were few other outlets to discuss such topics. "It was a way for people to connect about their love for animals, and the curiosity about the creatures that were coming into their backyards at night and exhibiting very unusual behaviors."

It was at the Contra Costa Times that Bogue, in the mid-1980s, met Kazakoff, who was then working as a business reporter and editor. The two got to know each other while working on a project, Kazakoff said, but the pivotal moment centered around a whale poster.

In 1988, Kazakoff was walking down a hallway at work when she ran into Bogue, who was carrying what she told him was a "beautiful" print of types of whales.

"And he looks at me and he says, 'Well, then you should have it,' " Kazakoff recalled. "So then that's how he said we started dating. A little whale poster will get you far."

Bogue's column was also how he met the acquaintance of baseball legend La Russa, who managed the Oakland A's from 1986 to 1995.

McKeever

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In 2002, Larry died and West Nile Virus hit the Niagara area, killing many of Kay's resident owls. She continued to work but her health began to decline, and the staff and volunteers of the Owl Foundation continued the work that she started. She lived in her home there until moving to Albright Manor in Ontario.

Kay was predeceased by her husband Larry, sister Betty Crowther and brother Donald Clarke. Kay is survived by children Genevieve and Rod MacFadyen; stepchildren Sheila Legon and Derek McKeever and their families; by Betty and Donald's children and their families.

Donations in memory of Kay may be sent to: The Owl Foundation, 4117 21st St., Vineland Station ON L0R 2E0.

Bogue

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The impetus for La Russa's shelter came in 1990, when a stray cat found her way onto the Coliseum field during a home game against the New York Yankees. La Russa captured the cat after some coaxing but had difficulty placing her in the East Bay shelters.

La Russa and his family were avid readers of Bogue's column and sought him out. "It was his advice that said, 'Yes, there was a need,' that motivated (La Russa's wife) Elaine and I to begin ARF (Animal Rescue Foundation) in February '91, and here it is 30 years later and ARF is going strong," La Russa said in an interview with *The Chronicle*. "Without Gary's guidance, it wouldn't have happened."

The two men remained close over the years, and Bogue served as the foundation's executive director for a time, La Russa said.

"Gary was a real mentor," La Russa said, noting that his friend's column probably touched millions over the years. "He was an inspiration to a lot of us."

Besides his wife, he is survived by two children, Jeff Bogue and Corey Colburn, stepson Karl Nielsen, six grandchildren and three great-grandchildren.

Megan Cassidy is a San Francisco Chronicle staff writer.

News

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environment had never encountered cats or other predators.

"First, we compared the behaviour of bilbies from the predator-free and predator-exposed populations in a small fenced pen of a bit over 50 m²—primarily to see how they'd react to a new environment," says Ms. Ross.

The team found that the behaviour of the animals that had previous predator exposure differed from the predator "novices".

"Animals that had lived in an environment with predators moved less and sought cover more quickly," says Ms. Ross.

"This shows that they were wariest of potential threats, whereas the predator-free group of bilbies showed fewer signs of predator awareness."

The fact that animal behaviour can be changed by predator training has been

"Unfortunately, we found that 71% of the predator-free bilbies died in the week after release, but only 33% of the predator-exposed bilbies met the same fate—showing that the bilbies who had been exposed to the very real threat of predators already had benefited from that experience."

The findings have important implications for the conservation of native animals and programs that seek to reintroduce species like the bilby.

"Our native [Australian] animals did not evolve with introduced cats and foxes," says lead author Dr. Katherine Moseby.

"Isolating threatened animals from introduced predators on islands or inside fenced reserves exacerbates the issue of prey naivety. We are advocating for a different approach whereby threatened species are exposed to these predators in the wild under controlled conditions."

The research provides evidence that predator exposure improves survival in



Pretty-eyed glass frog (*Centrolene callistommum*), from the Chocó in Esmeraldas province, Ecuador. More than 40% of amphibian species worldwide are now considered threatened by climate change.

demonstrated before—it's what the group found next that is particularly interesting.

"In a second experiment, we released bilbies from the predator-exposed paddock and some from the predator-free paddock into a third paddock with some feral cats," says Ms. Ross.

the first 40 days following translocation, and thus that *in situ* predator training may give predator-naïve species a vital edge that increases the chance of creating a sustainable population in areas with some predators.

"Our research shows that it is possible

PHOTO © SANTIAGO RON. CC BY-NC-ND 2.0 LICENSE.

to make ‘better’ prey species, because ultimately if native animals are to survive in the wild they need to be able to tolerate the threat posed by introduced predators,” says co-author Professor Mike Letnic.

Katherine Moseby agrees: “Although it may take decades or even centuries for our native species to develop the skills they need to combat feral cats and foxes, we need to be working towards that co-existence now.”

The greater bilby is a nocturnal marsupial native that once roamed over 70% of the Australian mainland. Today, the bilby is listed as vulnerable globally and nationally, with predators—mainly feral cats and foxes—thought to be largely responsible for their continuing decline. With advances in conservation research,

the aquarium industry and for display in commercial venues like shops and restaurants. Humane Society International, whose Chinese partner group VShine sent a representative at the release, praised Dalian’s law enforcement for saving the baby seals and arresting eight suspects.

In all, 71 seal pups were found alive but highly distressed; another 29 had already died and a further 20 dead seals were later found buried under nearby concrete. At less than two weeks old when found, the surviving pups were so young they hadn’t even been weaned from their mothers’ milk and required emergency veterinary care at a local institute of marine and aquatic sciences. Despite the best efforts of the specialist carers and veterinarians, some of the very weakest pups subsequently died

“We are thrilled that our Chinese partner group, VShine, was able to send animal welfare observers to the release of these seal pups back to the wild. When the pups were found by police, they were starving and traumatised, but after receiving veterinary care and rehabilitation, they are now in good health and have a good chance of thriving back at sea. For these seal pups to have been cruelly ripped away from their mothers, and crammed into a dark shed to await their fate, is really contemptible. In a country with a shocking record for wildlife exploitation and woefully little regard paid to animal protection by many police departments, Dalian police are to be congratulated for their swift action, without which many more of these seal pups would surely have perished. Their eagerness to take wildlife crime seriously, including rescuing the animals, arresting those found responsible and offering cash rewards to help apprehend more perpetrators, should act as an example to police across China in how to tackle animal cruelty cases. Sadly, China’s growing obsession for keeping marine species like seals and turtles in captivity is fuelling wildlife crime such as this, which causes immense animal suffering and loss of life.”

The hunting or trading of spotted seals without permission is banned by China’s Wildlife Protection Law, but remains a huge problem.

(See the video: <https://www.hsi.org/news-media/video-seal-pups-released/>)

Intergovernmental Report finds Unprecedented Decline of Species

BONN, Germany (May 6, 2019)—Nature is declining globally at rates unprecedented in human history—and the rate of species extinctions is accelerating, with grave impacts on people around the world now likely, warns a landmark new report from the Intergovernmental Science-Policy



Spotted seal (*Phoca largha*).

including live predator exposure, they just might bounce back from the brink.

Spotted Seal Release

LONDON, UK (MAY 13, 2019)—Thirty-seven spotted seal pups have been released back to the wild in China three months after Dalian police found the stolen animals starving and dying in a shed at a remote coastal farm in the village of Hutou, Wafangdian. The pups were snatched from the wild by traffickers for

at the marine hospital, but the surviving pups have now been released, including 24 in April.

Despite being a protected species in China, spotted seals are still hunted. Once killed for Chinese traditional medicine (male seal genitalia was used to improve virility), the pups are now stolen from their mothers to supply aquariums and commercial venues across China.

Dr. Peter Li at Humane Society International said:

WE'RE GIVING FUR BACK TO THE ANIMALS!

Born Free USA provides donated fur items to wildlife rehabilitation centers at no cost. These coats, stoles and hats provide familiar warmth and enrichment in rehabilitating injured, ill, and orphaned animals. If you're a wildlife rehabber and would like to use fur to comfort your animals, please contact us at fur@bornfreeusa.org. For more information about the Fur for the Animals campaign, please visit bornfreeusa.org/furfortheanimals



Platform on Biodiversity and Ecosystem Services (IPBES), the summary of which was approved at the 7th session of the IPBES Plenary, meeting last week (29 April–4 May) in Paris.

“The overwhelming evidence of the IPBES Global Assessment, from a wide range of different fields of knowledge, presents an ominous picture,” said IPBES Chair, Sir Robert Watson. “The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide.”

“The Report also tells us that it is not too late to make a difference, but only if we start now at every level from local to global,” he said. “Through ‘transformative change’, nature can still be conserved, restored and used sustainably – this is also key to meeting most other global goals. By transformative change, we mean a fundamental, system-wide reorganization across

technological, economic and social factors, including paradigms, goals and values.”

“The member States of IPBES Plenary have now acknowledged that, by its very nature, transformative change can expect opposition from those with interests vested in the status quo, but also that such opposition can be overcome for the broader public good,” Watson said.

The IPBES Global Assessment Report on Biodiversity and Ecosystem Services is the most comprehensive ever completed. It is the first intergovernmental Report of its kind and builds on the landmark Millennium Ecosystem Assessment of 2005, introducing innovative ways of evaluating evidence.

Compiled by 145 expert authors from 50 countries over the past three years, with inputs from another 310 contributing authors, the Report assesses changes over the past five decades, providing a comprehensive picture of the relationship between economic development pathways and their impacts on nature. It also offers a range of possible scenarios for the coming decades.

Based on the systematic review of

about 15,000 scientific and government sources, the Report also draws (for the first time ever at this scale) on indigenous and local knowledge, particularly addressing issues relevant to Indigenous Peoples and Local Communities.

“Biodiversity and nature’s contributions to people are our common heritage and humanity’s most important life-supporting ‘safety net’. But our safety net is stretched almost to breaking point,” said Prof. Sandra Díaz (Argentina), who co-chaired the Assessment with Prof. Josef Settele (Germany) and Prof. Eduardo S. Brondízio (Brazil and USA). “The diversity within species, between species and of ecosystems, as well as many fundamental contributions we derive from nature, are declining fast, although we still have the means to ensure a sustainable future for people and the planet.”

The Report finds that around **one million animal and plant species are now threatened with extinction**, many within decades, more than ever before in human history.

The average abundance of native spe-

cies in most major land-based habitats has fallen by at least 20%, mostly since 1900. More than 40% of amphibian species, almost 33% of reef-forming corals and more than a third of all marine mammals are threatened. The picture is less clear for insect species, but available evidence supports a tentative estimate of 10% being threatened. At least 680 vertebrate species had been driven to extinction since the 16th century and more than 9% of all domesticated breeds of mammals used for food and agriculture had become extinct by 2016, with at least 1,000 more breeds still threatened.

“Ecosystems, species, wild populations, local varieties and breeds of domesticated plants and animals are shrinking, deteriorating or vanishing. The essential, interconnected web of life on Earth is getting smaller and increasingly frayed,” said Prof. Settele. “This loss is a direct result of human activity and constitutes a direct threat to human well-being in all regions of the world.”

To increase the policy-relevance of the Report, the assessment’s authors have ranked, for the first time at this scale and based on a thorough analysis of the available evidence, the five direct drivers of change in nature with the largest relative global impacts so far. These culprits are, in descending order: (1) changes in land and sea use; (2) direct exploitation of organisms; (3) climate change; (4) pollution and (5) invasive alien species.

The Report notes that, since 1980, greenhouse gas emissions have doubled, raising average global temperatures by at least 0.7 degrees Celsius – with climate change already impacting nature from the level of ecosystems to that of genetics – impacts expected to increase over the coming decades, in some cases surpassing

the impact of land and sea use change and other drivers.

Despite progress to conserve nature and implement policies, the Report also finds that global goals for conserving and sustainably using nature and achieving sustainability cannot be met by current trajectories, and goals for 2030 and beyond

indirect drivers of change, as well as the social values that underpin them,” said Prof. Brondízio. “Key indirect drivers include increased population and per capita consumption; technological innovation, which in some cases has lowered and in other cases increased the damage to nature; and, critically, issues of governance



PHOTO © IPBS.NET

How was the figure of 1 million threatened species calculated? Watch the [video here](#).

may only be achieved through transformative changes across economic, social, political and technological factors. With good progress on components of only four of the 20 Aichi Biodiversity Targets, it is likely that most will be missed by the 2020 deadline. Current negative trends in biodiversity and ecosystems will undermine progress towards 80% (35 out of 44) of the assessed targets of the Sustainable Development Goals, related to poverty, hunger, health, water, cities, climate, oceans and land (SDGs 1, 2, 3, 6, 11, 13, 14 and 15). Loss of biodiversity is therefore shown to be not only an environmental issue, but also a developmental, economic, security, social and moral issue as well.

“To better understand and, more importantly, to address the main causes of damage to biodiversity and nature’s contributions to people, we need to understand the history and global interconnection of complex demographic and economic

and accountability. A pattern that emerges is one of global interconnectivity and ‘tele-coupling’ – with resource extraction and production often occurring in one part of the world to satisfy the needs of distant consumers in other regions.”

Other notable findings of the Report:

- Three-quarters of the land-based environment and about 66% of the marine environment have been significantly altered by human actions. On average these trends have been less severe or avoided in areas held or managed by Indigenous Peoples and Local Communities.

- More than a third of the world’s land surface and nearly 75% of freshwater resources are now devoted to crop or livestock production.

- The value of agricultural crop production has increased by about 300% since 1970, raw timber harvest has risen by 45% and approximately 60 billion tons of renewable and nonrenewable resources are

now extracted globally every year—having nearly doubled since 1980.

■ Land degradation has reduced the productivity of 23% of the global land surface, up to US\$577 billion in annual global crops are at risk from pollinator loss and 100–300 million people are at increased risk of floods and hurricanes because of loss of coastal habitats and protection.

■ In 2015, 33% of marine fish stocks were being harvested at unsustainable levels; 60% were maximally sustainably fished, with just 7% harvested at levels lower than what can be sustainably fished.

■ Urban areas have more than doubled since 1992.

■ Plastic pollution has increased ten-fold since 1980, 300–400 million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities are dumped annually into the world's waters, and fertilizers entering coastal ecosystems have produced more than 400 ocean 'dead zones,' totalling more than 245,000 km² (591–595)—a combined area greater than that of the United Kingdom.

Negative trends in nature will continue to 2050 and beyond in all of the policy scenarios explored in the Report, except those that include transformative change—due to the projected impacts of increasing land-use change, exploitation of organisms and climate change, although with significant differences between regions.

The Report also presents a wide range of illustrative actions for sustainability and pathways for achieving them across and between sectors such as agriculture, forestry, marine systems, freshwater systems, urban areas, energy, finance and many others. It highlights the importance of, among others, adopting integrated management and cross-sectoral approaches that take into account the trade-offs of food and energy production, infrastructure, freshwater and coastal management, and biodiversity conservation.

Also identified as a key element of more sustainable future policies is the evolution of global financial and economic systems to build a global sustainable economy, steering away from the current limited paradigm of economic growth.

“IPBES presents the authoritative science, knowledge and the policy options to decision-makers for their consideration,” said IPBES Executive Secretary, Dr. Anne Larigauderie. “We thank the hundreds of experts, from around the world, who have volunteered their time and knowledge to help address the loss of species, ecosystems and genetic diversity—a truly global and generational threat to human well-being.” ■

Space use and habitat selection of American badgers (*Taxidea taxus*) in southwestern Wisconsin

JC Doyle, DW Sample, L Long, TR Van Deelen. *The American Midland Naturalist*. 2019;182(1):63-74. <https://doi.org/10.1674/0003-0031-182.1.63>

Badger (*Taxidea taxus*) life history and ecology are poorly described despite widespread distribution in North America. We used radio-telemetry to estimate home range size and quantify habitat selection for badgers living in agricultural habitat in southwestern Wisconsin, U.S.A. Badgers in Wisconsin established relatively large home ranges (3 to 30km²), with those of males tending to be larger than females. Badgers selected broadly for nonforested grassland habitat in a matrix of agriculture, although fine-scale use varied substantially by individual. These patterns suggest that badgers tolerate levels of human alteration associated with agriculture in Wisconsin, although there may be limits to that tolerance.

Noise as an informational cue for decision-making: the sound of rain delays bat emergence

I Geipel, MJ Smeekes, W Halfwerk, RA Page. *Journal of Experimental Biology*. 2019; 222(3), 1-6. [jeb192005]. <https://doi.org/10.1242/jeb.192005>

Background noise can have strong native consequences on animals, reducing individual fitness by masking communication signals, impeding prey detection and increasing predation risk. While the negative impacts of noise across taxa have been well documented, the use of noise as an informational cue, providing animals with reliable information on environmental conditions has been less well studied. In the tropical rainforest, downpours can be intense and frequent. Strong rainfall may impede efficient orientation and foraging for bats that need echolocation to both navigate and detect prey, and can result in higher flight costs due to increased metabolic rates. Using playback experiments at

natural roosts we tested whether two bat species, differing in their hunting strategies and foraging habitats, use rain noise as a cue to delay emergence from their roosts. We found that both species significantly delayed their emergence time during rain noise playbacks compared to silence and ambient noise controls. We conclude that bats can use background noise, here the acoustic component of rainfall, as a reliable informational cue to make informed decisions, here about whether to initiate foraging trips or remain in the shelter of their roosts. Our findings suggest that environmental background noise can sometimes be beneficial to animals, in particular in situations where other sensory cues may be absent.

Immersive story

Biodiversity thrives in Ethiopia's church forests: Ecologists are working with the nation's Tewahedo churches to preserve these pockets of lush, wild habitat

Alison Abbott

Mycoplasmosis of house finches (*Haemorrhous mexicanus*) and California scrub-jays (*Aphelocoma californica*) in a wildlife rehabilitation facility with probable nosocomial transmission

KH Rogers, DH Ley, and LW Woods. *Journal of Wildlife Diseases*. April 2019;55(2):494-498. <https://doi.org/10.7589/2018-06-162>

We describe an investigation of an outbreak of conjunctivitis in juvenile House Finches (*Haemorrhous mexicanus*) and California Scrub-jays (*Aphelocoma californica*) at a central California, US wildlife rehabilitation facility. In late May 2015, the facility began admitting juvenile finches, the majority with normal eyes at intake. In June, with juvenile finches already present, the facility admitted juvenile scrub-jays, all with normal eyes at intake. In July, after conjunctivitis was observed in increasing numbers of juvenile finches and scrub-jays, carcasses were submitted for postmortem examination. Histopathology of five finches and three scrub-jays identified lymphocytic infiltrates in the ocular tissues. Conjunctival swabs from 87%

(13/15) finches and 33% (4/12) scrub-jays were PCR-positive for *Mycoplasma gallisepticum*. One finch and two scrub-jays were PCR-positive for *Mycoplasma synoviae*. Additionally, gene sequencing (16S ribosomal RNA and 16S-23S intergenic spacer region) identified *Mycoplasma sturni* from 33% (3/9) scrub-jays. This outbreak of conjunctivitis suggested that *M. gallisepticum*-infected juvenile finches admitted to and maintained in a multispecies nursery likely resulted in transmission within the facility to healthy juvenile finches and scrub-jays. Evidence of other *Mycoplasma* spp. in finches and scrub-jays indicates that these species are susceptible to infection and may act as carriers. This outbreak highlighted the need for effective triage and biosecurity measures within wildlife rehabilitation facilities.

Towards a more effective model of wildlife care and rehabilitation: A survey of volunteers in New South Wales, Australia

R Haering, V Wilson, A Zhuo, and P Stathis. *Australian Zoologist*. 2019. In-Press.

The provision of wildlife rescue and rehabilitation services in New South Wales (NSW) relies heavily on the volunteer sector. The NSW Government regulates the sector and is responsible for identifying measures for its support and delivery of services. To inform this process, we undertook an extensive review of the sector. We report here on the results from our survey of NSW volunteer wildlife rehabilitators, who have collectively reported over 1,000,000 rescues of sick and injured free-living wildlife over the past 16 years. The survey provided a unique insight into the demographics of the sector, the challenges faced, and the value of their contribution to wildlife rehabilitation. Volunteers' views on the operation of wildlife rehabilitation providers cover five key areas: governance, training, standards of care, service capacity and reporting, as well as the support received from other stakeholders, NSW Wildlife Council (the peak body for the sector), veterinary professionals and government. We found that the volunteer wildlife rehabilitation

sector in NSW provides a significant public good that is of high value to the environment, community and government. We make recommendations for investment and strategic improvements to the capacity of the sector to continue to deliver services including transitioning wildlife rehabilitation providers towards a system of accreditation in the future.

Greater vulnerability to warming of marine versus terrestrial ectotherms

ML Pinsky, AM Eikeset, DJ McCauley, JL Payne, and JM Sunday. *Nature*. 2019;569:108–111.

Understanding which species and ecosystems will be most severely affected by warming as climate change advances is important for guiding conservation and management. Both marine and terrestrial fauna have been affected by warming, but an explicit comparison of physiological sensitivity between the marine and terrestrial realms has been lacking. Assessing how close populations live to their upper thermal limits has been challenging, in part because extreme temperatures frequently drive demographic responses and yet fauna can use local thermal refugia to avoid extremes. Here we show that marine ectotherms experience hourly body temperatures that are closer to their upper thermal limits than do terrestrial ectotherms across all latitudes—but that this is the case only if terrestrial species can access thermal refugia. Although not a direct prediction of population decline, this thermal safety margin provides an index of the physiological stress caused by warming. On land, the smallest thermal safety margins were found for species at mid-latitudes where the hottest hourly body temperatures occurred; by contrast, the marine species with the smallest thermal safety margins were found near the equator. We also found that local extirpations related to warming have been twice as common in the ocean as on land, which is consistent with the smaller thermal safety margins at sea. Our results suggest that different processes will exacerbate thermal vulnerability across these two realms.

Higher sensitivities to warming and faster rates of colonization in the marine realm suggest that extirpations will be more frequent and species turnover faster in the ocean. By contrast, terrestrial species appear to be more vulnerable to loss of access to thermal refugia, which would make habitat fragmentation and changes in land use critical drivers of species loss on land.

Post-release behavior of surf scoters (*Melanitta perspicillata*) following an oil spill: An experimental approach to evaluating rehabilitation success

RT Golightly, PO Gabriel, CL Lockerby, SEW de la Cruz, JY Takekawa, LA Henkel, JG Massey, and MH Ziccardi. *Waterbirds*. 27 March 2019;42(1),39-50. doi.org/10.1675/063.042.0105.

Effectiveness of rehabilitating wildlife following oil spills has been controversial. Impacts include mortality or changes in behavior affecting health or reproduction. Immediately following a bunker fuel oil spill on San Francisco Bay, California, USA, a unique experiment was conducted to examine the movement and foraging behavior of surf scoters (*Melanitta perspicillata*) that had been oiled, captured, cleaned, rehabilitated, and radio-marked. Unoiled surf scoters were similarly cleaned, rehabilitated, and radio-marked while other unoiled surf scoters were radio-marked as controls. Surf scoters in the control group had larger home-ranges ($46.29 \pm 3.23 \text{ km}^2$) than either the oiled/rehabilitated ($32.58 \pm 5.48 \text{ km}^2$) or rehabilitated only groups ($31.06 \pm 3.05 \text{ km}^2$); the control group also was more likely to use unsheltered, shallow areas of the bay ($66.9 \pm 4.3\%$ of locations) than either the oiled/rehabilitated ($50.3 \pm 5.2\%$) or rehabilitated only groups ($58.2 \pm 6.5\%$). The oiled/rehabilitated group was closer to shore ($986 \pm 149 \text{ m}$) than rehabilitated ($1,894 \pm 295 \text{ m}$) or control groups ($2,113 \pm 227 \text{ m}$). Differences in habitat use, movement patterns, and home range sizes indicated that surfscoters held in captivity were more restricted in their movements; therefore, captivity and rehabilitation

practices may also influence success of the rehabilitation.

Rescue and rehabilitation of an Indian rock python (*Python Molurus*): first case study from Pakistan

FM Khan, F Abbas, A Nazli, M Manzoor, & ZI Khan. *Journal of Bioresource Management*. 2019;4(1). doi.org/10.35691/JBM.5102.0068.

Pythons are facing the threat of extinction due to human annihilation and interference in natural habitats of pythons. Indian rock python (*Python molurus*) has been stated as Lower Risk/Near Threatened by International Union for the Conservation of Nature (IUCN). Therefore, there is an intense need to change the perception of people and encourage them to coincide with this big snake. Current study involved the rescue and rehabilitation of an Indian rock python (*P. molurus*) spotted at the shrine of Baba Shah Jeevan, Rawalpindi, Pakistan. Python was grasped by skilled snake catchers and taken to the wildlife sanctuary in Balkasar Research Complex, Chakwal, Pakistan for the purpose of conservation. The python was kept in cage designed for reptiles (especially for snakes) having proper soil bed and shelter. Proper hygienic condition is maintained in the cage with climbing structures for the python and an adult chicken is feed to it every week. After rescue, the python was force-fed, however the natural feeding behavior of constriction and killing of prey was resumed by it after few weeks. Rescue, rehabilitation and release of pythons create a coexisting environment in between pythons and human being instead of python-human conflict, ultimately decreasing the risk of population decline of large snakes.

Effects of lead from ammunition on birds and other wildlife: A review and update

DJ Pain, R Mateo, and RE Green. *Ambio*. 2019;48: 935. https://doi.org/10.1007/s13280-019-01159-0

Poisoning of wild birds following ingestion of lead from ammunition has long been recognised and considerable recent

research has focused on terrestrial birds, including raptors and scavengers. This paper builds upon previous reviews and finds that both the number of taxa affected and geographical spread of cases has increased. Some lead may also be absorbed from embedded ammunition fragments in injured birds which risk sub-lethal and welfare effects. Some papers suggest inter-specific differences in sensitivity to lead, although it is difficult to disentangle these from other factors that influence effect severity. Sub-lethal effects have been found at lower blood lead concentrations than previously reported, suggesting that previous effect-level 'thresholds' should be abandoned or revised. Lead poisoning is estimated to kill a million wildfowl a year in Europe and cause sub-lethal poisoning in another ≥ 3 million. Modelling and correlative studies have supported the potential for population-level effects of lead poisoning in wildfowl, terrestrial birds, raptors and scavengers.

Coccidian parasites from birds at rehabilitation centers in Portugal, with notes on *Avispora bubonis* in Old World

SV Cardozo, BP Berto, I Caetano, A Thomás, M Santos, IP da Fonseca, and CWG Lopes. *Revista Brasileira de Parasitologia Veterinária*. 2019;28(2),187-193. <https://dx.doi.org/10.1590/s1984-29612019023>

Portugal has some rehabilitation centers for wild animals, which are responsible for the rehabilitation and reintroduction of birds, among other animals, into the wild. Coccidian parasites of these wild birds in rehabilitation centers are especially important because these centers can introduce coccidian species into new environments through the reintroduction of their respective hosts. In this context, the current study aimed to identify intestinal coccidia from wild birds at two rehabilitation centers for wild animals located in two municipalities of Portugal. Eighty-nine wild birds of 9 orders and 11 families were sampled, of which 22 (25%) were positive for Coccidia. *Avispora* spp. were found in raptors. Sporocysts of *Sarcocystinae* subfamily were recovered from owls. An

Isoospora sp. was found in *Turdus merula* (Linnaeus, 1758), and an *Eimeria* sp. was found in *Fulica atra* (Linnaeus, 1758). Among the coccidian species, *Avispora bubonis* (Cawthorn, Stockdale, 1981) can be highlighted. The finding of this species indicates that transmission of coccidians from the New World to the Old World may be occurring, potentially through dispersion by *Bubo scandiacus* (Linnaeus, 1758) through Arctic regions or by means of anthropic activities, and/or through other unknown mechanisms.

Trends of the Florida manatee (*Trichechus manatus latirostris*) rehabilitation admissions 1991–2017

RL Ball, M Malmi, J Zgibor. doi: <https://doi.org/10.1101/773713>.

Note: This article is a bioRxiv preprint and has not been certified by peer review. First posted online Sep. 20, 2019.

A retrospective study of admission data of 401 West Indian manatees (*Trichechus manatus latirostris*) presented to the David A. Straz Jr. Manatee Critical Care Center at ZooTampa at Lowry Park (ZooTampa) for rehabilitation from August 1991 through October 2017. Causes of admittance, location of rescue, gender, and age class were all recorded for each manatee admitted. Admittance categories as defined by the Florida Fish and Wildlife Conservation Commission (FWC) included watercraft collisions, natural causes, entanglement, entrapment, orphaned calves, captive born, mothers of rescued calves, calves of rescued mothers, human, and other. The admitted population was primarily from the southwest and northwest coasts and related waterways of Florida. The gender difference was relatively equivocal (54% female) while the adults comprised 79% of the admissions. The overall total admissions increased steadily over the study period as did the admissions for each individual categories of admission. Watercraft collisions and natural causes combined were 71% of all admissions for the entire study period and are the dominant causes of admission. Watercraft collisions are more likely to occur during May through October, whereas natural

causes of admittance are more likely to occur between December and March. Rehabilitated manatees may reduce overall manatee mortality and can provide insight into population-based health concerns if evaluated appropriately. Future efforts can incorporate physical examination findings, hematology, biochemistry profiles, and ancillary diagnostic testing to continue to improve the individual welfare of this marine mammal in its natural range. Admissions data could also potentially serve the wider conservation and recovery efforts if it is proven that the data obtained is at least as informative as that obtained by the carcass salvage program. Limited conservation resources could then be re-directed as new challenges arise with the expanding population and potentially expanding range of this species.

Epidemiological implications of drug-resistant bacteria in wildlife rehabilitation centers

FP Sellera. *J Infect Public Health*. 2019;12(5):748-49. doi: [10.1016/j.jiph.2019.06.002](https://doi.org/10.1016/j.jiph.2019.06.002).

The constant increase of antimicrobial resistance in human and animal pathogens is a current public health concern. In this regard, even though this issue seems to be more related to humans, food-producing and companion animals, it also has implications for wildlife. To date, discussions about transmission routes of drug-resistant bacteria in wildlife are in evidence. Their identification in migratory wild animals inhabiting remote environmental niches with limited human footprints has been documented, such as in isolated oceanic islands and Antarctic region. Direct contact with agricultural and livestock facilities or other anthropogenic impacted environments has been considered the main transmission pathway of drug-resistant pathogens to wild populations. On the other hand, some studies have point out that wildlife-human interactions and contact with other diseased animals could also favor these transmissions. Wildlife rehabilitation centers provide shelter, care and rehabilitation with the central purpose of releasing native wildlife back into their natural habitat. These institu-

tions are remarkably important for wildlife conservation, playing a paramount role to reduce the negative impacts of human-associated activities in wildlife ecosystems. However, it is plausible that reintroduction programs could unintentionally contribute for the transmission of human-associated pathogens to wild animals and natural environments. Ingestion of contaminated food and direct contact with other hospitalized animals or rehabilitation staff may be potential transmission pathways of drug-resistant bacteria to animals undergoing rehabilitation. A remarkable example was observed in sanctuary apes from Zambia and Uganda, where the transmission of drug-resistant, human-associated lineages of *Staphylococcus aureus* between humans and chimpanzees was suggested. Similar situations were documented in wildlife rehabilitation centers in U.S. Jijón et al. have identified a ceftiofur-resistant *Salmonella Kentucky* in an Eastern gray squirrel (*Sciurus carolinensis*) in Ohio. Likewise, Steele et al. have recovered 13 multidrug-resistant bacteria from seabirds in California and Washington. Unfortunately, it remains unclear if the animals entered the rehabilitation facilities carrying these strains or if they became colonized after admission. More worrisomely, some global priority pathogens [e.g., extended-spectrum β -lactamases (ESBL)-producing *Enterobacteriaceae*, carbapenem-resistant *P. aeruginosa*, multidrug-resistant *Salmonella* spp., and methicillin-resistant *Staphylococcus* spp.] may present versatile behavior and be able to colonize and persist in gut or skin microbiota of human and wildlife hosts. As a result, asymptomatic animals colonized by these bacteria may lead to severe ecological implications when released into the environment. In summary, the appearance of drug-resistant pathogens in wild animals of rehabilitation centers constitutes a serious risk to balance of wildlife ecosystems. The reintroduction of asymptomatic carriers could offer substantial implications to conservation of endangered or threatened species. As a matter of urgency, scientific community and wildlife authorities must debate this issue as a new ecological concern. Perhaps,

transmission of drug-resistant bacteria could be reduced by implementation of simple prophylactic measures. Additional actions could involve housing infected animals individually to avoid cross-contamination to other hospitalized animals. Finally, continuous surveillance of antimicrobial resistance may significantly contribute to determine possible transmission routes of drug-resistant pathogens between humans, wildlife and their shared environments.

A novel orthoreovirus associated with epizootic necrotizing enteritis and splenic necrosis in American crows (*Corvus brachyrhynchos*)

MJ Forzán, RW Renshaw, EM Bunting, E Buckles, J Okoniewski, K Hynes, M Laverack, M Fadden, A Dastjerdi, K Schuler, et al. *Journal of Wildlife Diseases*. October 2019;55(4), 812-22. doi.org/10.7589/2019-01-015

Epizootic mortalities in American Crows (*Corvus brachyrhynchos*) during the winter months, referred to as winter mortality of crows, have been recorded in North America for almost two decades. The most common postmortem findings include necrotizing enteritis, colitis, and fibrinous splenic necrosis. These findings are proposed to be due to infection with a Reovirus sp. Our objectives were to characterize the pathology and seasonality of the epizootics in New York State (NYS), confirm the causative role of an Orthoreovirus sp., and determine its phylogeny. On the basis of our proposed case definition for reovirus, we examined case data collected by the NYS Wildlife Health Program for 16 yr. A total of 558 cases of reovirus were recorded between 2001 and 2017. Reovirus had a clear seasonal presentation: cases occurred almost exclusively in winter months (71% in December–January). Detailed data from a 2-yr period (2016–17) demonstrated that reovirus caused up to 70% of all recorded crow deaths during epizootic months. Crows with positive orthoreovirus isolation from the spleen or intestine were 32 times more likely to die with characteristic histologic lesions of enteritis or enterocolitis and

splenic necrosis than crows with negative isolation results. An in situ hybridization probe specific to virus isolated from NYS crow reovirus cases demonstrated a direct association between viral presence and characteristic histologic lesions. Sigma C (capsid protein) sequences of isolates from NYS crows showed high homology with Tvärminne avian virus, recently proposed as a novel *Corvus* orthoreovirus clade, and only distantly related to the avian orthoreovirus clade. Our study indicated that a novel orthoreovirus was the cause of winter mortality (or reovirus) of American Crows and placed the NYS isolates in the newly proposed genus of *Corvid* orthoreovirus.

Fatal West Nile virus infection in a Virginia opossum (*Didelphis virginiana*) with pulmonary lepidic-predominant adenocarcinoma.

Benjamin Lamglait and Stéphane Lair. *Journal of Wildlife Diseases*. October 2019;55(4), 990-94. doi.org/10.7589/2018-12-284

A fatal case of West Nile virus (WNV) infection was diagnosed based on histopathologic findings and the presence of WNV RNA by reverse transcription PCR in the affected organs in a Virginia opossum (*Didelphis virginiana*) in Quebec, Canada in 2017. Disease caused by WNV has not been described in a marsupial species. ■

TAIL END



Clyde always knew he had something a little extra.

BACTRIAN CAMEL (*Camelus bactrianus*)

PHOTO © LILLIAN CAMERON. CC BY-SA 2.0.

INSTRUCTIONS FOR AUTHORS

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

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

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

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Lappet-faced vulture (*Torgos tracheliotos*). Ready for its close-up (see page 7). PHOTO © RICHARD TOWELL. CC BY-NC-ND 2.0.



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