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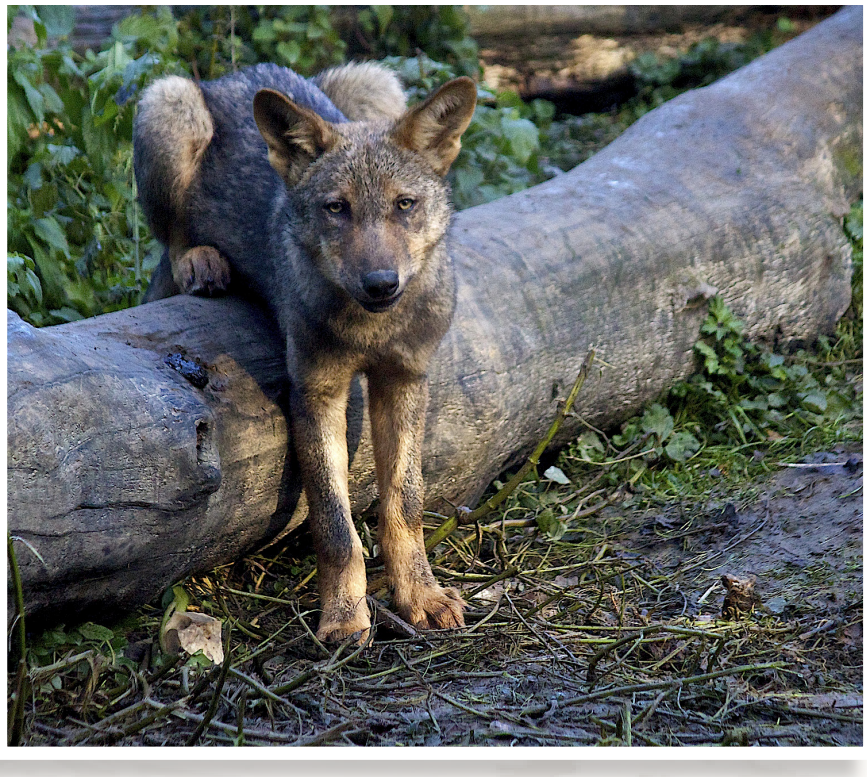
ABOUT THE JOURNAL

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



Left:
Young Iberian wolf (*Canis lupus signatus*).
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On the cover:
Koala pair (*Phascolarctos cinereus*).
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EDITORIAL

Celebrating Our International Duty of Wildlife Rehabilitation

This year marks the 100th anniversary of the Convention for the Protection of Migratory Birds, signed August 16, 1916, by the US and Great Britain (on behalf of Canada). Over the course of the 20th century, birds who spent part of their migratory travels in North America were given federal protection by the US, Canada, Mexico, Japan, Russia, and many South and Central American governments. Looking back from 2016, that first treaty was a watershed moment for the international protection of all wildlife, not just for birds that crossed the 49th parallel. It is part of our wildlife rehabilitation history.

History

1916 Convention for the Protection of Migratory Birds, between the US and Canada

1936 Convention for the Protection of Migratory Birds and Game Animals, between Mexico and the US

1940 Western Hemisphere Convention, a multilateral treaty by 17 American countries

1972 Convention for the Protection of Migratory Birds and Birds in Danger of Extinction and Their Environment, between the US and Japan

1976 Convention Concerning the Conservation of Migratory Birds and Their Environment, between the US and the former USSR

1979 Bonn Convention on Migratory Species (CMS), among 122 countries

Treaties and rehabilitators

Avian rehabilitation in the US is governed by the Migratory Bird Treaty Act, and in Canada by the Migratory Birds Convention Act; both acts were created to carry out the agreements made in the 1916 Convention. Wildlife rehabilitation, in North America at least, owes a direct debt to the 1916 Convention for the parameters governing our care for birds. Other treaties may be equally important to other countries practice of wildlife rehabilitation—in Chile, the CMS provides a framework for care and capture of migratory species.

International treaties are a tool to protect wildlife; what we sometimes forget is that they apply not just to sovereign nations, but to individual citizens, companies, and nongovernmental organizations, be they international like IWRC or local.

Migration and rehabilitation

Migration is a fact of life for species as diverse as hummingbirds, wildebeest, and sea turtles. We would be poor rehabilitators indeed if we didn't take migration into account in wildlife care and management—especially as it pertains to release criteria: when, where, and the critical suitability of a release site. Wildlife rehabilitators protect animals all along migratory routes; we must communicate and share resources to ensure that Swainson's hawks are still seen on the pampas of Argentina and the Taiga plains of Canada, and snow leopards exist in mountainous regions from Pakistan to Tajikistan.

According to the Fish & Wildlife Service, "International cooperation among governments, NGOs, and other stakeholders is required along the entire flyway and throughout the entire life cycle of a species to share knowledge and to coordinate conservation efforts."

International migratory protections have come a long way, and have a ways still to go. But it all began 100 years ago with that first treaty. The Migratory Bird Treaty Centennial is an opportunity to engage the public to increase knowledge of and support for conservation programs and promote everyday actions for wildlife conservation around the world.

Reference: www.fws.gov/birds/MBTreaty100/messages.php

—Kai Williams
Executive Director

Landmark SeaWorld Policy Shifts

Washington, DC (March 17)—In a dramatic shift that signals an eventual end to the practice of keeping captive orcas for public exhibition, SeaWorld announced it would cease all of its orca breeding programs for the company's nearly 30 whales. This action will make the current group the last generation of SeaWorld's orcas. The Humane Society of the United States, which worked with SeaWorld on these new policies, praised its reforms as a major step forward toward a humane economy in which corporations respond and adapt to public concerns over animal welfare.

"These two organizations have been long-time adversaries, but we're excited now to see the company transforming its operations for the better on animal welfare," said Wayne Pacelle, president and CEO of The HSUS. "Today's announcement signals that the era of captive display of orcas will end and that SeaWorld will redouble its work around rescue and rehabilitation of marine mammals in crisis and partner with us to tackle global threats to marine creatures."

"SeaWorld takes seriously its responsibility to preserve marine wildlife. As one of the largest rescue organizations in the world, we will increase our focus on rescue operations so that the thousands of stranded marine mammals like dolphins and sea lions that cannot be released back to the wild will have a place to go," said Joel Manby, president and CEO of SeaWorld. "This is a defining moment. The fact that SeaWorld is doing away with orca breeding marks truly meaningful change," said Gabriela Cowperthwaite, director of *Blackfish.*

Through collaboration or confrontation, and sometimes a combination of the two, The HSUS has worked in recent years to secure substantial animal welfare commitments from companies working within food and agriculture, cosmetics and chemical manufacturing, fashion, the pet industry, animals in entertainment, and other sectors. In addition to its new policies for orcas, SeaWorld has committed to maximizing its focus on rescue and rehabilitation of marine animals in distress and highlighting the plight of unreleasable animals to foster a stronger bond between humans and animals and to educate people about ongoing threats to these animals.

Deb Sheaffer (July 5, 2016)

Deb Sheaffer, Portland Audubon's Wildlife Veterinarian, passed away on July 5, just a month after she learned that the cancer she had battled so bravely last summer had returned. She is survived by her husband Ron, her children Nate and Mary.

Deb volunteered at the Wildlife Care Center in the early 1990s and became its first staff veterinarian and operations manager in 2003. She was a vital part of the community. In recent years, she and Lacy Campbell co-managed the Center.

In the 1990s, when Portland Audubon depended on local veterinarians to donate their skills, Deb was always game, whether called on late at night, facing an outrageous adventure, or treating an animal others might decline.

During her time on staff, Deb treated more than 30,000 wild animals, mentored hundreds of volunteers, and answered tens of thousands of wildlife questions from the public. She taught Junior Wildlife Camps and presented research on lead toxicity and wildlife diseases at conferences. According to Director Bob Sallinger, "...she was a healer, a teacher, a mentor, and a warrior in the fight to save our imperiled planet. She will live on in all the people she touched, all the love she put into the Center, and all the wild birds she put back into the sky."

In lieu of flowers, the family has requested that donations in honor of Deb be made to Portland Audubon's Wildlife Care Center. You can also see Deb here, in an OPB story on the Wildlife Care Center.

Record-breaking Heat

Silver Spring, MD, USA (March 17)—Record warmth across the globe was aided by a strong El Niño that peaked during the winter. The average temperature for the globe during December-February was 2.03°F above the 20th century average according to scientists from NOAA's National Centers for Environmental Information. This was the highest temperature for December-February in the 1880-2016 record, surpassing the previous record set in 2015/16 by 0.52°F. This also marks the highest 3-month departure from average for any 3-month period on record, surpassing the previous record set last month, November 2015-January 2016, by 0.16°F. The February average temperature for the globe was 2.18°F above the 20th century average. This was not only the highest for the month of February in the 1880-2016 record (surpassing the previous record set in 2015 by 0.59°F), but it surpassed the all-time monthly record set just two months ago in December 2015 by 0.16°F. February 2016 also marks the 10th consecutive month a monthly global temperature record has been broken.

Transportation Industry Getting Serious about Wildlife Trafficking

London (March 15)—The signing of a new declaration at Buckingham Palace committing global transportation industry leaders to major steps in fighting criminal wildlife trafficking has been hailed by The Duke of Cambridge as "a game changer in the race against extinction."

Forty CEOs, chairmen, and other leaders of airlines, shipping firms, port operators, customs agencies, intergovernmental organizations and conservation charities from around the world have become the founding signatories of the Declaration of the United for Wildlife International Taskforce on the Transportation of Illegal Wildlife Products.

The Buckingham Palace Declaration is the result of a year's worth of meetings, research, and coalition building by the United for Wildlife Transport Taskforce, with industry representatives including companies and organizations based in China, the USA, the UAE, Kenya, the UK, and Denmark.

PHOTO © NROSIE WALUNAS/USFWS. CC BY-NC-ND 2.0 LICENSE.

A newly hatched bog turtle (*Glyptemys muhlenbergii*) with its egg sac still attached. Past Illegal wildlife (pet) trade is one factor in this US species' IUCN status as "critically endangered."

The Buckingham Palace Declaration commits signatories to eleven commitments that will raise industry standards to prevent traffickers from exploiting weaknesses as they move their products from killing field to marketplace. The commitments focus on information sharing, staff training, technological improvements, and resource sharing across companies and organizations worldwide, as well as assistance to those in nations who are in need of expertise and new systems.

The work of the United for Wildlife Transport Taskforce has been strongly supported not only by the transport sector but by a number of intergovernmental agencies including the World Customs Organisation, the United Nations Development Programme, and the Convention on Illegal Trade in Endangered Species of Flora and Fauna (CITES)—the world's regulatory instrument on trade in endangered species.

The commitments in the Buckingham Palace Declaration include:

- Developing information-sharing systems for the transport industry to receive credible information about high-risk routes and methods of transportation,
- Supporting a secure system for passing information about suspected illegal wildlife trade from the transport sector to relevant customs and law enforcement authorities, and
- Notifying relevant law enforcement authorities of cargoes suspected of containing illegal wildlife and their products and, where able, refusing to accept or ship such cargoes.

United for Wildlife, the global coalition of conservation organizations of which The Duke of Cambridge is president, will focus on implementation.

World Wildlife Fund Reports That Lack of Government Support Affects Wildlife Ranger Safety

Kuala Lumpur, Malaysia (March 3)—The men and women who protect the planet's wildlife feel they lack support from governments to enable them to do their jobs safely, according to the results of an Asia-based survey released on World Wildlife Day.

The survey included 530 rangers across 11 tiger range countries and found that 63 percent had faced a life-threatening situation, 74 percent felt they were ill-equipped, and 48 percent felt they lacked adequate training. Surveys from other regions will be released in the coming months.

"It's a dangerous job and bravery is not enough," said Rohit Singh, president of the Ranger Federation of Asia (RFA) and WWF Enforcement Specialist. "Poaching is at critical levels across Asia and these heroic men and women must have the necessary tools and training to do their job safely and successfully."

The survey also found that many rangers have a poor work/life balance, with 45 percent of rangers seeing their families for less than five days a month, while 30 percent of rangers ranked low or irregular pay as one of the worst aspects of their jobs.

Rangers are the first line of defense for the world's endangered species, many of which are threatened by the unprecedented surge in wildlife crime. The current global poaching crisis is increasingly driven by international organized criminal networks, which increase the risk of violence and danger for rangers.

The aim of the survey is to provide a snapshot of ranger working conditions and gain insight into the factors that affect the motivation of rangers. Similar surveys are underway across Africa and South America. These will be followed by in-depth reports on working condition indicators (pay, hours worked, access to equipment,

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Case study: Iatrogenic diabetes mellitus in a koala *(Phascolarctos cinereus)* receiving treatment with prednisolone

Sheridan E. Lathe

PHOTO ©ZOE SHUTTLEWORTH. CC BY-NC-ND 2.0 LICENSE.

ABSTRACT: Diabetes mellitus is a well recognized condition in human and veterinary medicine that can be induced by the administration of glucocorticoids. Prednisolone is a glucocorticoid used to treat inflammation in koalas *(Phascolarctos cinereus)*. A free-living koala from the South Australian Mount Lofty Ranges population received treatment with prednisolone for the treatment of pruritis and skin inflammation. Clinical signs of diabetes mellitus developed in this koala during treatment with prednisolone and resolved after cessation of treatment.

KEY WORDS: Australia, diabetes, iatrogenic diabetes mellitus, koala, prednisolone

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Introduction

A two-year-old, free-living female koala (*Phascolarctos cinereus*) was presented at the Adelaide Koala and Wildlife Hospital (Plympton, Adelaide, South Australia) in March 2015 with pruritic and exudative dermatitis of the chin, ventrum, and forelimbs associated with excessive salivation and wetting of the fur. A physical examination was carried out under sedation and no cause was found for the excessive salivation. An impression smear from affected skin revealed a mixed infection of *Malassezia* species and unidentified gram positive cocci. The animal subsequently developed clinical symptoms of diabetes mellitus while being treated with prednisolone, which is used in the treatment of koalas at a number of facilities in Australia to control inflammation associated with cystitis and skin conditions.

J. Wildlife Rehab. 36(2): 7-10. © 2016 International Wildlife Rehabilitation Council.

Diabetes mellitus is a metabolic disease characteried by insulin deficiency or resistance, resulting in hyperglycemia.[1] Two cases of diabetes mellitus have been described in koalas (*Phascolarctos cinereus)*,[2,3] however, pathogenesis could not be determined definitively in either case. Steroid-induced diabetes mellitus is a well-recognized syndrome in human medicine[4] and has also been described in feline medicine in detail.[1] Glucocorticoids have been documented in causing insulin resistance by a variety of mechanisms.[4,1] These mechanisms include the inhibition of glucose transport in skeletal muscle, the suppression of insulin secretion by pancreatic beta cells, and interference with insulin signalling pathways.[4,1]

Methods

Oral trimethoprim-sulfamethoxazole (TMS) (Bactrim®, Mutual Pharm, USA) suspension was started at 15 mg/kg twice daily to control bacterial infection. Oral nystatin (Nilstat®, Aspen Pharm, AUS) was started at 50,000 IU/kg twice daily to control fungal infection. Oral prednisolone (Redipred®, Aspen Pharm, AUS) was started at 0.5 mg/kg twice daily to control pruritis. On day one during the initial examination, the koala's blood glucose concentration was 4.82 mmol/L (ref: 2.7–7.2 mmol/L).[5]

TABLE 1. PREDNISOLONE DOSE AND CORRESPONDING BLOOD GLUCOSE LEVELS.

DAY OF TREATMENT	PREDNISOLONE ADMINISTERED (DOSE RATE: 0.5 MG/KG)	BLOOD GLUCOSE (MMOL/L)
1	Twice	4.82
2	Twice	
3	Twice	
4	Once	
5	Once	
6	Once	
7	Once	20.01
8	Once	21.02
9	Once	
10	-	
11	Once	22.9
12	-	19.8
13	Ceased treatment	20.3
14	-	20.1
15	-	
16	-	
17	-	
18	-	
19	-	1.2
20	-	1.2

A urinalysis performed on day three of treatment did not identify glucosuria. Urinalysis was repeated on day seven of treatment and identified glucose in the koala's urine. Urinalysis results were obtained from free catch samples that had been in contact with concrete flooring or litter trays. A drop of urine was placed onto the glucose test square of a Seimens Multistix urine dipstick and the glucose was read at 60 seconds.

A blood sample was collected that identified the koala's blood glucose concentration was 20.01 mmol/L. This prompted regular blood glucose readings, with blood glucose concentrations remaining above 17 mmol/L for the next seven days. Whole blood was taken on days one, seven, and eight from the cephalic vein using a 22 g needle and 3 ml syringe. The whole blood was placed into a lithium heparin tube and centrifuged. The serum was separated and the blood glucose level determined using the IDEXX VetTest 8008® Chemistry Analyzer (IDEXX, USA). Due to difficulty with blood draws in conscious koalas, daily sampling was not always possible but was attempted. Smaller whole blood samples were taken from the cephalic vein using a 22 g needle and 1 ml syringe on subsequent days due to difficulty obtaining enough blood volume to run in the IDEXX VetTest 8008 Chemistry Analyzer. These blood samples were read using OneTouch VerioIQ® Glucometer (LifeScan Europe, Switzerland).

Treatment with prednisolone was ceased on day 13. Six days after cessation of treatment with prednisolone, the blood glucose level declined to 1.2 mmol/L. Trimethoprim-sulfamethoxazole and nystatin treatment were continued during this time.

Table 1 presents the blood glucose levels measured during treatment and the corresponding dose of prednisolone. The blood glucose concentrations became elevated between day one and day seven of treatment and fall to below normal range between day two and day six after the cessation of oral prednisolone.

Discussion

A variety of clinical signs were observed during the koala's treatment period, some of which could be attributed to diabetes mellitus. During the koala's time in the hospital, she was observed to have progressive weight loss, polydipsia, and lethargy. The koala weighed 4.5 kg on admission to the hospital and was 3.7 kg at the end of her treatment. Complete blood counts and serum biochemistry were run on day one and day seven of treatment with all values within the normal range, with the exception of blood glucose concentrations. An endoscopic examination of the oral cavity, trachea, and esophagus was conducted under anesthetic on day eight of treatment to diagnose a cause for the excessive salivation; no abnormalities were detected.

Although the koala did have improvements in skin condition during her treatment, the excessive salivation remained and weight loss continued. After a month of treatments with deteriorating condition, the decision was made to euthanize the koala.

A postmortem examination was performed immediately after euthanasia. No gross abnormalities were noted, with the exception of poor body and coat condition. Samples were taken of the

Figure 1 (top right). Gross examination revealed no abnormalities aside from poor body and coat condition.

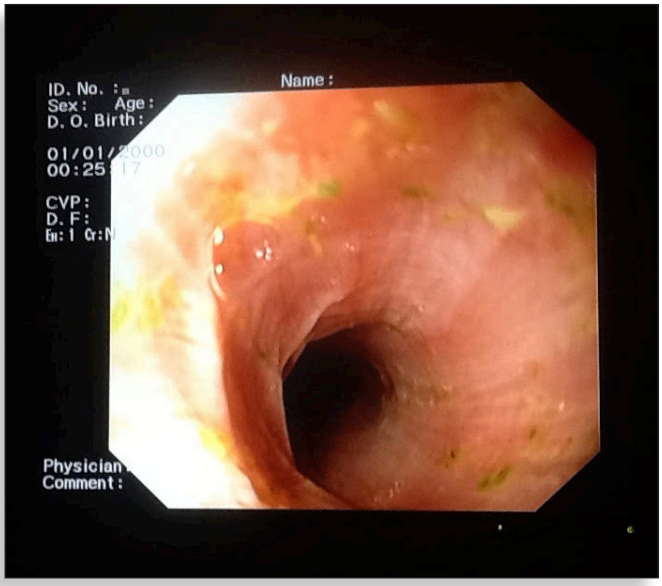

Figure 2 (bottom right). Endoscopic examination of esophagus on day eight of treatment.

pancreas and adrenal gland and sent to IDEXX laboratories for histopathological examination. Both the pancreas and adrenal gland were histologically normal. Type 1 human diabetes and canine diabetes display histological changes of the pancreas, including insulitis, inflammation, and a reduction or degeneration of beta cells.[6] The normal histological structure of the pancreas in this case suggests there was no auto-immune involvement in the development of diabetes, making it likely that the prednisolone reduced insulin secretion, caused insulin resistance leading to the manifestation of diabetes mellitus, or both. Changes in blood glucose concentrations are not reported with the use of nystatin. Trimethoprim-sulfamethoxazole has been associated with hypoglycemia, but a study in human diabetic patients showed no increases in blood glucose concentrations with its use.[7]

The limitations of this study include the inability to obtain regular blood samples due to patient compliance, staff availability, and technical skills of staff. Further testing such as insulin assays, fructosamine assays, and histopathological analysis of additional organs was not performed due to cost limitations.

Management implications

Steroid induced diabetes mellitus in the koala has not previously been reported. Clinical signs of diabetes mellitus developed in this koala during treatment with prednisolone and resolved after cessation of treatment. Steroid-induced diabetes mellitus may be a clinical syndrome currently going unrecognized in koalas receiving treatment with glucocorticoids. This case study suggests koalas may have a susceptibility to developing diabetes mellitus while receiving treatment with prednisolone, and the use of medium- to long-term glucocorticoid treatment should be approached with caution. If the use of glucocorticoid treatment is deemed necessary, regular blood glucose analysis and urinalysis should be performed.

About the Author

Dr. Sheridan Lathe worked as the head veterinarian for the Adelaide Koala and Wildlife Hospital in 2014 and 2015. During that time, the hospital treated over 1500 cases, over half of which were koalas. Dr. Lathe currently works in China for Animals Asia, where she aids in the rehabilitation of bears rescued from bile farms. She is currently contributing to studies on koala diseases and bear medicine.

Acknowledgments

Dr. Lathe would like to acknowledge the staff and volunteers at the Adelaide Koala and Wildlife Hospital for their dedication to the region's wildlife and for their assistance with treatments. In particular the author would like to thank Dr. Phil Hutt, who founded the hospital in 2013.

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Captive enrichment for owls *(Strigiformes)*

Aurora Potts

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Barn owl *(Tyto alba).*

ABSTRACT: Owls *(Strigiformes)* have been a source of fascination for wildlife rehabbers, zookeepers, falconers, and many others throughout history. They can be slow to learn and difficult to work with. Their behavior is quite different from diurnal raptors because of their unique nocturnal adaptations. Given their popularity as education and flight demonstration birds, captive owls offer researchers and observers a chance to observe how these animals interact with the world around them. Enrichment is an important component of keeping any animal mentally and physically healthy in captivity, but devising enrichment for owls can be challenging. A survey (Appendix A) was sent to 622 wildlife rehabilitation centers, raptor centers, nature centers, zoos, falconers, and similar institutions across the United States in an effort to determine the success and failure of various methods of enrichment for various owl genera, as well as imprints versus non-imprints. Significant findings suggest distinct correlations between imprints and non-imprints for both successful and failed enrichment among *Bubo* and *Tyto* species, respectively. Additionally, significant correlations were measured between imprints and non-imprints among all owl genera for successful and failed enrichment.

KEYWORDS: owl, genera, enrichment, zoo, wildlife, rehabilitation, cognitive abilities, animal welfare, falconry, husbandry, captivity

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Introduction

A survey was conducted to assess current captive owl enrichment practices in the United States. Enrichment helps encourage natural behaviors expressed by animals in the wild and stimulates them physically and mentally in captivity.[1] Owls are no exception; however, anyone who has had the pleasure, or perhaps frustration, of working with an owl will not think of this bird first among species that require significant stimulation.

Owls are highly instinctual predators with a very advanced brain for sensing light and sound.[2,3] Owls are known to cache their food, and it has been shown that captivity reduces the hippocampal volume of other food-storing birds.[4] Spatial orientation, memory, and other cognitive processes are directly linked to the avian hippocampus.[5] Captivity can cause stress, social isolation, and reduced exercise, and present fewer hippocampal-related opportunities than would otherwise be experienced in the wild, thereby depriving birds the use of their abilities to exhibit natural behaviors encouraged by hippocampal growth and usage, such as caching food.[4] This suggests food-caching owls in particular could benefit from enrichment that would utilize spatial orientation and memory, supporting the need to further investigate captive owl enrichment.

Owls are commonly kept in captivity because of their value as education birds.[6] Enrichment is a growing facet of animal welfare that is often overlooked as a consideration in manuals on captive owl husbandry.[7,6,8,9,10] Therefore, a closer examination of captive owl enrichment is warranted to help establish a baseline to improve upon within this field. Each owl genus may have unique enrichment preferences in captivity.

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Owls can become imprinted when raised in captivity from a very young age, possibly resulting in a more easily trained individual.[11] Many injured juvenile and adult owls arrive in captivity and are deemed non-releasable upon recovery. It is possible that imprinted owls may respond to enrichment differently from non-imprinted individuals.

Study Area

The study area consisted of 622 wildlife rehabilitation centers, raptor centers, nature centers, zoos, falconers, and similar institutions in all 50 United States. These institutions represent the current practices for owl enrichment in the nation. An Internet search using the Google search engine produced these institutions using key words: owl, wildlife rehabilitation, and zoo, paired with each state's name.

Great-horned owl *(Bubo virginianus).*

Methods

An online survey was developed and hosted on Survey Monkey. The survey consisted of six questions aimed at distinguishing successful and unsuccesful enrichment for each owl genus with respect to making the distinction between imprinted and non-imprinted owls (Appendix A). Success was determined by any engagement from at least one past or present owl under the care of the respondent. Failure was determined by at least one past or present owl under the care of the respondent ignoring enrichment or displaying signs of stress resulting from the enrichment. Potential respondents were identified at 622 wildlife rehabilitation centers, raptor centers, nature centers, zoos, falconers, and similar institutions across the United States. Invitations were sent by email with a link to the instrument between February 23, 2015, and March 6, 2015, in one attempt with no reminders. The survey included a statement of anonymity and consent, as well as a notice that participants must be 18 years of age or older. The survey closed on March 30, 2015. A Pearson's correlation coefficient (r) test was performed to determine whether any significant relationships could be identified for each genus, and whether there was any significant difference between imprints and non-imprints.

Discussion

Owls possess a high level of brain complexity as indicated by their Portmann's index value of 14.37, which is just below the 15.3 value of crows.[12] The Portmann's index is measured by the ratio of weight from forebrain to brainstem compared to the body weight of the bird and is congruent with the oldest avian orders such as Galliformes and Columbiformes, having the lowest values of 3 and 4, respectively, while orders such as Psittaciformes possess values as high as 28.[13] Research conducted by Stingelin (1958);[14] Rehkamper, Frahm, and Zilles (1991);[15] Rehkamper, Frahm, and Mann (2001);[16] and Timmermans et al. (2000)[17] confirm the validity of the Portmann's index to measure avian brain complexity.[13]

The higher the brain complexity, the more mental stimulation and cognitive enrichment an animal in captivity can require. Higher cognitive abilities are shown in barn owls (*Tyto alba*) because they use illusory outlines to determine an object.[2] Barn owls have been the most extensively studied Strigiformes species, and neurological data strongly suggest they must assimilate enormous amounts of competing visual and auditory information in response to stimuli.[2,3] Additionally, Eastern screech owls (*Megascops asio*) portray a unique problem-solving intelligence given that they drop blind snakes (*Leptotyphlops dulcis*) into their nests to eradicate flies.[18] However, when given a means-end string test, eleven great gray owls (*Strix nebulosa*) were unable to comprehend the relationship between pulling a string in order to receive a food reward, with one exceptional individual that exceeded the chance level of correct choice occurrence.[12] Perhaps this test would be more successful with a barn owl. A different test that stimulates the owl's instinctual response to auditory and visual stimuli would also likely yield better results.

Sensory enrichment for the owl's hearing and eyesight, along with environmental enrichment such as exposure to the natural elements and hiding places, are important components for the captive owl. Wild owls must hunt for food; therefore, food enrichment is important for owls in captivity. Additional forms of owl enrichment may include objects to manipulate with their beak and talons (e.g., toys).

Positive reinforcement training for less stressful veterinary examinations and for the purpose of enriching and educational flight demonstrations are also great forms of enrichment for owls. Positive reinforcement training helps reduce stress with unfamiliar situations and medical procedures, but it also promotes learning and mental stimulation.[19,20] Positive reinforcement training involves conditioning a desired response with a reward, which is usually food. This can be problematic with many wild owls in particular, as access to food sources can be unpredictable and owls are able to fast for extended periods of time.[21,22] This means they may be less food motivated and, therefore, more challenging to train and enrich in this way.

It is important to make the distinction between non-imprinted and imprinted owls. Their behavior is very different. Owls are susceptible to imprinting—identifying humans as parents and as a mate template—during the first few weeks after hatching (Roger Holloway, pers. comm., April 17, 2015). Imprinted owls are habituated to humans, and they are generally easier to train and enrich. Non-imprinted owls are more likely to exhibit signs

of distress around humans.

It has been suggested that non-imprinted owls may possess higher self-preservation instincts and avoid unfamiliar or unnatural enrichment specifically. It is unclear if imprinting affects brain complexity; however, given that captivity affects hippocampal volume in food-caching birds,[4] it is possible an imprinted captive owl may not get enough physical exercise, resulting in poor hippocampus growth compared to a non-imprinted, wild-reared owl.

A correlation coefficient was calculated for each category's successes and failures for imprints and non-imprints, then again with imprints and non-imprints separated into genera. The frequency of success and failure for each category was recorded only once for each respective institution despite the number of individual birds in captivity (past or present). Depending on the genus, certain responses fell under different categories; for example, live fish are more likely visual (sensory) stimulation for *Aegolius*, but can fall under novel (food) for the larger genus *Strix*.

A correlation coefficient above 0.5 indicated a relationship was present.[23] Some survey responses provided broad responses while others were very specific. In order to include as many responses as possible in the analysis, specific enrichment was categorized into smaller categories within the main five aforementioned. For responses listing something broad, e.g., "novel food item" with no description of the item, each smaller category such as "Food–novel" added all specific novel food items listed in addition to the occasional broad answer. While the response "novel food item" could not be used with a specific novel food item, the response still contributed to the overall category in this way.

Results

Although the survey had a 21% (n = 133) total response rate, 29% (n = 39) of submitted surveys were incomplete, resulting in a 15% net response rate (n = 94). Survey responses were analyzed and grouped into five categories of enrichment: (1) sensory; (2) food; (3) manipulational; (4) environmental; and (5) social.

There was a high correlation between imprinted and non-imprinted *Bubo* species for both successful engagement (r = 0.928) and unsuccessful engagement (r = 0.757) with specific enrichment items (i.e., both imprints and non-imprints engaged with or failed to engage with the same enrichment items). Similarly, there was a high correlation between imprinted and non-imprinted *Tyto* species for both successful engagement (r = 0.887) and unsuccessful engagement (r = 0.757) with specific enrichment items (Appendices B and C). These two genera were the most prevalent in the survey responses and are likely the most commonly found in US wildlife rehabilitation centers and zoos.

Additionally, a significant correlation exists between the engagement responses of imprints and non-imprints across all reported owl genera for both successful enrichment (r = 0.933) and unsuccessful enrichment (r = 0.840). These data suggest little distinction is necessary in the choice of the enrichment provided to imprinted and non-imprinted captive owls (Appendices D and E).

The top three most common successful enrichment opportunities for imprints include glove training with 45 (8.8%) responses, flight training at 29 (5.7%) responses, and nesting opportunities with 25 (4.9%) responses (Appendix D). The top three most common successful enrichment opportunities for non-imprints include glove training at 85 (11.4%) responses, education programs with 46 (6.2%) responses, and boxes at 27 (3.6%) responses.

The top three most common failed enrichment opportunities for imprints include general pet toys with 17 (10.7%) responses, hidden food with 7 (4.4%) responses, and nesting opportunities and balls each with 6 (3.8%) responses (Appendix E). The three most common failed enrichment opportunities for non-imprints include glove training at 23 (6%) responses, nesting opportunities and paper products each with 19 (5%) responses, plus general pet toys with 16 (4.2%) responses.

Other noteworthy results include anecdotal evidence from the survey respondents, many of whom describe an innate need or desire, among the *Bubo* genus in particular, to shred items. Also, the use of live prey and monitoring the length of time it takes for rehabilitated owls to catch them was discussed in depth. Although some respondents report imprints interacting more with enrichment than did non-imprints, still others report the reverse. Additionally, anecdotal evidence suggests owls remember where their food is cached. The most curious thing may be that some owls can find hidden food while others cannot. This may be attributed to their motion-based scanning strategy for hunting.[2] However, I found no relationship in the data to suggest which owl genera are more or less likely to find hidden food.

Conclusions

Successful enrichment methods do not differ significantly between imprints and non-imprints, although some anecdotal evidence from survey respondents suggests age plays a major role in the willingness of a non-imprinted owl to engage with enrichment. This is similar to mammals in that younger individuals are more playful.[24,25] The level of engagement with different types of enrichment appears to be more individual-based rather than imprint-based. There were not enough data collected from owl genera, other than *Tyto* and *Bubo,* to draw any other genera-based conclusions. Future research should measure age and acquire a larger sample to include other owl genera.

About the Author

Aurora Potts is a 2015 graduate from Miami University in Oxford, Ohio, and Woodland Park Zoo's Advanced Inquiry Program. She received her undergraduate degree in Environmental Studies with a Film Studies concentration and a minor in Visual Arts from Eckerd College in St. Petersburg, Florida in 2010. In the past she has worked with education raptors as a bird trainer for World Bird Sanctuary. Currently she is in charge of enrichment as a seasonal assistant wildlife rehabilitator for Progressive Animal Welfare Society in Lynnwood, Washington. She hopes to continue her research with raptors professionally when the 2016 season is completed.

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APPENDIX A. *Survey Questions.*

Page 1. Imprint or not.

Imprint: *Definition* (verb): (of a young animal) come to recognize (another animal, person, or thing) as a parent or other object of habitual trust.

If any of your individuals are imprints, please indicate which owl genus they belong to. <*multiple choice, allowed more than one answer.*>

Please indicate here if you have multiple individuals of the same genus, where at least one individual is an imprint while the other is not. Please name the genus.

Tyto	*Mimizuku*	*Surnia*	*Uroglaux*
Phodilus	*Bubo*	*Glaucidium*	*Sceloglaux*
Otus	*Scotopelia*	*Xenoglaux*	*Pseudoscops*
Megascops	*Strix*	*Micrathene*	*Asio*
Pyrroglaux	*Jubula*	*Athene*	*Nesasio*
Gymnoglaux	*Lophostrix*	*Aegolius*	
Ptilopsis	*Pulsatrix*	*Ninox*	

<*comment box*>

Page 2. Successful enrichment for owl genera.

Specific examples may fall under these categories:

Sensory (auditory, olfactory, tactile)
Food
Manipulating
Environmental (substrate)
Social (training)

Please list enrichment items/opportunities (including specific training) that have succesfully engaged any and all owl genera you've housed in captivity past or present. <multiple textboxes> *(same as above list of owl species)*

Please indicate here if you have multiple individuals of the same genus where one individual responded positively to enrichment while the other was unsuccessful. Please name the genus and specify if one is an imprint while the other is not. <*comment box*>

Page 3. Unsuccessful enrichment for owl genera.

Examples may include ignoring an item such as a rope, being unable to locate a reward under a cup, failing to respond to a cue such as entering a box, or exhibiting signs of stress in response to any attempted enrichment.

Please list enrichment items/opportunities (including specific training) that have failed to engage any and all owl genera you've housed past or present. <*multiple text boxes*> *(same as above list of owl species)*

Please indicate here if you have multiple individuals of the same genus where one individual failed to respond positively to attempted enrichment while the other was successful. Please name the genus and specify if one is an imprint while the other is not. <*comment box*>

Page 4. The end! Thank you for your contribution to this survey. Your responses will be used to assist in the continued efforts to improve the lives of owls in captivity.

APPENDIX B. *Successful enrichment.*

Successful Enrichment for Tyto.

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Sensory—General Auditory	**6**	**9**			
Recorded owl calls	1	1	Maracas	0	0
Recorded nature sounds	2	1	Metal clapper spoon	0	0
Music	1	0	Random noise	0	0
Wind chimes	0	0	High-pitched squeak	1	0
Jingle bells	0	0	Remote audio flight cue	1	1
			Noise-maker	0	0
Sensory—General Visual	**4**	**3**			
Reflective items (ex: mirrors)	1	2	Chalk drawings	0	0
Surrounding wildlife	0	1	Laser pointer	1	0
Live fish	0	0	Bright colors	0	0
Live insects	2	0	Floating object	0	0
Mobiles	0	0	Sunken object	0	0
Bubbles	0	0	Watching TV	0	0
Animal photos	0	0			

APPENDIX B. ***Successful Enrichment for Tyto*** *(cont.)*

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Sensory—General Taste	**1**	**0**	Spices	1	0
Sensory—General Tactile	**23**	**11**			
Leather	1	0	Mulch pile	1	1
Wool	0	0	Sandbox	0	0
Ice	0	0	Rubber	0	0
Animal hide/fur/pelts	1	0	Litter mat	0	0
Handler's touch	1	0	Sisal rope wrap	0	0
Paper mache	2	1	Tissue paper	0	0
Tin metal	0	0	Artificial grass	3	0
Burlap	0	0	Rocks	0	1
Nesting opportunities/substrates	8	3	Wood	0	1
Greenery/browse	2	2	Carpet	0	1
Variety substrate	2	1	Snow	0	0
Stumps	0	0	Felt	0	0
Newspaper	1	0	Talc powder	0	0
Brush pile	1	0	Non-toxic paint on poster	0	0
Sensory—General Olfactory	**0**	**0**			
Synthetic deer urine	0	0			
Herbs	0	0			
Perfume	0	0			
Food—Hidden	**11**	**8**			
Food—Novel	**14**	**15**			
Skewered	1	0	Move barrier to access food	0	1
Varied	3	2	Coconut feeder	1	0
Live prey	2	5	Pinecone feeder	0	1
Large/whole prey	2	0	Suet feeder	0	1
Chunk meat	0	0	Live insects	0	0
Chick	1	0	Killed sparrows	0	0
Gizzard	0	0	Time variation	0	0
Rabbits	0	0	Blood	0	0
Natural Balance 5%	1	0	Popsicles	0	0
Fish	0	1	Popcorn	0	0
Puzzle feeder	1	0	Cooked pasta	0	0
Mealworms	0	0	Oatmeal	0	0
Produce	1	2	Yogurt	0	0
Differing locations	0	0	Corn on the cob	0	0
Skunk	0	0	Pumpkin	0	0
Squirrel	0	0	Jello treats	0	0
Manipulatory—Artificial Toy	**19**	7			
Stuffed animal	5	3	Dishes	0	0
Balls	3	1	Brush/broom heads	0	0
Rope toys	1	2	Feather duster	1	0
Kongs	1	0	Plastic material	0	0
General dog/cat/parrot toys	6	0	Willow basket	0	0
Rubber material	0	0	Scrub brushes	1	0

Manipulatory—Artificial Toy (cont'd.)

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Hanging toy	1	1	Bowling pins	0	0
Shoe	1	0	Hula hoop	0	0
Baby ring tower	0	0	Leather toy	0	0
Keys on ring	0	0	Bandana w/ knot	0	0
Manipulatory-Recycled Toy	**12**	**6**			
Paper/paper towels/decorations	3	5	Rice-stuffed sock for heating food	0	0
Paper cups	0	1	Cereal box/small cardboard box	3	0
Paper bags	1	0	Crickets in plastic bottle	1	0
Plastic jugs w/ holes	0	0	Cereal box	0	0
Tubes (cardboard or PVC)	2	0	Basket	0	0
Piece of rope	1	0	Pie plate	0	0
Egg cartons	1	0	Plastic produce container	0	0
Phone books	1	0	Pillow case tied to perch	0	0
TP rolls	0	0	Rags	0	0
Straw hat	0	0			
Manipulatory–Natural Toy	**4**	**1**			
Snake skins	0	0	Leaves for shredding	0	0
Corn husks	0	0	Antlers	0	0
Feathers	2	0	Hard-boiled egg	0	0
Rawhide	0	0	Horse hair	0	0
Bones	1	0	Sedge tied w/ knots	0	0
Pinecones	1	0	Corn on the cob	0	1
Environmental—General Enrichment	**6**	**5**			
Change of scenery	2	1	Duck decoys	1	0
Heat lamps	1	1	Gourds/pumpkins/squash	1	1
Owl decoys	0	0	Weathering/outdoor	1	2
Environmental—Water Enrichment	**2**	**2**			
Water tubs	1	2			
Misting/sprinkler	1	0			
Environmental—Furniture	**12**	**6**			
Stumps	1	0	Christmas tree	1	1
Swings	1	1	Evergreen wreath	0	0
Branches	3	2	Corn shock	0	0
Logs	1	0	Chicken-sized rubber ball	1	0
Willow baskets	0	0	Scarecrow	1	0
Variety perching	4	2	Snags	0	0
Traffic cone	0	0	Telephone cable perch	0	0
Environmental—Hiding Places	**7**	**7**			
Boxes (nest or cardboard)	6	6	Butcher paper around cage	1	0
Shelter	0	1	Cavity	0	0
Burrow	0	0			

APPENDIX B. ***Successful Enrichment for Tyto*** *(cont.)*

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Social—Any Training	**33**	**30**			
Glove training	12	13	Carry an item	0	1
Education programs	5	8	"GO" to perch cue	0	0
Flight training (w/or w/o creance)	12	2	Wing extension	0	1
Kennel training	2	3	Open mouth	0	0
Walks	1	1	V-jumps	1	1
New situations	0	0	Vocalize	0	0
Targeting	0	0			
Social—Interspecies Interaction	**1**	**4**			
Hooting w/ human	0	0	Perching in main room/office	1	1
Fostering	0	0	Opportunity to lay & incubate	0	0

Correlation = 0.886808035

Successful Enrichment for Bubo

	Bubo Imprint	*Bubo* Non-Imprint		*Bubo* Imprint	*Bubo* Non-Imprint
Sensory—General Auditory	7	7	Maracas	0	0
Recorded owl calls	1	2	Metal clapper spoon	0	0
Recorded nature sounds	1	1	Random noise	0	0
Music	2	2	High-pitched squeak	0	0
Wind chimes	1	2	Remote audio flight cue	0	0
Jingle bells	0	0	Noise-maker	0	0
Sensory—General Visual	**10**	**9**			
Reflective items (ex: mirrors)	5	3	Chalk drawings	0	0
Surrounding wildlife	3	2	Laser pointer	0	0
Live fish	1	2	Bright colors	0	0
Live insects	1	1	Floating object	0	0
Mobiles	0	0	Sunken object	0	0
Bubbles	0	0	Watching TV	0	0
Animal photos	0	1			
Sensory—General Taste	**1**	**0**			
Spices	1	0			
Sensory—General Tactile	**36**	**44**			
Leather	1	0	Mulch pile	1	2
Wool	1	1	Sandbox	1	2
Ice	1	1	Rubber	0	1
Animal hide/fur/pelts	2	1	Litter mat	0	1
Handler's touch	2	2	Sisal rope wrap	0	1
Paper mache	2	2	Tissue paper	0	1
Tin metal	1	0	Artificial grass	0	1
Burlap	1	0	Rocks	0	1
Nesting opportunities/substrates	11	14	Wood	0	0
Greenery/browse	4	7	Carpet	0	0
Variety substrate	4	4	Snow	0	0
Stumps	1	0	Felt	0	0
Newspaper	2	2	Talc powder	0	0
Brush pile	1	1	Non-toxic paint on poster	0	0

Successful Enrichment for Bubo *(cont.)*

	Bubo Imprint	*Bubo* Non-Imprint		*Bubo* Imprint	*Bubo* Non-Imprint
Sensory—General Olfactory	**0**	**0**			
Synthetic deer urine	0	0			
Herbs	0	0			
Perfume	0	0			
Food—Hidden	7	**6**			
Food-Novel	**21**	**22**			
Skewered	1	1	Move barrier to access food	0	1
Varied	5	4	Coconut feeder	0	1
Live prey	1	6	Pinecone feeder	0	1
Large/whole prey	1	1	Suet feeder	0	0
Chunk meat	1	0	Live insects	0	0
Chick	2	1	Killed sparrows	0	0
Gizzard	1	1	Time variation	0	0
Rabbits	1	0	Blood	0	0
Natural Balance 5%	1	0	Popsicles	0	0
Fish	1	0	Popcorn	0	0
Puzzle feeder	1	1	Cooked pasta	0	0
Mealworms	1	0	Oatmeal	0	0
Produce	1	1	Yogurt	0	0
Differing locations	1	1	Corn on the cob	0	0
Skunk	0	1	Pumpkin	0	0
Squirrel	0	1	Jello treats	0	0
Manipulatory—Artificial Toy	**34**	**16**			
Stuffed animal	7	2	Scrub brushes	0	1
Balls	10	7	Hanging toys	0	0
Rope toys	4	1	Shoe	0	0
Kongs	3	3	Baby ring tower	0	0
General dog/cat/parrot toys	6	0	Keys on ring	0	0
Rubber material	1	0	Bowling pins	0	0
Dishes	1	1	Hula hoop	0	0
Brush/broom heads	1	0	Hanging toy	0	0
Feather duster	1	0	Leather toy	0	0
Plastic material	0	2	Bandana w/ knot	0	0
Willow basket	0	1			
Manipulatory—Recycled Toy	**24**	**30**			
Paper/paper towels/decorations	7	9	Sock stuffed with rice for heating food		
Paper cups	1	1		0	1
Paper bags	2	2	Cereal box/small cardboard box	0	0
Plastic jugs w/ holes	1	0	Crickets in plastic bottle	0	0
Tubes (cardboard or PVC)	6	2	Cereal box	0	0
Piece of rope	2	1	Basket	0	0
Egg cartons	2	3	Pie plate	0	0
Phone books	3	5	Plastic produce container	0	0
TP rolls	0	3	Pillow case tied to perch	0	0
Straw hat	0	1	Rags	0	0

APPENDIX B. ***Successful Enrichment for Bubo*** *(cont.)*

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Manipulatory—Natural Toy	**12**	**15**			
Snake skins	3	2	Leaves for shredding	0	1
Corn husks	2	0	Antlers	0	1
Feathers	3	3	Hard-boiled egg	0	1
Rawhide	1	1	Horse hair	0	1
Bones	1	1	Sedge tied w/ knots	0	1
Pinecones	2	3	Corn on the cob	0	0
Environmental—General Enrichment	**9**	**8**			
Change of scenery	5	2	Duck decoys	0	0
Heat lamps	1	1	Gourds/pumpkins/squash	1	3
Owl decoys	1	0	Weathering/outdoor	1	2
Environmental—Water Enrichment	**9**	**10**			
Water tubs	2	3			
Misting/sprinkler	7	7			
Environmental—Furniture	**13**	**21**			
Stumps	1	2	Christmas tree	0	1
Swings	1	2	Evergreen wreath	0	1
Branches	5	6	Corn shock	0	1
Logs	2	2	Chicken-sized rubber ball	0	0
Willow baskets	1	0	Scarecrow	0	0
Variety perching	3	5	Snags	0	0
Traffic cone	1	0	Telephone cable perch	0	0
Environmental—Hiding Places	**6**	**11**			
Boxes (nest or cardboard)	5	7	Butcher paper around cage	0	0
Shelter	0	2	Cavity	0	0
Burrow	0	0			
Social—Any Training	**48**	**41**			
Glove training	21	19	Carry an item	1	0
Education programs	6	10	"GO" to perch cue	0	1
Flight training (w/ or w/o creance)	12	2	Wing extension	0	1
Kennel training	2	4	Open mouth	0	1
Walks	4	2	V-jumps	0	0
New situations	1	1	Vocalize	0	0
Targeting	1	0			
Social-Species Interaction	**3**	**5**			
Hooting w/ human	1	0	Perching in main room/office	0	1
Fostering	1	1	Opportunity to lay & incubate	0	0

Correlation = 0.927887757

APPENDIX C. ***Failed Enrichment.***

Failed Enrichment for Tyto

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Sensory—General Auditory	**3**	**6**	Jingle bells	0	0
Recorded owl calls	0	0	Maracas/rattle	0	1
Recorded nature sounds	1	1	Metal clapper spoon	0	0
Music	0	1	Random noise	1	0
Wind chimes	0	3	Noise-maker	1	0
Sensory—General Visual	**2**	**0**			
Reflective items (ex: mirrors)	0	0	Animal photos	0	0
Surrounding wildlife	0	0	Chalk drawings	0	0
Live fish	1	3	Laser pointer	0	1
Live insects	1	1	Floating object	0	0
Mobiles	0	0	Sunken object	0	0
Bubbles	0	3	Bright colors	0	1
Sensory-General Taste	**0**	**1**			
Spices	0	1			
Sensory-General Tactile	7	17	Stumps	0	0
Leather	0	1	Newspaper	0	1
Wool	0	3	Brush pile	0	0
Ice	0	2	Mulch pile	0	0
Animal hide/fur/pelts	1	0	Sandbox	1	0
Handler's touch	0	0	Felt	1	0
Paper mache	0	2	Talc powder	0	0
Tin metal	0	0	Artificial grass	1	0
Burlap	1	0	Rocks	0	0
Nesting opportunities/substrates	1	5	Bark	0	1
Greenery/browse	1	1	Non-toxic paint on poster	0	1
Variety substrate	0	0	Litter mat	0	1
Sensory-General Olfactory	**1**	**3**			
Synthetic deer urine	0	0			
Herbs	0	0			
Perfume	1	1			
Food-Hidden	**2**	**4**			
Food-Novel	4	4	Produce	0	1
Skewered	0	1	Differing locations	0	0
Varied	0	0	Blood	0	0
Live prey	0	0	Popsicles	0	0
Large/whole prey	0	0	Popcorn	0	0
Chunk meat	0	0	Cooked pasta	0	0
Chick	0	0	Oatmeal	0	0
Gizzard	0	0	Yogurt	0	0
Rabbits	0	0	Corn on the cob	1	0
Natural Balance 5%	0	0	Pumpkin	1	0
Fish	0	0	Jello treats	0	1
Puzzle feeder	0	0	Varied time	0	0
Mealworms	1	0	Manipulate barrier to access food	0	1

APPENDIX C. ***Failed Enrichment for Tyto*** *(cont.)*

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Manipulatory—Artificial Toy	**17**	**13**			
Stuffed animal	2	2	Keys on ring	1	0
Balls	0	2	Plastic frog	0	0
Rope toys	1	1	Bowling pins	0	0
Kongs	1	2	Brush/broom heads	0	1
General dog/cat/parrot toys	9	4	Hula hoop	0	0
Rubber material	0	0	Hanging toy	1	0
Dishes	0	0	Leather/sheepskin toy	1	0
Baby ring tower	1	0	Bandana w/ knot	0	0
Manipulatory—Recycled Toy	**5**	**6**	Egg cartons	0	0
Paper/paper towels	1	4	Phone books	1	0
Paper cups	1	0	Cereal box	0	0
Paper bags	0	0	Basket	0	0
Plastic jugs w/ holes	0	0	Pie plate	0	0
Tubes (cardboard or PVC)	1	1	Plastic produce container	1	0
Feather duster	0	0	Pillow case tied to perch	0	0
Piece of rope	0	1	Rags	0	0
Manipulatory—Natural Toy	**4**	**8**			
Snake skins	1	2	Antlers	0	0
Corn husks	0	0	Dried flowers/herbs	0	0
Feathers	1	2	Hanging log toy	1	0
Rawhide	0	0	Hard-boiled egg	0	1
Bones	0	0	Horse hair	0	1
Pinecones	1	0	Eggshells	0	1
Environmental—General Enrichment	**0**	**1**	Owl decoys	0	0
			Duck decoys	0	0
Change of scenery	0	0	Gourds/pumpkins/squash	0	1
Heat lamps	0	0	Weathering/outdoor	0	0
Environmental—Water Enrichment	**1**	**2**	Water tubs	0	0
			Misting/sprinkler	1	0
Environmental—Furniture	**4**	**2**	Variety perching	0	0
Scarecrow	1	0	Traffic cone	1	0
Stumps	0	0	Plastic yellow chair	1	0
Swings	0	0	Garbage lid	1	0
Branches	0	0	Corn shocks	0	1
Logs	0	0	Evergreen wreath	0	1
Willow baskets	0	0	Christmas tree	0	0
Environmental—Hiding Places	**0**	**0**			
Boxes (nest or cardboard)	0	0	Burrow	0	0
Shelter	0	0	Cavity	0	0
Social—Any Training	**2**	**1**	Kennel training	0	0
Glove training	0	1	Walks	0	0
Education programs	0	0	New situations	0	0
Flight training (w/ or w/o creance)	1	0	Targeting	0	0

(cont.)

	Tyto Imprint	*Tyto* Non-Imprint		*Tyto* Imprint	*Tyto* Non-Imprint
Social—Any Training	**2**	**1**			
Carry an item	0	0	Exercise yard	1	0
Non-food reward	0	0	Wing extension	0	0
Social-Species Interaction	**0**	**0**	Children	0	0
Hooting w/ human	0	0	Opportunity to lay & incubate	0	0
Fostering	0	0	Perching in main room or office	0	0

Correlation = 0.756661328

Failed Enrichment for Bubo

	Bubo Imprint	*Bubo* Non-Imprint		*Bubo* Imprint	*Bubo* Non-Imprint
Sensory—General Auditory	**5**	**1**	Jingle bells	1	0
Recorded owl calls	0	0	Maracas/rattle	1	0
Recorded nature sounds	0	1	Metal clapper spoon	1	0
Music	0	0	Random noise	1	0
Wind chimes	1	0	Noise-maker	0	0
Sensory—General Visual	**8**	**1**			
Reflective items (ex: mirrors)	3	0	Animal photos	1	0
Surrounding wildlife	0	1	Chalk drawings	1	0
Live fish	1	0	Laser pointer	0	0
Live insects	0	0	Bright colors	0	0
Mobiles1	0		Floating object	0	0
Bubbles	1	0	Sunken object	0	0
Sensory—General Taste	**0**	**0**			
Spices	0	0			
Sensory—General Tactile	**18**	**6**	Stumps	0	0
Leather	0	0	Newspaper	0	1
Wool	0	0	Brush pile	0	0
Ice	1	0	Mulch pile	0	0
Animal hide/fur/pelts	0	0	Sandbox	0	0
Handler's touch	0	1	Felt	1	0
Paper mache	0	0	Talc powder	1	0
Tin metal	0	1	Artificial grass	1	0
Burlap	0	0	Rocks	1	0
Nesting opportunities/substrates	5	2	Bark	0	0
Greenery/browse	2	1	Non-toxic paint on poster	0	0
Variety substrate	0	0	Litter mat	0	0
Sensory—General Olfactory	**4**	**0**	Herbs	1	0
Synthetic deer urine	1	0	Perfume	0	0
Food—Hidden	**2**	**1**			
Food—Novel	**9**	**3**	Large/whole prey	0	0
Skewered	0	0	Chunk meat	0	0
Varied	0	0	Chick	1	0
Live prey	0	0			

(continued)

	Bubo Imprint	*Bubo* Non-Imprint		*Bubo* Imprint	*Bubo* Non-Imprint
Food—Novel *(cont.)*	**2**	**1**	Popsicles	2	0
Gizzard	0	0	Popcorn	1	0
Rabbits	0	1	Cooked pasta	1	0
Natural Balance 5%	0	1	Oatmeal	1	0
Fish	0	0	Yogurt	1	0
Puzzle feeder	0	0	Corn on the cob	0	0
Mealworms	0	1	Pumpkin	0	0
Produce	1	0	Jello treats	0	0
Differing locations	0	0	Varied time	0	0
Blood	1	0	Move barrier to access food	0	0
Manipulatory—Artificial Toy	**23**	**8**			
Stuffed animal	1	2	Keys on ring	1	0
Balls	4	0	Plastic frog	1	0
Rope toys	2	0	Bowling pins	1	0
Kongs	0	0	Brush/broom heads	1	0
General dog/cat/parrot toys	8	5	Hula hoop	1	0
Rubber material	1	0	Hanging toy	0	0
Dishes	0	0	Leather/sheepskin toy	0	1
Baby ring tower	1	0	Bandana w/ knot	0	0
Manipulatory—Recycled Toy	**9**	**9**	Egg cartons	0	2
Paper/paper towels	2	5	Phone books	1	1
Paper cups	0	1	Cereal box	1	0
Paper bags	0	0	Basket	1	0
Plastic jugs w/ holes	0	0	Pie plate	1	0
Tubes (cardboard or PVC)	1	0	Plastic produce container	2	0
Feather duster	0	0	Pillow case tied to perch	0	0
Piece of rope	0	0	Rags	0	0
Manipulatory—Natural Toy	7	**0**			
Snake skins	1	0	Antlers	1	0
Corn husks	0	0	Dried flowers/herbs	2	0
Feathers	2	0	Hanging log toy	0	0
Rawhide	0	0	Hard-boiled egg	0	0
Bones	0	0	Horse hair	0	0
Pinecones	1	0	Eggshells	0	0
Environmental—General Enrichment	**1**	**0**	Owl decoys	0	0
			Duck decoys	1	0
Change of scenery	0	0	Gourds/pumpkins/squash	0	0
Heat lamps	0	0	Weathering/outdoor	0	0
Environmental—Water Enrichment	**2**	**0**	Water tubs	0	0
			Misting/sprinkler	2	0
Environmental—Furniture	**2**	**0**	Variety perching	0	0
Scarecrow	0	0	Traffic cone	1	0
Stumps	0	0	Plastic yellow chair	1	0
Swings	0	0	Garbage lid	0	0
Branches	0	0	Corn shocks	0	0
Logs	0	0	Evergreen wreath	0	0
Willow baskets	0	0	Christmas tree		

	Bubo Imprint	*Bubo* Non-Imprint		*Bubo* Imprint	*Bubo* Non-Imprint
Environmental—Hiding Places	**5**	**0**			
Boxes (nest or cardboard)	5	0	Burrow	0	0
Shelter	0	0	Cavity	0	0
Social—Any Training	**2**	**1**	New situations	1	0
Glove training	0	1	Targeting	0	0
Education programs	0	0	Carry an item	0	0
Flight training (w/ or w/o creance)	0	0	Non-food reward	1	0
Kennel training	0	0	Exercise yard	0	0
Walks	0	0	Wing extension	0	0
Social—Species Interaction	**0**	**0**	Children	0	0
Hooting w/ human	0	0	Opportunity to lay & incubate	0	0
Fostering	0	0	Perching in main room or office	0	0

Correlation = 0.757312426

APPENDIX D
Occurrence of Successful Enrichment Among All Genera

	Imprint	Non-Imprint		Imprint	Non-Imprint
Sensory—General Auditory	**24**	**32**	Wind chimes	2	4
Recorded owl calls	3	8	Jingle bells	0	1
Recorded nature sounds	3	5	High-pitched squeak	1	0
Music	4	6	Remote audio flight cue	1	1
Sensory—General Visual	**25**	**28**	Live insects	3	2
Reflective items (ex: mirrors)	13	12	Animal photos	0	1
Surrounding wildlife	5	9	Laser pointer	1	0
Live fish	2	3	Watching TV	1	1
Sensory—General Taste	**3**	**0**			
Spices	2	0			
Sensory—General Tactile	**76**	**103**			
Leather	2	0	Handler's touch	4	8
Wool	2	1	Paper mache	4	5
Ice	2	2	Tin metal	1	0
Animal hide/fur/pelts	4	4	Burlap	1	0
Nesting opportunities/substrates	**25**	**26**			
Greenery/browse	7	20	Litter mat	0	1
Variety substrate	11	15	Sisal rope wrap	0	1
Stumps	1	0	Tissue paper	0	1
Newspaper	3	3	Artificial grass	3	2
Brush pile	2	4	Rocks	0	3
Mulch pile	2	5	Wood	0	1
Sandbox	2	4	Carpet	0	1
Rubber	0	1	Snow	0	1
Sensory—General Olfactory	**0**	**0**			
Perfume	0	0			
Food—Hidden	**22**	**20**			

(continued)

APPENDIX D. ***Occurrence of Successful Enrichment Among All Genera*** *(cont.)*

	Imprint	Non-Imprint		Imprint	Non-Imprint
Food—Novel	**48**	**100**			
Skewered	2	2	Produce	2	4
Varied	14	15	Differing locations	1	6
Live prey	4	26	Skunk	0	1
Large/whole prey	3	3	Squirrel	0	1
Chunk meat	1	0	Move barrier to access food	0	3
Chick	3	4	Coconut feeder	1	1
Gizzard	1	3	Pinecone feeder	0	2
Rabbits	1	0	Suet feeder	0	1
Natural Balance 5%	2	0	Live insects	9	20
Fish	1	1	Killed sparrows	0	2
Puzzle feeder	2	3	Time variation	0	3
Manipulatory—Artificial Toy	**64**	**44**	Brush/broom heads	1	0
Stuffed animal	15	10	Feather duster	2	1
Balls	17	14	Plastic material	0	2
Rope toys	6	3	Willow basket	0	1
Kongs	6	6	Scrub brushes	1	1
General dog/cat/parrot toys	12	7	Hanging toys	1	1
Rubber material	1	0	Shoe	1	0
Dishes	1	1	Bandana w/ knot	1	0
Manipulatory—Recycled Toy	**43**	**54**	Phone books	4	8
Paper/paper towels/decorations	12	17	TP rolls	0	3
Paper cups	1	2	Straw hat	0	1
Paper bags	3	2	Rice-stuffed sock for heating food	0	1
Plastic jugs w/ holes	2	0	Cereal box/small cardboard box	3	1
Tubes (cardboard or PVC)	10	9	Crickets in plastic bottle	1	0
Piece of rope	3	3	Pillow case tied to perch	0	1
Egg cartons	3	3	Rags	1	0
Manipulatory—Natural Toy	**21**	**26**			
Snake skins	4	3	Leaves for shredding	0	1
Corn husks	2	0	Antlers	0	1
Feathers	6	4	Hard-boiled egg	0	1
Rawhide	2	1	Horse hair	0	1
Bones	3	4	Sedge tied w/ knots	0	1
Pinecones	4	7	Corn on the cob	0	1
Environmental—General Enrichment	**20**	**38**	Owl decoys	2	0
			Duck decoys	1	1
Change of scenery	9	17	Gourds/pumpkins/squash	3	6
Heat lamps	3	6	Weathering/outdoor	2	8
Environmental—Water Enrichment	**16**	**23**	Water tubs	6	9
			Misting/sprinkler	10	15
Environmental—Furniture	**29**	**54**	Logs	3	4
Stumps	2	2	Willow baskets	1	0
Swings	2	5	Variety perching	8	16
Branches	10	17	Traffic cone	1	0

	Imprint	Non-Imprint		Imprint	Non-Imprint
Environmental—Furniture (cont.)			Chicken-sized rubber ball	1	0
Christmas tree	1	4	Scarecrow	1	0
Evergreen wreath	0	1	Snags	0	1
Corn shock	0	1	Telephone cable perch	0	1
Environmental—Hiding Places	**18**	**41**	Burrow	0	1
Boxes (nest or cardboard)	15	27	Butcher paper around cage	1	1
Shelter	1	8	Cavity	1	1
Social—Any Training	**104**	**141**	Targeting	1	1
Glove training	45	85	Carry an item	1	1
Education programs	16	46	"GO" to perch cue	0	1
Flight training w/ or w/o creance	29	8	Wing extension	0	3
Kennel training	4	15	Open mouth	0	1
Walks	5	13	V-jumps	1	1
New situations	2	3	Vocalize	0	1
Social—Species Interaction	**8**	**17**			
Hooting w/ human	1	0	Perching in main room/office	1	3
Fostering	2	4	Opportunity to lay & incubate	3	0

Correlation = 0.932628217

APPENDIX E

Occurrence of Failed Enrichment Among All Genera

	Imprint	Non-Imprint		Imprint	Non-Imprint
Sensory—General Auditory	**10**	**21**	Maracas/rattle	1	1
Recorded owl calls	0	2	Metal clapper spoon	1	0
Recorded nature sounds	1	6	Random noise	3	0
Music	0	3	Noise-maker	1	0
Wind chimes	1	6	Remote auditory cue	1	0
Jingle bells	1	0	Radio talk show	0	1
Sensory—General Visual	**13**	**38**			
Reflective items (ex: mirrors)	5	9	Chalk drawings	1	1
Surrounding wildlife	0	5	Laser pointer	0	1
Live fish	2	8	Bright colors	0	3
Live insects	1	2	Floating object	0	1
Mobiles	1	0	Sunken object	0	1
Bubbles	1	6	Hand movements	1	0
Animal photos	1	1	Watching TV	0	1
Sensory—General Taste	**0**	**1**			
Spices	0	1			
Sensory—General Tactile	**27**	**70**	Tin metal	0	1
Leather	0	1	Burlap	1	0
Wool	1	6	Nesting opportunities/substrates	6	19
Ice	1	3	Greenery/browse	3	6
Animal hide/fur/pelts	2	1	Variety substrate	0	5
Handler's touch	0	5	Newspaper	0	4
Paper mache	0	8			

(continued)

	Imprint	Non-Imprint		Imprint	Non-Imprint
Sensory—General Tactile (cont.)					
Brush pile	0	2	Artificial grass	2	1
Mulch pile	0	1	Rocks	1	0
Sandbox	1	1	Bark	0	1
Felt	2	0	Non-toxic paint on poster	0	1
Talc powder	1	0	Litter mat	0	2
Sensory—General Olfactory	**5**	**6**	Herbs	1	1
Synthetic deer urine	1	0	Perfume	1	2
Food—Hidden	7	**15**			
Food—Novel	**15**	**37**	Differing locations	0	1
Skewered	0	1	Blood	1	0
Varied	0	3	Popsicles	2	1
Live prey	1	9	Popcorn	1	1
Large/whole prey	0	2	Cooked pasta	1	1
Chick	1	1	Oatmeal	1	1
Gizzard	0	1	Yogurt	1	1
Rabbits	0	1	Corn on the cob	1	0
Natural Balance 5%	0	1	Pumpkin	1	0
Puzzle feeder	1	2	Jello treats	0	1
Live insects	1	2	Varied time	0	1
Produce	1	3	Move barrier to access food	0	2
Manipulatory—Artificial Toy	**42**	**44**	Keys on ring	2	0
Stuffed Animal	3	7	Plastic frog	1	0
Balls	6	10	Bowling pins	1	0
Rope toys	3	2	Brush/broom heads	1	2
Kongs	1	5	Hula hoop	1	0
General dog/cat/parrot toys	17	16	Hanging toy	1	0
Rubber material	1	0	Leather/sheepskin toy	1	1
Baby ring tower	2	0	Feather duster	0	1
Manipulatory—Recycled Toy	**16**	**35**			
Paper/paper towels	4	19			
Paper cups	1	1			
Manipulatory—Natural Toy	**13**	**25**	Antlers	1	2
Snake skins	2	6	Dried flowers/herbs	2	0
Corn husks	0	1	Hanging log toy	1	0
Feathers	4	5	Hard-boiled egg	0	1
Bones	0	1	Horse hair	0	1
Pinecones	3	4	Eggshells	0	1
Environmental—General Enrichment	**1**	**14**	Owl decoys	0	2
Change of scenery	0	6	Gourds/pumpkins/squash	1	3
Heat lamps	0	1	Weathering/outdoor	0	2

	Imprint	Non-Imprint		Imprint	Non-Imprint
Environmental—Water Enrichment			Logs	0	1
	3	**13**	Variety perching	0	3
Water tubs	0	6	Traffic cone	2	0
Misting/sprinkler	3	5	Plastic yellow chair	2	0
Environmental-Furniture	6	19	Garbage lid	1	0
Scarecrow	1	0	Corn shocks	0	2
Swings	0	2	Evergreen wreath	0	3
Branches	0	3	Christmas tree	0	1
Environmental—Hiding Places	**5**	**9**			
Boxes (nest or cardboard)	5	3	Burrow	0	1
Shelter	0	3	Cavity	0	1
Social—Any Training	**6**	**8**			
Glove training	0	23	New situations	1	1
Education programs	1	11	Targeting	0	1
Flight training (w/ or w/o creance)	1	2	Non-food reward	1	0
Kennel training	0	3	Exercise yard	1	0
Walks	0	4	Wing extension	0	1
Social—Interspecies Interaction	**0**	**4**	Perching in main room or office	0	1
Children	0	1	Humans watching enrichment	0	1

Correlation = 0.840101153

Rehabilitation and post-release monitoring of two wolves with severe injuries

H Rio-Maior, P Beja, M Nakamura, N Santos, R Brandão, et al. *Journal of Wildlife Management.* 2016;80:729–735.

Injured free-ranging wolves *(Canis lupus)* are often rehabilitated and released into the wild, but there is limited data on their post-release survival and behavior. We used global positioning system telemetry to document movements and spatial overlap with resident packs of two wolves in northern Portugal that were released following rehabilitation from severe traumatic injuries and were kept in captivity for 10–12 weeks in 2012. A yearling female, with a complex fracture on the thoracic limb, traveled 2,709 km over about 643 km^2, during the 12 months post-release before being illegally shot. During the first eight months, it was located frequently around three different pack territories, but afterwards its movements were restricted to a single pack territory. We tracked a yearling male with an amputated hind limb for five months and it traveled 922 km over about 574 km^2 before dying in a road casualty. It visited four different pack territories in succession but also spent time outside known territory boundaries. Our findings suggest that rehabilitated wolves can recover their locomotor activity and survive in the wild for several months, even after suffering severe injuries and spending three months or longer in captivity.

Using tailored tranquilizer combinations to reduce stress associated with large ungulate capture and translocation

LL Wolfe and MW Miller. *Journal of Wildlife Diseases.* 2016 Apr;52(2 Suppl):S118-24. doi: 10.7589/52.2S.S118.

Capture and translocation are important tools for managing and studying large ungulates. Although widely used, many established field practices cause fear and stress in subject animals that can hamper overall effectiveness and safety. Over the last 10 years, we have been exploring uses of tranquilizer combinations as adjuncts to wild ungulate capture and translocation work in Colorado, USA. Our approaches have been tailored to various field applications to reduce fear and stress, facilitate handling, and improve the overall success of capture and translocation for research or management purposes. For physical capture (drop net or helicopter-net gunning) with local release, combinations of midazolam and azaperone administered immediately upon capture provide transient tranquilization and muscle relaxation during manual restraint and handling to prevent hyperthermia and capture myopathy. For extended tranquilization (during transport and overnight holding), adding a sustained-release haloperidol formulation provides calming effects for at least 24–48 h. In our assessment, appropriate and adaptive use of these tranquilizer combinations benefits captured animals without impeding management or research goals.

Related topic:

Efficacy and safety of a medetomidine–azaperone–alfaxalone combination in captive white-tailed deer *(Odocoileus virginianus)*

K Pon, N Caulkett, and M Woodbury. *Journal of Zoo and Wildlife Medicine.* 2016;47(29-37)

Advances in animal welfare for free-living animals

Wildlife Welfare Supplement Editorial Board. *Journal of Wildlife Diseases.* 2016;52(S4-S13)

Over several decades, animal welfare has grown into its own free-standing field of scientific study, from its early beginnings in laboratory animal research to eventually include exhibited animals and farm animals. While it has always been present to some degree, consideration of animal welfare for free-ranging animals has lagged behind, developing as a field of study in the last 20 years or so. Part of that increase was that animal welfare legislation was finally applied to studies being done on free-ranging animals. But it is the appreciation by the biologists and veterinarians working on wild animals, in which the quality of their results is largely controlled by the quality of the animals they use in their studies, which has resulted in increased attention to the well-being or welfare of the animals that they use. Other important influences driving the recognition of wildlife welfare have been changes in the public's expectations of how wild animals are dealt with, a shift in focus of wildlife professionals from managing animals that can be hunted or angled to include nongame species, the decrease in participation in hunting and fishing by members of the public, and the entry of large numbers of women into fish and wildlife agencies and departments and into veterinary medicine. Technical improvements have allowed the safe capture and handling of large or dangerous animals as immobilization drugs and equipment have been developed. The increasing use of sedating drugs allows for handling of animals with reduced stress and other impacts. A number of topics, such as toe-clipping, branding, defining which taxa can or cannot feel pain, catch-and-release fishing, and more, remain controversial within wildlife science. How we treat the wild animals that we deal with defines who we are as wildlife professionals, and animal welfare concerns and techniques for free-ranging animals will continue to develop and evolve.

Mass change values of landbird migrants at an inland stopover site dominated by nonnative vegetation

RJ Smith, MI Hatch. *The American Midland Naturalist.* 2016;175(1)

Early successional habitats are declining in eastern North America while at the same time remaining habitats are being invaded by a suite of nonnative shrub species. While the significance of these transitional habitats to breeding birds is well known, increasing evidence suggests they are important during the postfledging/premigratory and migratory periods, not only for shrub-nesting species but also for many species that breed in late-successional habitats. Additionally, a number of studies suggests exotic species have the potential to alter habitat quality, in turn affecting the fitness of migratory landbirds. The purpose of this study was to evaluate

fitness correlates associated with migrant use of shrubland habitat dominated by nonnative honeysuckle *(Lonicera spp.)* in order to gauge habitat quality for spring migrants using an inland stopover site in northeastern Pennsylvania. We used estimates of mass change as our fitness indicator, with positive mass change indicating quality habitat. Our results suggest most birds gain mass while using honeysuckle-dominated habitat and many species, including species that characteristically breed in forested habitats, accrue fitness advantages from using shrubland habitat during spring stopover in northeastern Pennsylvania. However, we emphasize the need to examine the cumulative effects of exotic vegetation through multiple stages of the avian annual cycle to better understand the fitness consequences of nonnative vegetation on migratory landbirds.

Unpredictable environments lead to the evolution of parental neglect in birds

SM Caro, AS Griffin, CA Hinde, and SA West. *Nature Communications* 7. 2016 March 29;Article 10985. doi:10.1038/ncomms10985

A nest of begging chicks invites an intuitive explanation: needy chicks want to be fed and parents want to feed them. Surprisingly, however, in a quarter of species studied, parents ignore begging chicks. Furthermore, parents in some species even neglect smaller chicks that beg more, and preferentially feed the biggest chicks that beg less. This extreme variation across species, which contradicts predictions from theory, represents a major outstanding problem for the study of animal signalling. We analyse parent–offspring communication across 143 bird species, and show that this variation correlates with ecological differences. In predictable and good environments, chicks in worse condition beg more, and parents preferentially feed those chicks. In unpredictable and poor environments, parents pay less attention to begging, and instead rely on size cues or structural signals of quality. Overall, these results show how ecological variation can lead to different signalling systems being evolutionarily stable in different species.

News

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etc.) and a second, more detailed ranger perception survey incorporating in-depth interviews. It is hoped that this large data set will influence and improve government policy towards rangers and their working conditions.

Corvids Sustaining Forests

Petaluma, CA, USA (Feb 3)—A review in *The Condor: Ornithological Applications* explores how oaks and pines depend on corvids, the group of birds that includes ravens, crows, and jays, to reproduce and spread—and how birds may be the key to helping these valuable trees weather the challenges of habitat fragmentation and climate change.

Eurasian jay (*Garrulus glandarius glandarius*), a corvid found to have a crucial role in the preservation of European oaks.
PHOTO ©LUC VIATOUR. CC BY-NC-ND 2.0 LICENSE.

Corvids store seeds in small caches spread across the landscape, a behavior called "scatter-hoarding." Birds cache more seeds than they eat, so some sprout, helping trees colonize new areas. Many oaks and pines have adaptations to encourage dispersal by birds, producing large, nutritious seeds with protective chemicals that keep them from rotting, which encourages scatter-hoarding by eliminating the need for animals to eat the seeds immediately.

The Review by Mario Pesendorfer of the University of Nebraska-Lincoln and his colleagues at the Smithsonian Migratory Bird Center, Cornell Lab of Ornithology, and The Nature Conservancy explore specific examples of such relationships from around the world. In Europe, Eurasian jays are proving to be a crucial ally for oaks as habitat fragmentation and climate change increasingly impact European hardwoods. In the western US, researchers have shown that repeated long-distance dispersal events by Clark's nutcrackers are essential to establish and maintain Ponderosa pine populations and that Pinyon jays help maintain the tree's genetic diversity. In the eastern US, blue jays speed forest fire recovery by increasing their caching effort after fires and selecting canopy gaps as cache sites.

Harnessing this bird behavior may aid habitat restoration. Europeans have been aware of the relationship between jays and oaks for centuries, and managers in some areas of western Europe are planting small stands of seed-source trees and relying on corvids to help disperse them across the landscape. In America, conservationists are exploring the possibility of reintroducing Channel Island scrub jays to islands where they were extirpated to speed the recovery of oak and pine vegetation after livestock removal.

"In light of the globally changing climate and increasing habitat fragmentation, these winged dispersers that transport seeds over long distances are likely to become more important, as they enable plant populations to shift their range," says Pesendorfer. "Since oaks and pines are important keystone species that themselves provide habitat for hundreds of animal species, such dispersal can have ecosystem-wide benefits." ■

Causes of stranding and mortality, and final disposition of loggerhead sea turtles *(Caretta caretta)* admitted to a wildlife rehabilitation center in Gran Canaria Island, Spain (1998–2014): a long-term retrospective study

J Orós, N Montesdeoca, M Camacho, A Arencibia, P Calabuig. *PLOS One*. 2016 Feb. http://dx.doi.org/10.1371/journal.pone.0149398

Aims: The aims of this study were to analyze the causes of stranding of 1,860 loggerhead turtles *(Caretta caretta)* admitted at the Tafira Wildlife Rehabilitation Center in Gran Canaria Island, Spain, from 1998 to 2014, and to analyze the outcomes of the rehabilitation process to allow meaningful auditing of its quality.

PHOTO © FWC FISH & WILDLIFE RESEARCH INSTITUTE. CC BY-NC-ND 2.0 LICENSE.

Juvenile loggerhead sea turtle (*Caretta caretta*) collected from surface habitat in a research study.

Methods: Primary causes of morbidity were classified into seven categories: entanglement in fishing gear and/or plastics, ingestion of hooks and monofilament lines, trauma, infectious disease, crude oil, other causes, and unknown/undetermined. Final dispositions were calculated as euthanasia (Er), unassisted mortality (Mr), and release (Rr) rates. Time to death (Td) for euthanized and dead turtles, and length of stay for released (Tr) turtles, were evaluated.

Results: The most frequent causes of morbidity were entanglement in fishing gear and/or plastics (50.81%), unknown/undetermined (20.37%), and ingestion of hooks (11.88%). The final disposition of the 1,634 loggerhead turtles admitted alive were: Er = 3.37%, Mr = 10.34%, and Rr = 86.29%. Er was significantly higher in the trauma category (18.67%) compared to the other causes of admission. The highest Mr was observed for turtles admitted due to trauma (30.67%). The highest Rr was observed in the crude oil (93.87%) and entanglement (92.38%) categories. The median Tr ranged from 12 days (unknown) to 70 days (trauma).

Conclusions: This survey is the first large-scale epidemiological study on causes of stranding and mortality of Eastern Atlantic loggerheads and demonstrates that at least 71.72% of turtles stranded due to anthropogenic causes. The high Rr (86.29%) emphasizes the importance of marine rehabilitation centers for conservation purposes. The stratified analysis by causes of admission of the three final disposition rates, and the parameters Td and Tr should be included in the outcome research of the rehabilitation process of sea turtles in order to allow comparative studies among marine rehabilitation centers around the world.

Effects of "Swim with the Turtles" tourist attractions on green sea turtle *(Chelonia mydas)* health in Barbados, West Indies

K Stewart, T Norton, H Mohammed, D Browne, K Clements, et al. *Journal of Wildlife Diseases*. 2016;52(S104–S117).

Along the West Coast of Barbados, a unique relationship has developed between endangered green sea turtles (*Chelonia mydas*) and humans. Fishermen began inadvertently provisioning these foraging turtles with fish offal discarded from their boats. Although initially an indirect supplementation, this activity became a popular attraction for visitors. Subsequently, demand for this activity increased, and direct supplementation or provisioning with food began. Food items offered included raw whole fish (typically a mixture of false herring [*Harengula clupeola*] and pilchard [*Harengula humeralis*]), filleted fish, and lesser amounts of processed food such as hot dogs, chicken, bread, or various other leftovers. Alterations in behavior and growth rates as a result of the provisioning have been documented in this population. The purpose of this study was to determine how tourism-based human interactions are affecting the overall health of this foraging population and to determine what potential health risks these interactions may create for sea turtles. Juvenile green sea turtles (n = 29) were captured from four sites off the coast of Barbados, West Indies, and categorized into a group that received supplemental feeding as part of a tour (n = 11) or an unsupplemented group (n = 18) that consisted of individuals captured at sites that did not provide supplemental feeding. Following capture, a general health assessment of each animal was conducted. This included weight and morphometric measurements, a systematic physical examination, determination of body condition score and body condition index, epibiota assessment and quantification, and clinical pathology including hematologic and biochemical testing and nutritional assessments. The supplemented group was found to have changes to body condition, vitamin, mineral, hematologic, and biochemical values. Based on these

results, recommendations were made to decrease negative behaviors and health impacts for turtles as a result of this provisioning.

White-nose syndrome survivors do not exhibit frequent arousals associated with *Pseudogymnoascus destructans* infection

TM Lilley, JS Johnson, L Ruokolainen, EJ Rogers, CA Wilson, et al. *Frontiers in Zoology.* 2016 Mar;13(12).

Background: White-nose syndrome (WNS) has devastated bat populations in North America, with millions of bats dead. WNS is associated with physiological changes in hibernating bats, leading to increased arousals from hibernation and premature consumption of fat reserves. However, there is evidence of surviving populations of little brown myotis *(Myotis lucifugus)* close to where the fungus was first detected nearly ten years ago.
Results: We examined the hibernation patterns of a surviving population of little brown myotis and compared them to patterns in populations before the arrival of WNS and populations at the peak of WNS mortality. Despite infection with *Pseudogymnoascus destructans*, the causative fungal agent, the remnant population displayed less frequent arousals from torpor and lower torpid body temperatures than did bats that died from WNS during the peak of mortality. The hibernation patterns of the remnant population resembled pre-WNS patterns with some modifications.
Conclusions: These data show that remnant populations of little brown myotis do not experience the increase in periodic arousals from hibernation typified by bats dying from WNS, despite the presence of the fungal pathogen on their skin. These patterns may reflect the use of colder hibernacula microclimates by WNS survivors, and/or may reflect differences in how these bats respond to the disease.

Assessment of the rates of injury and mortality in waterfowl captured with five methods of capture and techniques for minimizing risks

MF O'Brien, R Lee, R Cromie, and MJ Brown. *Journal of Wildlife Diseases.* 2016;52(S86-S95)

Swan pipes, duck decoys, cage traps, cannon netting, and roundups are widely used to capture waterfowl in order to monitor populations. These methods are often regulated in countries with national ringing or banding programs and are considered to be safe and, thus, justifiable given the benefits to conservation. However, few published studies have addressed how frequently injuries and mortalities occur, or the nature of any injuries. In the present study, rates of mortality and injury during captures with the use of these methods carried out by the Wildfowl & Wetlands Trust as part of conservation programs were assessed. The total rate of injury (including mild dermal abrasions) was 0.42% across all species groups, whereas total mortality was 0.1% across all capture methods. Incidence of injury varied among species groups (ducks, geese, swans, and rails), with some, for example, dabbling ducks, at greater risk than others. We also describe techniques used before, during, and after a capture to reduce stress and injury in captured waterfowl. Projects using these or other capture methods should monitor and publish their performance to allow sharing of experience and to reduce risks further.

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USF&W banding a spectacled eider female goose on the Yukon Delta NWR in Alaska.

Association between positive canine heartworm *(Dirofilaria immitis)* antigen results and presence of *Acanthocheilonema odendhali* microfilaria in California sea lions *(Zalophus californianus)*

DDR Krucik, W Van Bonn and SP Johnson. *Journal of Zoo and Wildlife Medicine.* 2016;47(1):25-28.

This study establishes a relationship between positive canine heartworm *(Dirofilaria immitis)* test results frequently observed in California sea lions *(Zalophus californianus)* and infection with the filarid nematode *Acanthocheilonema odendhali*. Four commercially available canine heartworm antigen tests were evaluated for cross-reaction with *A. odendhali* in California sea lions. Sera were tested from fifteen California sea lions with *A. odendhali*-associated microfilaremia, confirmed by blood smear, and with no evidence of *D. immitis* infection at necropsy. Ninety-five percent of tests were falsely positive for *D. immitis.* This study also determined that the prevalence of *A. odendhali* infection in stranded California sea lions from central California is approximately 23% by comparing the number of findings of microfilaremia to the total number of California sea lions sampled at The Marine Mammal Center between 2005 and 2011, inclusive. *Acanthocheilonema odenhali* microfilaremia in California sea lions is likely to cross-react with canine heartworm antigen tests, and clinicians should interpret results with caution.

Animal migration: Dispersion explains declines

RA Fuller. *Nature.* 2016 Mar 24;531(451–452).

Migratory birds are declining globally. A broad study of European migratory birds finds that species that disperse widely during the non-breeding season are less likely to be in decline than are species with more restricted dispersion. ■

TAIL END

Okay, so the quad shot latte *may* be too much for me.

Hooded merganser (*Lophodytes cucullatus*).

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INSTRUCTIONS FOR AUTHORS

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

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Young male fallow deer (Dama dama) with still-growing antlers in velvet.
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