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IN THIS ISSUE

Raccoon behavior after release: Home range, movement, and survival Can rehabilitation help to increase population size of an endangered penguin? Treatment of a difficult tarsometatarsal fracture in a common buzzard Profile of the Turtle Rescue Team at North Carolina State University's veterinary college Up for Discussion: Testing rehabilitated predators for release readiness

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 in numerous locations, and an annual symposium, IWRC works to disseminate information and improve the quality of care provided to wildlife.



Left: Yellow-eyed penguin and chick (Megadyptes antipodes). PHOTO @f0rbe5 (ON FLICKR.COM). USED WITH PERMISSION.

On the cover: The Northern raccoon (Procyon lotor). PHOTO @RUTHANNE ANNALORO. USED WITH PERMISSION.



International Wildlife Rehabilitation Council PO Box 3197 Eugene, OR 97403 USA Voice/Fax: (408) 876-6153 Toll free: (866) 871-1869 Email: office@iwrc-online.org www.iwrc-online.org



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JOURNALOF ILDLIKK REHABILITATION

Volume 30(1)

CONTENTS

PEER-REVIEWED PAPERS

7

Home Range, Movements, and Survival of Rehabilitated Raccoons (*Procyon lotor*) in Ontario, Canada

Rick Rosatte, Mark Ryckman, Sue Meech, Sarah Proceviat, Laura Bruce, Dennis Donovan, and J. Chris Davies

13

An Assessment of Rehabilitation as a Tool to Increase Population Size of an Endangered Seabird, the Yellow-Eyed Penguin (*Megadyptes antipodes*)

Hiltrun Ratz and Chris Lalas

21

External Coaptation of Tarsometatarsal Fracture in a Common Buzzard (*Buteo buteo*)

Dorota Rozanska, Pawel Rozanski, Izabela Polkowska, Ireneusz Balicki, and Maciej Orzelski

25

The North Carolina State University College of Veterinary Medicine Turtle Rescue Team: A Model for a Successful Wild-Reptile Clinic

Gregory A. Lewbart, Jennifer Kishimorig, and Larry S. Christian

DEPARTMENTS

Editorial by Kieran Lindsey	4
Up for Discussion: Providing live prey to predators before release	5
Certification: Part 3 by Nancy Hawekotte	31
Foresters Log: Bears and Burns by Mary Stuever	33
Tail Ends	34
Submission Guidelines	35

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EDITORIAL

Everyday Wildlife

Ever ask yourself, why did I get involved in wildlife rehabilitation?

There are probably as many answers to that question as there are rehabilitators, although there are sure to be some similar themes. Perhaps you dreamt of becoming a veterinarian, but life had other plans. Perhaps you are a veterinarian who hoped to work at a zoo, but had to find another way to care for wildlife. Perhaps you wanted to get involved in conservation, or learn more about the natural world. Or, you may never have imagined you'd be doing this kind of work, but rehabilitation found you anyway, blowing into your life disguised as a neonate squirrel tossed from the nest during a storm... or a dove that mistook your window for clear blue sky.

When I first joined the rehabilitation community, my answer to this question would have been "all of the above." Thousands of intakes, and decades, later, I'm no longer actively caring for wildlife, so I often find myself wondering why I'm still here. I've toyed with various responses, but if I'm honest with myself (and with *JWR* readers), fear plays a significant role.

In this rapidly urbanizing world, I'm afraid that wildlife and the natural world are becoming irrelevant to a large portion of the human population. The potential consequences of this trend are enormous and terrifying. Sure, wild animals are easy to find on television and in magazines, but let's face it: a mass media ecosystem is far from diverse, presenting "charismatic megafauna" native to exotic, or at least to remote, locations. But wildlife will not retain its relevancy when it's presented in the context of once-in-a-lifetime trips to Tanzania or the Grand Tetons.

If we want people to care enough to take action in support of wildlife, we have to help them recognize the daily contribution of sound and color and wonder that wildlife adds to their quality of life. A warbler's liquid aria pouring through the kitchen window; a flash of scarlet against sparkling snow as a fox tiptoes through the alley; the fascination of finding a translucent gecko glued to the siding while munching a moth beneath the front porch light—it's these small, daily events that will galvanize support for the protection of species, diversity, and habitat.

Rehabilitation is the perfect venue, I think, for strengthening the connection between people and wildlife. When a squirrel darts out in front of a car, when a sparrow decides to nest in the dryer vent, they don't ask if the driver or homeowner is a member of Audubon or a Discovery Channel viewer. That means rehabilitators have a singular opportunity to preach to someone other than the choir. If we take the time, we can make these close encounters with wildlife stepping stones that lead to heightened awareness and appreciation of a natural world that's just as available and awe-inspiring in neighborhoods as in national parks.

Rehabilitation may be the only wildlife vocation—avocation that provides daily access to a new audience for a conservation message. I don't believe wildlife can afford for us to let the opportunity pass by. That's why I'm involved in wildlife rehabilitation.

Kieran Lindsey, PhD, Editor Journal of Wildlife Rehabilitation

Errata: On the inside front cover of JWR 29(2-3), the photo caption contained a typo. It should have read Hanuman langur. Our apologies to the photographer.

INSIGHT

Up for Discussion: PROVIDING LIVE PREY TO PREDATORS BEFORE RELEASE

Some wildlife rehabilitators believe a predator, such as a coyote or hawk, should demonstrate that it can hunt, catch, and kill live prey before it is released and that to release these animals without this proof is inhumane. Others argue that providing live prey is of marginal use, since any test conducted within an enclosure doesn't provide the same conditions the predator will face in the wild. Ethical issues abound when talking about this subject. What's your take on this issue? Are live prey a part of your predator rehabilitation protocol?

THE QUESTIONS:

Is it humane to release a live animal into a predatory animal's enclosure without any means of escape? Does it matter whether or not the prey is a live "feeder" animal? Should animals admitted for rehabilitation ever be used as live prey for other rehabilitation cases?

THE RESPONSES:

reat questions. Is it humane to **J**release a live animal into a predatory animal's enclosure without any means of escape? It comes down to the question of suffering, doesn't it? And what exactly is suffering? We have to acknowledge the predator is also under stress and suffering, both from its injuries and from being captive, and yet we are beyond judging this part of the process. I see the act of placing live food, be it a meal worm, a goldfish, a chick, or a rabbit in a predator's enclosure as much a part of the professional rehabilitation process as anything else that is done to give the wild animal its second chance. That said, I believe it's important that the people who work at a facility which offers live food, no matter how small the creatures, have a means to offer their respects for those lives taken-a nondenominational something-a candle in the window, perhaps. As for the question of whether wild patients should ever be used as prey for other rehabilitation cases, I believe this is an ethical question that can, and should, only be answered by those who manage a facility's rehabilitation program. Personally, I can only see salvaging and utilizing a wild patient's body that has already expired.

> **Rebecca Dmytryk** WildRescue Moss Landing, California, USA

A t Wild Bird Rescue, we only care for our avian friends. My viewpoint on this topic is that it should be situation dependant. If a raptor comes to us with simply a wing injury, there is no need to "test feed." If the injury involves a leg or foot, but the raptor can use both feet, there is no need to "test feed."

If the raptor has head trauma and had to be force-fed before they started selffeeding, then it would probably be required to provide live food to ensure their trigger mechanism to kill is, in fact, functioning. If the leg or foot injury kept them from using the foot, live prey may be needed to ensure the foot works well enough to grasp and kill their prey.

Once we are satisfied with the results, we no longer feed live prey. We feed live prey just long enough for us to be sure we are releasing a fully functional raptor back into the wild.

At no time do we feed birds who are at our facility for rehabilitation.

Bob Lindsay, *Executive Director Wild Bird Rescue, Inc. Wichita Falls, Texas, USA*

A tour facility, we use live prey for our juvenile animals, of any species, that would normally prey in the wild once released—like raptors, raccoons, foxes, and skunks. We also use live prey to be sure that an owl that had sustained a head injury can indeed hunt before releasing it. I've seen a couple of head-injured owls not be able to hunt, even though they were beautifully flighted and ate the dead prey very readily.

The situation in which the predators are getting their live prey in captivity cannot begin to mirror what they would encounter in the wild. What I tell my staff and volunteers is that they at least get the experience of knowing what it feels like to have live prey in their talons, paws, or mouth, so that when they are lucky enough to actually capture the live prey in the wild, they will know how hard they need to hold on to it and that it could very well bite back.

We never use live animals admitted for rehabilitation as live prey. It's definitely a gray area, but that is not why the finder brought us the animal. Even if the animal has no chance of recovery, depending on the injury, we tell the finder that they should take comfort in knowing that the animal will die a humane death in our hands, rather than suffering or being eaten while still somewhat alive in the wild.

We raise rodents at our facility and a good number of the mice get fed out, live, in the summer months. Again, this is a gray area, but this is the purpose of these animals. They have lived an excellent life up until that moment when "it is time to be a mouse and feed a predator." It's always hard to watch, but we feel that releasing a predator that has never hunted is hardly worth the effort of rehabilitation, if you do not give that animal the life skills it needs to survive. The rodents that are raised as food are going to die one way or another, it's just the method in which they die that some people are uncomfortable with. I think many, including me, would have to admit that it is not humane to offer live prey to a predator with no means of escape for the prey, but in reality, we can't have hundreds of domestic rodents running free around here... we have plenty of 'wild' rodents as it is.

We think that this is just one of those difficult facts of being an ethical rehabilitator—if you don't like to be exposed to the reality of what it means to be a predator, you should be vegetarian yourself and consider rehabilitating herbivorous animals only... it is never a fun activity for any of us, but we feel it is a necessary one.

Caryn Goron

CVT/Animal Care Supervisor Wildlife Images Rehabilitation and Education Center Grants Pass, Oregon, USA

V/e would never release an orphan raptor, who has never learned to hunt with his or her parents, without time in "mouse school" (live mice), just as we feed live crickets and mealworms to songbirds. Also, raptors which are with us for a length of time also get some live mice. Accipitors and falcons also get a chance at live birds. These prey are never our patients-we do not feed live patients to live patients. However, we are able to get some pigeons, starlings, and house sparrows that are trapped at the airports and which would otherwise be euthanized. You can't be sure these birds can hunt without testing on live prey. Our enclosures are large enough, with enough growth (trees, ground cover) to make the birds work to catch their prey.

> Ann C. Lynch, Director South Bay Wildlife Rehab Rancho Palos Verdes, California, USA

Thanks to the IWRC for bringing up this avoided subject!!! Holly Hadac, Vice-President Michigan Wildlife Rehabilitators

I didn't know there was much controversy about the first issue. It makes me feel bad every time I offer the tame mice to orphaned raptors, raccoons, and skunks, but it's part of our "parental" responsibility. The orphans don't really learn to hunt, but at least learn to kill. The first time they kill, it is pretty tortuous, but they become experts quickly. It would be preferable to euthanize a predator orphan than to release it without any experience at all. The second issue is controversial. Some rehabbers routinely feed starlings

I have been doing rehab for more than 30 years, and as time has passed, I myself

feel that "live testing" is needed in most cases, unless it is an adult and has been at OWL for only a brief time. Some birds admitted with head trauma

and house sparrows to predator orphans,

sometimes even to injured adults. I prefer

not to do that myself, as it is a betrayal to

Northern California region, USA

the animal as well as the finder.

Tehama Wild Care

Karen Scheuermann

some birds admitted with head trauma need to be tested to make sure there is no problem with their ability to catch live prey. For instance, some of these birds cannot keep prey in focus and hit walls when trying to catch it (lack of depth perception). This is not always able to be diagnosed by the eye specialists.

If a bird has had a leg injury, you need to know it can make the strike without rebreaking the leg. With wing injuries, the bird must be able to move appropriately to make the necessary strike.

As for enclosures, you must ensure the enclosure is geared to the size of raptor you are live-testing. Do they have the space to catch live prey properly? We use several different sizes for live-testing and can enlarge the cages to give the prey a better chance of evading the raptors.

The birds start with short grass, then longer grass and branches, logs, etc. are introduced to create a more natural setting, as would occur in the wild. Food and water for the prey is also put in the cages, so if they aren't caught, they are not suffering. We have a cage (now being rebuilt) used for live fish for osprey and eagles. I have found, over years of using domestic-bred prey, that they do not show the same fear as live, wild prey. We have, in the past, used live feeder fish to get osprey to eat before they go into the live-testing cages. Some of the cages make the raptors work for their dinner. On the occasion when we are unsure of a given bird doing well, we work with falconers to ensure the bird can hunt and survive.

One other point that was questioned was if it is appropriate to feed admitted ani-

mals as prey. At Owl, we only rehabilitate birds of prey; if another species is brought to us, we assess it for releasability. If it is releasable, the rescuers are sent to the group that can assist them. If the animal or bird is nonreleasable, we ask the people that brought it in if it can be used for food. If the answer is yes, the injured bird or animal is fed to a raptor—that day—so as not to prolong its suffering. If the answer is no, it is euthanized by injection with rescuers present so they know it was humanely destroyed. It is wrapped and marked so it will not be fed to the birds.

One issue about feeding live is the extended time the prey may spend in a predator's cage. This should be brief so they do not suffer or starve. The bird you are testing must be hungry enough to dispose of prey quickly, as well as learn how to do so.

We have three cages in which most of the live testing is done. One is 300' long, one is 128' long, and one is 120' long.

We're always available to answer questions and share information about our methods through OWL's site at *www.owlcanada.ca*.

> **Bev Day,** Founding Director OWL Delta, British Columbia

Istrongly believe live prey should be introduced to raptors prior to release. Granted, it is easier to catch prey in an enclosure, but at least the birds learn to kill prey. I have flight cages that are rodent-proof (sheet metal into ground for a foot and above ground for 3 feet). Live prey is released into a leaf-covered area within the cage. Raptors have to spend 2–3 weeks with only live prey (for food) before release.

> Sallie Delahoussaye Wildlife Rescue, Inc. Austin, Texas, USA

IWRC presents new discussion topics in our member e-newsletter and encourages every member to respond to the questions. Replies may be edited for space and clarity.

Home Range, Movements, and Survival of Rehabilitated Raccoons (*Procyon lotor*) in Ontario, Canada

Rick Rosatte, Mark Ryckman, Sue Meech, Sarah Proceviat, Laura Bruce, Dennis Donovan, and J. Chris Davies

Introduction

Raccoons are one of the most common mammals in Ontario, Canada. It is estimated that there are approximately 1 million raccoons in the southern part of the province (Rosatte 2000). Due to their high population densities, especially in urban areas of Ontario, raccoons are one of the most common species handled by wildlife rehabilitators (Rosatte 2000). Two key questions that have arisen in the past, with respect to raccoon rehabilitation, are "How well do rehabilitated raccoons survive?" and "Where should raccoons be released when they have been rehabilitated?" In Ontario, the Ministry of Natural Resources regulates the rehabilitation of wildlife, and a set of conditions dictate where raccoons can be released. Currently, those conditions stipulate that raccoons should be released in close proximity to the area in which they lived prior to rehabilitation. Previous studies in Ontario indicated that raccoons released substantial distances from their home range traveled great distances (which could result in the transmission of diseases to new areas), and mortality was extremely high (Rosatte and MacInnes 1989). Therefore, we initiated a study in Ontario during 2004–2007 to determine the survival and movements of raccoons that had been rehabilitated and released within 1 km of their original prerehabilitation acquisition area. This paper details the results of that study.

Methods

This study was conducted in the southern portion of Ontario, Canada (Fig. 1), between the cities of Newcastle (43°56'N, 78°34'W) and Napanee (44°13'N, 76°58'W), and northward to Bobcaygeon (44°30'N, 78°31'W). The study area encompassed approximately 8,000 km² in the mixed-wood plains ecozone, which is considered to be part of the Great Lakes–St. Lawrence forest region; it is characterized by mixed deciduous–evergreen forests and tolerant hardwood forests (Lee *et al.* 1998). Major tree species include white (*Pinus*

strobus) and red pine (*P. resinosa*), oak (*Quercus* spp.), elm (*Ulmus* spp.), maple (*Acer* spp.) and birch (*Betula* spp.). Wetlands are numerous in certain areas. The area has a high concentration of agricultural activities, as well as a high humanpopulation density.







erated by the surrounding Great Lakes (Huron, Erie, and Ontario), which produce relatively warm summers and cool winters. The area receives between 750–1,200 mm of precipitation annually. Mean daily January temperatures range from -3° C to -12° C. Mean daily July temperatures range from 18° C to 22° C (Anonymous 2003).

IN YOUR PRACTICE: Post-release data are rare in rehabilitation, but are crucial to understanding the efficacy of captive care protocols. In order to gain credibility with other, established wildlife professions, the definition of successful rehabilitation needs to expand beyond release.

ABSTRACT: During 2004 to 2007, twenty rehabilitated raccoons were fitted with radio collars and released within 1 km of their acquisition location in southern Ontario, Canada, to study their movements and survival. Data were used from 13 of those animals. Mean home range for male and female raccoons fitted with VHF collars was 2.4 and 1.0 km². Mean and maximum linear distance from the release site for rehabilitated raccoons was a mean of 1 and 2 km, respectively, and the movement rate of male and female GPS-collared raccoons was 90 and 24 m/hr, respectively. Rehabilitated raccoons appeared to use available habitat randomly, with no single habitat being used more or less than expected. Survival of rehabilitated raccoons during the study period was 0.384, with mean survival time for rehabilitated raccoons being 484 ± 83 days. Data suggest that raccoon survival is a function of time and is not affected by rehabilitation status. We suggest that rehabilitated raccoons be released in the general area in which they were acquired, in order to minimize movements and the transmission and spread of infectious diseases and parasites, as well as to minimize the impact on resident animals.

KEY WORDS: home range, movements, Procyon lotor, raccoon, rehabilitation, survival, Ontario

CORRESPONDING AUTHOR

Dr. Rick Rosatte Ontario Ministry of Natural Resources Wildlife Research and Devel. Section Trent University, DNA Building 2140 East Bank Dr., Peterborough, Ontario, K9J 7B8, Canada Phone: 1–705–755-2280 Email: *rick.rosatte@ontario.ca*

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Raccoon rehabilitation

Five raccoons were rehabilitated by a member (S. Meech) of the Ontario Wildlife Rehabilitation and Education Network (OWREN) during the winter of 2003–2004. Four of the animals were brought to the rehabilitator as juveniles (1M, 3F). Two of these animals (1M and 1F) were orphaned siblings whose mother was struck and killed by a vehicle south of Peterborough, Ontario. The other two juveniles were also orphans; one from Bobcaygeon, Ontario and the other from Newcastle, Ontario. The fifth rac-

coon, from Peterborough, Ontario, was being kept as a pet before being brought to the rehabilitator.

All five were eventually released at their original acquisition locations in May 2004. An additional five raccoons (5M) were rehabilitated over the summer and released in September 2004; however, the data were only used from one of these animals due to dropped or lost collars.

In 2006, 10 juvenile raccoons (4F, 6M) from two family units were brought to the rehabilitation centre from an area north of Napanee, Ontario. Both groups were orphaned after their mothers were killed by vehicles. One group consisted of three females and three males,

while the other group consisted of three males and one female. Following rehabilitation, these raccoons were released in late August or early September 2006 within 1 km of their original location.

Upon acceptance by the rehabilitator, raccoons were quarantined for a period of 14 days. Juvenile raccoons were fed a powdered milk supplement (Esbilac[™], PetAg, Hampshire, Illinois, USA) and dog food, with the gradual addition, over time, of fruit and vegetables. Cooked chicken was introduced at 10 wk, at which point raccoons were fed in the late evening to encourage nocturnal activity. Raccoons were housed separately in outdoor cages in a private, wooded area. Cages were equipped with branches, wading pools, mossy logs, etc. to mimic natural habitat. Make-shift hammocks were strung from the cages as dens, because naturallyoccurring dens in the cages were typically used as latrines.

Raccoons were vaccinated against feline rhinotracheitis, calici virus, and panleukopenia with Felovax PCT[™] (Fort Dodge Laboratories, Fort Dodge, Iowa, USA) at 6, 12, 16, and 20 weeks. Raccoons were also vaccinated against canine distemper (Fervac D, United Vaccine Company, Madison, Wisconsin, USA) and

rabies (IMRAB 3[™], Merial Inc., Athens, Georgia, USA) prior to release. For radio-collaring, raccoons were immobilized with an injection of 10:1 ketamine:xylazine at a dose rate of 15 mg/kg ketamine and 3 mg/kg xylazine. All raccoons were also marked with individually numbered ear tags (National Band and Tag Company, Newport, Kentucky, USA).

All raccoons released in May 2004 were fitted with VHF collars (Advanced Telemetry Systems, Isanti, Minnesota, USA), while two of the five released in September 2004 had GPS



collars (Lotek Engineering Inc., Newmarket, Ontario, Canada) and the others had VHF collars. One raccoon from each group released in late August or early September 2006 (Napanee area) was fitted with a GPS collar, while all others received VHF collars. All raccoons were released within 1 km of their site of acquisition and were tracked until June 2007 or until they succumbed.

Diurnal rest sites of radio-collared raccoons (both VHF and GPS) were estimated, once weekly, using standard ground-telemetry techniques. Telemetry equipment consisted of a portable telemetry receiver (Lotek SRX-400 or STR 1000, Lotek Engineering Inc.,

Newmarket, Ontario), a hand-held GPS unit, a compass, and a 3-element Yagi antenna (Lotek Engineering Inc., Newmarket, Ontario). A minimum of three bearings was recorded for each animal (GPS collars included). All locations were recorded in Universal Transverse Mercator coordinates, which are based on the North American Datum 1983. Location estimates were calculated in LOCATE II (Pacer Inc., Truro, Nova Scotia). In order to minimize the effects of telemetry error, location estimates based on only two bearings were discarded, as were location estimates whose 95% error ellipses were >1 km². However, error ellipses were generally much smaller (0.59 ± 0.34 km²). GPS collars were programmed to record location estimates at 0600, 1200, and 1800 hr, and hourly between 1800 and 0600 hr in order to capture nocturnal movement patterns. From November to April, GPS collars were programmed to obtain a location every 4 hr.

To assess accuracy of ground-telemetry techniques and equipment, we calculated straight-line distances between the locations estimated manually (using the VHF component of GPS collars) and the GPS-estimated locations. As GPS-collared raccoons were found in different portions of the study area, this gave us a random sample. It also allowed us to estimate locations when raccoons were in buildings, etc., habitats that are not typically included in dummy collar tests. In order to increase accuracy of the location estimate, we eliminated any locations that were estimated with fewer than three satellites. One hundred location-pairs were randomly selected, for which both VHF and GPS data were available. Raccoons were assumed to be resting during daylight, thus reducing the likelihood that an animal was moving at the time of location. Mean distance between location estimates was 43 ± 31 m for both types of collar data.

Estimation of home ranges and movements

Seasonal and annual home-range sizes of raccoons were calculated using the minimum convex polygon (MCP) estimator with Hawth's Tools (Beyer 2004) in ArcGis 9.1 (ESRI, Redlands, California, USA). Home ranges were generated for raccoons with ≥15 locations. For animals fitted with GPS collars, we randomly chose 27 locations and generated MCPs from these locations. This process was repeated 20 times to obtain an average MCP home-range size for GPS-collared animals. We chose to select 27 locations because this was the mean number of locations obtained for VHF-collared animals. We used 27 locations as a minimum for both overall and seasonal MCPs of GPS-collared raccoons. For animals fitted with GPS collars, we defined seasons as follows: winter-breeding (December 1 to March 31), rearing (April 1 to July 31), and predenning-dispersal (August 1 to November 30). Seasonal MCPs were not generated for VHF-collared animals due to insufficient sample sizes within certain seasons.

We calculated mean and maximum linear distances from the release site to each telemetry location for each animal. A multivariate analysis of variance (MANOVA) was used to test for the influence of sex and age on movement variables. If no differences were found, sex and age classes were pooled for further analysis. All statistical tests were performed in SPSS (Version 10, SPSS Inc., Chicago, Illinois, USA).

Using sequential telemetry locations obtained with GPS collars, we calculated movement rates by determining straight-line distances (in meters) between consecutive locations and then dividing the distance by time elapsed between locations.

Habitat analysis

Relevant habitat types were delineated using GIS data obtained from the Ontario Ministry of Natural Resources. The Southern Ontario Interim Landcover data layer (Ontario Ministry of Natural Resources, Peterborough, Ontario, Canada) was used, which represents the landscape in the study area circa 2000–2002. As the vast majority of the study area was comprised of agricultural areas, the landscape was not expected to have changed drastically since 2002. The dataset was created using advanced remote sensing and GIS techniques. Similar habitat types were combined to reduce the number of habitat variables (Table 1).

TABLE 1. Habitat use (relative to availability) by rehabilitated raccoons in southern Ontario during 2004–2007¹.

Habitat	Mean	SD	t	Р
Agriculture	1.46	1.39	1.322	0.206
Buildings	0.92	0.29	-1.079	0.298
Development	0.93	0.15	-1.769	0.097
Hedgerow	0.97	0.18	-0.596	0.56
Waterline	1.12	0.42	1.176	0.258
Pits and quarries	1.01	0.28	0.159	0.876
Transportation	1.05	0.38	0.479	0.639
Unclassified	12.50	45.10	1.024	0.322
Water bodies	12.00	42.10	1.044	0.313
Wooded areas	1.53	2.43	0.877	0.394

¹Means represent habitat use relative to habitat availability. The habitat with the lowest mean value was used most, relative to availability (i.e., animal locations are closest to this habitat, relative to random points), whereas the element with the largest value was used least, relative to availability. Similar habitat types were combined to reduce the number of habitat variables. They included: agriculture = monoculture, mixed agriculture, and rural land-use; wooded areas = wooded area and plantation; water bodies = wetland, coastal wetland, and water body; development = pervious and impervious built-up areas.

Habitat analyses were performed in ArcGIS 9.1 (ESRI), and the Euclidean distance method described in Conner and Plowman (2001) was used to test for the presence of nonrandom habitat use by raccoons. For animals fitted with VHF collars, we generated 200 randomly distributed points within each animal's MCP home range using Hawth's Tools (Beyer 2004). For GPScollared animals, we generated 500 random locations. Because variance measures are not included in an analysis of Euclidean distance, generating too many points was not a concern (Conner and Plowman 2001). Straight-line distance was then calculated from each telemetry location and each random point, to the nearest representative of each habitat type, thereby obtaining mean distances for each animal as well as the expected mean distance to each habitat type. Ratios of actual distance to expected distance to each habitat type were calculated. A MANOVA (Wilks' lambda statistic) was utilized to determine if nonrandom habitat use was occurring, and we then used *t*-tests to determine which habitats were being used disproportionately-if nonrandom use was occurring. Paired t-tests were used on all possible habitat combinations to determine which habitats were used more, or less, than others. Statistical significance was set at $\alpha = 0.05$ for all tests.

Survival analysis

Raccoon survival was determined using the Kaplan-Meier method, modified for staggered entry of individuals (Pollock *et al.* 1989). Equality of survival functions between age–sex classes and rehabilitation status were tested using the Tarone-Ware statistic. Survival times of these rehabilitated raccoons, and survival of nonrehabilitated raccoons from another study (Rosatte *et al.* 2010), were compared using the Tarone-Ware statistic. Mortalities of nonrehabilitated raccoons, which occurred before the onset of the rehabilitated raccoon study period, were truncated to create equivalent study-period lengths for comparative purposes. In addition, variables thought to influence raccoon survival were also modeled using the Cox proportional hazards model (CPH). Factors tested using the CPH included sex, age, rehabilitation status, and four interaction terms describing possible relationships between the three variables: age*sex, age*rehabilitation status, sex*rehabilitation status, and age*sex*rehabilitation status. Candidate models were constructed to include all biologically relevant variable combinations. All survival analyses were performed in SPSS (SPSS Inc.).

Candidate models were compared through multi-model inference, using Akaike weights (*w*) corrected for small sample size (AIC_c; Burnham and Anderson 2001). Fulfillment of the proportional hazards assumption was tested for each candidate model by plotting partial residuals against survival time.

Results

Home range and movement statistics

MCP home-range estimates for VHF-collared raccoons were based on a mean of 27 ± 26 locations. Overall MCP home-range estimates for GPS-collared raccoons were based on the mean MCP size obtained from 20 MCPs generated from 27 randomly selected locations. Three VHF-collared raccoons (2M, 1F) were censored from the analysis due to insufficient locations. An analysis of variance (ANOVA) revealed a significant difference between VHF- and GPS-collar home ranges (F_{111} = 9.627; P = 0.01); results are therefore presented separately. Mean homerange size of VHF-collared male raccoons (n = 6) was 2.37 ± 2.49 km², while VHF-collared females (n = 6) had home ranges that were 0.91 ± 0.85 km² in size. However, this difference was not significant ($t_{3,476}$ = 1.127; P = 0.331). GPS-collared raccoons (n = 3) had a mean home range of 7.6 ± 5.94 km². Mean seasonal home-range sizes of GPS-collared rehabilitated raccoons (n = 3) were $1.97 \pm 2.92 \text{ km}^2$, $0.82 \pm 0.09 \text{ km}^2$, and $2.61 \pm 4.11 \text{ km}^2$ for the winter-breeding, rearing, and predenning-dispersal seasons, respectively.

Mean linear distance from release site of rehabilitated male raccoons (n = 7) was 1.03 ± 0.94 km and 0.954 ± 1.3 km for female raccoons (n = 9). An ANOVA did not reveal any sexspecific differences in mean distance from the release site ($F_{1,14} = 0.018$; P = 0.896).

Mean-maximum linear distance from the release site of rehabilitated male raccoons was 2.13 ± 1.9 km and 2.18 ± 2.22 km for female raccoons. An ANOVA did not reveal any sex-specific differences in maximum distance from release site ($F_{1,14} = 0.002$; P = 0.964). The greatest movement by a female raccoon was 7.2 km from the release site; the greatest movement by a male was 4.15 km. The three rehabilitated raccoons that were fitted with GPS collars moved at a rate of 89.8 m/hr for

the male and 23.72 ± 9.42 m/hr for the two female raccoons. Nightly movement rates averaged 38.5 ± 34.7 m/hr, while daily rates averaged 21.5 ± 16.4 m/hr.

Habitat analysis

Raccoon habitat use was not influenced by sex ($F_{10,3} = 3.21$; P = 0.183) or collar type ($F_{10,3} = 6.357$; P = 0.077). All data were therefore pooled together for further analysis. *T*-tests of habitat use: availability ratios failed to detect any nonrandom habitat use. Results of univariate *t*-tests suggested that no single habitat was used more or less than expected (Table 1). Likewise, pair-wise comparisons of habitat types suggested that no single habitat was used more or less than any other habitat.

Survival

Over the course of the study, we recorded five mortalities (5/16 = 31%). Causes of mortality included predation (n = 2), vehicular collision (n = 2), and unknown causes (n = 1). Two raccoons were censored from the analysis due to loss of contact and collar drop. Average tracking span was 222 ± 212 days. Two female raccoons that were released in 2004 survived 684 and 730 days, respectively. Survival time for male rehabilitated raccoons was 163 ± 39.7 days and 545.2 ± 102 days for females. However, this difference was not significant (Tarone-Ware statistic = 0.56; P = 0.454). Cumulative study period (2004–2007) survival of rehabilitated raccoons was estimated at 0.384 (Fig. 2).

Comparing survival of rehabilitated and nonrehabilitated raccoons

Survival of rehabilitated raccoons was compared to that of nonrehabilitated raccoons (from Rosatte *et al.* 2010) and was not found to be statistically different (Tarone-Ware = 3.11; P = 0.078). Mean survival time for nonrehabilitated raccoons (n = 88) was 774.1 ± 56.74 (SE) days, but was only 448.6 ± 91.76 days for rehabilitated raccoons (n = 16). In order to create approximately equivalent study periods, 10 censors of nonrehabilitated raccoons were truncated from the beginning of the appropriate study period (06 May 2004). These included six females and four males, with spans of 18–1,293 days. Only one of these censors was due to mortality, while the remaining nine censors were the result of either dropped collars or loss of contact.

Results of CPH modeling provided no clear evidence in support of any one survival model. Five models had Δ AICc ≤ 2 , suggesting that they all fit the data similarly (Burnham and Anderson 2001). The top three models accounted for less than half (45%) of the evidence in support of the data. The null model (survival as an effect of time, all other covariates = 0) received an AICc weight (*w*) of 0.12, while the top-ranked model (status/ age*sex) received a weight of 0.17. This suggests that, given our data, we gained very little knowledge regarding the survival of raccoons by adding information to the model. The data suggested that raccoon survival is a function of time and is not affected by gender, age-at-release, or rehabilitation status.

FIGURE 2. Survival of 12 rehabilitated raccoons in southern Ontario, Canada during 2004–2007¹.



¹The time period includes: 1 = May–Dec 2004; 2 = Jan–Jun 2005; 3 = Jul–Dec 2005; 4 = Jan–Jun 2006; 5 = Jul–Dec 2006; 6 = Jan– Jun 2007; Survival lines = mean and 95% confidence limits.

Discussion

In our study, no habitat was used more, or less, than other habitat types, suggesting that raccoons are habitat generalists. But does this mean that rehabilitated raccoons can be released anywhere? One of the most important aspects of the rehabilitation of raccoons is the issue of where to release them (Lerman 1982). Ludwig (1982) and Ludwig and Mikolajczak (1984) noted the importance of selecting proper release sites, as well as initiating postrelease studies for rehabilitated animals. In addition, Fritzell (1991) discussed the issues of releasing wildlife into unfamiliar habitat, including the carrying capacity of the habitat as well as the territoriality of the species already in the release area.

We are suggesting that rehabilitated raccoons be released in the same general area from which they were acquired in order to minimize the spread of infectious diseases and parasites, thereby negating the impact of issues such as the effect on resident animals. In our study, although our sample sizes were small, mean homerange values for male and female VHF-collared rehabilitated raccoons released in Ontario were, on average, 2.4 and 1.0 km², respectively, with GPS-collared raccoons having a mean home range of 7.6 km² (the larger estimates for GPS collars are likely a result of locations taken during the evenings when raccoons were active, as opposed to VHF data, which were based on daytime resting locations only). Movements were restricted, averaging 1-2 km from the release site. Evidence from other studies suggests that raccoons released into unfamiliar habitats may lead to raccoon movements that are more extensive than those of resident raccoons. Mosillo et al. (1999) monitored survival and dispersal of relocated raccoons in suburban and rural habitats of Chicago, Illinois, United States. They detected no differences in the survival of raccoons that were relocated from different habitats, but found greater movements in raccoons that were relocated from suburban habitat to rural forests, when compared to raccoons resident in the rural forest habitats. In our study, movements by raccoons that were rehabilitated and released where they were acquired were no

different than resident, nonrehabilitated raccoons. Rosatte and MacInnes (1989) noted extensive movements and poor survival of raccoons that were relocated from urban to rural habitats in Ontario, Canada. This suggests that our recommendation to release rehabilitated raccoons close to the point of acquisition is a wise one.

The movements of raccoons, rehabilitated or not, can contribute to the spread of infectious diseases such as rabies. Nettles et al. (1979) documented the shipment of raccoons from Florida to North Carolina, USA, by a hunting club. Two raccoons in that shipment were diagnosed with rabies, and they could have infected the remainder of the shipment, which were released in North Carolina. Schopler et al. (2005) evaluated risks associated with wildlife rehabilitation and wildlife rabies in North Carolina. They suggested that educational efforts directed at rehabilitators would have direct public health benefits. It was also revealed in a study of translocated raccoons in the southeast United States that they were infected with 19 helminth parasites that were exotic to resident animals. Some of those parasites were pathogenic, to some degree, to both humans and wildlife (Schaffer et al. 1981). Again, in view of this, it would be prudent for wildlife rehabilitators to release rehabilitated raccoons into the same area from which they were acquired, thereby minimizing the spread of rabies, and other diseases and parasites, to new areas.

During our study, we also hoped to determine if the survival of rehabilitated raccoons was any different than that of animals that were not rehabilitated. We acknowledge that our small sample size may have affected the results of the analysis. The Tarone-Ware statistic, which we used in the analysis, is based on chi-square statistics and, therefore, on asymptotic theory (Sokal and Rohlf 1995). If sample sizes are too small, the assumptions of the chi-square distribution may not be met. Furthermore, it is known that the power of the Tarone-Ware test to detect differences in survival functions is limited when the survival functions cross (Marubini and Valsecchi 2004), as they do in this case. In view of these limitations, our data suggest that raccoon survival is merely a function of time and is not affected by gender, age at release, or rehabilitation status. These results are a strong support for proper rehabilitation of young animals, leading to excellent survival rates when released. Without rehabilitation until they were old enough to survive on their own, these young animals would most likely have died. Results from this work suggest that rehabilitation efforts can be successful, particularly when the release area is in close proximity to where the young animals were originally found.

Summary

Home range, movements, and survival of rehabilitated raccoons were studied in eastern Ontario, Canada, during 2004 to 2007. Movements by raccoons released within 1 km of their area of acquisition for rehabilitation were not extensive, survival did not appear to be related to rehabilitation status, and raccoons did not select for any particular habitat upon release.

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About the Authors

Dr. Rick Rosatte is a senior research Scientist with the Ontario Ministry of Natural Resources Wildlife Research and Development Section (OMNR, WRDS). He specializes in wildlife disease research and control; in particular, rabies and chronic wasting disease. Other interests include the restoration of elk and the ecology of cougars in Ontario, Canada.

Mark Ryckman is a population ecologist with Manitoba Conservation in Winnipeg, Manitoba, Canada.

Sue Meech is a wildlife rehabilitator in Napanee, Ontario, Canada.

Sarah Proceviat is a biologist with Summit Environmental Consultants in Calgary, Alberta, Canada.

Laura Bruce is a wildlife resource technician with the OMNR, WRDS in Peterborough, Ontario, Canada.

Dennis Donovan is the Coordinator of the OMNR, WRDS Rabies Research and Development Unit in Peterborough, Ontario, Canada.

Dr. J. Chris Davies is the manager of the OMNR, WRDS in Peterborough, Ontario, Canada.

An Assessment of Rehabilitation as a Tool to Increase Population Size of an Endangered Seabird, the Yellow-Eyed Penguin (*Megadyptes antipodes*)

Hiltrun Ratz and Chris Lalas

Introduction

Wildlife rehabilitation is a unique form of wildlife management that targets individuals instead of populations (Williams 1990). Rehabilitated animals are individuals that would have died without intervention (Ress and Guyer 2004) and, thus, each potentially repre-

sents the addition of one individual to a species' population. Avian rehabilitation facilities typically quantify success as the release rate of treated birds (Wisecarver and Bogue 1974; Snelling 1975; Norris 1989; Martell et al. 1991; Fajardo et al. 2000; Dubois and Frazer 2003a), which is consistent with the concept that rehabilitation is undertaken for the welfare of individuals rather than for the conservation management of species (Kirkwood and Best 1998). The rehabilitation of birds is gaining acceptance as a con-



servation management tool, particularly for endangered species (Wisecarver and Bogue 1974; Duke *et al.* 1981; Martell *et al.* 1991; Perez *et al.* 1996; Sweeney *et al.* 1997; Kirk-wood and Best 1998; Dubois and Frazer 2003b). Rehabilitated animals contribute to population size only if they survive and successfully breed after release (Servheen and English 1979; Fraser and Moss 1985; Scott and Carpenter 1987; Martell *et al.* 1991; Grunsky-Schoeneberg and Hueppop 1997; Wolfaardt and Nel 2003; Dubois and Frazer 2003a). Consequently, evidence of breeding by rehabilitated animals, after release, is vital in order to justify what can otherwise be considered as an emotive and unscientific exercise (Smith 1996).

Rehabilitation has become a standard response to the public expectation for action when wildlife populations are threatened as a result of man-made disasters (Williams 1990). For example, major rehabilitation efforts, involving up to tens of thousands of seabirds, are undertaken after oil spills (e.g., Williams 1990; Sharp 1996; Underhill *et al.* 2000; Massey 2006). However, long-term monitoring of rehabilitated, oiled seabirds IN YOUR PRACTICE: The true measure of "success" for any rehabilitated animal is not its release back to the wild, but its survival as part of an active breeding population. This paper investigates the impact of rehabilitated birds on longterm population size utilizing postrelease data collection and analysis.

ABSTRACT: We investigated the effectiveness of rehabilitation for injured or sick resident breeders as a tool to increase population size of endangered yellow-eyed penguins (Megadyptes antipodes). Recent modelling of conservation measures showed that population growth for this species is achievable only through intensive management, including rehabilitation, with a predicted increase of 9% after 15 years. We tested this by monitoring resident breeders treated since 1997 at the rehabilitation facility of an eco-tourism venture, Penguin Place, near Dunedin, southern New Zealand. Males outnumber females in the wild breeding population; thus, annual nest numbers are derived from the number of females. Of 28 rehabilitations of resident female breeders, 24 (83%) were released, 16 (67%) of which bred again. Our results indicate that rehabilitation increased the average annual survival for adult females by 7%, an increase not statistically significant. Subsequent breeding generated 10% increases in cumulative totals for nests and for chicks fledged. We conclude that rehabilitation of this species can enhance population size, but is applicable only at locations already managed to mitigate anthropogenic threats to this species.

KEY WORDS: yellow-eyed penguin, annual survival, breeding success, conservation management, non-oiled birds, New Zealand.

CORRESPONDING AUTHOR: Hiltrun Ratz, PhD Penguin Place Harington Point Road, RD 2 Dunedin 9077, New Zealand Email: penguins@xtra.co.nz

J. Wildlife Rehab. 30(1): 13-20 © 2010 International Wildlife Rehabilitation Council has indicated low survival, following release, for most species (Sharp 1996; Anderson *et al.* 1997; Grunsky-Schoeneberg and Hueppop 1997; Partridge 1997; Goldsworthy *et al.* 2000; Jessop and Du Gueschlin 2000; Golightly *et al.* 2002). The most notable exception has been for African penguins (*Spheniscus demersus*) rehabilitated after the 1994 Apollo Sea oil spill in South Africa; that rehabilitation effort exhibited no reduction in survival rate, and the penguins' ability to breed successfully was not compromised (Whittington 2003; Whittington *et al.* 2003). African penguins are the most extreme example of a positive effect of rehabilitation: It was determined that the species population size in 2002 was about 20% larger than it would have been without any rehabilitation of oiled birds (Ryan 2003).

Published postrelease studies of rehabilitated terrestrial birds have targeted raptors (eagles, hawks, and owls) and have typically encountered difficulties and biases in monitoring (e.g., Servheen and English 1979; Duke et al. 1981; Hamilton et al. 1988; Ress and Guyer 2004); only one study (Sweeney et al. 1997) has quantified postrelease breeding success. Equivalent studies in seabirds are restricted to oiled individuals. We investigated the outcome of rehabilitation of (nonoiled) injured, emaciated, or diseased resident breeders to determine if rehabilitation was an effective tool to increase the population size of an endangered species, the yellow-eyed penguin (Megadyptes antipodes), at an ecotourism venture, Penguin Place, Dunedin, southern New Zealand. At this facility, penguins have been monitored and intensively managed since 1992 to eliminate or minimize detrimental anthropogenic impacts (Ratz and Thompson 1999; Lalas et al. 2007). Our investigation used their records, kept since 1997, for penguins treated at the Penguin Place onsite rehabilitation facility.

Rehabilitation could also enhance population size by saving individuals at risk from natural events unrelated to anthropogenic threats. It is possible that rehabilitation may be considered an inappropriate conservation management method because it serves to sustain weaker individuals. However, survival and fecundity are determined largely by environmental factors that are unrelated to individual fitness (Newton 1989, 1998) and, therefore, perceived weaknesses in rehabilitated penguins are unlikely to be inherited. Busch and Cullen (2009) divided the conservation management treatments applied to yellow-eyed penguins into three categories: 1) trapping (killing introduced mammalian predators that eat penguin chicks), 2) revegetation (creation of nesting habitat by revegetation, nest boxes, or both), and 3) intensive management (combination of trapping, revegetation, and rehabilitation). Methods at Penguin Place fit the definition of intensive management. Modelling indicated that population increases for this species are achievable only through intensive management, with a predicted increase of 9% after 15 years (Busch and Cullen 2009).

Yellow-eyed penguins

The yellow-eyed penguin is designated as an endangered species due to the combination of anthropogenic threats, their small geographic range, and extreme fluctuations in population size (Lalas *et al.* 2007; BirdLife International 2008). The longevity of yellow-eyed penguins can exceed 20 yr and, typically, females start breeding at 2–3 yr old and males at 3–5 yr old (Richdale 1957). Annual survival of males (average 88%) is slightly higher than that of females (average 85%), leading to an age-related disparity in the ratio of males to females from 1:1 at 2–3 yr old to 2:1 at 10 yr old (Richdale 1957). The species is monogamous and, thus, annual nest numbers are driven by the number of female breeders. Breeders show high site fidelity (individuals breed at only one location): 96% for females and 99% for males (Richdale 1957; Table 68). Philopatry (individuals breed at their natal location), however, is low; at most, 59% for females and 79% for males (Richdale 1957; Table 68).

Methods

Definition for years based on timing of breeding season

To calculate annual survival and fecundity, we used the 12 mo from mid-September of one year (the start of egg laying) to mid-September the following year; this was based on the breeding cycle of the penguins rather than on the calendar year. Years shown along the x-axis of figures represent calendar years at the start of the breeding season; e.g., 1992–1993 becomes 1992.

Study site

The study was done at two sites in New Zealand. Pipikaretu Beach (179°45'E, 45°48'S) and Ryans Beach (170°45'E, 45°49'S) are adjacent sandy beaches, 500 m apart, situated near the tip of Otago Peninsula, Dunedin, New Zealand. The two beaches are of similar length (500 m and 550 m, respectively) and have similar sizes (each about 5 ha) and breeding habitats that are occupied by yellow-eyed penguins (Ratz and Thompson 1999). Ryans Beach and the southern half of Pipikaretu Beach are entered legally only by the landowner and scientists, while the northern half of Pipikaretu Beach is the site of an ecotourism operation, Penguin Place, with about 50,000 visitors annually (Ratz and Thompson 1999). Both locations are monitored for breeding success and adult survival; monitoring occurs twice weekly from September to February when eggs and chicks are present, then weekly from February until May during the obligatory annual moult ashore by juvenile (first year) and adult birds.

Annual survival of yellow-eyed penguin breeders

Extensive banding of adults and chicks started at Pipikaretu Beach and Ryans Beach in 1992–1993 and continued throughout the study as unbanded adults were recruited into the breeding population (Ratz and Thompson 1999). Adults were sexed from head measurements (Setiawan *et al.* 2004) or from the sex of the mate. We defined breeders as adults that nested in a given year or previously, and analyzed annual survival separately for male breeders and female breeders. Unbanded or unsexed breeders were excluded from calculations for annual survival, but were included in annual numbers for nests and for chicks fledged.

The annual survival of banded adult breeders was recorded

for 15 years from 1992-1993 to 2006-2007 for both locations, updating Ratz et al. (2004) and Lalas et al. (2007); data accounted for adults taking a year off from breeding, following the method described in Ratz et al. (2004). We calculated annual survival as the number of adult breeders alive at the end of a year divided by the number at the start of the year. Average annual survival through a designated number of years was calculated as the sum of end-of-year totals divided by the sum of start-of-year totals; therefore, the calculations involved replication of individuals among years. A reduction in annual survival at Ryans Beach was attributed to predation by a New Zealand sea lion (Phocarctos hookeri) (Lalas et al. 2007). Consequently, we divided analyses of survival for adult breeders into two periods: 10 years, 1992-1993 to 2001-2002, before onset of sea lion predation; and five years, 2002-2003 to 2005-2006, after onset of sea lion predation. We treated data for annual survival as binomial distributions, with calculations for 95% confidence intervals and statistical comparisons following Lalas et al. (2007). Sample sizes were represented by the number of birds at the start of each year for comparisons between two years, and by the number of years for comparisons between longer durations.

The only published long-term data for annual survival of yellow-eyed penguins was collected and analyzed by Richdale (1957) from 18 years of monitoring, 1936–1937 to 1953–1954, at four locations on Otago Peninsula within 15 km south of Pipikaretu Beach and Ryans Beach. We compared our data for sex-specific survival of breeders with data presented by Richdale (1957: 150) in Table 69, "Survival of Breeding Penguins in Relation to Age (Birds of known age)."

Rehabilitation and postrelease survival of rehabilitated breeders

The reasons penguins were brought to the rehabilitation facility at Penguin Place were divided into three categories: 1) underweight during the moult, 2) injured, or 3) sick. Penguins that were underweight during the moult were too light to survive the obligatory four weeks of fasting that occurs through the annual moult. Injured penguins had wounds that were usually treated by a veterinarian. Sick penguins were all others that had no obvious injury and were not moulting, but were usually emaciated.

Records for yellow-eyed penguins treated at the rehabilitation facility started in 1997–1998. Consequently, all data for annual survival presented for the first 5 yr, from 1992–1993 to 1996–1997, included unknown numbers of rehabilitated breeders; therefore, analyses of the effect of rehabilitation of breeders were restricted to the last 10 yr of 1997–1998 to 2006–2007. All rehabilitated breeders were banded and sexed.

To assess the effect of the rehabilitation of breeders, annual survival of breeders was calculated in two ways: 1) for 'excluding rehabilitated breeders,' rehabilitated breeders were designated as nominally dead and, therefore, deleted from the population; and 2) for 'including rehabilitated breeders,' rehabilitated breeders were designated as having re-entered the population after release, if they were resighted in the following year.

Results

Annual survival of yellow-eyed penguin breeders

Annual survival at Pipikaretu Beach for adult male breeders was significantly different, and lower, during the 5 yr after the onset of sea lion predation (2002–2003 to 2005–2006) than during the 10 yr before (1992–1993 to 2001–2002) (Z = 2.089, P < 0.05), but the lower survival was not significant for females (Z = 1.338, P > 0.05) (Table 1, Fig. 1).

Annual survival at Ryans Beach during the last 5 yr was significantly different, and lower, than during the first 10 yr for both sexes (males: Z = 4.521, P < 0.001; females: Z = 2.805, P < 0.01) (Table 1, Fig. 2).

Further analyses for Ryans Beach were restricted to the 10 yr that preceded the onset of predation by sea lions. Mean annual survival through the first 10 yr was similar between Pipikaretu Beach and Ryans Beach for male breeders, but was significantly higher (Z = 2.625, P < 0.01) at Pipikaretu Beach for female breeders (Table 1); therefore, data for the two beaches were not combined. Although annual survival was higher for males than for females in most years at both beaches (Figs. 1, 2), this trend was not reflected in statistically significant intra-annual differences, with the exception of one year, 2001–2002, at Pipikaretu Beach (Z = 2.385, P < 0.05). The mean annual survival of male breeders (89.8%) was not significantly different than that of female breeders (82.5%) through the 15 yr at Pipikaretu Beach (Z = 1.270, P > 0.05) or through the first 10 yr at Ryans Beach (males = 87.9%, females = 73.6%, Z = 0.694, P > 0.05) (Table 1).

Sex-specific average annual survival of breeders from Richdale (1957: Table 69), 87.7% (n = 560) for males and 84.5% (n = 542) for females, was not significantly different (Z = 1.438, P > 0.05). Average annual survival of breeders for the 10 yr before the onset of predation by sea lions (1992–1993 to 2001–2002) at Pipikar-



FIGURE 1. Average annual survival (±95% confidence intervals) of males (circles) and females (squares) at Pipikaretu Beach, Dunedin, New Zealand, through 15 years from 1992–1993 (1992) to 2006–2007 (2006).

etu Beach and Ryans Beach (Table 1) only differed significantly from Richdale (1957: Table 69) for the lower average of 73.6% for females at Ryans Beach (Z = 3.177, P < 0.01).

Sex-specific averages were not significantly different between all 15 yr at Pipikaretu Beach (Table 1) and Richdale's (1957) findings, although the average annual survival of breeders at Pipikaretu Beach was higher for males (89.8%) and lower for females (82.5%).

Survival and fecundity following release of rehabilitated breeders

A total of 13 rehabilitations of 12 male breeders (one rehabilitated twice), and 28 rehabilitations of 24 female breeders (one rehabilitated 5 times) from Pipikaretu Beach or Ryans Beach, were carried out at the rehabilitation facility at Penguin Place through the 10 yr from 1997–1998 to 2006–2007. Of the three categories describing the need for rehabilitation, 'underweight during the moult' predominated and accounted for 62% of males and 71% of females (Table 2). The remaining males all had injuries. Of the remaining females, one-half were injured and one-half were sick (Table 2).

The release rate for male breeders was 61% (*n*=8 of 13), of which 88% (*n*=7 of 8) bred again and fledged a total of 12 chicks by the end of the 2006–2007 breeding season (Table 3). Rehabilitation did not generate a significant increase in annual survival of male breeders in any year. Similarly, there was no significant difference in average annual survival of males through the 10 yr, excluding (81.7%) or including (83.2%) rehabilitated breeders (Z = 0.524, P > 0.05) (Table 3). Eighteen more male breeders would have needed to be rehabilitated throughout these 10 yr to create a statistically significant ($Z \ge 1.96$, $P \le 0.05$) increase in average of 1.3 males rehabilitated from an average of 46 male breeders annually (Table 3), 100 more yr would be needed to create a statistically



FIGURE 2. Average annual survival (±95% confidence intervals) of males (circles) and females (squares) at Ryans Beach, Dunedin, New Zealand, through 15 years from 1992–1993 (1992) to 2006–2007 (2006).

significant increase in the annual survival of male breeders.

The release rate for female breeders was 86% (n = 24 of 28), of which 67% (n=16 of 24) bred again and fledged a total of 36 chicks by the end of the 2006–2007 breeding season (Table 4). Rehabilitation did not generate a significant increase in annual survival of female breeders in any yr, although in one year, 2003-2004, 21% of female breeders were treated in the rehabilitation facility. Similarly, there was no significant difference in average annual survival of females through the 10 yr, excluding (68.8%) or including (73.9%) rehabilitated breeders (Z = 1.460, P > 0.05). Seven more female breeders would have needed to be rehabilitated through these 10 yr to create a statistically significant increase in average annual survival of female breeders. Alternatively, with an average of 2.9 females rehabilitated from an average of 37 female breeders annually (Table 4), eight more years would be needed to create a statistically significant increase in the annual survival of female breeders. Data from the 10 yr (Table 4) indicated that the annual proportion of female breeders rehabilitated (y) varied inversely with annual survival, excluding rehabilitation (x) (r =0.802, P < 0.001, $\gamma = 0.144/x - 0.144$). Over the recorded range in female survival, this inverse relationship indicates that the proportion of female breeders rehabilitated could rise from about 3% at the maximum (83%) rate for annual survival to about 19% at the minimum (43%) rate.

The higher average annual survival of male breeders compared to female breeders at Pipikaretu Beach and Ryans Beach generated a surplus of males and, therefore, annual nest numbers were dependent on the number of female breeders. Since the start of records for rehabilitated penguins in 1997–1998, nesting by rehabilitated female breeders created 2–17% increases in annual nest numbers from 1998–1999 to 2006–2007 for Pipikaretu Beach and Ryans Beach combined (Table 5). This corresponded to a 10% increase in the cumulative total for nests through the 9 yr (Table 5), with four of the 18 rehabilitated female breeders still alive at the end of the 2006–2007 year. A total of 403 chicks were fledged through the 9 yr, 36 (9%) from rehabilitated females after their release from the rehabilitation facility (Table 4). Rehabilitation of female breeders therefore increased the number of chicks fledged by 10%, from 367 to 403.

Following rehabilitation, none of the male breeders fledged chicks that were subsequently recorded as breeding. However, four rehabilitated female breeders fledged six chicks (four females and two males) postrelease that were subsequently recorded breeding at Penguin Place. Three of these recruits started breeding in the 2006–2007 breeding season, two in 2007–2008, and one in 2008–2009. Together, these three recruits fledged two chicks in 2006–2007, one chick in 2007–2008, and were currently (December 2008) raising four chicks.

Discussion

Penguin Place is an ecotourism venture on private land that uses profits from guided tours to finance local conservation work and that includes an on-site rehabilitation facility. Four terrestrial threats that are faced by yellow-eyed penguins are attributable to anthropogenic causes: degradation of breeding habitat, introduced mammalian predators, human disturbance, and accidental fires (BirdLife International 2008). All of these threats have been addressed at Penguin Place and either eliminated or minimized (Ratz and Thompson 1999; Lalas et al. 2007). These threats decrease fecundity through the disruption of breeding but, with the exception of kills by dogs (Canis familiaris), do not lower adult survival. Unlike these aspects of conservation management, rehabilitation addresses an issue largely unrelated to anthropogenic threats: Yellow-eyed penguins requiring treatment have had their survival compromised due to natural causes that include emaciation, injury, or sickness.

Rehabilitation of 12 male and 18 female yellow-eyed penguin resident breeders at Penguin Place, through 10 yr, created a 10% increase over what the population size would have been without the addition of rehabilitated birds, as reflected in the number of nests and in the number of chicks fledged. This is similar to the 9% increase in population size after 15 yr, attributable to rehabilitation, as predicted from modelling the effects of different conservation management strategies by Busch and Cullen (2009). This contribution by rehabilitated birds would be at the expense of natural recruitment-if the population were at carrying capacity. This did not occur at Penguin Place because the population size of yellow-eyed penguins decreased by about one-third through the 10-yr study period and, thus, the rehabilitated birds were additive, not compensatory.

Adult survival is the most important demographic parameter affecting population performance in long-lived species (Caswell 2001). Increasing adult survival, therefore, presents an opportunity to stabilize or increase the population of an endangered species, and this is achieved if rehabilitated individuals return to breed, as happened at Penguin Place. We found that rehabilitation of resident breeders did not generate a statistically significant increase in the average annual survival rate of either TABLE 1. Banded yellow-eyed penguin breeders, of known sex, used for calculations of annual survival from 1992–1993 to 2006–2007 at Pipikaretu Beach and Ryans Beach, Dunedin, New Zealand. All rehabilitated penguins were included in the analyses.

		Pipikaretu Beach		Ryans Beach				
Year	Mal	es	Fem	ales	Ma	les	Fem	ales
	At start	At end	At start	At end	At start	At end	At start	At end
1992–93	20	19	20	20	14	13	12	12
1993–94	23	23	23	21	13	13	12	11
1994–95	24	22	22	20	16	15	16	1
1995–96	26	25	26	25	18	17	20	13
1996–97	30	27	29	23	25	22	25	15
1997–98	30	29	28	25	24	22	20	16
1998–99	33	27	29	21	24	18	19	13
1999–2000	29	27	22	20	18	17	18	15
2000-01	30	29	26	22	22	19	19	13
2001–02	33	28	30	18	24	18	21	16
2002–03	28	25	19	16	22	14	19	10
2003-04	26	20	18	12	15	8	10	3
2004–05	23	21	15	14	9	6	3	2
2005-06	23	19	21	16	8	4	8	5
2006-07	24	20	20	14	8	6	7	4
Total 15 yr: 1992–93 to 2006–07	402	361	348	287	260	212	229	158
Average survival	0.8	98	0.	825	0.8	0.815		90
Subtotal 10 yr: 1992–93 to 2001–02	278	256	255	215	198	174	182	134
Average survival	0.9	921	0.	843	0.8	79	0.7	36
Subtotal 5 yr: 2002–03 to 2006–07	124	105	93	72	62	38	47	24
Average survival	0.8	847	0.	774	0.6	13	0.5	511

TABLE 2. Reasons for admission into the rehabilitation facility at Penguin Place, 1997– 1998 to 2006–2007. The percentages represent the proportion of the total for each sex.

Season	Under during	Underweight during moult		Injured		:k
	Males	Females	Males	Females	Males	Females
1997–98	0	1	1	0	0	1
1998–99	5	6	0	0	0	1
1999–2000	1	2	0	1	0	0
2000-01	0	0	1	1	0	0
2001–02	2	2	2	1	0	0
2002–03	0	2	0	0	0	0
2003–04	0	4	1	1	0	1
2004–05	0	1	0	0	0	0
2005–06	0	0	0	0	0	1
2006–07	0	2	0	0	0	0
Total	8 62%	20 71%	5 38%	4 14%	0 0%	4 14%

TABLE 3. Annual number and fate of yellow-eyed penguin male breeders treated at the rehabilitation facility at Penguin Place through 10 years, 1997–1998 to 2006–2007. The total number of chicks fledged post-release are reported in the first breeding season following rehabilitation, not in the season when chicks were fledged.

YEAR	POP. SIZE	TREA (n)	ATED %	RELEASED (n)	SIGHTED ALIVE (n)	BRED AGAIN (n)	CHICKS FLEDGED (n)	ANNUAL S REHABILI EXCLUDED	SURVIVAL, FATED (%) INCLUDED	INCREASE IN SURVIVAL (%)
1997–98	54	1	2	1	1	1	1	0.926	0.944	1.9
1998–99	57	5	9	4	3	3	5	0.737	0.789	7.1
1999–2000	47	1	2	0	0	0	0	0.936	0.936	0
2000-01	52	1	2	1	1	1	2	0.904	0.923	2.1
2001–02	57	4	7	2	2	2	4	0.772	0.807	4.5
2002–03	50	0	0	-	-	-	-	0.780	0.780	-
2003–04	41	1	2	0	0	0	0	0.683	0.683	0
2004–05	32	0	0	-	-	-	-	0.844	0.844	-
2005–06	31	0	0	-	-	-	-	0.742	0.742	-
2006–07	32	0	0	-	-	-	-	0.813	0.813	-
Total	453	13	2.9	8	7	7	12	0.817	0.832	1.8

TABLE 4. Annual number and fate of yellow-eyed penguin female breeders treated at the rehabilitation facility at Penguin Place through 10 years, 1997–1998 to 2006–2007. The total number of chicks fledged post-release are reported in the first breeding season following rehabilitation, not in the season when chicks were fledged.

YEAR	POP. SIZE	TREA (n)	ATED %	RELEASED (n)	SIGHTED ALIVE (n)	BRED AGAIN (<i>n</i>)	CHICKS FLEDGED (n)	ANNUAL REHABILI EXCLUDED	SURVIVAL, TATED (%) INCLUDED	INCREASE IN SURVIVAL (%)
1997–98	48	2	4	2	2	2	3	0.813	0.854	5.1
1998–99	48	7	15	5	4	3	13	0.625	0.708	13.3
1999–2000	40	3	8	3	2	2	5	0.825	0.875	6.1
2000–01	45	1	2	1	1	1	3	0.756	0.778	2.9
2001–02	51	3	6	3	2	2	8	0.627	0.667	6.4
2002–03	38	2	5	2	2	2	0	0.632	0.684	8.2
2003–04	28	6	21	4	3	3	4	0.429	0.536	24.9
2004–05	18	1	6	1	1	1	0	0.833	0.889	6.7
2005–06	29	1	3	1	0	0	0	0.724	0.724	0.0
2006-07	27	2	7	2	2	-	-	0.593	0.667	12.5
Total	372	28	7.5	24	19	16	36	0.688	0.739	7.4

sex; 2% for males and 7% for females. However, the survival rate for females would become significant in another 8 yr at the current average annual rate of rehabilitation. Yellow-eyed penguins are subject to extreme fluctuations in population size (BirdLife International 2008; Busch and Cullen 2009). Fluctuations were evident at Penguin Place and they may have confounded analyses.

Annual survival of male breeders was typically higher than that of female breeders, both through the 15 yr of our study and the 18 yr of Richdale's (1957) study. However, differences in long-term averages were not statistically significant within either study, or between Richdale's (1957) and our data for Pipikaretu Beach, the location that did not exhibit anomalously low annual survival attributed to sea lion predation. A higher annual survival of males creates a skewed sex ratio in the breeding population, so that annual nest numbers are derived from the number of female breeders (Ratz *et al.* 2004). Annual survival of female breeders is the most important demographic parameter in the viability of the species; population modelling with the Richdale (1957) value of 85% for annual survival of yellow-eyed penguin female breeders generated an annual population growth of 3–6% (Efford and Edge 1998).

Yellow-eyed penguins show high site fidelity (Richdale 1957); therefore, we chose to restrict our analyses to resident breeders because rehabilitated breeders can be easily monitored postrelease. However, the 42 rehabilitations of resident breeders accounted for only about 15% of the total of about 300 rehabilitations of yellow-eyed penguins at Penguin Place through the 10 yr starting in 1997; about 40% were unfledged chicks, about 25% were nonresident adults, and about 20% were juveniles (Hiltrun Ratz, unpubl. data). Our aim is to assess survival and breeding success for this majority of rehabilitations. This exercise is complicated by the low philopatry that reduces the reliability of finding birds, the long duration required to account for the age of primiparity, and by differences in first-year survival among cohorts. Up to and TABLE 5. Increases in annual nest numbers at Pipakaretu Beach and Ryans Beach, Dunedin, New Zealand, 1998–1999 to 2006–2007, created by rehabilitated (rehab) females.

YEAR	TOTAL NESTS <i>(n)</i>	REHAB FEMALES NESTING (n)	NESTS EXCLUDING REHAB FEMALES (n)	INCREASE IN NESTS (%)
1998–99	62	1	61	2
1999–2000	47	2	45	4
2000-01	47	4	43	9
2001–02	59	5	54	9
2002–03	41	6	35	17
2003–04	30	4	26	15
2004–05	18	6	12	50
2005-06	30	3	27	11
2006-07	26	3	23	13
Cumulative Total	360	34	326	10

including the 2008–2009 breeding season, six chicks that were fledged postrelease by rehabilitated females had returned to breed at Penguin Place at the time of publication.

Penguin Place is committed to maintaining an on-site rehabilitation facility for yellow-eyed penguins, not only as a successful addition to conservation management, but also in response to a public expectation that a commercial ecotourism venture has a responsibility to enhance the welfare of local wildlife. We are adamant that rehabilitation should only be considered for locations such as Penguin Place, where terrestrial anthropogenic threats have been mitigated—rehabilitation of adult yellow-eyed penguins is pointless if they cannot successfully breed.

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About the Authors

Hiltrun Ratz has been the resident scientist, since 1997, at Penguin Place, a private ecotourism venture that finances the

conservation of yellow-eyed penguins through commercial guided tours. Since completing her PhD at Otago University, Dunedin, New Zealand on the ecology, identification, and control of introduced mammalian predators of yelloweyed penguins, she has been



responsible for the welfare of the penguins at three colonies on the Otago Peninsula as well as the rehabilitation of ill and injured penguins at Penguin Place. She is also a member of the oiled wildlife response team for the Otago Peninsula.

Chris Lalas, BSc, MSc, PhD, is a consulting scientist who has worked with yellow-eyed penguins since 1979. Chris completed his doctorate on the diet of New Zealand marine cormorants in 1983 and is an Honorary Lecturer at the Department of Marine Science, Otago University, Dunedin, New Zealand. As a volunteer, Chris has monitored one yellow-eyed penguin colony on the Otago Peninsula annually since 1995, while being employed in fisheries and oil exploration. Chris has published extensively on New Zealand fur seals and sea lions, as well as on penguins.

External Coaptation of Tarsometatarsal Fracture in a Common Buzzard (*Buteo buteo*)

Dorota Rozanska, Pawel Rozanski, Izabela Polkowska, Ireneusz Balicki, and Maciej Orzelski

Introduction

Bone fractures are common in wild and captive birds (Fix and Barrows 1990, Rinkevich *et al.* 1999). Because they have thin cortices and more calcium than mammalian bones, avian bones are more brittle, and trauma often results in multiple fractures (Benett and

Kuzma 1992, Wissman 1999). The humerus, the femur, the bones of the pelvic girdle, and some ribs are pneumatic and contain air-filled medullary canals involved with the respiratory cycle during flight (Wissman 1999). The bones of the leg, below the tibiotarsus, have very poor softtissue covering. Fractures in this area are often open and comminuted (a fracture in which bone is broken, splintered, or crushed into a number of pieces).

The principles of fracture fixation are the same as those appointed



for mammals (Rinkevich 1999). However, the decision about the method of fracture repair depends on several factors, including what the bird's future ability to function will be. The treatment and outcome may be different for a companion or education bird that doesn't need to fly or capture food, as compared to a wild bird that requires flight and hunting prowess to be released and successfully live in the wild (Forbes 1998).

The objective of this study was to present a case of a comminuted distal tarsometatarsal and open fracture in a common buzzard, and to describe the surgical treatment and external coaptation (joining together or fitting of two surfaces) of fractured bone.

Case report

An adult male (1,450 g) common buzzard (*Buteo buteo*) was brought to the clinic of the Department of Animal Surgery of the University of Life Sciences in Lublin (Poland) 7 days after the bird was found by a member of a public. The bird had been living in the wild and was found on the ground. Upon admission, the bird was very stressed, but its general condition was good. Examination revealed an open fracture of the distal tarsometatarsus of the right limb. There was one lacerated wound measuring 0.5×1 cm, with no signs of bleeding over the dorsolateral aspect of the tarsometatarsus. Toe-pinch reflex response was present. The fracture had probably originated 10–14 days before the bird was brought to the clinic.

IN YOUR PRACTICE: Papers that focus on veterinary-medical treatment are valuable for both veterinarians and the rehabilitators with whom they work. Since *JWR* serves an international membership, readers have the oppportunity to explore the challenges faced by colleagues in regions beyond their own. Seeing how those challenges are overcome given the resources available can stimulate creative thinking and add to the rehabilitation toolkits all utilize.

ABSTRACT: Bone fractures are common in birds. Avian long bones, although very strong, have thin cortices and contain more calcium than mammalian bones; therefore, they are more brittle and susceptible to injuries. Injured avian bones readily splinter. The bird's movements, and the sharp edges of fractured bone, may cause soft tissue and skin damage, potentially resulting in an open, contaminated fracture. Especially susceptible bones are those with little soft tissue coverage, such as the tibiotarsus or tarsometatarsus. This article describes a case of comminuted distal tarsometatarsal and open fracture in a common buzzard. It reviews traditional methods of tarsometatarsal fracture repair, and their advantages and disadvantages for use in the presented case, and describes the surgical treatment and external coaptation of fractured bone used on this patient.

KEY WORDS: external coaptation, tarsometatarsus, fracture, common buzzard, *Buteo buteo*

CORRESPONDING AUTHOR

Dorota Rozanska Department and Clinic of Animal Surgery Faculty of Veterinary Medicine University of Life Sciences Ul. Gleboka 30 20-612 Lublin, Poland Email: *d-rozanska@tlen.pl*

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FIGURE 1. Initial radiograph, showing proximal oblique fracture.

Before radiographs were taken, the animal was anesthetized using xylazine (2 mg/ kg) and ketamine (5 mg/kg), administered intravenously. Initial radiographs showed an open distal comminuted fracture with a separate 0.5×0.7 -cm fragment of bone necrosis, as well as lead fragments at a fracture site on the right tarsometatarsus. The radiograph also showed a proximal oblique fracture. (Fig. 1).



FIGURE 2. The wound after surgical treatment.



FIGURE 4. The wound three weeks after surgery.



PHOTO © LABORATORY FOR RADIOLOGY A

FIGURE 5. Follow-up radiograph 3 weeks after surgery.

(as potassium clavulan-

ate) and amoxicillin (as

amoxicillin trihydrate), 125 mg/kg twice daily,

were administered to the

bird orally for 10 days

post surgery. The patient

also received meloxicam

(a non-steroidal antiinflammitory drug; 0.4

mg/kg orally) once daily

for 5 days. Blood work

was not done in this

individually in a stainless

steel, wooden-bottomed

cage. A stable, natural

The bird was housed

case.



FIGURE 3. External coaptation of injured region.

After radiographs were taken, the surgical field was cleaned and prepared aseptically. The large pieces of dirt and other debris were separated from the wound, and the dry piece of dead (necrotized) bone was gently removed. The wound was flushed with saline, and the edges were subtly scrubbed with the scalpel to provoke bleeding to further cleanse the wound. Proximal and distal bone fragments were reduced, and the edges of the wound were closed with a simple skin suture (Fig. 2). After the fracture was reduced, a light external coaptation splint was made. First, all toes, tarsometatarsus, and distal tibiotarsus of the right leg were bandaged with a cotton-wool bandage. To immobilize the toes in order to prevent their movement and tendon contracture, a plastic flat form, shaped like a buzzard's footprint, was prepared. The shoe was fastened to the bandaged toes with adhesive tape. The entire coaptation splint was bandaged with a few layers of self-adherent bandage. To harden the dressing, the self-adherent bandage was partially covered with cyanoacrylate glue (Fig. 3). This external device remained on the buzzard's leg for 3 wk, but because the fracture was open, it was changed every week. Clavulanic acid



FIGURE 6. External coaptation of tarsometatarsus.

wooden perch was placed in the cage, which allowed the bird to stand comfortably. No bandaging to protect the other weightbearing foot, or the tail sheaths, was needed. The animal was provided with a diet containing whole body parts (e.g., rabbits, chickens, ducks, and mice) and water was available *ad libitum*.

After 3 wk, the dressing was removed (Fig. 4) and follow-up radiographs were taken. The radiographs showed osseous repair of the fractured tarsometatarsus had occurred. There was no evidence of infection around or within the fracture. Endosteal callus production and inflammation were seen as increased intramedullary density at the fracture site. The periosteal callus area was barely visible on radiographs (Fig. 5). The fracture felt stable on palpation. The skin sutures were removed; substantial thickening of the skin and soft tissue covering were observed. To assure total recovery and simultaneously to let the bird regain the ability to catch prey, the external splint was used for the next 2 wk (Fig. 6). After this time, the device was removed and the buzzard was placed in a large aviary to practice flying and prey grasping. All aspects of prey capture and dispatch appeared normal (Fig. 7).

Discussion

The bird discussed in this study was found by a member of public, probably a few days after an accident which caused the bone fracture. Unfortunately, the person who found it did not appreciate the importance of the bird seeing a veterinary surgeon, and the buzzard was held for 7 days. The finder did not secure

the fracture, and the bird was only given food and water. It regained its strength, but as it still couldn't stand correctly, the finder brought the buzzard to the clinic.

Open (and thus contaminated) fractures left untreated for longer than 24 hr have a much poorer prognosis (Benett and Kuzma 1992, McCoy 1992). The longer the fracture remains unsecured, the more probable are the drying of tissues, muscle constriction, and progression of infection (Redig 1986). Also, any fracture near a joint carries a poor prognosis for a normal return to function (Forbes 1998). The prognosis for the buzzard discussed here was



FIGURE 7. The buzzard two weeks after external coaptation removal.

guarded. The toe-pinch reflex response was positive, suggesting that the peripheral nervous system was not seriously damaged. The bird's general condition was good. Although physical and radiographic examination revealed substantial damage of bone and surrounding soft tissues, the decision for surgical treatment was made.

The literature provides little information regarding treatment of fractures of the distal portion of the leg, below the tibiotarsus. Many authors describe management of tibiotarsal fractures (Benett and Kuzma 1992, Orosz 1999, Wissman 1999, Meij and Westerhof 2006) and treatment of foot injuries (McCoy 1992, Meij and Westerhof 2006) but, unfortunately, we have not found an article about comminuted open tarsometatarsal fracture fixation. It may be the result of our lack of access in Poland to some foreign published resources.

There were many factors to consider when choosing a method of fixation to repair the fracture. Because of the buzzard's method of finding and procuring food, the bird had to recover fully from its injuries and had to regain 100% fitness. Because the fracture was old, open, comminuted, and close to the metatarsophalangeal joint, external fixation was difficult to perform. The use of bandages, splints, or slings often work well for fracture fixation (Benett and Kuzma 1992, McCoy 1992, Rinkevich *et al.* 1999, Wissman 1999). External coaptation of tibiotarsal fractures work well for birds that weigh less than 120–200 g (Forbes 1998, Wissman 1999). The buzzard in this case weighed 1,450 g. It has been reported that treatments such as external coaptation, intramedullary pins, bone-plate fixation, or external skeleton fixation not only fail for rehabilitating wild birds, but require prolonged hospitalization of avian patients (Benett and Kuzma 1992, McCoy 1992, Rinkevich *et al.* 1999). The use of splints may also result in both poor alignment and joint ankylosis. Tendon contracture

> lus or shortening of the bone may also occur (Forbes 1998, Wissman 1999). After considering all of

or entrapment within the cal-

these facts, we concluded that the treatment of choice for the buzzard was external coaptation. The general principles of fracture stabilization are the same as those defined for mammals and include rigid immobilization (Benett and Kuzma 1992, Wissman 1999). To eliminate movements of the reduced bone fracture, neighbouring joints must be immobilized. In the case of a break at the metatarsophalangeal joint, the entire foot has to be immobilized. To

prevent tendon contracture in the described case, a flat, plastic form was used instead of a cotton ball. Such placement of the foot gave the bird opportunity to stand stably on the ground and to maintain its balance. The shoe also prevented overloading of the fractured bone.

Avian bones heal remarkably fast (Benett and Kuzma 1992, Wissman 1999). In the case of the buzzard, the fracture was clinically stable after 3 wk. Considering the type of injury, its location, and the weight of the bird, recovery was incredibly fast. To ensure that any overloading connected with body weight and normal activity would not weaken soft tissue structures, and to prevent adjacent fractures, another external coaptation splint was made. The animal did not stop favouring the right foot with the tarsometatarsus immobilization; however, the buzzard could improve its range of motion. An early return to function also prevented ankylosis (Benett and Kuzma 1992). This was especially important because normal limb function was required for the buzzard, as we intended to release it.

Conclusions

Avian orthopedics are a unique challenge to veterinary surgeons, but with a good knowledge of bone repair techniques and avian anatomy and physiology, repairs can be successful and profitable. The presented case demonstrates that an older, comminuted tarsometatarsal fracture, with a poor prognosis, can be successfully treated with external coaptation. NB: Radiograph images were provided by the Laboratory of Radiology and Ultrasonography, and are used with permission.

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About the Authors

Dorota Rozanska DVM, PhD, finished her studies on Faculty of Veterinary Medicine of Agricultural University in Lublin in the year 2000. She now works in the Department and Clinic of Animal Surgery, specializing in anesthesiology, surgery and rehabilitation of small animals, especially birds and rodents. Dorota conducts research on anesthesia of particular bird and rodent species



and on new methods of osteosynthesis in avian orthopedics. She was the originator and co-founder of the Center of Wild Birds Rehabilitation at the University of Life Sciences in Lublin in 2004 and, since that time, has run the Center. Dorota completed her doctoral dissertation in 2006.



Pawel Rozanski DVM, PhD, Department of Animal and Environmental Hygiene, Faculty of Biology and Animal Breeding, University of Life Sciences in Lublin, Poland. Pawel qualified at the University of Life Sciences in Lublin in 1997. He is a wildlife rehabilitator at the Wildlife Rehabilitation Center in Lublin. His specialties are raptor rehabilitation, raising of juvenile

raptors, and waterbirds and small mammals. Pawel has a special interest in the veterinary orthopedics of raptors.

Izabela Polkowska DVM, PhD, Department and Clinic of Animal Surgery, Faculty of Veterinary Medicine, University of Life Sciences in Lublin, Poland. Izabela qualified at the University of Life Sciences in Lublin in 1988. She is a veterinary surgeon specializing in small mammal soft-tissue surgery, and orthopedics for exotic pets and birds. Izabela



has a special interest in veterinary dentistry.

Ireneusz Balicki DVM, PhD, Department and Clinic of Animal Surgery, Faculty of Veterinary Medicine, University of Life Sciences in Lublin, Poland. Ireneusz qualified at the University of

Life Sciences in Lublin in 1985 and specializes in veterinary surgery. He has a particular interest in anesthesiology and ophthalmology.

Maciej Orzelski DVM, PhD, Department and Clinic of Animal Surgery, Faculty of Veterinary Medicine, University of Life Sciences in Lublin, Poland. Maciej qualified at the University of Life Sciences in Lublin in 1998. He specializes in anesthesiology for small mammals and birds. He has a special interest in raptor rehabilitation.



The North Carolina State University College of Veterinary Medicine Turtle Rescue Team: A Model for a Successful Wild-Reptile Clinic

Gregory A. Lewbart, Jennifer Kishimorig, and Larry S. Christian

Introduction

When an incoming class of veterinary students is asked what they see themselves doing in four years, many indicate they would like to treat wildlife. While not all students with a passion for wild-animal medicine end up in this field on a full-time basis, a good

number are able to incorporate wildlife medicine into their companionanimal practice setting. Running a full-service wildlife clinic (amphibians, reptiles, birds, and mammals) is demanding of both time and financial resources. Injured and sick mammals present a significant zoonotic risk, especially for rabies, in some parts of the country. Birds fre-



Eastern painted turtle (Chrysemys picta picta).

quently require several treatments, multiple feedings, or both within a 24-hr period. Turtles are excellent patients for the following reasons: 1) They tend to be hardy and resilient; 2) they are easy to handle and work with; 3) they generally don't require a lot of hospital space; 4) they are not noisy; 5) they are portable (students can transport them easily and care for them at home when necessary); 6) most require feeding just three to four times weekly; and 7) most chemotherapeutic treatments are given no more frequently than every 24 hr.

At the North Carolina State University College of Veterinary Medicine (NCSU-CVM), approximately 40 first-, second-, and third-year students, plus about 10 staff and visiting volunteers, participate in a clinical program called the Turtle Rescue Team (TRT). Currently in its eighth full year, the TRT has treated over 1,200 turtles belonging to nine different species (several frogs, lizards, and snakes have also been treated). Most cases present for vehicular trauma. Dogs, lawnmowers, fishing gear, and even horses have also caused injury requiring medical treatment.

The three major goals of the TRT are to 1) provide first-, second-, and third-year veterinary students an opportunity to work with and manage clinical wild-turtle cases, 2) provide competent and state-of-the-science veterinary care to sick and injured wild turtles, and 3) provide clinical case material for the generation of new knowledge in the form of case reports and hypothesis-driven, peer-reviewed publications.

The NCSU-CVM TRT has been featured in the *Journal of the American Veterinary Medical Association* and *Reptiles Magazine* (Krum 2002, Guzik 2003), and many students know of the TRT before entering veterinary school.

IN YOUR PRACTICE: Wild reptiles and amphibians comprise a minority of rehabilitation intakes. However, this paper demonstrates their need of knowledgeable rehabilitation, and offers suggestions on developing and operating such a specialized program. One need not live near a veterinary teaching hospital to gain valuable insight into addressing this often overlooked aspect of rehabilitation.

ABSTRACT: The North Carolina State University College of Veterinary Medicine (NCSU-CVM) Turtle Rescue Team (TRT) is a veterinary student-run organization that treats native, sick, and injured, wild chelonians. First-, second-, and third-year students are responsible for case management, consultation coordination, on-site diagnostic testing, and placing of recuperating animals with local wildlife rehabilitators. Several clinical research publications have resulted from these opportunities. Active student participants can also gain credit by attending 8 hours of lecture-seminar about reptile medicine. On assessment, 86% of survey respondents found the program valuable or extremely valuable to their veterinary medical education. The logistics of organizing and operating this service are discussed, and its value as a clinical learning tool is supported by the results of a survey.

KEY WORDS: administration, chelonians, clinic, logistics, reptiles, turtles

CORRESPONDING AUTHOR

Gregory A. Lewbart, VMD Department of Clinical Sciences North Carolina State University College of Veterinary Medicine 4700 Hillsborough Street Raleigh, North Carolina 27606, USA. Email: greg_lewbart@nsu.edu

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Financial support

The NCSU-CVM TRT is a volunteer organization that relies primarily on donations. The project began in 1997, when a local wildlife rehabilitator who worked closely with the NCSU-CVM on sporadic turtle cases moved to another state. Shortly after leaving, she made a large donation in her father's name, and the funds were used to begin stocking and outfitting a wild-turtle clinic. A core group of students and a faculty mentor began structuring the TRT and developing fund-raising ideas to sustain the program. Donations from good Samaritans (those bringing the sick and injured turtles to the NCSU-CVM) make up the bulk of our funding. Each person who brings a turtle to the NCSU-CVM is asked to fill out a contact and history form, and they are also encouraged (but not required) to leave a donation. The Merck-Merial Summer Research Program has helped fund a full-time student director during the summer months on several occasions. Other sources of funding include donations received at the annual NCSU-CVM open house, bake sales, "mock" turtle-soup sales, T-shirt sales, generous allotments from the Student Chapter of the American Veterinary Medical Association (SCAVMA), and a collection jar that is set up at the annual North Carolina State Fair.

The average annual TRT budget is approximately \$7,000.00. These funds are used to pay for some student salary support, clinical supplies, husbandry materials including food, and clinical



Blandings Turtle (Emydoidea blandingii).

services (radiology, clinical pathology, microbiology, etc.) within the NCSU-CVM teaching hospital.

The TRT is housed in a laboratory area that is separate from the teaching hospital. This provides autonomy and biosecurity and eliminates the need for patient hospitalization fees.

Student training

All veterinary students are eligible to participate in the TRT. Since the caseload is already in decline by the time first-year students begin the fall semester, this student group normally has minimal involvement until the spring semester. Second- and third-year students are the most involved and carry the bulk of the clinical responsibility. They also train the first-year students (and other new TRT members) in the day-to-day operation of the TRT.

Each spring there is a TRT workshop, where interested students are introduced to the project and have the opportunity to gain hands-on experience with some actual turtle patients. During this workshop, students learn how to identify the most common chelonian species, perform a physical examination, obtain diagnostic samples, administer fluids and medications, and are exposed to the basics of anesthesia and surgery. Teaching rounds are held at least once-a-month during the school year, where the cases in the clinic are discussed and general questions about the service are addressed. The faculty mentor is available on a daily basis (when on campus) to answer questions and consult on clinical cases.

The faculty mentor is ultimately responsible for the TRT program and is the clinician of record for communications with the veterinary teaching hospital, the Institutional Animal Care and Use Committee (IACUC), and the North Carolina Wildlife Commission. The faculty mentor spends approximately 5% of his time working with TRT-related issues (the week-to-week percent effort varies with the time of year).

Student participation varies widely. Some students, who are simply team members, may spend only 1 or 2 hours a month on the TRT. More interested or motivated team members may commit two or three times this amount of time to the program. Team captains, who carry a pager for weekly on-call duty, may spend 5 to 10 hours a week on the TRT during the busy summer months. The TRT president, who is usually paid during the summer, spends between 25 and 40 hours a week on the TRT. Finally, in recent years, a student has been designated as the rehabilitation coordinator. This person acts as a liaison between the TRT and 60 rehabilitators (many of whom have affiliations with the NCSU-CVM). During the summer, this person spends between 15 and 20 paid hours per week on the TRT.

Admitting a patient

The group of students and veterinary school staff members is divided into four teams, each of which has one or two student captains. Teams alternate on-call weeks so that each team is responsible for turtle emergencies and hospitalized cases 1 week out of each month. The on-call group captain also carries the "TRT pager," which alerts her or him to an incoming case or telephone question about an existing patient. There are also an overall student director (president) and a veterinary technician who coordinates schedules, orders supplies, and acts as a liaison between students, faculty, and rehabilitators. The experienced veterinary technician is available every day to answer student questions, and his office space is in the same room as the TRT clinic, facilitating close monitoring of the program. The technician's salary is statesupported, and during the peak case season (June–September), TRT-related work requires about 25% of his time. Most patients are received at the main NCSU-CVM hospital admissions desk, where the person delivering the turtle is asked to fill out the proper paperwork while the receptionist pages the on-call student. For urgent cases (since first-, second-, and third-year students are frequently attending lectures or laboratory sessions), the veterinary technician can receive the case and begin emergency treatment if necessary. Each patient is assigned a number (chronologically, based on the year) which is applied to the animal's carapace (when possible and appropriate) with white surgical tape. This number also appears on the animal's medical record.

Initial patient evaluation and treatment

Working with the history provided, the student identifies and weighs the turtle, then assesses the animal's condition. The majority of our patients (approximately 65%) are the victims of vehicular trauma. Many have lost a significant amount of blood, and many have open wounds that are portals for microbial infection. These patients usually receive parenteral fluids, empirical antibiotics, and an analgesic. Once the patient is stabilized, a plan is developed that frequently involves surgical repair of the fractured shell and soft-tissue lacerations.

Patient care and monitoring

Most of the turtles spend between 3 days and 3 weeks in the clinic. During this time period, they are examined and evaluated at least every 24 hours. A treatment order form is used to track medications and treatments, and each animal has a medical progress sheet where the student's daily "Subjective Objective Assessment Plans" are entered. The students responsible for a particular case make decisions on the plan for treatment and rehabilitator placement with the help of the faculty mentor and a student–rehabilitation coordinator. Approximately 95% of discharged turtles spend some time with one of our 60 rehabilitators. The remaining discharged turtles are released directly to the wild; these turtles typically have very minor clinical problems. Approximately 65% of TRT turtles survive to be released.

Consultations

Because the TRT is run by a veterinary college, students have the benefit of advice from faculty and staff specialists. They regularly consult with ophthalmologists, neurologists, surgeons, radiologists, pathologists, and pharmacologists. These specialists have been an invaluable resource and are considered part of the overall "team" that works hard to help sick and injured wild turtles, even though they don't regularly attend rounds or training sessions.

Laws and regulations

Before beginning medical-rehabilitation work with any wildlife, including turtles, it is necessary to be familiar with local, state, and federal laws regarding these animals. Every state has differ-

TABLE 1: NCSU-CVM TRT publications (student names in bold)

Scientific Abstracts

Henson, H., G. A. Lewbart, D. J. Marcellin-Little, S. Roe, and M. K. Stoskopf. 1997. A new approach to fracture fixation in chelonians. *Proceedings of the International Association for Aquatic Animal Medicine* 28:59.

Henson, H., and G. A. Lewbart. 1998. Preliminary evaluation of ketorolac as a postoperative analgesic in injured wild turtles. *Proceedings of the International Association for Aquatic Animal Medicine* 29:11–12.

Bakal, R.S., G. A. Lewbart, and J. M. Cullen. 1999. Penile prolapse and amputation in an eastern box turtle (Terrapene carolina). Proceedings of the International Association for Aquatic Animal Medicine 30:141–142.

Willer, C. J., and G. A. Lewbart. 2001. Retrospective analysis of eastern box turtles (Terrapene carolina carolina) in North Carolina with aural abscesses. *Proceedings of the International Association for Aquatic Animal Medicine* 32:15–16.

DeBolt, R. K., C. Eads, J. F. Levine, and G. A. Lewbart. 2003. North Carolina eastern box turtles with aural abscesses and upper respiratory disease. CVM Research Forum Proceedings abstract.

Peer-Review Abstracts

Kishimori, J., G. A. Lewbart, D. J. Marcellin-Little, S. Roe, M. Trogdon, H. Henson, and M. K. Stoskopf. 2001. Chelonian shell-fracture repair techniques. *Exotic DVM Veterinary Magazine* 3.5: 35–41.

Thomas, H. L., **C. J. Willer**, M. A. Wosar, K. A. Spaulding, and G. A. Lewbart. 2002. Egg-retention in the urinary bladder of a Florida cooter turtle, Pseudemys floridana floridana. *Journal Herpetological Medicine and Surgery* 11(4): 4–6.

Willer, C. J., G. A. Lewbart, and Lemons C. 2003. Aural abscesses in wild eastern box turtles, Terrapene carolina carolina from North Carolina: Aerobic bacterial isolates and distribution of lesions. *Journal Herpetological Medicine and Surgery* 13(2): 4–9.

Souza, M., K. Hall, J. Wilson, and G. A. Lewbart. 2004. Surgical removal of an artificial chicken egg from the gastrointestinal tract of a black rat snake, Elaphe obsoleta. *Journal Herpetological Medicine and Surgery* 14(4): 4–5.

Case, E., G. A. Lewbart, and P. D. Doerr. 2005. The physiological and behavioural impacts of and preference for an enriched environment in the Eastern box turtle (Terrapene carolina carolina). *Applied Animal Behaviour Science* 92:353–365.

ent laws and regulations when it comes to maintaining reptiles in captivity, and there is a good general reference on the subject (Levell 1997). Certain species of turtles are also federally protected. Many states also require a wildlife rehabilitator's license when wild animals are held in captivity for prolonged periods of time. The TRT has a valid rehabilitator's license from the North Carolina Wildlife Commission. In North Carolina, anyone (including rehabilitators) can keep up to five native reptiles that are not considered endangered, threatened, or of special concern (less than 1% of our patients fit into any of the three previously mentioned categories).

Controlled substances

Certain substances, such as ketamine and butorphanol, are controlled and need to be handled accordingly. The pharmacy staff at most veterinary colleges can be of assistance in answering questions and explaining the regulations on drug storage and record keeping. The TRT keeps a double-lock box in the clinic space for the storage of controlled substances, including euthanasia solution. Over the past couple of years, ketamine has been largely replaced by noncontrolled propofol for induction, and butorphanol is being replaced by the nonsteroidal drugs ketoprofen and meloxicam. A detailed controlled-substance logbook is maintained and available for inspection.

Scholarly work

While the NCSU-CVM TRT is primarily a clinical service, it has generated a number of clinical research papers and case reports (Table 1). A retrospective study that addresses a number of clinical and case-related issues is underway and should be published in the near future.

The TRT is regulated by an IACUC protocol and all participating students are required to pass the university IACUC training-program examination. Although the turtles are not research animals, they are non client-owned vertebrates under the authority of the university. Any hypothesis-driven research involving TRT animals that includes procedures not deemed necessary for the clinical support of the animals requires a separate IACUC or IACUC addendum.

TABLE 2A: Demographics of respondents to the survey of participants in the TRT Program.

Status	No.
CVM Students	27
Internship	
Small Animal	3
Exotic	3
Other (Aquatic, Zoo)	2
Residency	
Exotic	1
Other (Pathology)	1
Private Practice	
Small Animal/Exotic	2
Exotic Only	1
Industry	1
Academic	2
Wildlife Rehabilitation	2

TABLE 2B: Graduation year of respondents to the survey of participants in the TRT Program.

Graduation Year	No.
2001	2
2002	2
2003	3
2004	8
2005	8
2006	10
2007	4

Activity	Not Valuable	Somewhat Valuable	Valuable	Extremely Valuable
Preparation for clinical rotations	-	6	11	16
Career choice	1	6	7	20
Preparation for current veterinary role	_	4	9	17
Reptile medicine	-	1	4	30
% of responses (value)	0.80%	12.90%	23.50%	62.90%

TABLE 3A: Rating of the value of participation in the TRT Program.

TABLE 3B: Report of routine technical procedures performed with the TRT and assessment of their respective learning values for a clinician/future clinician.

Activity	Not Valuable	Somewhat Valuable	Valuable	Extremely Valuable
Basic husbandry	_	2	14	21
Rehabilitation	-	1	8	21
Wound care (flushing, debriding)	-	-	12	25
IM injections	-	1	10	26
SQ injections	-	2	9	25
Intracoelomic injections	-	_	9	28
IV injections	1	-	3	20
Nutritional support (tube feeding)	1	-	5	27
Blood-sample collection	-	_	3	20
Radiography	-	1	2	19
Anesthesia	-	_	2	21
Other procedures	-	_	-	4
% of responses	0.60%	2.00%	22.40%	74.90%

TABLE 3C: Report of clinical skills obtained while working on the TRT and assessment of their respective learning values for a clinician/ future clinician.

Activity	Not Valuable	Somewhat Valuable	Valuable	Extremely Valuable
Soft tissue surgery	1	-	3	18
Shell repair	-	-	_	24
Other surgical procedures	1	-	2	12
Radiographic interpretation	-	_	3	17
CBC/Chemistry interpretation	-	1	6	7
Antimicrobial therapy	-	1	5	20
Other pharmacologic therapy	-	1	5	20
Case management	-	-	3	22
Analgesic therapy	-	_	6	22
% of responses	1.00%	1.50%	16.50%	81.00%

Outcome assessment

A survey instrument was developed, drawing on the work of Gerwels, Price, and Swanson (Gerwels et al. 2000) to determine the effectiveness of the TRT with relation to clinical skills, technical skills, and overall value. Approximately 100 surveys were distributed (by e-mail or hard copy) to past and present TRT veterinary-student members (based on TRT records), and 37 TRT members completed the survey. Their demographics are tabulated in Tables 2A and 2B and their assessment of the program, both overall and as to the technical and clinical skills attained, are reported in Tables 3A, 3B, and 3C, respectively. The vast majority of students responding to the survey found the TRT to be either extremely valuable (75%) or valuable (22%) with regard to a number of different technical procedures. With regard to clinical skills, 81% found it extremely valuable and 16% valuable. In terms of overall value, 86% found it either valuable or extremely valuable and 13% somewhat valuable.

Based on the results of this survey, it can be concluded that the NCSU-CVM TRT is a valuable learning program that helps prepare veterinary students for future veterinary studies.

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About the Authors

Gregory A. Lewbart, MS, VMD, Dipl ACZM is Professor of Aquatic, Wildlife and Zoological Medicine in the Department of Clinical Sciences, North Carolina State University, College of Veterinary Medicine in Raleigh, North Carolina, USA.

Jennifer Kishimori, DVM, is a veterinarian serving in the United States Army Veterinary Corps in Fayetteville, North Carolina, USA.

Larry S. Christian is an Aquatic Animal Research Technician in the Department of Clinical Sciences, North Carolina State University, College of Veterinary Medicine in Raleigh, North Carolina, USA.

Certification: A Continuing Dialogue

by Nancy Hawekotte

Introduction

Until 2006, the field of wildlife rehabilitation had no standard method of identifying the knowledge level of its practitioners, and early on that knowledge itself wasn't standardized. The ensuing years have seen the growth and refinement of a solid body of scientifically reliable and trainable methodology in the discipline.

The last decade has also seen the development of numerous educational resources for wildlife rehabilitators. Yet, unlike many wildlife professions, no means existed to define a common standard of practice. This hampered progress in rehabilitation both within the field and in our relationships with other professionals—important allies in the wildlife sciences.

In 2006, IWRC addressed this need, launching the Certified Wildlife Rehabilitator[™] (CWR) program. This column investigates the meaning of the CWR designation to this rapidly changing field and attempts to address our members' questions and concerns. It springs from an ongoing dialogue from two perspectives, those of Kieran Lindsey, Certification Review Board Chair; and the author, a long-time mammal rehabilitator. [For Parts 1 & 2 of this column, see JWR, Vols. 29 (1) and 29(2-3)].

The CWR designation parallels other professional certifications in ensuring a specific level of knowledge, as authenticated by an independent, professional organization. One earns the designation by passing a test on a range of topics related to wildlife and the practice of rehabilitation. Anyone may take the exam. Grading is pass–fail and there are no required classes or texts. It may be retaken until passed. The CWR designation must be renewed every two years by earning continuing education units.

First offered at the 2007 IWRC Education Symposium, the exam is now offered both online on demand and in proctored formats. At the time of this writing, 70 individuals can display CWR after their names.

More information about the CWR program can be found at *iwrc-online.org/ certification/index.html* and in the downloadable "CWR Applicant's Handbook."

The Interview

Previous installments examined the role of the CWR program in the field and the nature of professionalism; its relationship to permits; what it confers to the individual; and IWRC's role in its development and oversight. Also discussed were continuing education requirements, and costs. This episode examines the test itself: its scope and content, the knowledge level required to pass, how it is graded, and who can take it.

Nancy Hawekotte (NH): What kind of test is the CWR exam? How is it different from the IWRC Basic Wildlife Rehabilitation (BWR) examination?

Kieran Lindsey (KL): The CWR exam covers a broader number of subjects, and the subjects that are found in the BWR test are covered in greater detail. Long-term care, nutrition, enrichment, and release assessment are all included in the CWR Exam.

NH: Does it cover areas not specific to rehabilitation?

KL: No, all of the topics covered are related to rehabilitation, but not all are exclusively applicable to rehab. The topics can be found in the CWR Applicant's Handbook,

and include typical rehabilitation issues such as triage, handling, husbandry, fluid therapy, nutrition, release considerations, and euthanasia. There are also questions on basic physiology, ecology, natural history, and behavior—because rehabilitation is not limited to medically-related care.

The CWR exam tests for the broad range of knowledge necessary for the successful practice of rehabilitation knowledge that everyone needs whether their focus is narrow or broad. The goal of rehab is to prepare animals for life after release. The CWR exam is based on the belief that a rehabilitator needs a clear understanding of the effects of his or her work on the entire life cycle of the animal in hand.

We're trying to move to a point where rehabilitators are no longer satisfied with equating success with release alone. We want to encourage rehabilitators to be thinking about success in ecological terms; not just survival of an individual animal, important as that may be, but our impact at the population level as well. That requires an understanding of both wound management and behavior, nutrition and habitat carrying capacity.

NH: I understand the exam contains questions requiring some knowledge across a range of species. Why is this necessary?

REHABILITATORS NEED A CLEAR UNDERSTANDING OF THE EXTENDED EFFECTS OF THEIR WORK THROUGHOUT THE CYCLE OF AN ANIMAL'S LIFE.

KL: The more we learn about our world, the more we understand the relationships of its components. For rehabilitation to be successful postrelease, we need to know how these components affect, and are affected by, the animals we care for.

Moreover, rehabbers often find themselves with an unfamiliar species in hand, sometimes for longer than they'd like. They need to be well versed in universal aspects of triage care, even if the animal is headed elsewhere. A rehabilitator needs to be able to identify the species at hand and how to access information on its natural history.

NH: My practice has a fairly limited focus. What will certification do for me?

KL: Most rehabilitators, at one time or another, have had to care for a species with whom they are unfamiliar or for which they lack proper facilities. Their natural next step is to find a rehabilitator who works with that species and arrange a transfer. Certification provides peace

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of mind when another rehabber steps forward. We may know little about that individual, but the CWR behind their name indicates a specific level of knowledge and commitment. With certification, sourcing trusted peers is much easier. The measure becomes not the number of years spent rehabilitating, but the quality of the knowledge acquired during those years.

Secondly, as the public becomes more aware and educated about rehab—think of the many television shows that feature "wildlife emergencies"—they are growing to expect a higher standard of care. Certification indicates to them that you meet those standards and deserve their trust.

Lastly, the Internet offers the public a great deal of rehab advice, often bad. Our hope is that, over time, the public will learn to look for a CWR as a source of reliable information.

NH: How can a specialist, whether singlespecies or working only with mammals (or birds or herps), hope to pass?

KL: This is not a specialization exam. While it's more challenging than IWRC's Basic Wildlife Rehabilitation, it is largely intended to show your grasp of the basic tenets of rehabilitation and of knowledge that applies across the spectrum of species. There's no need to worry you'll be asked a lot of passerine-specific questions when your area of expertise is opossums or coyotes.

NH: It certainly appears that the CWR designation is intended for (and only attainable by) the rehabilitator with a lot of experience. Is two years enough, or ten years?

KL: This question illustrates an issue that shows the need for certification. Prior to certification, assessment of one's skill had been loosely based on length of time rehabbing. but we all know both good *and* poor rehabbers who've been practicing for many years. This is not about length of time, but knowledge acquired.

NH: Is it feasible that a novice rehabilitator could pass the exam?

KL: Yes, perhaps. It would depend on their preparation and level of commitment, how quickly they can learn and absorb. Remember, this is a test of knowledge rather than hands-on skills. There is no lab component to the CWR exam, and we don't claim that anyone passing the test can gavage waterfowl, for example. We do know that they understand the process and can determine when it is appropriate and when it is not.

Someone who has been rehabilitating for a short time, but who is very motivated, could pass. On the other hand, a veterinarian with years of experience in domestic animal care may not be able to pass the exam if he or she doesn't have any background in topics more specific to wildlife rehabilitation, i.e., wildlife behavior, release criteria, or habitat assessment.

NH: What if one fails the test?

KL: There is a 2-week waiting period for retesting and a minimal administration fee (\$20 as of this writing), but you can retest as often as you want with no strikes. Each new test is freshly computer-generated at random from a database of thousands of questions and answers. There's no black mark to erase, and no one knows your results outside of those who grade the tests. In fact, if you take it online, it is electronically graded. Only your status

(pass or fail) will be in your IWRC file. Those who pass are announced and added to the CWR Registry. No one outside the IWRC office knows who didn't pass.

NH: Are there specific texts I should study to prepare for the exam?

KL: The "CWR Applicant's Handbook" has a long list of resources, all of which provide excellent information pertinent to the exam. A practicing rehabilitator may already own one or more of them, and may have read others.

NH: How will I know when I've studied adequately to take the test? Or that I've studied the right material?

KL: The "CWR Applicant's Handbook" includes a list of exam topics and concepts. My personal approach would be to read through the list, noting which topics are familiar and, more importantly, which are not. As we discussed earlier, the Handbook also includes various study resources—books, classes, websites, etc.

One of the first rehabilitators to achieve certification had a unique perspective on exam preparation. She told me she took the exam expecting to fail the first time, but to learn a lot about where she needed to focus her efforts for a second attempt. In fact, she passed on the first attempt, but I have to admit it wasn't a bad plan. She understood that the questions would be significantly different on the retake exam, but would cover the same material. Certification, to be meaningful, requires that rehabilitators stretch themselves a bit, but the sense of accomplishment that comes with achieving a challenging goal pays big dividends.

Watch for the next installment of "CWR: A Continuing Dialogue" in JWR 30(2). We'll explore questions IWRC has received from its members. Meanwhile, visit *iwrc-online.org/certification/index. html* for more information and a copy of the "CWR Applicant's Handbook."

Nancy Hawekotte is a communications professional and 21-year wildlife rehabilitator, having worked in a variety of roles. She lives in Omaha, Nebraska.

Forester's Log BEARS AND BURNS

by Mary Stuever

resh burn areas draw all kinds of curious animals, and foresters are among the crowd. From the years of mopping up forest fires-spending the last few days on assignment putting out any smoking log or duff that is near the control line-I have witnessed many animals that find fresh-burned ground fascinating. The elk come in and browse on the needles of remaining saplings as if they are discovering a smoke-flavored delicacy. The raptors fly around, hoping to catch some rodent emerging from the safety of their burrow, but no longer into a world that offers immediate camouflage. The bears saunter through, turning over rocks and logs and generally just seeming to look around.

Often, we debate if we see so many bears after a fire because bears are attracted to burn areas, or if bears are always this close in the woods, but until the brush has burned away, they are just hidden from our view.

Therefore, I should not have been so surprised that afternoon, when marking trees on Buddy Elkin's ranch outside of Grants, to hear three sharp whistles coming from the drainage below me.

As a homeschooling parent and a consulting forester, my kids often work with me. In this instance, my work was to mark "leave" trees on a private salvage sale after a major wildfire. The work required me to evaluate every tree in the area, which meant continually moving up and down the slope.

My seven-year old twins preferred playing in the drainage bottom while I worked the hillsides by marking trees that had the best chance of postfire survival.

We all had whistles, and through the day we would communicate. One whistle was a simple question, "Everything is fine, but where are you?" This was answered with a single whistle. Throughout the day, every ten to twenty minutes, we would signal each other. I would also leave my gallon paint cans with the kids, and I'd tie in with them, in person, each time I emptied the quart-size paint gun I carried with me.

The two-whistle call was more serious in nature. It meant, "Come here as soon as you can, even though it is not an emergency." Usually, the kids used this call to signal they were ready for lunch, or that they needed a jacket from the car, or some other pressing reason to ask Mom to set down her paint can for awhile.

The three-whistle call was a real emergency, and up until this day, we had never used it. When I heard it, I immediately came crashing down the hill slope in the direction of the kids. As soon as I spotted Roland, he was waving his arms at me to stop.

Between us there was a large black bear that was fixed on something behind the kids. It only took a second to realize it was a bear cub. I hollered at the bear to let her know I was behind her and to distract her from my children. Then I told the twins to start moving slowly up the drainage toward our car, away from the bears.

Mama Bear must have had the same idea, because she growled at her cub and the little guy started moving down the



Black bear cub (Ursus americanus)

drainage. In less than a minute, I was reunited with my cubs, and she was reunited with hers.

I'm not sure what the bear family did the rest of the day, but we broke camp and headed home. I left the kids with their father and finished the marking job alone. \blacklozenge

Mary Stuever is a consulting forester specializing in forest ecosystems of the American Southwest. She can be reached at sse@ nmia.com. This month's Forester's Log column will appear in Mary's new book, The Forester's Log: Musings from the Woods, UNM Press, Spring 2009.



INSTRUCTIONS FOR AUTHORS

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

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

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

Kieran Lindsey, Editor jwr.editor@gmail.com

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

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

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

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

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

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The endangered yellow-eyed or hoiho penguin (*M. antipodes*) is endemic to New Zealand. PHOTO@MARY CURTIS METTEER. USED WITH PERMISSION.

IWRC

PO Box 3197 Eugene, OR 97403 USA Voice/Fax: (408)876-6153 Toll free: (866)871-1869 Email: office@iwrc-online.org www.iwrc-online.org



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