INTERNATIONAL WILDLIFE REHABILIATION COUNCIL

Volume 30, Number 3 2010

JOURNAL OF WILDLIFE REHABILITATION



IN THIS ISSUE: One-footed bat survival...Compared husbandry protocols for mallard ducklings...Pre-weaning social complexity in raccoons...Feeding stations and wild moose behavior

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.



Female elk, also known as red deer *(Cervus elephus)*.
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On the cover:
Adult moose *(Alces alces)*.
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JOURNAL OF WILDLIFE REHABILITATION

Volume 30(3)

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EDITOR'S CORNER

This was not a "good news" summer.

That's an understatement if ever there was one, I know. True, the blown-out well spewing oil into the Gulf of Mexico was eventually capped and then killed, but it may be years or even decades before we realize the full impact on wildlife populations and habitat. Even the impact on individual animals will be hard to reckon, given that it's likely only a small percent of the wild creatures mired in oil were discovered, much less admitted into a rehabilitation facility.

I am by nature an optimistic person, but an environmental disaster of this scale really put me to the test. Is it possible for some small good to come from catastrophe?

Perhaps.

Wildlife rehabilitation has long been viewed with a degree of suspicion by more-established and accepted wildlife professions. We have our champions within the permitting agencies and academia, certainly, but these individuals are not the majority. It's no secret that, in some circles, rehab has been grudgingly accepted as necessary only because the public demands it. In other cases, the worst possible examples among us are held up as the norm and used as a reason to dismiss the entire rehab community.

The Deep Water Horizon spill, the subsequent call for assistance from rehabilitators by both state and federal governments, and the response of rehabilitators to their pleas, may offer a chance to reframe the role of wildlife rehabilitation.

But it won't happen without a concerted effort on the part of our community.

We have a unique opportunity to let the world—both the public and our fellow wildlife professionals—know about the integral role wildlife rehabilitators have played in this response. IWRC is working to facilitate this effort by offering to coordinate the collection of data on the number of hours and dollars spent. [If you've not done so, please email your data to *spillreport@theiwrc.org*]. At a time when all government agencies are going over budgets with fine-toothed combs, we need to be able to quantify the value of having a group of trained, permitted individuals at the ready when disaster strikes. It's important to reiterate that rehabilitation is about far more than taking care of cute baby animals.

It's also important for the scientific community to understand that without the knowledge gleaned from caring for individual animals in thriving populations—the myriad "common" birds, mammals, reptiles, and amphibians found in homes and rehab centers across the country—we would not be as well equipped to step in and assist populations for which the survival of every individual is crucial.

Wildlife rehabilitation is not just a hobby—it's serious work that deserves to be taken seriously. Now that "baby season" has passed here in the United States, consider taking a few moments to think about how you might help to get the word out. Write a letter to the editor of a local newspaper. Suggest that a local television station do an update on the spill with an emphasis on the role rehabilitators played (and don't forget to remind them that there are rehabilitators in their community). Network with rehabilitators in your state, and develop a plan for improving communications with the permitting agency, using disaster preparedness and response as a starting point for conversation.

It's time for rehabilitation—and rehabilitators—to come out of the shadows and be recognized as valuable members of the wildlife conservation team. ■

Kieran J. Lindsey, Editor

Duck Stamp Cachet to Benefit Wildlife

Dateline: July 28, 2010

WASHINGTON, DC (USA)—U.S. Secretary of the Interior Ken Salazar has unveiled a special edition federal duck stamp envelope, or cachet, which is available for purchase for US$25. The cost is US$10 more than a regular duck stamp, and the extra funds will be used to acquire wetlands for use as national wildlife refuges along the Gulf Coast.

The cachet features a silk rendering of an award-winning photograph of St. Marks National Wildlife Refuge on Florida's Gulf Coast by David Moynahan, and the 2010–11 federal duck stamp, which depicts an American wigeon painted by artist Robert Bealle of Waldorf, Maryland.

All migratory bird hunters must buy a US$15 federal duck stamp each year in addition to state licenses, stamps, and permits. The public can purchase the special edition federal duck stamp cachet from Amplex Corp. by calling 1–800–852-4897 or online at www.duckstamp.com.

Since 1934, federal duck stamp sales have raised more than US$750 million to acquire and protect more than 5.3 million acres of wetlands, including habitat on hundreds of the 552 National Wildlife Refuges in all 50 states and U.S. territories.

Bass Pro Shops is underwriting the first edition of the cachet and will market it in its retail stores in the U.S. and Canada.

Edmonton Rehab Group Finds New Home

Dateline: August 12, 2010

EDMONTON, ALBERTA (CAN)—A great blue heron (*Ardea herodias)* spotted on the unfinished roof of what will be the new home of the Wildlife Rehabilitation Society of Edmonton (WRSE) seemed an auspicious sign on the day 50 animals made the move in pet carriers, and the odd cardboard box, to a spacious new facility near Spruce Grove.

WRSE, which accepts injured wildlife from across northern Alberta, had to leave its previous home on the University of Alberta farm in south Edmonton. The building sits in a transportation utility corridor and the space is needed for new roads, said Marilyn Fleger, the society's executive director.

Searching the area for possible sites, the society contacted the Nature Conservancy of Canada. The conservancy, along with Ducks Unlimited, owns property with a house on it, and the two conservation groups decided WRSE could use the house as office space. The property has woods and wetlands.

Fleger said WRSE does not have to pay rent, but it will cover utilities. The CA$500,000 facility was entirely funded by creative sentencing money stemming from environmental charges faced by the Canadian National Railway and Imperial Oil.

The main building at the new site consists of five converted work camp trailers donated by Precision Drilling. The trailers are joined together, and the resulting 4,000 square feet are split into numerous rooms.

Holly Duvall, the society's volunteer coordinator and project manager, pointed out the tub room, which holds a large household bathtub that will likely accommodate muskrats and waterfowl. The society also now has a second pool, 8 × 7 × 2.5-feet deep. Other rooms in the trailer open onto outdoor pens into which animals and birds will be released as they recuperate. By early 2011, the society hopes to have a functioning acute-care facility in the city, while the rural site concentrates on long-term rehabilitation.

First Oiled Birds from Michigan Spill Set Free

Dateline: August 12, 2010

AUGUSTA, MICHIGAN (USA)—A group of officials and journalists stood along the rain-splattered edge of a lake Wednesday, watching as small brown and white dots scurried through rain across the edge of a lake as a group of rehabilitators, officials, and journalists watched. The dots were 11 Canada geese (*Branta canadensis*) and seven mallard ducks (*Anas platyrhynchos*).

Kara Haas, environmental education coordinator for the W.K. Kellogg Bird Sanctuary in Augusta, says she has no idea whether they'll stay or go. The birds were the first oiled waterfowl to be released from the wildlife rehabilitation center in Marshall following the July 26 crude oil spill into the Kalamazoo River. Hundreds of birds, turtles, frogs, fish, and mammals were impacted.

In the coming weeks, the center expects to release 50 to 70 more birds, said Tom Alvarez, public affairs specialist for the U.S. Fish and Wildlife Service. Each oiled bird will have a green band around its leg. Detloff held up one of the green bands used on all the birds. The bands will help bird sanctuary employees know if the oiled birds are still around. They also contain a message for any hunters who kill the waterfowl species: "Oil Spill Bird. Contact DNRE."

Wild Life Inc. Welcomes Endangered Owls

Dateline: August 15, 2010

BLOOMINGTON, INDIANA (USA)—Nearly a dozen barn owls (*Tyto alba*) were taken to Wild Life Inc., a wildlife rehabilitation center in southern Indiana. The birds are on the state endangered list, and the Indiana Department of Natural Resources says there are only a couple dozen active nests in the state each year. As a result, having this many at one rehabilitation center is an unusual occurrence.

The first four nestlings were brought to the center in mid-June after they were discovered in a building being razed in Lynnville, Indiana. Three more young owls arrived in late June, and another four were found in a Greene County silo in early August. ■

Clinical Signs and Histopathologic Findings Associated with a Newly Recognized Protozoal Disease *(Trichomonas gallinae)* in Free-ranging House Finches *(Carpodacus mexicanus)*

N. L. Anderson, C. K. Johnson, S. Fender, S. Heckly, M. Metzler, P. Nave, and J. Yim

Journal of Zoo and Wildlife Medicine 41(2): 249–254, 2010.

This paper describes the clinical signs and histopathologic findings associated with an emergent disease associated with *Trichomonas gallinae* infections in free-ranging house finches (*Carpodacus mexicanus)* in California. Wet mounts were necessary to detect *T. gallinae* infections in house finches because classical clinical presentation, such as caseous stomatitis or ingluvitis, occurred in <25% of cases. Early detection was instrumental in preventing trichomoniasis outbreaks in a high-density nursery ($P < 0.0001$). Detection before onset of clinical signs was critical. Despite treatment, approx. 95% of house finches died within 24 hr of displaying signs of illness. In contrast, 58% of *T. gallinae*-positive house finches housed in a nursery survived if they received treatment before onset of clinical signs. Recurrent protozoal shedding in survivors was not evident.

Post-release Survival of Orphaned Wild-born Polecats *(Mustela putorius)* Reared in Captivity at a Wildlife Rehabilitation Centre in England

A. Kelly, R. Scrivens, and A. Grogan

Endangered Species Research 12(2): 107–115, 2010.

Many thousands of rehabilitated wildlife casualties and captive-reared orphans are released back to the wild each year. Most wildlife rehabilitators equate release with success, and very little is known about the post-release survival of rehabilitated wildlife. We measured the post-release survival of orphaned polecats, *Mustela putorius,* a species of conservation concern and currently a UK Biodiversity Action Plan (BAP) priority species. Between 1997 and 2008, 137 polecats were admitted to the RSPCA (Royal Society for the Prevention of Cruelty to Animals) Stapeley Grange Wildlife Centre in northwest England. Of these, 89 (65%) were orphaned juveniles. Forty-three percent of adults and 89% of juveniles were released back to the wild following rehabilitation. Between 2005 and 2008, we radio-tracked 32 juvenile polecats at five release sites in Cheshire and North Wales, UK. These individuals were tracked for 3 to 104 days (median = 27.5). Of the 32 radio-tracked animals, 26 (81%) were still alive after 14 days, and a minimum of 16 (50%) were still alive after 1 mo. Twelve percent were known to have died in road traffic collisions, 22% shed their collars, and the signal was lost for 56%. Those for which the signal was eventually lost were tracked for 13 to 103 days (median = 38.5 days). Two female polecats trapped following release in 2007 had lost 30% and 18% of their body weight, respectively. The data suggest that the survival of rehabilitated polecats is sufficient to justify the resources used in the rehabilitation process and that the animals' long-term welfare is not compromised by being held in captivity.

Baylisascaris procyonis in Raccoons in Texas and its Relationship to Habitat Characteristics

A. E. Kresta, S. E. Henke, and D. B. Pence

Journal of Wildlife Diseases 46(3): 843–853, 2010.

Raccoons (n = 590) were collected from October 1999 to August 2003 from 35 counties across Texas, USA, and gastrointestinal tracts were examined for *Baylisascaris procyonis*. We documented *B. procyonis* in central and eastern Texas. *Baylisascaris procyonis* occurred in 5.4% of raccoons in Texas with an overall mean abundance and mean intensity of 0.4 ± 0.1 and 7.4 ± 2.3, respectively. Prevalence was higher in central Texas ecoregions and on clayey soil texture than other regions or soil textures of Texas. Mean parasite abundance was highest in the Postoak Savanna ecoregion located in central Texas. Our findings expanded the range of *B. procyonis* in Texas and confirmed that areas of Texas with clayey soil texture are more vulnerable to *B. procyonis* transmission. This study gives a better understanding of where *B. procyonis* may occur in Texas and which environmental characteristics are better suited for *B. procyonis* occurrence and transmission, especially in areas where likelihood of frequent human contact with raccoons and their feces increases.

Natal Dispersal and Philopatry of Red Foxes in Urban and Agricultural Areas of Illinois

T. E. Grosselink, K. A. Piccolo, T. R. van Deelen, R. E. Warner, and P. C. Mankin

Journal of Wildlife Management 74(6): 1204–1217, 2010.

Dispersal and philopatry may be influenced by habitat, intraspecific and interspecific interactions, and resource quality. Dispersal may vary substantially between urban and rural wildlife populations due to differences in urban–rural habitat and trophic relationships. We examined effects of environmental, body condition, and social influences on dispersal and philopatry of urban and rural red foxes *(Vulpes vulpes)* in east-central Illinois and western Indiana, USA. We recorded 96 dispersal events and 66 cases of philopatry in juvenile foxes. We used Akaike's Information Criterion to evaluate regression models of dispersal probability, initiation date, distance, and days spent dispersing. Habitat (i.e., urban–rural), sex, row-crop percentage in natal home ranges, family home-range overlap, and social interactions with family members all influenced

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Increasing Pre-Weaning Social Complexity Affects Orphan Raccoon Behavioral Development Before and After Weaning

Vanessa T. Kanaan and Edmond A. Pajor

Introduction

Wildlife rehabilitation is the process by which orphaned, injured, or ill wildlife regain the health and skills required to function normally and live self-sufficiently when released back into their natural habitat (International Wildlife Rehabilitation Council 2008). In order to rehabilitate wildlife properly, species-specific knowledge within several disciplines, including veterinary medicine, natural history, animal ethics, and animal behavior is required, yet is not fully available. In recent years, the need for more scientifically sound information on how to improve wildlife rehabilitation practices has become apparent (Miller 2000), especially in regard to species considered by humans to be a nuisance. Although several studies have investigated post-release success in different species (see Ludwig and Mikolajczak 1985 for a review), little is known about the pre-weaning welfare of wildlife under human care.



YOUNG RACCOONS (*PROCYON LOTOR*). PHOTO ©LOREN KAHLE. USED WITH PERMISSION.

Early social experiences may have profound effects on the behavioral development and welfare of several species. Animals raised in socially enriched early environments cope better with social and nonsocial stressors later in life, as shown in domestic pigs (*Sus scrofa*), who tend to eat more solid food and engage in less aggressive interactions when mixed with other individuals (Weary *et al.* 1999), and in laboratory rodents (*Mus* spp.), who show a higher propensity to engage in social activities and to achieve well-defined social roles during social interaction tests (D'Andrea *et al.* 2007). In contrast, early social deprivation may have detrimental, long-term effects such as reduced social motivation in adult rats (*Rattus norvegicus*) (Mintz *et al.* 2005) and a reduced ability to play with peers or to cope with aggression, and nonhuman primates have shown an increase in abnormal behavior (Harlow 1969; Berman *et al.* 1997). The effect of early social environments on the behavioral development of wildlife raised in rehabilitation centers has not been vastly investigated.

The raccoon (*Procyon lotor*) is often described as a solitary species, except during breeding periods or while caring for the young (Sieber 1984). However, recent reports suggest that some level of sociality is common among adults of this species (Chamberlain and Leopold 2002; Gehrt and Fox 2004). This is not surprising when considering that, as an opportunistic species, raccoons may share dens and food sources (Whitaker 1980; Gehrt and Fritzell 1998) and possibly meet and interact with other individuals.

IN YOUR PRACTICE: Young raccoons are one of the most common mammals found in North American rehabilitation facilities. Research undertaken by Kanaan and Pajor offers insight into ways to address socialization needs of pre- and post-weaning raccoons in captive care.

ABSTRACT: The purpose of this study was to determine how early social environments affected raccoon (*Procyon lotor*) pre- and post-weaning behavior. At 7 wk of age, 24 raccoons were assigned to one of three social environments: littermate pairs (LT, $n = 4$); nonlittermate pairs (NL, $n = 4$), or housed singly with a stuffed animal (S, $n = 8$). Behavior was recorded weekly. When weaning was completed, three cubs (one from each treatment group) were mixed in outdoor pens. Behavioral responses to the novel pens, and to an unfamiliar human, were recorded. All data were analyzed using general linear models analysis of variance and Tukey's *post hoc* means tests. The S raccoons spent a smaller proportion of the observation time interacting with the stuffed animal than LT and NL raccoons did with their cage-mates. In response to novel pens, S vocalized more, and investigated the pens less, than did LT and NL. Additionally, S spent less time exposed to, and investigating, the human than did the other treatments. Overall, the presence of stuffed animals did not seem to substitute as a cage-mate during the pre-weaning period. Increasing social complexity before weaning altered the raccoon responses to novelty after weaning.

KEY WORDS: Early social environment, pre-release, raccoon, social behavior, weaning, well-being, wildlife rehabilitation.

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J. Wildlife Rehab. 30(3): 7–15
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FIGURE 1. Outdoor pens used during the post-weaning experimental period.



FIGURE 2. Video setup during the pre-weaning experimental period.

The presence of conspecifics can be a significant aspect of the early environment in raccoons, as it may allow individuals to learn the appropriate social skills required later in life, as shown in other species (pigs: D'Eath 2005; mice: D'Andrea *et al*. 2007). Raccoon litter size varies from one to seven, with three to five being the average (Hadidian *et al.* 1997). Therefore, in natural settings, raccoon cubs are able to interact with littermates, and possibly with other young individuals in shared dens, soon after birth. After weaning at 12–16 wk of age (Whiteside 2009), cubs are technically independent but often meet siblings and share den structures and forage near other individuals (Evans and Evans 1984; Gehrt and Fritzell 1998).

Under normal rehabilitation practices, the early social environments provided to cubs vary greatly, depending on many factors such as the age and health of the animal and the availability of conspecifics. It is common practice to provide individuals with the opportunity to socialize by housing them in pairs or groups formed by littermates, nonlittermates, or a mixture. In cases in which cubs cannot be group-housed, a stuffed animal is often provided (Evans and Evans 1984).

The effect of early social environments commonly adopted by wildlife rehabilitators on raccoon behavioral development and growth is unclear. The purpose of this experiment was to determine how housing systems providing different early social environments affected raccoon pre-weaning and post-weaning behavior and welfare. We hypothesized that increasing social complexity (here defined as the level of familiarity and relatedness, number of individuals, and quality of social interactions) would improve growth rates and behavioral responses to novel pens and unfamiliar humans.

Materials and Methods

Animals and Housing

This study was conducted at the Wildcat Wildlife Center (WWC) in Delphi, Indiana, United States. Twenty-four orphaned raccoons, admitted at the WWC in May and April of 2005, were used. Except for the social environment manipulations, the care provided followed standard operating procedures used at this facility. The WWC director and the volunteer veterinarian were contacted, and they were in charge of any health issues that occurred throughout the experiment. All procedures followed under the WWC guidelines were approved by Purdue University. Cubs received canine and feline distemper vaccinations and dewormer (pyrantel pamoate) once every 2 wk. Individuals' body weights, general health status, and eligibility for this study were determined upon arrival. In order to serve as a subject, cubs had to be 0–3 wk old (eyes still closed) and healthy.

There were three distinct housing and social environments in which animals were kept, depending upon their stage of development. During the pre-experiment period, from arrival until approximately 7 (±1) weeks of age, cubs were kept in the same social environment in which they were placed upon arrival and were housed in a '27-quart sterilite storage box' lined with newspaper and a towel. A heating pad was placed underneath half of the container to provide artificial heat. During this period, cubs were bottle-fed Fox Valley formula replacement (Fox Valley Nutrition, Lake Zurich, Illinois, USA) for raccoons, diluted in water (4:1 upon arrival and gradually increased to 1:2). To avoid overflow, bottle nipples were adjusted as cubs matured. Feeding schedule varied according to age and quantity of formula being consumed (4×/day for individuals consuming 0–59 ml, 3×/day for 60–118 ml, and 2×/day for 119–177 ml).

At 7 wk of age, cubs were transferred into a kennel (Deluxe Vari-Kennel® Jr., Petmate, Arlington, Texas, USA), 0.66 meters L × 0.45 W × 0.40 H, where they were housed for 5 wk. For simplicity, this period is referred to as 'pre-weaning experimental period' (weeks 0–4), as it defines the beginning of data collection. Except for the social environment, all kennels provided the same housing conditions (lined with newspaper and a towel and cleaned at least 3×/day). Eight raccoons were housed singly and were provided with a stuffed animal (S, $n = 8$). Eight raccoons were housed in a pair with a littermate (LT, $n = 4$ pairs). The remaining eight individuals were housed in pairs with a nonlittermate of similar age and weight (NL, $n = 4$ pairs). An effort was made to assure that the social environment was, in fact, changing. For instance, if there were only two littermates housed together before the treatment

was applied, we used these individuals in either S or NL treatments, and LT pairs were created for initial litters larger than two. Science Diet® Puppy feed (Topeka, Kansas, USA) and water were introduced as part of the diet in week 1 (8 wk of age), when individuals were taking at least 177 ml of formula 2×/day. Once animals were observed eating solid food regularly, formula feedings were gradually cut and weaning was completed.

At 12 wk of age (week 5 of the experimental period), cubs were moved to outdoor pens, initiating the 'post-weaning' period. Individuals were allowed to investigate the novel pen for 10 min. Then, one individual from each pre-weaning social environment was mixed into groups of three unfamiliar cubs in one of eight outdoor pens (1.82 meters L × 1.82 W × 2.43 H; Fig. 1). All pens (n = 8) provided the same social environment in which the cub began (S, LT, or NL), and solid side walls prevented visual and physical contact between cubs housed in adjacent pens. Initially, each pen was furnished with three kennels with wood shelves, grass, a large community water container, and food bowls inside the kennels. In week 6, fruits and vegetables were introduced as part of the daily diet. In week 7, mulch, log, ropes, and hammocks were added to the pen. Pens were cleaned at least 1×/day and human contact was kept to a minimum. Once the experiment was completed, management of the raccoons was turned over to the WWC.

TABLE 1. Behaviors recorded during the raccoon pre-weaning experimental period.

BEHAVIOR	DEFINITION
Active alone	The individual is active, but not in physical contact with cage-mate–stuffed toy; not sitting or lying, and not investigating pen, food, and water when available
Active not alone	The individual uses its face, paws, or both to make physical contact with the cage-mate–stuffed toy, not sitting or lying
Inactive alone	The individual is inactive, lying or sitting, not in physical contact with cage-mate–stuffed toy
Inactive not alone	The individual is inactive, lying or sitting, in physical contact with cage-mate–stuffed toy
Pen investigation	The individual uses its face, front paws, or both to make physical contact with the door, sides, and back walls of the kennel; includes hanging
Food	The individual uses its face, front paws, or both to make physical contact with the food bowl when the bowl is not empty (i.e., at least some food is inside bowl)
Water	The individual uses its face, front paws, or both to make physical contact with the water bowl when the bowl is not empty (i.e. at least some water is inside bowl)
Other	Any behavior that does not fall into an above category
Not visible	The individual is not visible

TABLE 2. Behaviors recorded during the raccoon post-weaning response to a novel pen.

BEHAVIOR	DEFINITION
Latency to leave kennel	Time taken by an individual to leave the kennel completely (all four legs and tail)
Experimenter investigation	The individual uses the front paws or the face to make physical contact with experimenter including touching, sniffing, climbing
Ground investigation	The individual's front paws and face are directed toward the ground; the individual may be standing on all four legs or walking
Kennel investigation	The individual uses the front paws or face to make physical contact with the kennel; includes climbing the kennel
Water investigation	The individual is in any type of physical contact with the water or water container including touching, sniffing, climbing, and drinking of water
Wall investigation	The individual uses the front paws or face to make physical contact with any of the pen walls, including climbing and hanging
Other	Any behavior that does not fall into an above category
Not visible	The individual is not visible during the observation period

Behavioral Measurements

Pre-weaning behavioral time budget. In order to collect data on behavioral time budget, raccoons were transferred to kennels set up with video equipment (Fig. 2), identified with livestock markers of different colors, and their behavior was recorded for a 24-hr period on 0, 1, and 4 wk of the experimental pre-weaning period. All aspects of this housing environment were kept the same as the home kennels, except for the addition of a nonglare plexiglass top and the presence of infrared lighting that allowed for video recording even under low light situations. A camera (Toshiba IK-64DNA; Toshiba, Irvine, California, USA) was placed on the wall above each kennel and the infrared light was set in the front. Behavior was recorded using a time-lapse VCR (Panasonic AG-TL95OP, Osaka, Japan) and a video multiplexer (Panasonic WJ-FS216, Osaka, Japan) and later analyzed. Cubs were returned to their home kennels at the end of the 24-hr period.

TABLE 3. Behaviors recorded during the raccoon post-weaning response to an unfamiliar human.

BEHAVIOR	DEFINITION
Latency to approach human(s)	Time taken by the first individual of the raccoon group to make any physical contact with the human
Duration exposed	The individual raccoon could be engaged in any activity, in a location that was visible to the human, including being on the log, walls, and ground
Duration hiding	The individual raccoon could be engaged in any activity, in a location that was not visible to the human, including being inside of or behind the kennel, underneath the log, inside of the hammock
Human investigation	The individual uses the front paws or the face to make physical contact with the unfamiliar human including touching, sniffing, and climbing
Other	Any behavior that does not fall into an above category
Not visible	The individual is not visible

TABLE 4. Treatment comparison (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) of behaviors recorded as a response to a novel pen during the post-weaning period. Data expressed as least-square means ± standard error.

BEHAVIOR	S	LT	NL
Vocalizations	6.66 ± 1.32%	2.50 ± 1.32%	1.50 ± 1.32%
Wall investigation	6.66 ± 6.35%	22.51 ± 6.35%	45.85 ± 6.35%
Experimenter investigation	22.17 ± 15.48%	55.90 ± 22.28%	45.77 ± 14.94%
Kennel investigation	21.62 ± 7.88%	26.97 ± 8.45%	18.35 ± 6.57%
Water container investigation	7.98 ± 12.67%	2.66 ± 13.51%	13.61 ± 10.56%
Ground investigation	26.98 ± 9.13%	23.65 ± 9.73%	19.34 ± 7.61%
Latency to leave the kennel	219.70 ± 86.13 sec	67.75 ± 123.95 sec	94.53 ± 83.11 sec

Behaviors (Table 1) were quantified from video recordings using 10-min scan samplings.

Post-weaning response to novel pen. Prior to being mixed with unfamiliar animals during the post-weaning period, each individual's response to the novel pen was recorded. Each cub was individually transported in a kennel into the outdoor pen, the kennel was placed inside the pen, and its door was opened. To test responses to the novel pen, it was divided into three separate sections. In the first part of the test, raccoons were given a total of 5 min to leave the kennel before being removed by the experimenter. Once the individual was outside of the kennel, its door was closed to prevent raccoon access to the inside again. The experimenter then started the second part of the test, in which the raccoons were allowed to interact with any part of the new pen, in the presence of the experimenter, for 5 min. For the third part of this test, the observer left the pen, allowing the raccoon to explore the pen by itself for another 5 min. Cubs were tested in a pre-determined, randomized order on each day and returned indoors after each test.

All tests were recorded using a camcorder (Sony DCR-TRV350 NTSC; Sony Corp., Toyko, Japan) located outside of the pen and later analyzed using continuous sampling. Behaviors recorded are described in Table 2.

Post-weaning response to an unfamiliar human. Raccoon responses to an unfamiliar human were collected on week 8 of the experimental period. Immediately prior to initiating the test, the experimenter entered the pen and assured that all three raccoons were awake. The experimenter then left the pen and an unfamiliar female entered the pen. The human stood motionless and did not make eye contact with any raccoons on the right side of the pen for 10 min. Behaviors (Table 3) were obtained from video recordings. All tests were recorded using a camcorder (Sony DCR-TRV350 NTSC) located outside of the pen and were later analyzed using continuous sampling.

Weight Gain and Formula Consumption

Formula consumption was recorded during the pre-weaning period. Cubs were weighed 1×/wk, immediately before feeding, until week 6 after the treatment was applied.

Statistical Analysis

Statistics are reported as least-square means ± standard error (SE). Statistical significance was accepted at $P < 0.05$ and reported as such. All P-values between 0.05 and 0.10 were considered a trend, and exact P-value was reported; all $P > 0.10$ were reported as non-significant (NS). Treatment comparisons were analyzed using each kennel as the experimental unit during the pre-weaning period time budget (S, $n = 8$; LT, $n = 4$; NL, $n = 4$); the individual cub was used for the weight gain, formula consumption, and the habituation test data ($n = 8$), as well as the pen during the human approach test ($n = 8$). Data were analyzed using the general linear model analysis of variance (ANOVA) in Minitab® statistical software v.14 (State College, University Park, Pennsylvania, USA). The assumptions of parametric analysis (homogeneity of variance, normality of

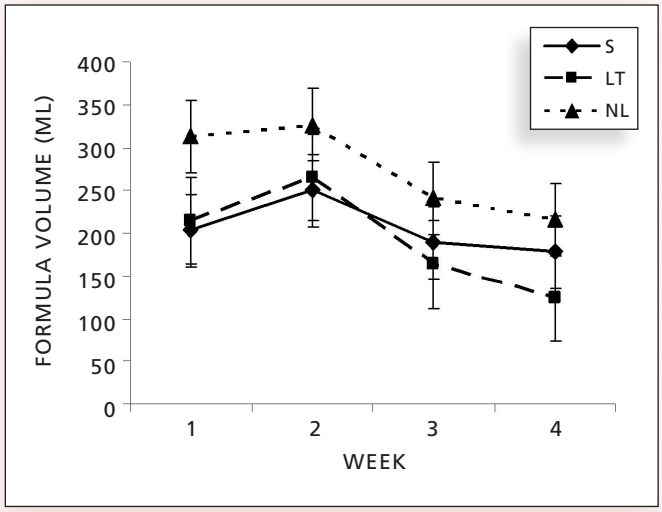


FIGURE 3. Comparison of formula consumption among treatments (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) throughout the experiment. Data expressed as log square (LS) means ± standard error (SE).

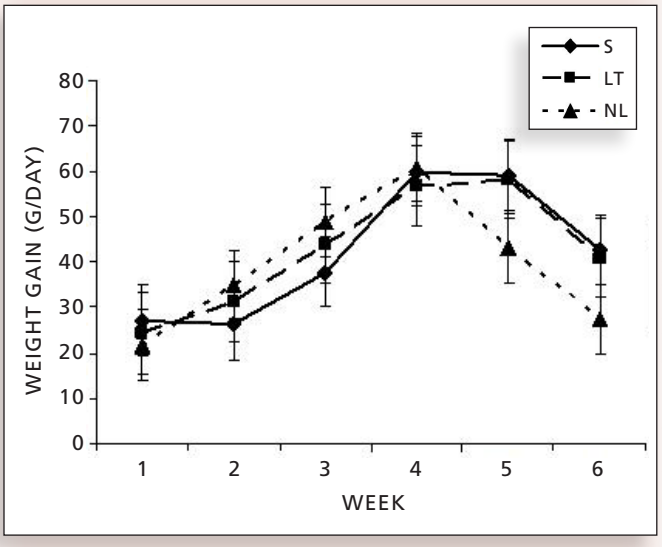


FIGURE 4. Comparison of mean daily weight gained among treatments (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) throughout the experiment. Raccoons were moved outside on week 5. Data expressed as LS means ± SE.

error, and linearity) were confirmed *post hoc* by inspecting a plot of the residuals versus the fitted values and a residual histogram, and suitable transformations were applied as required. Tukey pairwise comparisons were performed for significant main effects and interactions.

Weight gain and formula consumption: Raccoon mean daily weight gains and formula consumption data were analyzed using repeated measures ANOVA. The model used in the analyses included the individual's 'litter' (degrees of freedom [df] = 11), 'week' of data collection (df = 5 for weight gain, df = 3 for formula consumption data), and 'treatment' (df = 2), as well as the interaction between the latter two.

Behavioral measurements: Time budget was analyzed using

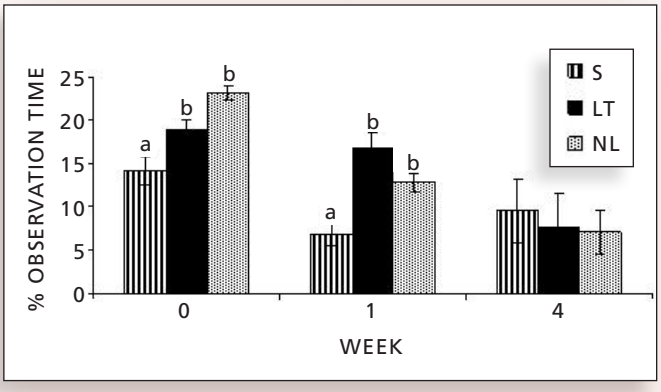


FIGURE 5. Treatment comparison (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) of the proportion of time spent active, and in contact, with the stuffed animal–cagemate during the pre-weaning experimental period. Data expressed as LS means ± SE. Treatment means with different letter superscripts are significantly different at $P < 0.05$.

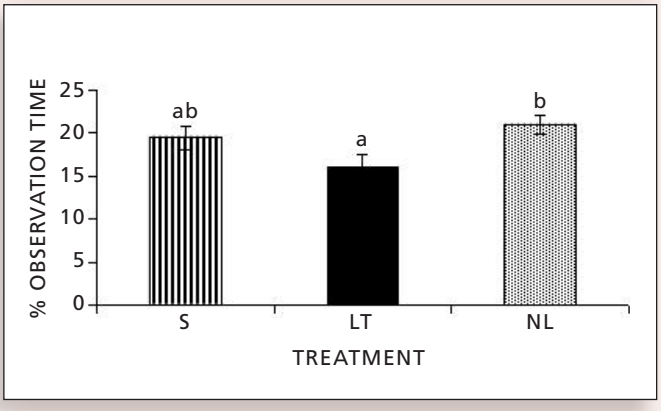


FIGURE 6. Overall treatment comparison (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) of the proportion of time spent active, but not in contact, with the stuffed animal–cagemate during the pre-weaning experimental period. Data expressed as LS means ± SE. Treatment means with different letter superscripts are significantly different at $P < 0.05$.

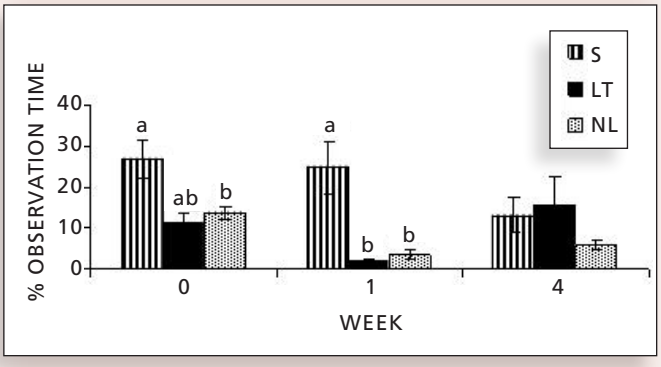


FIGURE 7. Treatment comparison (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) of the proportion of time spent inactive, and not in contact, with the stuffed animal–cagemate during the pre-weaning experimental period. Data expressed as LS means ± SE. Treatment means with different letter superscripts are significantly different at $P < 0.05$.

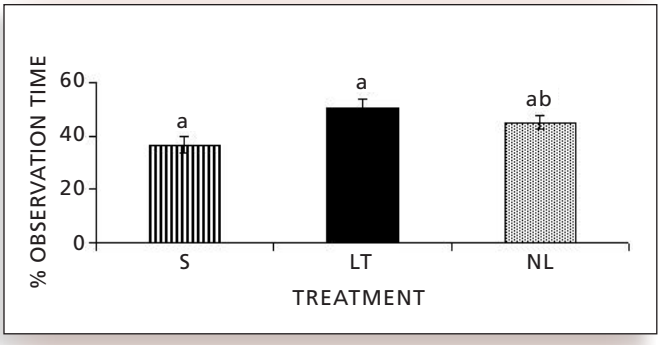


Figure 8. Overall treatment comparison (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) of the proportion of time spent inactive, and not in contact, with the stuffed animal–cagemate during the pre-weaning experimental period. Data expressed as LS means ± SE. Treatment means with different letter superscripts are significantly different at $P < 0.05$.

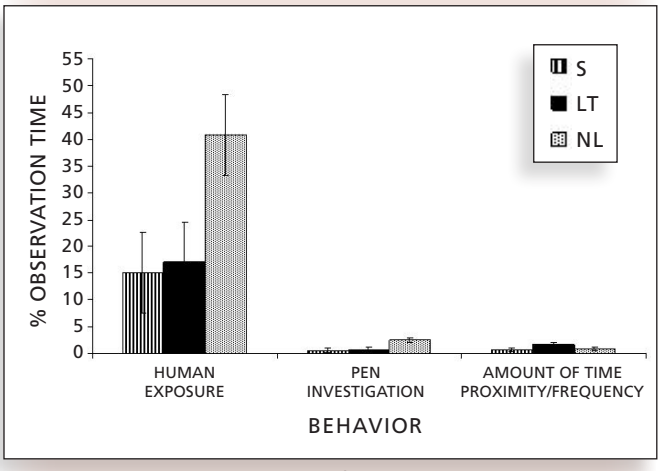


Figure 9. Treatment comparison (S = singly housed individuals, LT = littermate pairs, NL = nonlittermate pairs) of proportion of time spent exposed to human presence and investigating an unfamiliar human, while measuring the responses to an unfamiliar human during the post-weaning period. Data expressed as LS means ± SE. Treatment means with different letter superscripts are significantly different at $P < 0.05$.

repeated measures ANOVA. The model used in the analysis included 'week' of data collection (df = 2) and 'treatment' (df = 2), as well as the interaction between the two (df = 4). The model used for analysis of the response to a novel pen included the litter from which the individual came, in order to test for possible genetic effects (df = 11), and 'treatment' (df = 2). The results from the second and third stages of this test were not different from each other and were pooled together for the analysis. The model used in the response to an unfamiliar human included 'treatment.'

Results

Weight Gain and Formula Consumption

Average formula consumption did not differ between treatments in the pre-weaning experimental period (S = 212.0 ± 26.6 ml, LT = 191.6 ± 38.5 ml, NL = 273.9 ± 26.6 ml; $F = 2.54$, NS), and there were no 'day' by 'treatment' interactions ($F_{(6,95)} = 0.48$, NS). Formula consumption peaked 1 wk after the treatment was applied and decreased consistently as solid food was introduced as part of their diet (Fig. 3).

Average daily weight gains (DWG) were found not to differ among treatments for the entire experiment (S = 41.56 ± 2.86 g/day, LT = 40.71 ± 2.86 g/day, NL = 43.17 ± 2.86 g/day; $F = 0.16$, NS). The patterns of DWG for all treatments mirrored each other, indicating that there were no 'treatment' by 'day' interactions ($F_{(10,114)} = 0.77$, NS). However, there was a day effect ($F_{(5,114)} = 10.48$, $P < 0.05$). A drop in DWG for all treatments was evident after raccoons were moved outside (week 5) upon completion of weaning (Fig. 4).

Behavioral Measurements

Pre-weaning behavioral time budget: Results are described as the average percentage observations in which cubs engaged in behaviors. Singly housed cubs spent a smaller proportion of observation time in active-behavior contact with the stuffed animal in weeks 0 and 1 than in the other two treatments with their cage-mates (overall $F_{(2,52)} = 23.46$, $P < 0.05$). There were no treatment differences in week 4 (Fig. 5).

Overall, NL individuals spent a greater proportion of observation time engaged in active behavior alone; that is, not in contact with the cage-mate–stuffed animal, than did the LT treatment (overall $F_{(2,52)} = 3.52$, $P < 0.05$). There were no differences between S individuals and the other treatments (Fig. 6). There were no 'week' by 'treatment' interactions ($F_{(4,52)} = 1.89$, NS).

On weeks 0 and 1, S individuals spent a higher proportion of the inactive observation time alone; that is, not in contact with the stuffed animal, than did the other two treatments with cage-mates (overall $F_{(2,52)} = 20.72$, $P < 0.05$). These differences disappeared by week 5 (Fig. 7).

Singly housed individuals spent a smaller proportion of inactive observation time while in contact with a stuffed animal than did LT cubs with cage-mates (overall $F_{(2,52)} = 5.31$, $P < 0.05$, Fig. 8). There were no differences between LT and NL treatments and no 'week' by 'treatment' interaction ($F_{(4,52)} = 2.10$, NS).

There were no 'treatment' effects in the proportion of observation time raccoons spent investigating the 'kennel' (S = 34.96 ± 0.02, LT = 39.21 ± 0.02, NL = 35.87 ± 0.02; overall $F_{(4,52)} = 0.57$, NS) and engaged in 'food' (S = 8.92 ± 0.02, LT = 6.88 ± 0.02, NL = 5.47 ± 0.02; overall $F_{(4,52)} = 0.69$, NS) and 'water' behaviors (S = 6.96 ± 0.01, LT = 8.80 ± 0.01, NL = 7.57 ± 0.01; overall $F_{(4,52)} = 0.10$, NS. There were no 'treatment' by 'week' interactions for any of these variables ('kennel' $F_{(4,52)} = 1.09$, 'food' $F_{(4,52)} = 0.10$, 'water' $F_{(4,52)} = 0.19$, NS).

Post-weaning response to novel pen: During the novel pen investigation period, S individuals vocalized more than did the other two treatments (overall $F_{(2,10)} = 4.74$, $P < 0.05$) and spent a smaller proportion of time investigating the walls of the pen (overall $F_{(2,10)} = 4.74$, $P < 0.05$). There were no treatment differences in percentage of time spent investigating the experimenter (overall $F_{(2,10)} = 0.41$, NS), or in the percentage of time investigating the kennel (overall $F_{(2,10)} = 0.30$, NS), the ground ($F_{(2,10)} = 0.16$, NS), and the

water container (overall $F_{(2,10)}$ = 0.42, NS). In addition, there were no treatment effects on latency to leave the kennel (overall $F_{(2,10)}$ = 0.58, NS). Individuals were not observed pacing. See Table 4 for means and standard error.

Post-weaning response to an unfamiliar human. In response to an unfamiliar human, there were no treatment differences in the latency to approach the human (S = 256.2 ± 109.32 sec, LT = 341.1 ± 116.57 sec, NL= 182.8 ± 91.15 sec; $F_{(2,10)}$ = 0.51, NS), or in the proportion of time spent hiding while in the human presence (S = 49.01 ± 18.49, LT = 63.76 ± 19.72, NL = 31.18 ± 15.42; $F_{(2,10)}$ = 0.80, NS). NL individuals spent a higher proportion of time investigating the human than did individuals in the other treatments (S = 0.56 ± 0.47, LT = 0.67 ± 0.47, NL = 2.51 ± 0.47; overall $F_{(2,10)}$ = 5.25, $P < 0.05$). We also found a trend to suggest that S individuals spent a smaller amount of time investigating the human per bout of behavior than did LT individuals (overall $F_{(2,21)}$ = 2.84, $P = 0.08$); NL did not differ from the other treatments. NL individuals spent more time exposed to the human than did those raised singly (overall $F_{(2,21)}$ = 3.66, $P < 0.05$), and there was a trend to suggest the same was true in comparison to those raised with littermates ($P = 0.08$; Fig. 9).

Discussion

The data described in the present study establish, for the first time, how early social environments affect raccoon social behavior before and after weaning. During the pre-weaning period, we found that singly housed cubs did not interact or rest in contact with stuffed animals as much as did cubs housed in pairs. Lerman (1982) suggested, and it is generally accepted, that it is impossible to properly raise and socialize a raccoon which had been isolated during early development. Similar findings are reported in several species, including rodents (Varty *et al*., 2000), nonhuman primates (D'Andrea *et al*. 2007), and humans (Rutter 1981). As a result, it is common to house a single cub that cannot be paired with others with a stuffed toy, as a way to provide comfort and the feeling of another individual (Evans and Evans 1984). However, this procedure is based on anecdotal information rather than on scientific investigation. Our results suggest that the stuffed animal provided to S cubs does not substitute as a cage-mate for some social behaviors measured. For ethical and practical reasons, we chose not to have a control group in which animals were raised singly without a stuffed animal. Such investigation would allow for a more complete understanding of the role of a stuffed animal given to a singly housed raccoon.

In regard to the raccoons housed in pairs during the pre-weaning experimental period, we found that the pair arrangement had a modest effect on their behavioral time budget. Sharing an environment with a cub from another litter is uncommon for young raccoons in natural situations, but not impossible, as several mothers can share a den if needed (Whitaker 1980, Gehrt and Fritzell 1998). In wildlife rehabilitation settings, it is common practice to gather cubs of similar ages and sizes, despite the lack of understanding about the consequences on animal development and well-being. We found that NL pairs spent more active time alone than did LT pairs throughout the pre-weaning experimental period, a finding which could be explained by the lack of familiarity between the cubs that formed the pairs. The patterns of behavior during the pre-weaning period could have long-term effects and may explain the differences in responses to novelty later in the experiment.

Our post-weaning results show that individuals raised singly during the pre-weaning period may not be as comfortable as those from the other treatments when allowed to investigate a novel pen. According to Sieber (1984), whistles, churrs, and squeals are the most common vocalizations in young raccoons and have been associated with the mother's absence or other aversive situations. High vocalization levels have also been associated with a response to isolation in chickens (Jones and Carmichael 1997), sheep (Porter and Bouissou 1999), and pigs (Grandin 2001). Due to the poor sound quality of our recordings, we were unable to distinguish between the different types of calls. However, the high frequency of vocalizations noted in individuals that were raised singly with a stuffed animal suggests that they may be more distressed when introduced to novel environments than are individuals from the other treatments. Interestingly, singly housed raccoon cubs were already physically isolated before being placed in the novel pen, unlike the other two treatments. Therefore, it is possible that the combination of the novel aspect of the environment, and the continued isolation, amplified raccoon vocalizations and stress responses during the test.

On the other hand, we found that individuals raised in nonlittermate pairs were more willing to investigate novel environments than were those raised singly or with a littermate. The lack of fear of novel environments may be a desirable trait for animals that will be reintroduced to the wild, as they will have to explore new surroundings in order to find shelter, food, and water sources. Michler and Hohmann (2005) reported that raccoons use a variety of structures as dens, most of which are very different from those commonly offered during the rehabilitation process; the same is probably true for water sources and food items.

In addition, cubs raised in nonlittermate pairs were more comfortable around unfamiliar humans than were individuals from the other treatments. For instance, NL cubs spent a higher proportion of time investigating the human, and exposed to the human presence, than did LT and S cubs. Historically, the human approach test (a behavioral test similar to the setup we used to measure raccoon response to humans) was proposed as an assessment of fear shown by pigs in relation to humans (Hemsworth *et al*. 1981). The assumption was that pigs which were fearful of humans would show avoidance behavior in relation to them. Although not investigated in raccoons, fear is likely to be the primary motivation behind an animal's response to an unfamiliar human, but inferences can also be drawn about its social attachment and the nature of its past experience with humans (Waiblinger *et al.* 2006). It is important to note that the amount of time raccoons spent investigating the human was minimal, and not all individuals engaged in this behavior. Regardless, the lack of fear of humans is usually assumed to be disadvantageous for releasable animals, especially those considered a nuisance, as

they have higher risks of contracting and spreading diseases and parasites (Michler and Hohmann 2005) or of having a negative encounter with a human or domestic animal. It is possible that the extra social experiences with unfamiliar raccoons, the contact NL cubs had with the caretakers, or both, were generalized to the unfamiliar human. Therefore, it might be necessary to make a more rigorous pre-release training program for raccoons that have had a more-complex early social environment. In contrast, being fearless around humans may be beneficial for raccoons that are trying to establish themselves in a new environment where humans are present. Further investigation is necessary to determine the costs and benefits of fear of humans in raccoons who share their environments with us.

The early social environments provided in this experiment had little effect on raccoon daily weight gain and formula consumption. Similar patterns have been found in other species. For instance, weight gain was similar between isolated and socially reared rats (Pascual *et al.* 1999). Also, allowing unfamiliar piglet litters to comingle during the lactation period had no effect on daily weigh gain (Kanaan *et al.* 2008). In contrast, other studies have found that group-housed mice, or litters allowed to interact during the lactation period, showed higher weight gains and food consumption compared to those individuals raised in isolation or in a less-complex social environment (Yamada *et al.* 2000, Weary *et al*. 2002). It is possible that raccoon high adaptability, in regard to food availability, is stronger than the effects of the treatments.

Conclusions

The presence of stuffed animals does not seem to compensate for the lack of a cage-mate during the pre-weaning period. Housing animals singly during the pre-weaning period may have effects that could be potentially undesirable to raccoons when encountering a new environment later in life. Nonlittermate pairs seem to be more comfortable with novelty after weaning. Further investigations are necessary to determine how these findings related to post-release behavior and survivability. We conclude that increasing social complexity before weaning altered responses to both social and nonsocial challenges after weaning.

Acknowledgments

The authors thank the Purdue University Department of Animal Sciences for funding. We also thank the Wildcat Wildlife Center director Carol Blacketer, and assistant director Denise Hays, for allowing this project to be conducted at the Wildcat Wildlife Center, Delphi, Indiana, United States.

Literature Cited

Berman, C. M., K. L. Rasmussen, and S. J. Suomi. 1997. Group size, infant development and social networks in free-ranging rhesus monkeys. *Animal Behavior* 53(4): 405–421.

Chamberlain, M. L., and B. D. Leopold. 2002. Spatio-temporal relationships among adult raccoons (*Procyon lotor*) in Central Mississippi. *American Midland Naturalist* 148(2): 297–308.

D'Andrea, E., E. Alleva, and I. Branchi. 2007. Communal nesting, an early social enrichment, affects social competences but not learning and memory abilities at adulthood. *Behavioural Brain Research* 183(1): 60–66.

D'Eath, R. B. 2005. Socialising piglets before weaning improves social hierarchy formation when pigs are mixed post-weaning. *Applied Animal Behaviour Science* 93(3–4): 199–211.

Evans, A. T., and R. H. Evans. 1984. Raising raccoons for release. *In:* Wildlife Rehabilitation 3. National Wildlife Rehabilitators Association, St. Cloud, Minnesota, USA. pp. 92–138.

Fernandez, E. J., and W. D. Timberlake. 2003. The effects of fixed- and variable-time schedules on stereotypic behaviors in two adult polar bears. Presented at the Association for Behavior Analysis Conference, San Franscisco, California, USA.

Gehrt, S. D., and L. B. Fox. 2004. Spatial patterns and dynamic interactions among raccoons in eastern Kansas. *Southwestern Naturalist* 49(1): 116–121.

Gehrt, S. D., and E. K. Fritzell. 1998. Duration of familial bonds and dispersal patterns for raccoons in South Texas. *Journal of Mammalogy* 79(3): 859–872.

Grandin, T. 2001. Cattle vocalizations are associated with handling and equipment problems at beef slaughter plants. *Applied Animal Behaviour Science* 71(3): 191–201.

Hadidian, J., G. R. Hodge, and J. W. Grandy. 1997. Wild neighbors: The humane approach to living with wildlife. The Humane Society of the United States. Fulcrum Publishing, Golden, Colorado, USA. 253 pp.

Harlow, H. F. 1969. Agemate or peer affectional system. *In:* Advances in the study of behavior, D. S. Lehrman, R. A. Hinde, and E. Shaw (eds.). Academic Press, New York, New York, USA. pp. 333–383.

Hemsworth, P. H., A. Brand, and P. Wilems. 1981. The behavioural response of sows to the presence of human beings and its relation to productivity. *Livestock Production Science* 8(1): 67–74.

International Wildlife Rehabilitation Council. [Online] http://www.theiwrc.org. Accessed 20 May 2008.

Jones, R. B., and N. L. Carmichael. 1997. Open field behavior in domestic chicks tested individually or in pairs: Differential effects of painted lines delineating subdivisions of the floor. *Behavioral Research Methods, Instruments & Computers* 29(3): 396–400.

Kanaan, V. T., E. A. Pajor, D. C. Lay Jr., B. T. Richert, and J. P. Garner. 2008. A note on the effects of co-mingling piglet litters on pre-weaning growth, injuries and responses to behavioural tests. *Applied Animal Behaviour Science* 110(3): 386–391.

Lerman, M. 1982. Comprehensive raccoon rehabilitation. *In:* Wildlife Rehabilitation 1. National Wildlife Rehabilitators Association, St. Cloud, Minnesota, USA. pp. 15–24.

Ludwig, D. R., and S. M. Mikolajczak. 1985. Post-release studies: A review of current information. *In:* Wildlife rehabilitation: Proceedings of the National Wildlife Rehabilitators Association, P. Beaver (ed.). St. Paul, Minnesota, USA, pp. 121–124.

Michler, F. U., and U. Hohmann. 2005. Investigations on the

ethological adaptations of the raccoon (*Procyon lotor*) in the urban habitat using the example of the city of Kassel, North Hessen (Germany), and the resulting conclusions for conflict management. IUGB-Congress, Hannover-Germany. pp. 417–419.

Miller, E. A. 2000. Minimum standards for wildlife rehabilitation, 3rd Edition. National Wildlife Rehabilitators Association, St. Cloud, Minnesota, USA. pp. 10–11.

Mintz, M., D. Rüedi-Bettschen, J. Feldon, and C. Pryce. 2005. Early social and physical deprivation leads to reduced social motivation in adulthood in Wistar rats. *Behavioural Brain Research* 156(2): 311–320.

Pascual, R., E. Verdú, A. Valero, and X. Navarro. 1999. Early social isolation decreases the expression of calbindin D-28k in rat cerebellar Purkinje cells. *Neuroscience Letters* 272(4): 171–174.

Porter, R. H., and M. F. Bouissou. 1999. Discriminative responsiveness by lambs to visual images of conspecifics. *Behavioural Processes* 48: 101–110.

Rutter, M. 1981. Maternal deprivation reassessed. Penguin Books, New York, New York, USA. 288 pp.

Sieber, O. J. 1984. Vocal communication in raccoons (*Procyon lotor*). *Behaviour* 90(1–3): 80–113.

Varty, G. B., M. P. Paulus, D. L. Braff, and M. A. Geyer. 2000. Environmental enrichment and isolation rearing in the rat: Effects on locomotor behavior and startle response plasticity. *Biological Psychiatry* 47(10): 864–873.

Waiblinger, S., X. Boivin, V. Pedersen, M. V. Tosi, A. M. Janczak, E. K. Visser, and J. B. Jones. 2006. Assessing the human–animal relationship in farmed species: A critical review. *Applied Animal Behavioural Science* 101(3–4): 185–242.

Weary, D. M., E. A. Pajor, M. Bonenfant, S. K. Ross, D. Fraser, and D. L. Kramer. 1999. Alternative housing for sows and litters, Part 2. Effects of a communal piglet area on pre- and post-weaning behaviour and performance. *Applied Animal Behavioural Science* 65(2): 123–135.

Weary, D. M., E. A. Pajor, M. Bonenfant, D. Fraser, and D. L. Kramer. 2002. Alternative housing for sows and litters, Part 4. Effects of sow-controlled housing combined with a communal piglet area on pre- and post-weaning behaviour and performance. *Applied Animal Behavioural Science* 76(4): 279–290.

Whitaker Jr., J. O. 1980. The Audubon Society field guide to North American mammals. Alfred A. Knopf, New York, New York, USA. 992 pp.

Whiteside, D. 2009. Nutrition and behavior of coatis and raccoons. Veterinary Clinics of North America: *Exotic Animal Practice* 12(2): 187–195.

Yamada, K., H. Ohki-Hamazaki, and K. Wada. 2000. Differential effects of social isolation upon body weight, food consumption, and responsiveness to novel and social environment in bombesin receptor subtype-3 (BRS-3) deficient mice. *Physiology & Behavior* 68(4): 555–561.

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Edmond Pajor



MALLARD DUCKLING ***(ANAS PLATYRHYNCHOS)***. PHOTO ©SUSAN HOWARD. USED WITH PERMISSION.

Testing Two Husbandry Protocols for Mallard Ducklings: Does Running Water or an Older "Mentor" Bird Improve Brood Weight Gain and Survival?

Anna Drake and David Fraser

Introduction

In contrast to the helpless nestling birds that flood rehabilitation facilities during the summer months, precocial birds such as ducks often require the rehabilitator to provide only a clean environment, appropriate temperature, and ample food and water. However, despite their apparent self-sufficiency, many ducklings die in care. At the two largest rehabilitation facilities in British Columbia, Canada, the 6-yr average mortality rates for uninjured mallards admitted when less than one week old was 29% and 42%, respectively (Drake and Fraser 2008). Pre-admission factors (brood size, body weight, and the length of time rescuers kept ducklings before admitting them) affect survival of ducklings in care and are, therefore, partially responsible for duckling deaths (Drake and Fraser 2008). However, as these factors are only weak predictors of death, rearing and housing practices almost certainly contribute. Because many (35–48%) of these deaths occur within the first 2 days after admission, they may be due to the inability of some individual ducklings to adapt to captive circumstances (Drake 2007).



MALLARD DUCKLINGS. PHOTO © MARK KLOTZ. USED WITH PERMISSION.

We tested the effect of two husbandry practices that have been claimed to improve duckling survival. The first practice was the provision of continuous, running water to duckling broods (Wittner 2003). The second was housing a "mentor" bird with new broods (Savory 1982; Clio Smeeton, pers. comm. 2005; Bourne WILDPro 2006; W. Todd, pers. comm. 2007). These practices were tested with controlled, split-brood experiments. As both studies used housing that differed from the standard housing used for mallard ducklings in the facility, they additionally provided an uncontrolled comparison of survival under different housing conditions.

Methods

Both studies were conducted at the Wildlife Rescue Association of British Columbia (WRA) in Burnaby, British Columbia, Canada. The studies were done in two consecutive years because the WRA generally did not receive enough ducklings in any given year to provide a large-enough sample size for analyses. In addition, the facilities lacked

IN YOUR PRACTICE: Research by Drake and Fraser explores options for improving brood survival for mallard ducklings that should prove to be of interest to waterfowl rehabilitators.

ABSTRACT: Mallard ducklings (*Anas platyrhynchos)* require relatively little time investment to rear in captivity, but high mortality rates are common during the first week in care. Two consecutive experiments used a split-brood method to assess effects of two different husbandry protocols upon duckling survival. The first provided birds with access to either a continuously running or static water supply. The second tested the effect of providing an older duckling as a brood "mentor." Ducklings provided with continuously running water did not show higher mean brood survival or mean weight gain than those provided with simple water troughs. Broods with mentors did not differ from controls in mean brood survival or mean weight gain; however, weight gains for the slowest-growing birds in groups with mentors were significantly greater compared to similar birds in control groups. Only 69% of the ducklings in the first study survived the first week in care, whereas all 61 in the mentor study did so. Although not explicitly tested, this may have resulted from warmer temperatures in the experimental brooders. We conclude that mentor birds may be helpful for birds that have difficulty thriving in captivity, but we suggest that warmer conditions may be key to improving duckling survival.

KEYWORDS: *Anas platyrhynchos*, care practices, duckling, mallard, temperature, wildlife rehabilitation.

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J. Wildlife Rehab. 30(3): 17–22
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TABLE 1. Suggested association between normal housing and duckling deaths, 2001–2006. All first-week deaths occurred within the first 3 days after admission.

HOUSING TYPE	SAMPLE SIZE	TEMPERATURE[1] (MEAN ± SD)	DEATHS IN FIRST WEEK
Standard (2001): *Sheltered outdoor wooden boxes, wire mesh floor, heat lamp 54 cm above floor*	111	—	20%
Standard (2002)	106	—	45%
Standard (2003)	167	—	34%
Standard (2004)	215	—	39%
Experimental (2005): *Sheltered outdoor poultry brooder, wire mesh floor, heated section*	49	28 ± 4°C (82 ± 7°F)	31%
Experimental (2006): *Sheltered outdoor poultry brooder, wire mesh floor, heated section, rubber matting in heated section*	61	32 ± 4°C (90 ± 7°F)	0%

[1]Mean housing temperature varied between the 2005 and 2006 experiments due to the addition of rubber matting: mean ± SD based on (>100) temperature readings taken over the course of each experiment. Housing temperature was not assessed between 2001–2004, but two measures taken in 2008 suggest standard housing was cooler, at approximately 24°C (75.2°F).

sufficient space to conduct both protocol tests simultaneously. All ducklings were brought to WRA by members of the public. Upon admission, ducklings were housed in cardboard boxes on an electric heating pad set at "low" until they were banded and assessed, generally within 20–60 min. Birds that were visibly in poor or critical condition, or did not meet the experimental criteria, were placed in the regular care facility and excluded from the study groups.

For both experiments, ducklings were housed in a standard, stacked, commercial poultry brooder with wire-mesh flooring (Petersime Brood-unit Model 25D20, Petersime Incubator Company, Gettysburg, Ohio, USA). The brooder was kept in a roofed, outdoor pen which excluded rain and predators. Each level of the brooder was separated into two cages by a solid, central partition. Each cage contained a heated section separated from the rest of the cage by a plastic curtain (Fig. 1A). Heat was produced by an overhead resistor coil (whole brood unit: 1040W, 115V) located in a vent 20 cm above the floor of each brooder level. The temperature within the heated section was set to 31°C (88°F) to reflect the recommended temperature of 30–32°C (86–90°F) for raising commercial ducklings in their first week (Clauer and Skinner 1985; Hamre 1994; Dean and Sandhu 2001). Brooder temperatures within the heated section were checked twice daily. Actual temperature varied throughout the day but averaged 28°C (82°F) in 2005. In 2006, perforated rubber matting (generic cupboard lining, e.g., Magic Stop) was laid down in the heated section, and along the length of the cage next to the water trough, to reduce temperature fluctuations and to make movement easier for smaller birds by reducing the mesh size they were required to walk on. Temperature averaged 32°C (90°F) in 2006. Water was provided in troughs that held approximately 3 L when full. Following facility protocol, *ad libitum* Gamebird Starter® (Pro-form Feeds [26% protein], Unifeed, Chilliwack, British Columbia) and mixed, shredded greens (primarily romaine lettuce and carrot in a 3:1 ratio) were provided. Feed and water were completely replaced twice daily.

Brooders were cleaned twice daily. Birds were caught and placed in a cardboard box and the floor mesh was scrubbed with a bristle brush and water to remove feces throughout 2005 and 2006. During 2006, the rubber mats were removed and hosed off at this time as well. Brooders and matting were cleaned thoroughly between brood-rearing experimental periods with 1:16 diluted Peroxigard® (accelerated hydrogen peroxide [7.0%], Bayer Inc., Toronto, Ontario) and a bristle brush.

In both studies, ducklings were weighed at admission. Birds were then weighed twice daily for the 1-wk duration of the two experiments, between 07:30 hr and 09:00 hr and between 18:30 hr and 20:00 hr, when they were removed for cage cleaning and before their diets were replaced. All weights were measured on an MP-2000 electronic scale (±0.5 g) (WAS MP-2000, Western Scale Co. Ltd., Port Coquitlam, British Columbia).

Experimental protocols were approved by the University of British Columbia's Animal Care Committee (A05-0776) and the WRA Animal Care Board (meeting of 18 April 2005). All birds were monitored for their well-being and could be removed from the study at the discretion of facility staff. If at any point birds were found to be in poor or critical condition, they were treated according to facility protocols.

2005 Water Study

Forty-nine ducklings (10 broods) were studied between 20 May and 28 June, 2005. Only broods of two or more individuals, weighing <90 g, were used in the study.

Broods were split at admission and randomly allocated to treatment or control groups. Brood-mates were placed on the same level of the stacked brooder with the solid central partition separating the treatment and control birds. Because lone ducklings are easily stressed, single birds (from split broods of 2 or 3 individuals) were housed with a "company bird" which was not included in the analysis.

Control groups had water troughs that were emptied and refilled twice daily and were topped off as necessary; maximum total volume available at any one time was 3 L and never fell below 1 L. Treatment birds had continuous-flow troughs that

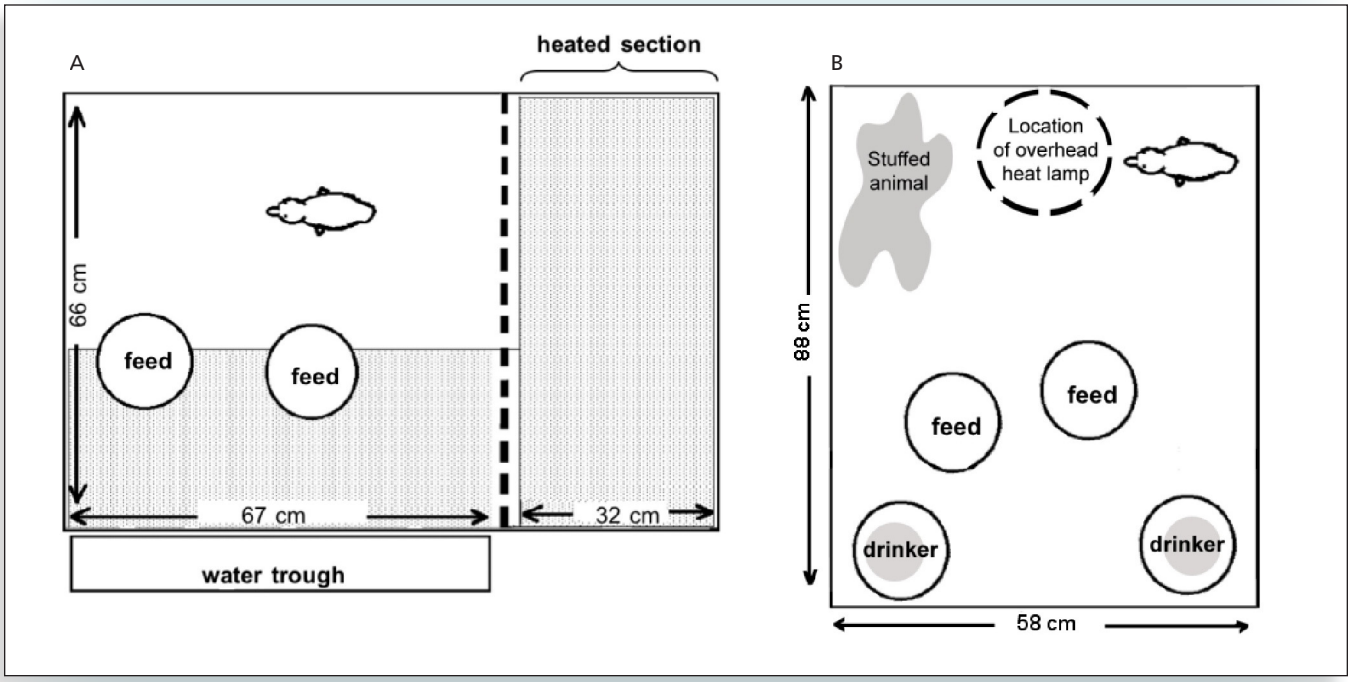


FIGURE 1. (A) A diagram of experimental housing (Petersime Brood-unit, Model 25D20; Petersime Incubator Company). Shaded sections indicate the location of perforated rubber matting used during the 2006 study. A dotted line indicates the location of the plastic curtain. (B) A diagram of standard duckling housing used at the Wildlife Rescue Association of British Columbia.

were fed directly from the facility water line through 0.6-cm internal diameter plastic hosing at an average rate of 9 ml/sec (±2 ml SD); these were passively drained through a hole drilled into the far side of the trough, into a plastic hosing of 1.6-cm internal diameter. Continuous-flow troughs held 2.3 L (±0.2 L SD) of water at any one time. As a result, water in these troughs was effectively replaced every 5 min.

2006 Mentor Study

Sixty-one ducklings (8 broods) were included in the mentor study between 20 May and 29 June, 2006. Only broods of three or more individuals, weighing <60g, were used in the study.

Broods were split at admission and randomly allocated to treatment or control groups on the same level of the stacked brooder as in the previous experiment. Seven of the eight broods consisted of more than three individuals. For the single brood of three, the lone bird in the brood split was assigned to the treatment group so that it would not be housed alone.

Birds assigned to control groups were raised with their siblings. Birds assigned to treatment groups were also reared with their siblings (with the exception of the lone bird from the split brood of three) and, in addition, were given an older bird as a "mentor." The mentor bird had spent at least 1 wk at the facility and was in good health and showing normal weight gain. Mentors integrated well with the novice groups, except for one bird that was replaced within the first 5 min because it was aggressive towards the group. Mentors averaged 135 g (range: 68–215 g) or approximately four times the weight of the novice ducklings. The addition of a mentor meant that groups with mentors had one more bird in their cage in even-numbered broods; in odd-numbered broods, the extra sibling was always assigned to the control group so that group size would be the same.

Housing and Care of Non-experimental Birds

For the purposes of comparing housing, data records on 599 ducklings that had been kept in standard WRA housing between 2001–2004 were compiled from case sheets.

Regular housing for ducklings at the WRA consisted of brooder boxes with wooden sides, wire-mesh flooring, and mesh lids 30 cm above the flooring to prevent birds from jumping out (Fig. 1B). Brooder boxes were kept in a roofed, outdoor pen which excluded rain and predators. Heat was generated via standard 100W heat lamps 54 cm above the cage floor. Temperatures on the floor of the brooder averaged 24°C (75.2°F). Birds were often supplied with stuffed animals, which they sat on or against, bringing them closer to the heat lamp. Until 2006, water was provided using inverted jar drinkers (Fig. 1B) that were subsequently replaced with automatic waterers. As above, birds received *ad libitum* Gamebird Starter® (Unifeed) and mixed, shredded greens that were completely replaced twice daily. Brooders were cleaned twice daily, with birds being caught and placed in a cardboard box during cleaning and the brooder being scrubbed with a bristle brush and water to remove feces.

Data Analysis

Because individual birds could not be treated as statistically independent, the experimental unit was the brood. Treatment effects were tested by comparing the proportion of the group that did not survive the first week in care with the group means for weight gain and body weight at the end of 1 wk in care. To compare

weight-gain rates between treatments, individual weight values were log-transformed, and the growth curves were then analyzed as linear functions by the use of least-squares regression analysis. During the first week in care, the assumption of exponential weight gain fit the observed growth patterns very well, as none of the birds approached its asymptotic weight. The regression slope for each bird was used to calculate mean rate-of-gain for each group within each treatment. In the 2005 study, only birds that survived to the end of the experimental period were included in the rate-of-gain and week-one weight comparison. In the 2006 study, all birds survived to the end of the experimental period and, thus, all were included in the analysis.

The effects of treatments on mortality and weight-related measures were tested by a paired *t*-test, except for 2005 mortality which was not normally distributed and, therefore, was tested by a paired Wilcoxon signed-ranks test. Tests were one-tailed, with the assumption that treatment groups would gain weight faster, weigh more at 1 wk, and experience fewer deaths than did control groups.

In the 2006 mentor experiment, we observed more-uniform body weights for ducklings in the treatment group. Therefore, additional paired *t*-tests were used to compare the slowest-gaining bird in each treatment and control group. A Bonferroni correction was applied to critical values to reduce the chance of type-I errors (Sokal and Rolf 1994). A corrected *P*-value is reported for these results.

For the purposes of comparing housing, data records on 599 ducklings that were kept in standard WRA housing between 2001–2004 were compiled from case sheets. First-week deaths, by year, were tallied for those birds that weighed <90 g at admission and were compared to the deaths occurring within the experimental broods in 2005 and 2006. All analyses were done using Excel 2004® (Microsoft Corp., Redmond, Washington, USA) and SAS software (JMP 3.0, JMP 6.0, SAS 9.1 [1989, 2005, 2002], SAS Institute Inc., Cary, North Carolina, USA).

Results

2005 Water Study

Fifteen birds died across 6 broods within the first week. Although continuous-flow troughs were notably cleaner than control troughs, mortality rates were not significantly lower in treatment groups (31% vs. 32%, $z = 0.0$, $P = 0.5$). Duckling deaths meant that two of the smaller broods could not be included in the weight-gain analysis. In the remaining eight replicates, groups provided with a continuous-flow water trough showed a tendency toward better growth (11.3 g/day vs. 10.4 g/day; $t = 1.59$, $P = 0.08$) but no significant difference in final weight (128.8 g vs. 125.0 g; $t = 3.72$, $P = 0.27$).

2006 Mentor Study

There were no deaths in 2006. Groups provided with mentors did not show greater mean weight gain (7.8 g/day vs. 7.2 g/day; $t = 0.54$, $P = 0.30$) nor greater mean weight (86.9 g vs. 83.9 g; $t = 1.34$, $P = 0.11$) at one week ($n = 8$). *Post hoc* analysis ($n = 7$) did show, however, a reduced spread in body weights within broods housed with a mentor at the end of one week (16% vs. 27% mean CV; $t = 4.48$, corrected $P = 0.03$, two-tailed paired *t*-test). This seemed to be due, in part, to a tendency for the slowest-gaining bird in each treatment group to gain more weight in the first week than did the slowest-growing bird in each control group (5.8 g/day vs. 3.8 g/day; $t = 3.66$, corrected $P = 0.08$, two-tailed paired *t*-test). At the end of the first week in care, these slowest-gaining birds weighed, on average, 16.8 g more in the mentor groups than they did in the control groups ($t = 4.48$, corrected $P = 0.03$, two-tailed paired *t*-test).

Temperature Observations

In 2005, 15 of the 49 study birds died within the first week. All deaths occurred within the first 3 days of care. This mortality rate of 31% was within the facility's previous (2001–2004) 4-yr range (20%–45%; 4-year average 35%). In 2006, none of the 61 ducklings died over the course of the experiment. The relatively small sample sizes, and the lack of any control group, indicated that the deaths in 2005 and the lack of deaths in 2006 may have simply been the result of random chance or interyear variation in duckling health. However, it is also possible that the higher temperature of the brooders in 2006 (31.6°C [88.9°F] as compared to 27.8°C [82.0°F]) was beneficial to the broods. Housing, known temperature, and duckling death rates for both of the experimental studies, and for standard WRA housing (for purposes of comparison), are shown in Table 1.

Discussion and Conclusions

Wittner (2003) reported a marked improvement in duckling survival when veterinary hospital cages with towel flooring were replaced by heated, indoor, mesh-floored brooders with running-water drinkers. This success was attributed to improved drinking water access and to ducklings staying dry overnight (D. Wittner, pers. comm. 2005). However, reduced mortality may also have been the result of associated housing-design changes, management changes, or reduced disease load in the new environment. In conducting the split-brood studies, we sought to avoid such confounding of variables. Under our controlled conditions, we found no evidence that running water results in fewer deaths, greater weight gain, or greater body weight at 1 wk as compared to a static, continuously available water supply, despite the greater cleanliness of the running-water trough.

Savory (1982) found that rearing turkey poults with broiler chickens resulted in more-rapid initial growth, but had no significant effect on mortality and did not result in greater body weight at 8 wk of age, when compared to controls. Anecdotal reports suggest that providing same-species or poultry as "mentors" encourages feeding and reduces mortality in captive-reared precocial birds (Clio Smeeton, pers. comm. 2005; Bourne WILDPro 2006; W. Todd, pers. comm. 2007). We found that providing mallard

duckling broods with mentors did not result in reduced mortality, nor in greater mean body weight, by the end of the first week. We also did not find more-rapid mean weight gains in groups provided with mentors. However, *post hoc* analysis suggests that there was a benefit of the treatment to the slowest-gaining individual in each brood. These mentored, slowest-gaining birds gained significantly more weight (16.8 g more) than their counterparts in the control groups. This difference resulted in the least-thriving bird in mentor groups ending the experiment an average of 29% heavier than their counterparts in control groups.

Mentored, least-thriving ducklings may have weighed more than their counterparts because of behavioral differences. Older mallards spend more time in "comfort" and resting activities than do younger birds (Ringelman and Flake 1980; Pietz and Buhl 1999). Observation of the ducks indicated that mentor birds were notably less active than newly admitted birds; they spent more time resting than moving and moved mainly to obtain food and water. Often, individual birds in the novice brood would rest next to the mentor bird while the brood-mates without mentors were active. Studies of turkey poults provided with adoptive hens found that the hens did not encourage feeding but, instead, induced rest periods which, the authors suggest, allow poults to conserve energy during development (Duncan *et al.* 2004). Additionally, Anderson and Alisauskas (2002) suggest that social hierarchies in duckling broods affect individual growth. The mentor's large body size may result in its automatically becoming the dominant bird in the group, without overt competition, which in turn may benefit smaller birds. Behavioral studies would have to be done in order to support any of these explanations. Because risk of death is greater for birds with slow weight gains (Cox *et al.* 1998), it is possible that the use of mentors may reduce mortality where conditions are less favorable than occurred in this study.

Although it was not tested directly, the housing used in the mentor experiment appeared to improve duckling survival. The poultry brooders used in this experiment differed from the standard WRA brooders in their heating system (using a resistor coil rather than heat lamp) and this, together with a separate heated section and rubber matting on the floor, appeared to maintain higher and (likely) more stable temperatures within the brooder. This may have reduced the amount of energy ducklings expended to maintain homeothermy. Other factors may have contributed: in particular, sterilization of experimental caging between broods may have reduced disease transfer; and the large water troughs in the experimental brooders ensured that birds were never without water. Smaller, inverted jar drinkers used in the facility brooders require constant refilling and may have occasionally become empty.

In conclusion, we found that running water had no effect on duckling survival or growth when compared to continuously available static water. Mentor ducklings appear to benefit the least-thriving birds in novice broods; however, this effect appears to be small relative to the apparent effect of the housing modifications on brood survival. We suggest that keeping birds warm (31–32°C [88–90°F]) and dry, and ensuring they have constant access to water, will have the largest impact on survival. However, as providing a mentor is a simple, low-cost procedure that does not appear to be detrimental in any way (see sidebar), it may be a worthwhile practice, especially where housing is suboptimal.

Note on duckling mentors

Rehabilitators often avoid mixing broods, particularly with birds of different ages, because the ensuing aggression can result in deaths. In this study, only one of nine older birds did not integrate well with the younger brood and, thus, had to be replaced. This may be because the mentor birds were singletons [individuals received without brood mates] and were motivated to join a group. For mallard ducklings, as with the young of many species, much aggression occurs when individuals in established groups challenge new individuals. However, this type of aggression was not directed toward the mentor, perhaps because of the body-size difference. Even so, monitoring novice broods and mentors for the first day of care is important to ensure that aggression is not a problem.

Diet is an additional concern associated with the mentoring system. In our experience, ducklings do well on high-protein (>20%) food during early development, but are at risk of developing wing deformities ("angel-wing" or "slipped-wing," or carpometacarpal deformity) should they be kept on this diet after 2–3 wk of age (see Kear 1975; Kreeger and Walser 1984; Bourne WildPRO 2006). We, therefore, recommend that mentors should be as young as possible (but have already spent at least a week in captive care) and should be removed from broods on high protein diets after they are 2–3 wk of age or weigh more than 260–280 g (Lokemoen et al. 1990).

LITERATURE CITED

Anderson, V. R., and R. T. Alisauskas. 2002. Composition and growth of king eider ducklings in relation to egg size. *Auk* 119(1): 62–70.

Bourne, D. WILDPro®. Stimulating feeding of downies (waterfowl). Wildlife Information Network. Available at: http://www.wildlifeinformation.org. Accessed October 2006.

Clauer, P. J., and J. L. Skinner. 1985. Raising waterfowl. University of Wisconsin–Extension Publication A3311. Available at: http://poultryextension.psu.edu/WFowl.html. Accessed January 2007.

Cox, R. R., M. A. Hanson, C. C. Roy, N. H. Euliss Jr., D. H. Johnson, and M. G Butler. 1998. Mallard duckling growth and survival in relation to aquatic invertebrates. *Journal of Wildlife Management* 62(1): 124–133.

Dean, W. F., and T. S. Sandhu. 2001. Duck housing and management. International Duck Research Cooperative, Inc.

Available at: http://www.duckhealth.com/housmngt.html. Accessed 27 April 2005.
Drake, A. 2007. Mallard duckling care and survival at a wildlife rehabilitation center. M.Sc. Thesis, University of British Columbia, Vancouver. 78 pp. Available at: www.landfood.ubc.ca/animalwelfare/publications/pdfs/theses/Drake_MSc_2007.pdf
Drake, A., and D. Fraser. 2008. Admission trends and mortality correlates for mallard ducklings at wildlife rehabilitation facilities. *Journal of Wildlife Rehabilitation* 29(1): 4–14.
Duncan, I. J. H., J. Karrow, L. M. Panning, and A. E. Malleau. 2004. Starve-out in turkey poults: There's more to life than feeding. 40th Eastern Nutrition Conference. Animal Nutrition Association of Canada. pp. 71–83.
Hamre, M. L. 1994. Raising ducks. University of Minnesota Extension Service. Available at: http://www.extension.umn.edu/distribution/livestocksystems/DI1189.html. Accessed March 2005.
Kear, J. 1975. Notes on the nutrition of young waterfowl, with special reference to slipped-wing. *International Zoo Yearbook* 13(1): 97–100.
Kreeger, T. J., and M. M. Walser. 1984. Carpometacarpal deformity in giant Canada geese (*Branta canadensis maxima* Delacour). *Journal of Wildlife Diseases* 20(3): 245–248.
Lokemoen, J. T., D. H. Johnson, and D. E. Sharp. 1990. Weights of wild mallard *Anas platyrhynchos*, gadwall *A. strepera*, and blue-winged teal *A. discors* during the breeding season. *Wildfowl* 41[1990]: 122–130.
Pietz, P. J., and D. A. Buhl. 1999. Behaviour patterns of mallard *Anas platyrhynchos* pairs and broods in Minnesota and North Dakota. *Wildfowl* 50[1999]: 101–122.
Ringelman, J. K., and L. D. Flake. 1980. Diurnal visibility and activity of blue-winged teal and mallard broods. *Journal of Wildlife Management* 44(4): 822–829.
Savory, C. J. 1982. Effects of broiler companions on the early performance of turkeys. *British Poultry Science* 23(2): 81–88.
Sokal, R. R., and F. J. Rolf. 1994. Biometry. 3rd Edition. W. H. Freeman and Company. New York, New York, USA. 896 pp.
Wittner, D. 2003. Brooder room plans for maximum success in raising waterfowl and shorebirds. *Wildlife Rehabilitation* 21(1): 40–47.

Acknowledgments

The authors would like to thank Clio Smeeton (rehabilitator, Cochrane, Alberta, Canada); W. Todd (Bird Department, Houston Zoo Inc.); and D. Wittner (senior biologist and wildlife trauma specialist at the Alberta Institute for Wildlife Conservation, Alberta, Canada). These three contributed valuable information that improved the quality of our study.

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Anna Drake is a graduate of the University of British Columbia Animal Welfare Program (M.Sc. 2007). She first became involved in wildlife rehabilitation in 1999 as volunteer with the Wildlife Rescue Association of British Columbia, Canada (WRA). She later worked for four summers as seasonal staff at the WRA. Anna is currently a Ph.D. candidate in wildlife ecology at Simon Fraser University in Burnaby, British Columbia, Canada.


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Anna Drake

David Fraser is a Professor in the Animal Welfare Program at the University of British Columbia. He has done research and teaching on the management, behavior, and welfare of animals since the 1970s.


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David Fraser and friend.

Case Study: Agitation and Hyperactivity of Moose and Elk at a Wildlife Rehabilitation Shelter in Response to Removal of Temporary Feeding Stations

Roy V. Rea and Marshall S. Schneider



MOOSE (*ALCES ALCES*). PHOTO ©CHUCK HILLIARD. USED WITH PERMISSION.

IN YOUR PRACTICE: Rea and Schneider offer observations that can be used by rehabilitators to reduce stress for wild ungulates in captive or near-captive settings while potentially reducing handler risk as well.

ABSTRACT: This case study reports on agitation and hyperactivity as observed in two human-habituated moose *(Alces alces)* in February of 2009 and in one elk (*Cervus elaphus*) on February 2010 at a wildlife shelter in northern British Columbia, Canada. The behavior occurred following the removal of temporary feeding structures that had held tree boughs and branches during feeding experiments. Activities recorded and discussed include stiff-legged stomping, rearing, posturing, back arching, bluff charging, snorting, and barking; the raising of guard hairs on the neck and withers is also reported. Such activities had never before been observed in these circumstances by caretakers throughout the 20 years of operations at the shelter. To mitigate the occurrence of such behaviors, possible approaches could be to dismantle feeding stations only after animals have become accustomed to the absence of food, or to distract animals with additional food items while dismantling the feeding stations.

KEY WORDS: Agitation, *Alces alces*, behavior, *Cervus elaphus*, feeding trials

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Introduction

Like many ungulates, moose and elk are known to bed, walk, or pace slowly about when undisturbed (Bubenik 1998). However, neutral behaviors can change in response to real or perceived danger, fright, crowding, and startling.

Although animals becoming agitated and displaying imminent aggression in response to various stimuli has been recorded (Bubenik 1998; Grandin and Johnson 2005), and anyone who has observed social interactions amongst moose and elk know how aggressive they can become if provoked (Bogomolova *et al*. 2002), few studies have been conducted on potential stressors and how such stressors may effect captive animals (Moberg and Mench 2000). As such, biologists rely heavily on anecdotal information about how animals, such as those raised in shelters, respond to various forms of stress (Moberg and Mench 2000).

Case study

Here, we report on the behavior of a 3-yr-old cow, a 9-mo-old moose calf, and a 9-mo-old elk calf that had been hand-reared at the Northern Lights Wildlife Shelter in Smithers,

J. Wildlife Rehab. 30(3): 23–26
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FIGURE 1. The feeding station constructed to feed willow and birch saplings to moose at the wildlife shelter over a 3-day period in February 2009.

British Columbia. These animals displayed agitation and hyperactivity directed towards experimenters in response to our removal of temporary feeding stations. Feeding stations were constructed to facilitate cafeteria-style feeding trials, over a 3-day period in 2009 and a 2-day period in 2010, as part of two different experiments we were conducting to learn about the feeding preferences of ungulates (specifically moose) in northern British Columbia.

All moose and elk at the wildlife shelter had been orphaned and subsequently bottle-raised and, as such, were considered habituated to human presence. All animals were free to feed from the feeding station at the shelter, but also used the surrounding and unfenced wilderness areas where they were able to mix with, and behave as, wild animals.

First Encounter

On 27 February 2009, after a 3-day experiment in which we fed willow (*Salix scouleriana*) and birch (*Betula papyrifera*) saplings to three semi-tame moose at the shelter, we had begun to disassemble a feeding station that had been built for the purpose of our experiment. The station had two 6" × 6" pine (*Pinus contorta* var. *latifolia*) beams, each 16 ft long, and two ratchet straps that bound the two beams together in order to pinch and hold the browse plants in a stationary and upright position so that the moose could feed (Fig. 1). This system was our design and was simply used to feed entire plants to moose in a way that more-closely mimicked how they feed on such plants in nature—that is, vegetation in an upright position and not lying on the ground.

When we finished our experiment on the third day of testing, we removed the ratchet straps and carried one beam back to the compound from which we had collected them earlier. When we returned to retrieve the second remaining beam, one of two moose calves that had been feeding there began to display aggressive behaviors (the other moose calf had wandered off into the surrounding woodlands). This aggression toward us matched interactions we and the caretakers had previously observed at the shelter, when moose become irritated with each other or with deer and elk with which they share resources. However, such interactions had not occurred over the course of our experiment, nor had any aggression been directed at caretakers. Activities of the calf included stiff-legged posturing, kicking, back arching, bluff charging, snorting, and barking, all of which are reported aggression behaviors of moose (Bubenik 1998). Additionally, the calf in question appeared disgruntled and stood in a protective stance between us and the remaining beam.

After about 3 min of this hyperactivity display, the moose calf resumed its normal behavior and wandered off toward a salt block about 30 m east of the feeding station we had erected. We discounted the behavior and carried the second beam to where we had put the first beam some 40 m to the north.

When we returned to the feeding station site, we found the 3-yr-old cow had arisen from her bed, about 15 m from the station, where she had been lying for the past hour during our deconstruction activities. She was rearing and stomping in a stiff-legged fashion around the area where the feeding station had been, sniffing the ground with her ears back and the guard hairs of her neck and withers erect. Additionally, she was roaring, coughing, and snorting in an apparent bout of hyperactivity that lasted for at least 5 min; roughly half of her behavior was directed at us, while the rest of the behavior appeared to be directed outwardly at nothing in particular. Following the hyperactivity, the cow remained preoccupied with the area of the removed station for at least 20 min.

Upon discussion, we were able to connect the behavior of the two animals and speculate at the cause. These aggressive behaviors could have been linked to other stimuli in the environment. However, we had not observed such activity over the 3-day period in which the feeding station had been available for the animals. In addition, beyond removing the station, there were no apparent

changes in the environment to which we could attribute such behavior. Therefore, we concluded that both animals became stressed in response to our dismantling and removal of the station, which had served as a constant supply of hand-picked, very palatable browse for several days.

Second Encounter

In mid-February 2010, we set up a cafeteria-style feeding trial with the boughs of several conifers (*Pinus contorta*, *Pinus sylvestris*, *Abies lasiocarpa*, *Pseudotsuga menziesii* var. *glauca*, *Picea abies*, and *Picea glauca*) in an effort to determine feeding preferences for various conifer species by moose and elk. These materials were provided to the animals over a 2-day period (20 hr in total) by placing three replicates of the boughs of different species into piles; these piles were separated from one another by approx. 3 m (Fig. 2). Upon completion of the experiment, we began to collect uneaten materials for transport back to our laboratory at the University of Northern BC in Prince George, British Columbia. Although the moose appeared unaffected by our removal of the boughs from the feeding piles that had been established the previous day, the lone elk that had been feeding there began to exhibit signs of stress when approximately half of the materials had been collected. In this instance, the elk charged at us with its head held high and its neck and chest stretched out in front of it. Along with charging, it kicked out with its front legs; this continued for approx. 6–7 min, during which we were required to retreat behind trees and a portion of the fenced shelter. Ultimately, we were required to leave the feeding station for about an hour, after which we returned to collect the left-over materials with an all-terrain vehicle we strategically parked between the plant materials and the elk.

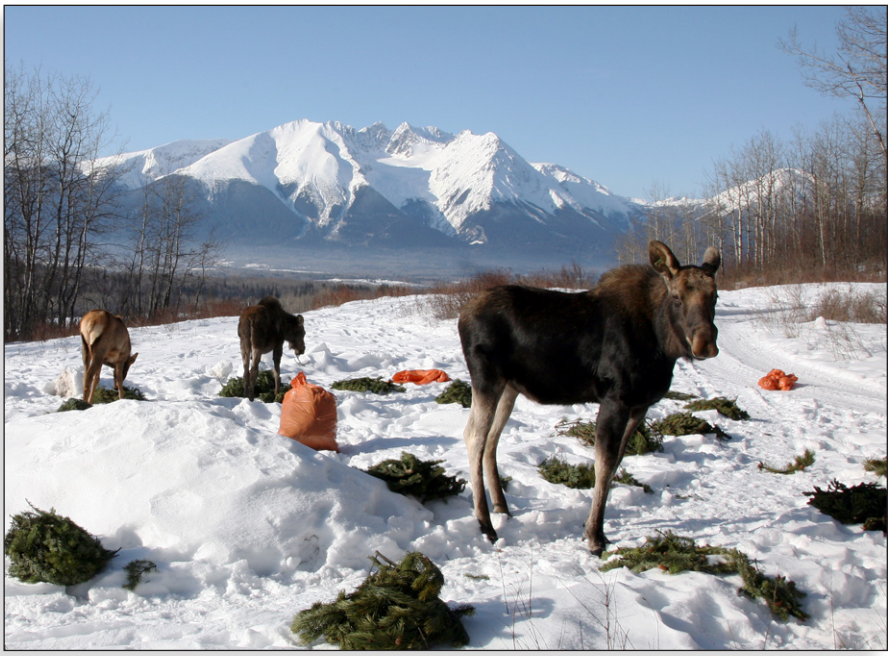


FIGURE 2. Moose and elk (far left) foraging on the boughs of different coniferous trees that were set out in a cafeteria-style feeding trial on February 18, 2010. This photograph was taken as we were completing the set up of the station and shows the bags (one still full) that were used to transport boughs to and from the site.

Conclusions

No prior experiences with human-habituated ungulates at the shelter over the past 8 yr of research prepared us for the reaction of those animals to our activities on these two occasions. We have also been unable to find any reports of similar activities against humans in the literature, albeit all of those behaviors have been observed in members of the deer family interacting with other wildlife in the wild and denote stress under a variety of circumstances (Cowan and Geist 1961; Bubenik 1998). Our recounting of the animal's behavior surprised Peter and Angelika Langen, who own and operate the shelter and have worked there since 1990 to rehabilitate animals from throughout northern British Columbia. Such behaviors do occasionally occur between animals when competing for food during normal feedings at the station. They also occurred between animals feeding during the cafeteria-style trials. The difference in this case study is that such actions were directed at humans, not during the construction of the station or during the feeding trials, but only when we were removing station components and food resources.

Presumably, differences in forage intake between individual animals could have had an effect on how animals reacted to our removal of food resources. However, our assessment of intake rates by different animals in both trials revealed no significant differences in browse consumption between those animals under apparent stress and those that appeared oblivious to our removal of the station materials. Moose, deer, and elk all fed in the 2010 trial, but only the elk acted out when we removed the coniferous forage items. A preference for birch shoots over conifer boughs may help to explain why moose acted out more in year 1 than in year 2, but we could find no literature supporting this hypothesis, and our sample sizes are too small to draw any such conclusions.

Based on our observations of how animals react to one another during regularly scheduled feedings at the shelter, we do not believe that the amount of time that the feeding station is operational would alter the outcomes we report here—many animals react to competition over resources at their troughs with explosive aggression and dominance over one another before the food is even loaded into the troughs. However, plant quality may influence behavior if the provided experimental foods are of high quality and are normally difficult to locate around the shelter; animals may consider such resources rare and worth fighting over.

Interestingly, the cow that became aggressive in 2009 was also

present in the 2010 experiment, but happened to have wandered off into the nearby woodlands before we packed up the conifer boughs. Therefore, we could not test whether or not this reaction was possibly tied to simply one individual's behavioral repertoire. Because stressors can influence different species, or even different individuals of the same species, in different ways (Moberg and Mench 2000), it is difficult to predict how other animals might react to the removal of a feeding station. Again, more research is need to clarify individual and species-specific reactions to what we observed and now report here.

Management recommendations

To mitigate the occurrence of such behaviors, one possible approach could be to remove temporary feeding stations only after animals have adapted to the concept of an empty feeding station. Therefore, in the future, we plan to provide alternative food for animals when nearing the completion of our experiments. Extra food materials brought to the experiment could be used by researchers to direct animals away from the feeding stations while they are being dismantled. Waiting for regularly scheduled feeding times at the shelter before distributing extra food, and then dismantling the feeding station, may also allow for a quick and stress-free removal of the station while the animals are otherwise occupied. This method may mitigate the likelihood of animals reacting in a similar fashion and may reduce the stress that appeared to be caused by the removal of food resources and feeding paraphernalia from animals.

The ability to identify—and rectify—various sources of stress for human-habituated animals living in zoos and wildlife shelters is a challenge for animal keepers (Moberg and Mench 2000). As such, our challenge is to continue to seek all possible methods to minimize both undue stress and any potential harm to researchers and animals alike. We recommend that similar considerations be made for others contemplating similar experiments. Finding ways to reduce stress on animals involved in such experiments is paramount to appropriate animal care, but also respects the time and effort contributed by those operating shelters whom, in many cases, devote their lives to the health and safety of those animals for which they care and rehabilitate.

Acknowledgments

We'd like to thank Peter and Angelika Langen who own and operate the Northern Lights Wildlife Shelter in Smithers, British Columbia, Canada. Thanks to their dedication and the long hours spent bottle-raising moose, we have a wonderful resource at our fingertips that will assist us in future efforts to answer various questions on the biology and ecology of ungulates.

Literature Cited

Bubenik, A. B. 1998. Behavior. *In:* Ecology and management of the North American moose, A. W. Franzmann and C. S. Schwartz (eds.). Smithsonian Institution Press, Washington, D.C., USA. pp. 173–221.

Bogomolova, E. M., Y. A. Kurochkin, and A. N. Minaev. 2002. The study of moose behavior on the Kostroma moose farm. *Alces* 38(2): 37–40.

Cowan, I. McT., and V. Geist 1961. Aggressive behavior in deer of the genus *Odocoileus. Journal of Mammalogy.* 42(4): 522–526.

Grandin, T., and C. Johnson. 2005. Animals in translation: Using the mysteries of autism to decode animal behavior. Scribner. New York, New York, USA. 356 pp.

Moberg, G. P., and J. A. Mench. 2000. The biology of animal stress: Basic principles and implications for animal welfare. CABI Publishing, Wallingford, United Kingdom. 392 pp.

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Roy Rea

Marshall S. Schneider was a Research Associate with Roy at the time of the study. Both have worked together on several projects related to moose foraging ecology.

Marshall and Roy are brothers and grew up in the wilderness of Northern British Columbia, where they both gained a great appreciation for moose and the environment in which they live.


Marshall Schneider

Case Study: A Little Brown Bat (*Myotis lucifugus*) Survives in the Wild with Only One Foot

K. A. Jonasson, M. E. Timonin, K. Norquay, A. K. Menzies, J. Dubois, and C. K. R. Willis

Statement of Problem

Current rehabilitation guidelines recommend euthanasia for bats with severe or crushing foot injuries. A wild bat missing its right foot, but otherwise healthy, was captured while studying bats in a Reserve north of Grand Rapids, Manitoba, Canada. The little brown bat (*Myotis lucifugus*) had apparently been injured after being captured and banded three years earlier. The current guidelines raised the issue of whether this bat should be euthanized or allowed to remain in the wild.



LITTLE BROWN BAT (*MYOTIS LUCIFUGUS*). PHOTO © SCOTT A. YOUNG. USED WITH PERMISSION.

Discussion

Bats depend on their feet for a range of functions important for survival. Most importantly, bats use their feet for gripping a substrate while roosting, but they also rely on feet for grooming and cleaning their ears; some species trawl their feet just below the water's surface during feeding (e.g., *Noctilio leporinus*; Altenbach 1989). The nearly adult-sized feet of neonatal bats emphasizes the importance of feet, during the pre-volant phase of life, for remaining attached to the mother or to a substrate when mother bats leave to forage (Orr 1970).

Although the loss of an appendage is likely to interfere with survival for any wild mammal, losing a foot could be additionally problematic for bats because the unique specialization of their forelimbs leaves them with only two feet as opposed to four. Indeed, injuries to the bones of the foot are considered severely debilitating for bats because grooming may be impeded, or impossible, for an individual hanging by the uninjured foot (Lollar and French 1998). Given the importance of feet for bats, it is not

IN YOUR PRACTICE: Jonasson *et al.* report on the capture of a healthy, one-footed wild adult bat and, as a result, offer rehabilitators the chance to reevaluate criteria for animals that may not appear, at first glance, to be good candidates for release.

ABSTRACT: We report our observations of a little brown bat (*Myotis lucifugus*), captured at a hibernaculum in the wild, and apparently healthy despite a missing right foot. Current guidelines would indicate that bats with missing appendages cannot survive, and thus biologists should perform euthanasia rather than attempting rehabilitation. The healthy status of this animal suggests that bats with missing feet may be better candidates for rehabilitation than previously suggested.

KEY WORDS: Bat, foot injury, survival

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J. Wildlife Rehab. 30(3): 27–29
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surprising that wild bats with missing feet have, to our knowledge, not previously been reported in the literature, although wild bats missing a few toes have been captured in good health (Lollar and French 1998). Based on the assumption that quality of life is severely diminished for bats with crushing foot injuries or missing feet, Lollar and French (1998) argued that individuals with missing or severely damaged feet should be euthanized instead of rehabilitated. If bats with missing feet are to be kept in captivity, Lollar and French (1998) recommend that a handler groom them and clean their ears twice daily to ensure that the bats are able to echolocate normally.



FIGURE 1. Posterior, dorsal view of a little brown bat *(Myotis lucifugus)* missing its right foot.

Our observation of a wild, healthy little brown bat (*Myotis lucifugus*) lacking its right foot suggests that this level of long-term care is not necessary in all instances. There are two possible explanations for the apparent good health of this individual that are not necessarily mutually exclusive. The appendage may have remained partially functional, allowing the bat to groom effectively while hanging from the intact foot. Alternatively, the bat may have benefited from allogrooming by roost-mates during the summer or by other bats sharing the hibernaculum in winter. Allogrooming has been documented in a few bat species including female Bechstein's bats (*Myotis bechsteinii*; Kerth et al. 2003), vampire bats (*Desmodus rotundus*) via reciprocal male-male interactions (Denault and McFarlane 1995), and within bachelor colonies of little brown bats (King 1990).

Methods

On 25 May 2009 (near the end of the hibernation at our study site), while studying bats in Firecamp cave (54.3°N, 99.3°W) near the Walter Cook Caves Park Reserve north of Grand Rapids, Manitoba, Canada, we captured a hibernating male little brown bat that was missing its right foot. The bat was in deep torpor, roosting in a cluster of approximately 65 conspecifics in an approximately 35-cm vertical crack. The injury appeared completely healed and in place of the foot was a stump with a small protrusion with no articulation or claw (Fig. 1). The appendage retained articulation at the ankle-joint alone, indicating that tarsals and metatarsals were present but phalanges were not.

This individual had been banded previously with an individually numbered, split-ring, aluminum forearm band on 27 May 2006 when it was captured from the same hibernaculum. An injury was not noted at the time the bat was initially captured and, while it is possible, it is unlikely that the original banding team would not have noticed the injury. Therefore, it is likely that the bat lost the foot sometime during the three years after initial capture.

Results

At the time we recaptured this bat in 2009, its body mass was 7.3 g and forearm length was 36.3 mm. The body condition index for this individual (mass/forearm length = 0.201) was within 0.16 standard deviations (SD) of the mean body condition (mean = 0.203; SD = 0.013) of the 59 bats captured from the cave that day. The bat appeared well groomed and was free of ectoparasites. Thus, this severe foot injury did not appear to have impeded the bat's ability to roost, groom, or feed.

Management Implications

Our observations indicate that some bats are able to adapt to the loss of a foot and survive in the wild. Therefore, bats with severe injuries to the feet may be better candidates for rehabilitation, and for maintenance in captivity, than has been previously suggested. In addition, individuals of highly colonial species, such as little brown bats, may fare better in captivity if they are housed with conspecifics because it appears they may benefit from allogrooming.

Acknowledgments

We thank the Natural Sciences and Engineering Research Council (NSERC, Canada) and Manitoba Hydro for funding, and Manitoba Conservation for logistic support. We also thank the Misipawistic Cree Nation for the opportunity to work in their traditional territory.

Literature Cited

Altenbach, J. S. 1989. Prey capture by the fishing bats *Noctilio leporinus* and *Myotis vivesi*. *Journal of Mammalogy* 70(2): 421–424.

Denault, L. K., and D. A. McFarlane. 1995. Reciprocal altru-

ism between male vampire bats, *Desmodus rotundus*. *Animal Behaviour* 49(3): 855–856.

Kerth, G., B. Almasi, N. Ribi, D. Thiel, and S. Lüpold. 2003. Social interactions among wild female Bechstein's bats (*Myotis bechsteinii*) living in a maternity colony. *Acta ethologica* 5(2): 107–114.

King, M. A. 1990. Observations of allogrooming behavior in a bachelor colony of little brown bats, *Myotis lucifugus*. *Bat Research News* 31(4): 61–62.

Lollar, A., and B. French. 1998. Captive care and medical reference for the rehabilitation of insectivorous bats. Bat World Publications, Mineral Wells, Texas, USA.

Orr, R. T. 1970. Development: Prenatal and postnatal. *In:* Biology of bats, Vol. I, W. A. Wimsatt (ed.). Academic Press, Inc., New York, New York, USA. pp. 217–232.

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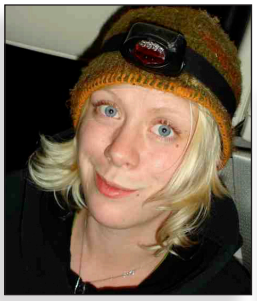
Mary E. Timonin spent a year in the Department of Biology at the University of Winnipeg as a Post-Doctoral Research Associate, studying behavior and physiology of bats, and is now a NSERC Post-Doctoral Fellow at Cornell University.

Kaleigh Norquay is a M.Sc. student and NSERC Canada Graduate Scholar in the Department of Biology at the University of Winnipeg. Kaleigh is using banding data and passive transponders to assess short- and long-term survival of bats in the wild.

Allyson K. Menzies is an Honors thesis student and NSERC undergraduate scholar in the Department of Biology at the University of Winnipeg. Her research has addressed between-individual variation in the personality and physiology of little brown bats.

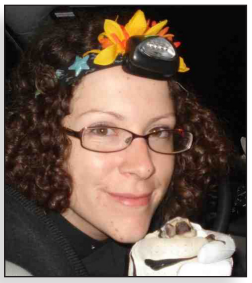
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Dr. Craig K. R. Willis is an Associate Professor in the Department of Biology and Centre for Forest Inter-disciplinary Research (C-FIR) at the University of Winnipeg. He and his students address questions about the behavior, ecology, physiology, and conservation of bats and other mammals.


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Mary Timonin


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Forester's Log: *Bear Scare*

by Mary Stuever

Perhaps I should have found another solution last weekend when my crew leaders radioed me about an elk carcass in the planting area. We were getting ready for the second annual White Mountain Apache Tribal Member Tree Planting Camp. The next day, the woods would fill with one hundred tree planters—novices, advanced beginners, veterans, instructors, inspectors—focused on the finer points of "getting the green side up."

Our first tree-planting camp in the fall of 2004 had been a wonderful jump-start to the planting season, pairing seasoned tree planting veterans with tribal members looking to learn new skills and have work for a few months. We hoped to repeat the program, and this year focused on tribal members who had already spent a season or two "hoedad-throwing." The hoedad, a narrow shovel mounted at a right angle to the handle, allows planters to cheaply place tree seedlings in the ground. Like any tool, experience brings expertise, and good instruction can bypass years of trial and error learning.

I keyed the mike, radioing back a flippant remark about using the elk as a microsite. Burying the carcass had been suggested, but it seemed like a lot of work and I reasoned that predators would just dig it up anyway. The tree planting specifications require seedlings to be planted with some sort of shade on the south and west sides. This placement is known as planting "micro-sites," and the tree planter adjusts the grid distance to find stumps, rocks, brush, and snags that will give a small seedling that surviving edge of shade. Not only would an elk carcass provide shade, but the decaying carcass might be a long-term source of nutrients, I rationalized.

We also needed to avoid disturbing the site since our Wildlife and Outdoor Recreation Department law enforcement officers would need to investigate. The bull had been shot and his antlers sawed off, clearly the work of an illegal poacher.

The next day one tribal member reported finding an eagle feather next to the elk, and that should have alerted me that other predators were soon to follow. Predators were not my only concern. The first day of camp we shut down early due to multiple dehydration cases as our water supply waned. We had also found a large rattlesnake and encountered multiple ground bee nests. Tree planting was proving to be a dangerous sport.

Tuesday saw continued dehydration cases and bee stings.

"We've sent one person a day to the emergency room," I complained Wednesday morning. "Let's be safe out there and break this record." Then we started the morning with a tree-climbing demonstration by some of the seasoned cone collectors. As a veteran climber scaled to the top of a 70-foot-high tree, more adventurous tribal members were trying on the harnesses and using the set ropes to pull themselves into the canopy of a nearby smaller tree. I was relieved when the crews headed to the field, certain that the day could not get more exciting.

By lunch time the radio was cackling with talk of bears. A bear had been spotted. A huge bear, according to the radio chatter. There was also a bear carcass near the elk now, but no one could approach to investigate because a live bear was standing guard. The crew leaders started pulling people back, and the safety officer snapped some pictures of the long-eared, young adult bear. Eventually the game warden arrived and closed down the program, requiring a clear area to "bring in dogs" and either run off the bruin or tranquilize and transport him to a different site.

Knocked out of the planting area, we had a horseshoe tournament back in our camp. Once it grew dark, traditional



PHOTO © NEW MEXICO DEPARTMENT OF GAME AND FISH. USED WITH PERMISSION.

Black bear (*Ursus americanus*).

Crown Dancers entertained the campers, and the singer spoke of the strength of bears. I ended the day around the campfire, listening to many bear stories, the lore of human–bear encounters that lend bears great respect, and the need for distance. By Thursday our bear was gone, and we were back to learning to put trees in the ground.

Friday, we shut down again when wind gusts started blowing down the 3-year-dead standing snags. The blackened trunks of burned forest are now reaching a point of decay where, even on a calm day, an errant wind gust can land a tree quickly on the ground.

With a half-million ponderosa pine seedlings waiting at the greenhouse to be planted this fall, I hope the season facing us is much calmer than our first five-day training program. ■

Mary Stuever is a consulting forester specializing in forest ecosystems of the American Southwest. She can be reached at sse@nmia.com. Mary is also the author of The Forester's Log: Musings from the Woods, published by UNM Press.

ABSTRACTS CONTINUED FROM PAGE 6

dispersal probability. Juvenile foxes with fewer row crops in their home ranges, individuals with high intrafamilial overlap of summer range, females, and urban foxes were associated with philopatry. Dispersals began mid-September and ended in March. Rural juveniles dispersed 23 days earlier than did urban conspecifics. Heavier foxes (capture weight) and those with heavily row-cropped home ranges dispersed earlier. Littermates dispersed at similar times, although in different directions. Dispersal distances averaged 44.8 km for all foxes (range = 1–478 km). Male and urban foxes dispersed farther than female and rural foxes, respectively. Time between dispersal and settlement averaged 41.2 days (range = 2–114 days), with urban foxes dispersing over longer time periods. Dispersal direction between the sexes had different directional distributions, though mean vectors for both were oriented north. Dispersing foxes selected cropland in proportion to availability, whereas grassland was selected preferentially. We demonstrate influences of habitat, resource availability, familial social interactions, and interspecific interactions on dispersal and philopatry of juvenile red foxes in an intensively row-cropped region of the Midwest. Our findings demonstrate red fox dispersal ecology differences in urban and rural environments. In Intensively row-cropped regions of the Midwest, where landscape crop harvest alters dispersal timing, minimizing seasonal habitat changes with permanent vegetative structure (e.g., crop food plots, native grass fields) would likely delay dispersal activity and increase survival.

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Polecat *(Mustela putorius)*

Effects of Mycoplasmal Upper Respiratory Tract Disease on Morbidity and Mortality of Gopher Tortoises in Northern and Central Florida

J. E. Diemer Berish, L. D. Wendland, R. A. Kiltie, E. P. Garrison, and C. A. Gates

Journal of Wildlife Diseases 46(3): 695–705, 2010.

Gopher tortoise (*Gopherus polyphemus*) populations on four tracts of public lands in northern and central Florida were studied from 1998 to 2001 to assess the effects of mycoplasmal upper respiratory tract disease (URTD). Adult gopher tortoises (n = 205) were marked for identification, serum and nasal flush samples were obtained for mycoplasmal diagnostic assays, and clinical signs of URTD (nasal discharge, ocular discharge, palpebral edema, and conjunctivitis) were evaluated. A subset of tortoises (n = 68) was radio-instrumented to facilitate repeated sampling and to document potential mortality. Presence of serum antibody to *Mycoplasma agassizii* was determined by enzyme-linked immunosorbent assay (ELISA), and Mollicutes species were detected in nasal flushes by polymerase chain reaction (PCR). Antibody prevalence varied among sites and years but was highest in 1998, exceeding 70% at two sites. Only 11 tortoises (5%) were positive by PCR, and three species (*M. agassizii, M. testudineum*, and a nonpathogenic *Acholeplasma*) were identified in nasal flush specimens. Nasal discharge, though rare (6% of tortoises), was significantly correlated with higher ELISA ratios, study site, and positive PCR status. Mortality events (n = 11) occurred on two of the three *M. agassizii*-positive sites; no mortality was observed on the *M. agassizii*-negative control site. However, none of the tested variables (ELISA result, study site, year, sex, presence of clinical signs, or carapace length) showed significant ability to predict the odds of death. Mycoplasmal URTD is believed to be a chronic disease with high morbidity but low mortality, and follow-up studies are needed to detect long-term effects. ■

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TAIL END



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"Yup—ya gotta do those stretches before you sprint!"

Winning caption by Teresa Smelser,
For The Birds Rehab, Montrose, Michigan.

Thanks, Teresa!

We've posted the next issue's Tail Ends photo on the web at:
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Male house finch *(Carpodacus mexicanus).*
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