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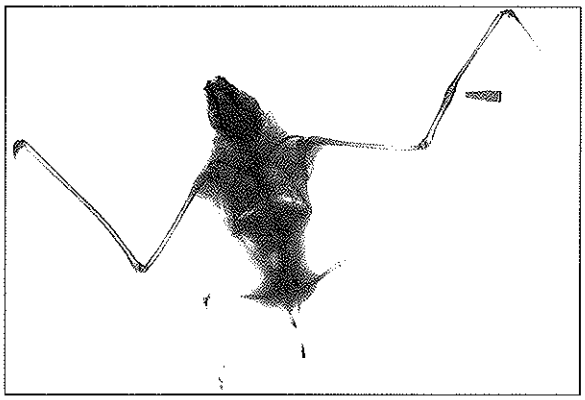
IN THIS ISSUE

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 quarterly publication, rehabilitation courses offered in numerous locations, and an annual conference, IWRC works to disseminate information and improve the quality of care provided to wildlife.

ON THE COVER: An rock pigeon (*Columbia livia)* may appear healthy; however, its presence on the ground may signal poor health. [photo: Lee Karney/USFWS]

BELOW: A healed radius in a flying big brown bat (*Eptesicus fuscus*). [see page 4]



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WILDLIFE MEDICINE AND REHABILITATION

DEPARTMENTS

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EDITORIAL

Moving Ahead: The IWRC Training and Certification Programs

At the IWRC Chicago Conference in October 2003, we introduced two new programs to our members and friends. We presented ideas that we had been exploring, and even presented an introductory "Charter Certification." We explained that we intended to invite input from our members, and that the program would remain undefined until such time as we received that input. To that end, we put several surveys (including one that gave instant feedback) on our website.

We are pleased to report that the interest and the response were excellent. Our online survey elicited hundreds of responses, and most were very positive and supportive. For example, 70% of respondents indicated that online training could meet their training needs; 25% indicated that it could partially meet their needs; 62% indicated they would prefer a mix of online and classroom training; 28% preferred online training; and 10% preferred classroom training. It would seem that online training is a very viable option for busy, cash-strapped rehabilitators.

We find it heartening to learn that there is so much interest in training—after all, training is IWRC's primary focus in the pursuit of its mission. It is only through adequate training, networking, and continuing education that we can advance the profession of wildlife rehabilitation, as rehabilitators all over the world are finding.

A few other interesting responses to our questions concerned multi-level certifications for wildlife professionals. To the question "*Do you think that a voluntary multi-level certification program for wildlife rehabilitation is a good idea?*", 80% responded in the affirmative and 18% responded with "Maybe." Only 2% of respondents didn't think certification was a good idea. To the question of whether a multi-level certification was preferred to a single-level, 81% preferred multi-level. These responses tell us clearly that wildlife professionals support training, and support proof of competence in the form of a multi-level certification plan.

In January 2004 we formed a new committee to deal with the issues of training and certification. The Training and Development Committee (TDC) is responsible for the overall direction of IWRC training, and for the development of new ideas and initiatives in the area of training and continuing education. We decided very early on that we weren't going to go far without input from our constituents—the wildlife rehabilitators, veterinarians, hotline operators, public relations experts, and facility managers who demand and require up-to-date information on every aspect of wildlife rehabilitation. To that end, we encouraged discussion at our membership session in Chicago, and directed our members and friends to our website, where further discussion and suggestions were encouraged.

Additionally, a subcommittee of the TDC was formed to explore certification options and develop program recommendations for IWRC. While we knew that it was important to have many voices involved in the discussion, we also know the speed and effectiveness of any committee is inversely related to its size. The solution? Keep the subcommittee small—four or five individuals active in wildlife rehabilitation but with little vested interest in certification because their primary professional focus is in another, albeit related, area (e.g., veterinary medicine, wildlife management). Subcommittee members have been guaranteed anonymity until the recommendations document has been submitted to the TDC; this decision was made to shield participants from being lobbied or pressured by anyone with a personal stake in the decision-making process.

At the same time, a large advisory panel was created to assist the subcommittee; the panel consists of 30–40 rehabilitators widely respected by the larger community. During discussion of

a particular aspect of certification, the subcommittee has developed a number of questions to be passed along to the advisory panel for comment. Advisory panel members have been guaranteed complete confidentiality so they can feel free to express their opinions honestly, frankly, and without fear, even if their perspectives are unpopular or simply not in step with the majority viewpoint. Every panel member has an equal voice in the process.

The subcommittee members have been thorough and productive. Their primary objective has been to help IWRC create a certification program that is ***voluntary, fair, equitable, relevant,*** and ***attainable.*** Certification should be a goal that any member of the rehabilitation community can expect to achieve with a reasonable amount of effort and, in doing so, receive community-wide recognition for excellence in the field.

There are still several details to iron out, but the subcommittee expects to deliver its recommendations document to the TDC by early June. There, committee members will discuss the proposed program, ask questions of the subcommittee, add their own comments, and then send the document on to the IWRC board of directors for consideration and implementation.

There are two ways to keep in touch with IWRC training and certification initiatives: visit the "Training and Certification" area of our website (www.iwrc-online.org) often, and join us at Portland for the rollout of our Training Plan and our Certification Plan—honed by the organization from the wishes of our members.

–Kieran Lindsey
Chair, Certification Subcommittee

–Joe MacLeod
President, IWRC

LETTERS

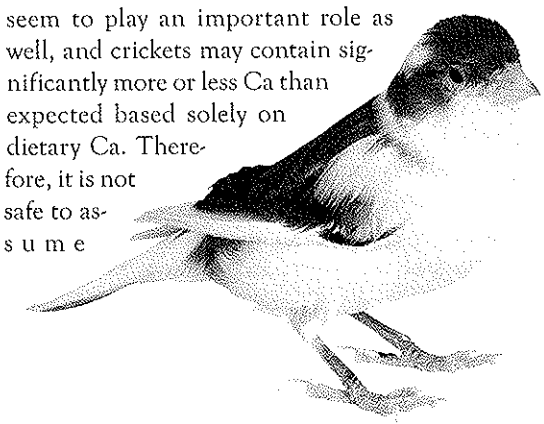
Food for Insects, Insects as Food (Revisited)

Q If I purchased a commercial cricket food instead of making my own according to one of the recipes in your article [Winn, D., S. Dunham, and S. Mikulski. 2003. Food for insects and insects as food: Viable strategies for achieving adequate calcium. *J. Wildl. Rehab.* 26(1): 4–13], how much calcium could I expect in the crickets that ate it?

A Some commercial cricket diets have been used in published research on insect mineral levels. For example, in a recent study by Mark Finke, Timberline Cricket Power Food® was the base for several diets that varied in calcium. Crickets fed this product with no added Ca (1.0% dietary Ca) contained 0.21% Ca (dry weight) with a Ca:P = 0.22:1.

It is more difficult to answer the question without analyzing insects that had actually consumed a particular product, but we could attempt to predict the result from analyses of crickets fed other diets with a comparable amount of Ca. For example, the Cricket Chow® sold by Fluker Farms contains about 1% dietary Ca. In a study by Mary Allen and others, crickets fed a diet with about 1% Ca achieved a Ca of 0.23% (dry weight), with Ca:P = 0.28:1—results not unlike those reported by Finke for crickets that ate another diet with a similar Ca content.

However, given the variety of available commercial diets, dietary Ca is not likely to always be an accurate predictor of the Ca in the cricket. As noted in our paper and by other investigators such as Susan Anderson, diet texture and particle size seem to play an important role as well, and crickets may contain significantly more or less Ca than expected based solely on dietary Ca. Therefore, it is not safe to assume that any cricket diet having about 1% Ca will produce results similar to those reported above. In our study, for example, three diets all having roughly 1% Ca produced crickets whose Ca content ranged from 0.22% to 0.56% (dry weight), with Ca:P ranging from 0.26:1 to 0.62:1.



–Diane Winn, Ph.D.

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The Editors encourage readers to respond to the articles, columns, and other items featured in the *Journal of Wildlife Rehabilitation.* Please direct general questions and comments to the Editor at runmuki@earthlink.net (USPS address on the journal's inside back cover). To respond to a specific article or column, please contact the author directly. (NOTE: Letters may be edited for clarity and length.)

A Healed Fractured Radius in a Flying Big Brown Bat (*Eptesicus fuscus*)

by Hannah M. ter Hofstede, Jacqueline Miller, John M. Ratcliffe, and M. Brock Fenton

ABSTRACT: An adult male big brown bat (*Eptesicus fuscus*) was captured in Toronto, Canada, with a healed fractured left radius. A radiographic analysis was obtained to assess and qualify the injury. Radiographs revealed a likely spiral or oblique fracture in an advanced stage of remodeling. There was no evidence of pinning or other repair artifact. Considering that the bat was estimated an adult when the injury occurred, and bone remodeling does not occur during hibernation, the authors suggest that the bat had been treated by a local wildlife rehabilitation center for this injury.

KEYWORDS: *Eptesicus fuscus*, radial fracture, rehabilitation, Chiroptera

HANNAH TER HOFSTEDE, JACQUELINE MILLER, and **JOHN RATCLIFFE** are graduate students in the Department of Zoology at the University of Toronto. Each has worked with bats in both temperate and tropical locales. **DR. BROCK FENTON** is professor and chair of the Department of Biology at the University of Western Ontario. He has studied bat behavior for more than 30 years and on five continents.

J. Wildlife Rehab. 26(4): 4–7

Introduction

Efficient locomotion is key to an animal's survival. It is generally considered impossible for a bat to survive broken arm bones (humerus or radius) because transverse and shear stresses acting on these bones result in high torsional load during flight (Swartz et al. 1992), which would prevent healing, flight, and foraging. This paper describes finding a volant big brown bat (*Eptesicus fuscus*) with a healed broken radius.

In September 2000 the authors participated in the humane removal of a colony of *Eptesicus fuscus* from a private residence in Toronto, Canada (at the request of the owner). Bats were captured upon exiting the attic with a harp trap, held for 2 days while the house was sealed by the owner (during which time they were fed mealworms and watered), and released 15 km away close to known hibernacula. During this process, one adult male's flight appeared to be irregular. Upon closer inspection, it was observed that the bat's left radius had been broken and that the broken wing appeared shorter than the other due to this injury, but that the bat was otherwise healthy (weight at capture 20.1 g; mean weight of colony members 19.3 g). The bat was brought to York University, Toronto, for observation. The bat could fly for extended periods of time and avoid obstacles in much the same way as its uninjured conspecific roostmates. On the downstroke, however, the left wing extended farther than the right wing. The bat was kept in a flight room over the winter. Unfortunately, during transportation from one location to another, the vehicle broke down and despite efforts to protect the bat from the cold temperature, it subsequently died. To determine the possible age and nature of the injury, a postmortem radiographic assessment was obtained at the Royal Ontario Museum, Centre for Biodiversity and Conservation Biology (CBCB), Toronto.

Methods

Radiographs of the bat with wing extended were taken in dorsoventral and lateral-oblique views, using a GE Faxitron imaging unit and Kodak Industrex IR film. Multiple films were obtained at low mA kV levels and between 32–35 kV to avoid overexposing the specimen, given its small bone size and hence reduced bone density. The authors obtained positive contact prints and enlargements of the radiographs to facilitate qualification of the bony remodeling evident around the fracture (Figure 1). Some magnification distortion is inevitable in radiographic studies, particularly with imaging units such as the Faxitron, which has a maximum source-to-film distance of about 50 cm. The authors' interests, however, were in qualitative features rather than quantitative measurements. Consequently, recommendations in the literature to minimize radiographic distortion were followed wherever possible (Ballinger 1995, Hildebolte et al. 1994, Sewerin 1990, Stevens 1989, Sweeney 1983).

Both the original films and contact prints were inspected to describe the nature and degree of osseous repair and remodeling, as well as for signs of fixation by materials used in the repair of long bone fractures (see, for instance, Dallman et al. 1990, DeYoung and Probst 1985). Candidate materials that can be employed in animals of very small size include surgical steel wiring, which can be easily recognized in plain film radiography.

Results

Radiographs reveal a mid-shaft radial fracture in advanced stages of healing and remodeling. Viewed more obliquely, the fracture shows a larger area of bony

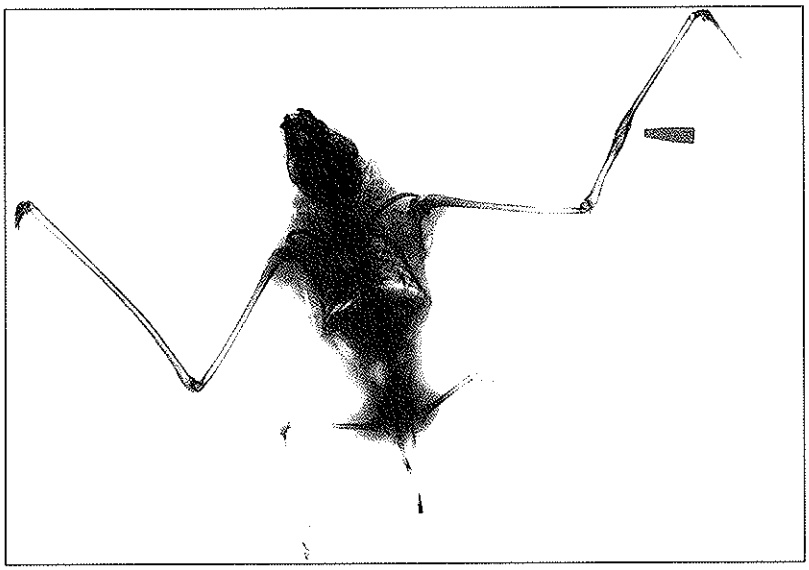
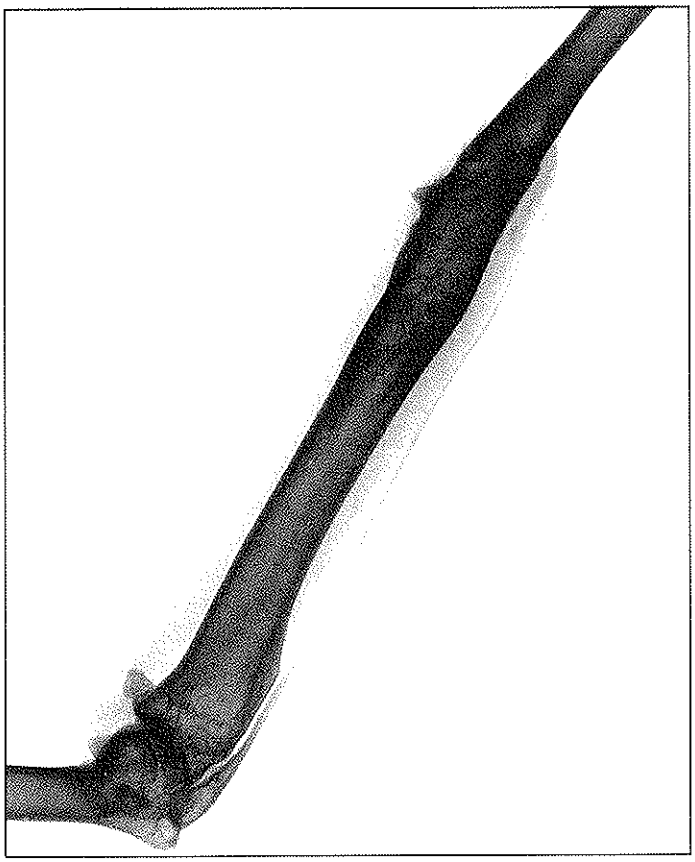
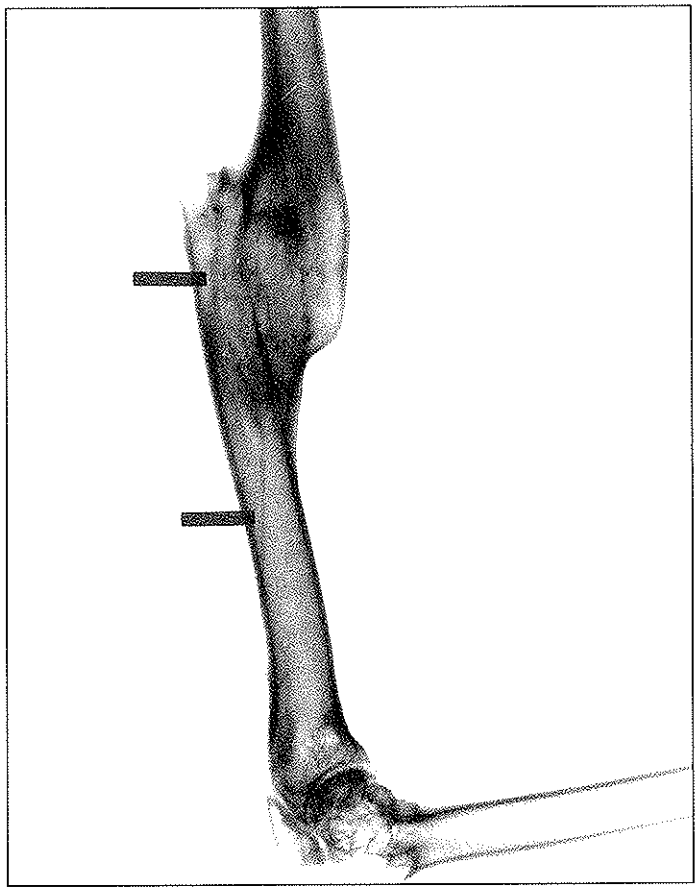


Figure 1 (left): A positive contact print of the bat radiographed in the dorsoventral view with the affected wing extended, showing the slight shortening and rotation of the fractured radius compared to the uninjured wing (scale factor x 0.7).

Figure 2 (below left): An enlarged positive contact print of the fracture (dorsoventral view) demonstrating the continuity of cortical bone, cortical/medullary differentiation, and the appearance of progressive remodeling (scale factor x 7.25).

Figure 3 (below right): An enlarged positive contact print of the fracture radiographed in the lateral-oblique (complementary) view, in which significant mal-alignment is most evident. Stress lines indicating bony reinforcement are marked (scale factor x 7).





deposition than when viewed dorsoventrally, suggesting healing while offset (Figures 2 and 3). The proximal end of the original fracture zone appears to override the distal end, and this thickened region of overlap is consolidated with woven bone. The shaft is completely bridged in the region of the fracture with no mal-union, such as false joint formation. In dorsoventral view, the shaft is fully remodeled with differentiation evident between cortical periosteum and medullary bone. The remodeled shaft appears only slightly wider here than elsewhere along the length of the radius. Given its location and the nature of wing architecture, the fracture was likely spiral or oblique. Viewed dorsoventrally, the bone appears more uniform and shaft-like in contour and some shortening is evident. While the healed fracture site appears slightly less dense than either end of the humerus, the difference is not pronounced. Longitudinal ridges bridge the zone of fracture and give the impression of exaggerated lines for muscular attachment. There is no evidence of prior fixation by pinning for stabilizing the bone.

Discussion

The forearm in bats consists of the cubitus (the fused radius and ulna) of which the radius is the largest component, compared to the ulna in typical terrestrial mammals (Adams 1992). The radius and humerus have the highest mineral content of the wing bones, giving them strength and stiffness to withstand considerable shearing stress (Papadimitriou et al. 1996). The radius in bats is generally long and gently bowed anteriorly. Its topographic features include the proximal flexor fossa on the medial surface, which receives the tendons of the biceps brachii and the insertion of the brachialis muscle. The supinator muscle inserts along the proximal midshaft. Distally there are the attachments of the abductor pollicus longus and extensor indicus posteriorly, and the extensor carpi ulnaris posterolaterally (Vaughan 1970a, 1970b). Maintenance of proper insertion would have been necessary for wing function. The fact that the bat could fly when it was caught suggests that such insertions had been maintained. The exaggerations of lines in the area of the healed fracture suggest that some compensation had occurred before the bat regained flight.

The fracture appears to have been in advanced stages of bony remodeling, as defined by conventional assignment of stages of fracture repair (see for instance Adams 1983, Stevens and Lowe 2000). While a fracture begins to heal as soon as the break occurs, in early stages there would be evidence of a large proliferation forming a callus that would be radiographically less opaque. The fact that the remodeled shaft appears to be only slightly wider at the original site of the fracture than elsewhere along the length of the radius, coupled with the appearance of stress ridges suggest that bony remodeling occurred under some functional strain. It is likely that the original fracture was partly stabilized by impaction of the adjacent ends, which would account for the slight shortening of the forelimb noted. There is, however, an absence of massive deposition at the site, although such deposition is common in fractures of long bones that repair independently while under functional strain or weight-bearing stress (see, for instance, accounts in Hoar 1945).

An adult bat with a broken radius would likely not survive due to the limitations on flight and foraging. How this bat could have survived its injury is puzzling. Combined, the authors have captured thousands of bats and never observed this injury before, although broken phalanges have occasionally been observed. Likewise, Mark Engstrom of the Royal Ontario Museum has captured tens of thousands of bats and has also never observed a healed fractured radius (pers. comm.). Three possible explanations were considered: the bat was a juvenile when the fracture occurred and was cared for by its mother during healing; the bat fractured its radius in the autumn and the bone healed during hibernation; or the bat was treated by a wildlife rehabilitation center.

The bat was believed to be an adult at the time of injury because there is no overall evidence of limb stunting, less the effect of bony compaction implied by the original injury. One would expect foreshortening that represents developmental delay in a limb as severely damaged as by a complete long bone fracture. Secondly, long bone fractures are physiologically demanding in terms of the resources necessary for repair. An example of such a stress would be the appearance of Harris lines, a feature common in long bones if there is a period of physiological/energy challenge during the period of skeletal development (Steele and Bramblett 1988). No such indicators are present. Also, the above-mentioned developmental perturbations would also delay the rate of epiphyseal fusion if the injury occurred prior to this event.

It is unlikely that the bat broke its arm immediately before hibernation, healing gradually over the winter, because bone remodeling does not occur during hibernation (Kwiecinski et al. 1987). A wildlife rehabilitation center might have cared for the bat during its convalescence. Bats with broken limb bones have been successfully rehabilitated using external skeletal fixtures (Wellehan et al. 2001) and splints (Northway 1975). The healing process can take up to 100 days (Wellehan et al. 2001), making the possibility that the bone healed on its own negligible. Since *E. fuscus* usually do not move long distances from year to year (Beer 1955), it was likely a local rehabilitation center. Toronto had three wildlife rehabilitation centers at the time the bat was captured: Wildcare, the Toronto Humane Society, and the Toronto Wildlife Centre. The Toronto Wildlife Centre stated they rehabilitate bats and generally use external splints for injuries of this nature. However, none of these institutions has easily accessible records for animals treated and released prior to 2001.

Once the bone healed, the bat would have had to learn how to fly with differently shaped wings before becoming a successful forager. The injured radius measures only 89% the length of the intact radius, based on measurements from a contact print (Figure 1). Fluctuating asymmetry is very low in bat forearms (Gummer and Brigham 1995), and weights of left and right bones are very similar in individuals (Dawson 1975), suggesting that symmetry may be important for efficient flight in bats. Perhaps the extended downstroke of the left wing was necessary to provide the equivalent lift as the right wing, since the shortening of the arm reduced the surface area of the left wing. This chance encounter not only provides evidence that bats can be rehabilitated after breaking major bones in the wing, but also that they can function after release into the wild.

Acknowledgements

We thank the Toronto Wildlife Centre for their assistance.

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Recommended Reading

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Stayin' Alive, Stayin' Alive: Feeding Ill and Emaciated Birds

by Janine Perlman and Astrid MacLeod

ABSTRACT: Birds presented in a state of severe emaciation represent some of the most difficult cases for rehabilitators. A bird that hasn't eaten for days is inevitably dehydrated, and rehydration must precede refeeding. A badly starved bird has been consuming its own body, including its gastrointestinal tract (GIT). A compromised GIT is incapable of digesting ordinary whole food; feeding such a diet generally results in a prolonged death for the animal. We present a treatment and refeeding regimen that provides the bird with sufficient nutrition to survive while permitting the GIT to heal and regenerate. Using this regimen, some birds with previously poor prognoses can recover. The authors present a case study of a rock pigeon admitted at half normal body weight.

KEY WORDS: starvation, emaciation, dehydration, rehydration, avian, columbid, gastrointestinal tract, tube feeding, refeeding, nutrition, elemental diet, digestive enzymes, rock pigeon, bird, trichomoniasis, pigeon

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JANINE PERLMAN, PH.D., conducted laboratory research in biochemistry and molecular genetics for 20 years. She is now a comparative nutritionist and wildlife nutrition consultant. She serves on the nutrition advisory group of the American Zoo and Aquarium Association, and on the board of directors of Advanced Primate Ethical Studies. She rehabilitates birds and small mammals.

J. Wildlife Rehab. 26(4): 8–20

Introduction

There are few cases that cause avian rehabilitators' hearts to sink faster than a badly emaciated patient. The bird's feather-light weight and deep, razor-thin keel mean that the rehabber is in for long days, short nights, and often, in the end, dashed hopes.

No one can save all such cases, but using regimens based on current biomedical information, it is possible to save some birds that previously would have died. Shimmel and White (1994) described treating emaciation in raptors. Kaplan (2003) has posted a protocol for reptiles. Here we describe a protocol that can be used for birds of most feeding categories (or trophic groups).

Birds are often presented by the public as "found on the ground," unable to fly. In many cases, they have been grounded for some time and have been unable to consume food or water. In advanced cases of emaciation, even without any other primary or secondary problem, there is too little pectoral muscle and available energy to support flying.

Treating severe emaciation requires an understanding of basic physiology. This article begins with brief reviews of nutritional biochemistry, and of the structure and function of the normal avian gastrointestinal tract. The authors describe the "shutting down" of the gastrointestinal tract (GIT) when the bird has been catabolizing its own body in order to survive. In the context of "reviving" the GIT as well as the rest of the bird, dehydration, and the importance of rehydration prior to refeeding, are discussed.

Methods

This paper is the result of literature searches and syntheses thereof, and is partly composed of summaries of texts and peer-reviewed articles. Based on information from medical and scientific literature, we have formulated a protocol for treating emaciated birds, which we present with its rationale. The authors and other rehabilitators have used the protocol successfully (pers. comms.) on birds that, from their and the authors' experience, had low probabilities of survival. A case study is also provided.

Calculations of digestive enzyme activities were performed using standard biochemical methods and product information from manufacturers.

Background

Energy and Nutrients

With a few exceptions, bioenergy ultimately comes from the sun. Plants capture solar energy and use it to chemically transform carbon dioxide, water, and minerals into carbohydrates, fats, and proteins. These familiar nutrients are macromolecules, large molecules comprised of subunits. As described below, carbohydrates are made of sugar subunits; fats are made of fatty acids; and proteins are chains of amino acid subunits.

Energy is stored by plants and animals when they make macromolecules. Energy is released when macromolecules are broken down (digested). Whether a bird eats energy stored by plants (such as seeds) or by animals (such as the muscle and fat of an insect), the process is the same. Digestion of the food releases energy that the bird uses for all its needs, including locomotion, performing the biochemical functions that permit life, and keeping warm.

Foods of both plant and animal origin are composed of the same kinds of major nutrients:

Carbohydrates include sugars, starches, chitin, glycogen, and cellulose. Starches (found mainly in storage structures of plants such as seeds and tubers), glycogen

("animal starch" in liver and muscle), chitin (the exoskeleton of arthropods and fungi), and cellulose (the "fiber" of plants, by far the most plentiful carbohydrate), are all macromolecules made of sugar subunits. (NB: Animals cannot break down cellulose, which is digested by enzymes found only in gut microbes.)

Fats *(in animals) and oils (in plants)* are the major form of energy storage for the respective organisms that make them. They are comprised of three fatty acids hooked to a backbone. Fatty acids are energy-rich chains made of smaller subunits.

Proteins are chains of *amino acids*. They, of course, comprise the major structural portions (muscle, organs) of prey.

All these foods have energy stored in them. When eaten by an animal such as a bird, they are either broken down to fill energetic requirements or, if "essential" (chemicals that are needed by the bird but that cannot by synthesized by it in sufficient amounts), they are used as building blocks for bodily structures, and for biochemicals required for metabolism.

The Normal Adult Avian GIT (summarized from Klasing 1998)

The entire length of the gastrointestinal tract is composed of several layers. The lining of the tract is a mucosal epithelial layer that protects the gut from mechanical harm and autodigestion. The cells of that layer have a high turnover rate. There are two muscle layers—the inner circular and outer longitudinal—that cause food to be mixed and moved.

Between species, the comparative anatomy of the entire GIT is dependent both on the trophic group to which the bird belongs, and also to its current diet (e.g., Starck 1999).

Foregut

Saliva lubricates food; the esophagus passes it through to its next destination, either crop or stomach. The esophagus is extensible, and unlike mammals, birds don't experience discomfort when food is lodged there. The esophagus may have a "pouch," or crop.

Both crops and stomachs are highly variable in their anatomy, depending on birds' natural diets.

The crop stores food for a very wide range of time; food can even be shunted past it if the stomach is empty. Although it functions mainly to store food until the stomach has room for it, glucose can be absorbed in the crop. In the crops of some birds are bacteria, notably lactobacillus, which can begin to ferment food and may provide vitamins.

The stomach is composed of the proventriculus (glandular stomach) and ventriculus (gizzard); both are highly variable depending on the bird's trophic category. The glandular stomach secretes HCl (hydrochloric, or stomach, acid), which denatures proteins and makes them accessible to proteases; and pepsin, an enzyme that breaks down protein. Both of these secretions coat the food.

The food is passed rather quickly to the gizzard, where it is masticated. Gizzards can be very muscular. The interior has a sandpapery layer, the cuticle. Many birds also eat various amounts of grit to aid in the physical breaking down of food. In some birds, the gizzard can change size depending on diet. (E.g., a chickadee may have a smaller gizzard with a thinner cuticle in summer when it is eating mainly insects. When winter seed consumption commences, the gizzard's mass, cuticle, and muscle increase.)

Unlike in mammals, avian GITs can move food in two directions, both posteriorly (from the mouth back), and anteriorly toward the mouth. There is often reflux from the gizzard to the proventriculus, as more acid and pepsin are added to food to aid its digestion.

Midgut

After the digesting food, or chyme, is mechanically and chemically reduced to small particle size in the gizzard, it is passed into the duodenum. It is there that bile salts from the liver, and bicarbonate and digestive enzymes from the pancreas, are added to the mix. Bile salts bind to lipids, making them accessible to digestive enzymes. Bicarbonate neutralizes stomach acid, allowing pancreatic enzymes to work.

Proteins are enzymatically broken into peptides and single amino acids. Fats are broken into diglycerides and fatty acids. Starches are broken into disaccharides. This all happens in the lumen of the small intestine. If there are portions resistant to digestion, they may be refluxed back into the gizzard for further breakdown, then passed back into the duodenum.

The interior wall of the small intestine is highly convoluted in villi (tiny fingerlike projections), so it has a great deal of surface area. The luminal cells of the villi make digestive enzymes at their surface. These enzymes break down any fragments of macromolecules that have not already been digested into single subunits; generally, it is only as single subunits that nutrients can be absorbed taken up for use in the body.

It is also through the great surface area of the villi that absorption occurs. For example, peptides are broken into single amino acids, which are then absorbed. Disaccharides are broken into monosaccharides and absorbed.

The nutrients pass into blood vessels leading to the liver. There they undergo processing, storage, or continued flow into the general circulation.

Hindgut

Ceca (singular = cecum) are paired organs at the distal end of the small intestine. They also vary greatly, according to the species' natural diet. Ceca may be vestigial or absent, as they are in the majority of species, or present in a range of sizes and with a variety of functions. The largest and most highly developed ceca act as hindgut fermenting chambers, in which otherwise indigestible foods, notably plant fibers, are broken down by gut flora, into volatile fatty acids usable as an energy

ENZYME TERMINOLOGY

Enzymes are commonly named for the kinds of molecules they disassemble. So, enzymes that break down proteins are *proteases*; lipids (fats) are broken down by *lipases*; and carbohydrates by *carbohydrases*. Nomenclature is more specific, as well, so lactose is digested by *lactase*, sucrose by *sucrase*, and so on. In each case, macromolecules (large molecules made of multiple subunits) are broken down into fragments comprised of single or a few subunits.

source by the bird. (The rectum can be another important site for hindgut fermentation.) In a few birds, nearly half of the bird's energy intake is generated in this way. In birds in which there is significant cecal fermentation, cecal droppings, or cecotropes, are produced, in much lower quantity than rectal droppings. Like rabbits, some birds (galliforms such as grouse, turkey, and chickens) eat their cecotropes, which assures reliable gut inoculation and may provide a source of vitamins manufactured by the bacteria.

Bacteria are present and necessary along most of the GIT. Their roles are not completely defined (Vispo and Karasov 1997), but several aspects of their function are known. One important function of these gut flora is "competitive exclusion," wherein they occupy space on the gut lining that could otherwise be taken by pathogens. They also contribute enzymes that digest nutrients, such as some sugars, that are not digestible by the bird's own complement of enzymes. Finally, they may manufacture vitamins (such as K) that are insufficient in the diet, which birds may either obtain from the bacteria in situ in the upper GIT, or by coprophagy (eating of feces).

After all possible nutrients are taken up from the small intestine or into the ceca, the remaining indigestible matter passes through the large intestine or colorectum, which is short compared to that of mammals. In many species, the ceca and colorectum (as opposed to the kidneys) are primary sites of water and salt uptake and regulation (Skadhauge 1989). As noted, in some species, fermentation takes place here. The remaining unabsorbed matter (feces) is moved to the cloaca. Urates and urine are also deposited in the cloaca. There may be selective deposition of the three, and they may, in a controlled way, be taken into the ceca for further digestion and/or to provide nitrogen for cecal flora.

Functional Variability Depends on Diet

Functional parameters also change with diet. The retention time of foods in the GIT varies greatly, both between trophic groups and among different foods consumed. The retention of a single meal may be spread out, both spatially along the GIT, and temporally, as various portions are retained and digested in various parts of the GIT. Easily digested, or completely indigestible, fractions may pass quickly; fractions that require more time for more complete use are retained for longer. For example, small frugivores (fruit eaters) may pass fruit seeds in fewer than 10 minutes, retaining more digestible parts of the fruit for closer to an hour. In contrast, ratites may retain fruit seeds for weeks, as every bit of nutrition is wrung from them. Typical mean retention times (the amount of time it takes 50% of the food to be voided) for various trophic categories range from less than an hour for frugivores and nectarivores (nectar feeders), to a couple of hours for insectivores and omnivores, to a few hours for carnivores, to several hours for some herbivores (plant eaters).

In addition to possessing gut structures that are particularly suited to the foods they eat in nature, *birds of specific trophic categories make digestive enzymes appropriate to their natural diet.* For example, faunivores (e.g., birds of prey, fish eaters, insectivores) secrete high levels of proteases, modest levels of lipases, and low levels of carbohydrases. These enzyme levels match very accurately the composition of the whole animal prey they eat. They do not digest large amounts of starch well, and if fed sugars, they are unable to regulate their blood glucose levels (Myers and Klasing 1999). They have evolved to make blood glucose from amino acids, in a process called gluconeogenesis. Thus, a number of aspects of avian metabolism are adapted to their natural foods.

Omnivores and opportunistic feeders have somewhat more generalized digestive and metabolic abilities. Their GITs may adapt to changes in diet or seasonal food availability (Karasov 1996). However, those changes may take days or even weeks. An emaciated warbler presented in July would have quite different dietary needs from one presented in October.

Ill and Emaciated Birds

Emaciation

Emaciation is the loss of fat and, in later stages, lean body mass, due to starvation. In mammals, starvation is conventionally divided into three stages (Robbins 1996). In birds, the stages are not easily separated and may occur rapidly and with considerable overlap. In the first, short, stage, after all food has exited the GIT, the bird relies on glycogen from liver and muscle to fuel its energy needs. Glycogen is rapidly depleted.

In the next, longer, stage, fat is mobilized and ketone bodies (modified subunits of fatty acids), rather than glucose, are oxidized for energy. The droppings of badly emaciated birds may have a characteristic sour/acidic odor (unpublished observation, author J. P.), possibly due to the presence of these ketones. In the last, rapid, stage of starvation, fat is exhausted and protein of muscle and other tissues, including internal organs, is broken down. Body weight diminishes rapidly. If emaciation has progressed significantly into this stage, the animal is difficult or impossible to save, because it does not possess enough organ structure or function to carry out the biochemical reactions needed to rebuild the body. Birds, particularly small ones with little fat deposition to begin with, may experience the three stages in a continuum that takes place in a few days, or even hours.

A rough estimation of degree of emaciation can come from palpating the keel (or breast) bone (or sternum). Passerines in good body condition should have a keel edge that is detectable but not prominent; depending on the species and circumstance of the bird, it might project less than 1 mm outward from the flight muscle that flanks it on both sides.

The amount of muscle and fat in the breast are reasonably good guides to body condition, and can sometimes be better indicators than is body weight. However, apparent body condition by palpation has some disadvantages. One is that birds that have been unflighted for even a relatively short time lose breast muscle as a result, and a long period without use of wings typically results in a 10% loss of body weight (pers. comm. with L. Powers, DVM; authors' unpub. obs.). This disuse atrophy is independent of starvation. Further, species that are not strong or habitual flyers may have normally prominent keel bones.

The other disadvantage is that different species at particular times of year vary in the mass of their breast muscle and fat. Pre-

migratory birds should, in some cases, be comparatively obese (e.g., Sargent 2000), and a "normal" body condition (or weight) may, at those times, indicate a significant problem.

Nevertheless, accurate weight measurements and comparison with standards such as those found in Dunning's (1984) *Body Weights of 686 Species of North American Birds* are indispensable in treating underweight birds.

Emaciation is divided into weight loss categories I–III (Robbins 1996). In Category I, 10% or less of body weight has been lost. In Category II, the bird's weight is decreased from normal by 10–25%. In Category III emaciation, the bird weighs only 50–75% of normal; birds at the low end of this range are very difficult to save. Again, note that, especially in birds, these categories may not correspond with stages of starvation, so that even a Category II bird may have lost significant lean mass.

Because the keel is so prominent in emaciation and these birds often cannot stand or perch, they should be provided with a snugly fitting elongated "donut" type nest, so that pressure lesions and bruising are minimized.

Emaciated birds are also typically ill. The illness (pathogen, toxin/pesticide, etc.) may be the primary problem, which then results in emaciation. Alternatively, the primary problem may have been injury and the illness may be secondary, as opportunistic infections arise from the starved bird's compromised immune system...or there may be both primary and secondary infections.

Ill birds are not, of course, necessarily emaciated. However, their diets often require special consideration, particularly if the bird is not self-feeding, or if the GIT is affected by the illness.

Starvation/Illness and the GIT

In birds, significant weight loss often means that the body has already catabolized lean body mass—i.e, protein. That protein comes from muscle and other tissues, including organs involved in the digestion of food. While animals that eat infrequently in nature can regenerate their GITs without a problem when fed after fasting (Starck and Beese 2003), that is not the case for animals that need to eat frequently. The GIT actually shrinks (e.g., Hume and Biebach 1996), and its ability to digest food may be significantly impaired (summarized in Agarwal et al. 2001). Cell replenishment, ordinarily very active in the gut lining, slows, and the gut wall becomes more permeable (Kudsk 2003; van der Hulst et al. 1998). Because the synthesis of digestive enzymes also requires energy, that, too, decreases greatly. Dehydration, catabolism, and depletion of water-soluble B-complex vitamins all contribute to weakening of the muscles of the GIT.

Illnesses can also wreak havoc on, in particular, the lining of the gut. Parasites, bacteria, and viruses can damage the epithelium. Antibiotics used to treat infections can alter populations of the normal and necessary bacterial flora that reside on the gut lining, and cause diarrhea/flatulence, overgrowth of pathogens, and additional vitamin depletion.

Thus, both illness and emaciation impair the ability of the GIT to mechanically and enzymatically digest food, and to absorb it. In addition, although there is a net release of energy when food is broken down, some energy is actually required for the digestive process itself (Robbins 1996). A badly emaciated bird has no reserves to spare, and the demands of digestion can be fatal.

The starved GIT has thus lost mass and the ability to function normally. It, itself, has to be re-fed and rebuilt before it can process food for the rest of the body. Since the gut of an emaciated bird has little ability to digest food, the first foods must be predigested. During this phase of refeeding, there is little weight gain; the body is rebuilding the organs needed to metabolize normal food. As the GIT regenerates, whole food with more calories can be added to the diet, and recovery of weight and strength can begin.

Mounting an immune response also taxes the body's store of nutrients. Protein (Blackburn 1977) and water-soluble vitamin requirements increase as the immune response is mounted. Antibacterial responses produce free radicals, which require more of a variety of antioxidants (Groff and Gropper 2000).

Further, dehydration nearly always accompanies emaciation, for any number of reasons. Most birds obtain much of their water from their food. Because of its debility, a starving bird has also likely lacked access to standing water. If emaciation is a result of a GI infection, diarrhea may have dehydrated and depleted the bird.

Results and Discussion

Treatment of Ill/Emaciated Birds

Before refeeding can begin, the fundamental requirements of normal body temperature and hydration must be met.

Temperature

A bird's body temperature must be within a small range around normal, or it cannot function and metabolize adequately even to utilize fluids. Normal temperature must also be maintained in order for the bird to fight infections. An emaciated bird has "turned down" its metabolic rate to conserve energy (Robbins 1996), and is likely not as warm as normal.

It should be kept in a very warm environment so that it needn't use any precious energy to maintain its own temperature (ideally, in its thermoneutral zone; Dawson and Whittow 2000). A suitable temperature may be as high as ~32°C (90°F) if the bird is generating little heat (author J. P., unpub. obs.). A thermoneutral temperature can be approximated as a few degrees Fahrenheit below that at which the bird acts to dissipate heat (e.g., by panting or spreading its wings). Be sure that the bird does not become so warm that it exhibits these behaviors or shows any sign of distress.

Water and Salt Balance

A basic requirement for the maintenance of life is that body fluids must remain within a small range of volume, and of relative amounts of electrolytes (mostly salts) and water. A comprehensive description of the physiological control of body fluid amounts and composition is beyond the scope of this article. Nevertheless, a few aspects of fluid and electrolyte regulation are relevant to treating dehydration.

Terminology

Blood and the fluid in and around cells all have the same total concentration of dissolved particles (solutes), or *osmoles*.

The most prevalent osmoles are *electrolytes*, or dissolved salts, and of those, the most prevalent are sodium and chloride, the two elements of table salt.

Rehydration solutions have concentrations of solutes that are compared to that of normal body fluids. Those that are the same as normal fluids are *isotonic*, those with higher solute concentrations are *hypertonic*, and those that have less solutes and are therefore more dilute are *hypotonic*.

Birds differ from mammals in the ways they maintain water and electrolyte levels.

Avian kidneys cannot make urine as concentrated as that of mammals—i.e., avian urine has less salt and more water (Schmidt-Nielsen 1997). Urine from the kidneys is deposited into the cloaca where it undergoes "reverse peristalsis" and is moved upward into the GIT. The colon, in particular, is a major location of secretion/reabsorption of water and salts in the species studied; this is typically where urine is finally processed before excretion. In some species, a salt gland is also crucial in excreting excess salt from the blood (Goldstein and Skadhauge 2000). There may be significant variability in the mechanisms and amount of water and salt retention, both between species and depending on the bird's recent history.

Rehydration Fluids

Rehydration protocols by non-oral routes of fluid administration will not be addressed here; they require veterinary training and/or advice. If the bird's condition permits and indicates it, the oral route is the method of choice for those of us who are not avian medical professionals. Following standard (and essential) medical protocol, the bird must be warm, conscious, and not experiencing seizures, before anything is given orally. Rehydration *must* precede significant refeeding. A dehydrated GIT cannot function; food will sit in the gut and rot, killing the bird.

If dehydration has come about through losses from diarrhea, vomiting, or bleeding, the problem is not simply the loss of body water. Essential electrolytes, too, have been lost, and must be replaced. In such cases, sodium, potassium, chloride, and water are all likely to be dangerously depleted.

In contrast, simple lack of intake results mainly in the loss of water, although some electrolytes are also lost through various avenues of sloughing and excretion. In water loss, the brain gradually adapts to dehydration, and sudden rehydration with large volumes of hypotonic (low-salt) solution can be harmful (DiBartola 2000). Therefore, electrolyte-containing solutions are generally advisable for oral use in dehydration from any cause.

There are a number of rehydration solutions, which contain various amounts of sodium, potassium, chloride, and dextrose. Some of the solutions are commonly administered intravenously or subcutaneously by veterinarians and physicians (all can be given orally, as well), and some are for oral administration only.

Many factors may come into play when choosing a rehydration solution. A few of them can be decisive in whether and how fast birds recover. One factor is the tonicity of the solution, and the contributions to it made by salts vs. by dextrose. Salts retain their effect on the solute load in the body, whereas dextrose only acts as a solute as long as it remains unmetabolized. Once that occurs (rapidly, in most situations) it no longer acts as an

TABLE 1. FLUIDS LIKELY TO BE USEFUL FOR REHYDRATION

Solution	Main Constituents	Comments
Lactated Ringer's (LRS), Physiological (Normal; 0.9%) Saline (NaCl), Normosol-R	Sodium, chloride	Isotonic; good for immediate, short-term use *without food*
2.5% dextrose, 0.45% NaCl	Dextrose, sodium, chloride	Isotonic but quickly becomes hypotonic in the body; may be a good choice for many birds other than faunivores
Unflavored Pedialyte®	Dextrose, sodium, potassium, chloride	Hypotonic; may be a good choice for many birds other than faunivores. Potassium is useful in some cases. For oral use only.
Homemade rehydration solution	Table salt (sodium chloride) or "Light salt" (sodium and potassium chlorides), 0.9 g in 100 ml water. *Do NOT use "salt substitute," which is pure potassium chloride.*	Isotonic. Grape juice (a source of nonsucrose sugars) can be added for sucrose-intolerant birds in need of sugar. *Dilute 1 volume grape juice with 7 volumes rehydration solution.* For oral use only.
Water	———	Use when food is added to treatment. For oral use only.

osmole. Additionally, in some cases, dextrose may specifically aid in rehydration (Farthing 1989; but see caveats below). Table 1 lists some fluids most likely to be useful for oral rehydration.

One implication of the relative inability of birds' kidneys to concentrate urine is that they may be unable to excrete excess salt. This has appeared to be the case for songbirds when food, which contains high levels of electrolytes, is soaked in Lactated Ringer's Solution (LRS); it has been repeatedly noted (author A. M., unpub. obs.; pers. comm. with other rehabilitators) that passerines become more dehydrated when subjected to this practice, because the resultant mix is hypertonic. *Never soak hypertonic food in, or administer such food with, fluids containing electrolytes. As soon as any significant amount of hypertonic food is given, isotonic fluids must be replaced with water.*

Do not use Gatorade® or any other "sports" drink. Such products contain sucrose and other ingredients that may be harmful to many birds.

Faunivorous birds do not tolerate high levels of glucose (Myers and Klasing 1999). Thus, for birds of prey (including insectivores), the use of oral glucose should be limited to cases (hypoglycemia) in which it is clearly indicated. In the absence of hypoglycemia, physiological saline or LRS should be used.

Glucose is, however, indicated for hypoglycemic seizures in any species, and pigeons, at least, have been found to rehydrate more quickly with oral glucose and soluble fiber (psyllium; Metamucil®) (Quesenberry and Hillyer 1998). In addition, starving birds of any species are at risk of hypoglycemia, and solutions containing glucose may be generally appropriate for omnivores, granivores, and of course birds that ordinarily eat significant amounts of fruit, nectar, or sap.

TABLE 2. REHYDRATION SOLUTION (FOR ORAL USE)

- 100 ml rehydration fluid (e.g., Lactated Ringer's Solution, unflavored Pedialyte®; see discussion above regarding choice of fluid)
- B-complex: Add an amount that contains 10 mg niacin. Niacin and pyridoxine are the only B vitamins that can be harmful in excess.
- Ascorbate (Vitamin C): 50 mg
- Vitamins A and D: 1000 IU and 200 IU, respectively. Cod liver oil contains these in a ratio of about 10:1, which is fairly close to the ideal 5:1 ratio.
- Vitamin E: 200 IU
- Probiotics: 5 cc live-culture plain yogurt
- 1 g L-glutamine

Continue all the vitamin supplementations, at the same rate, for all foods until bird is self-feeding.

Lactated Ringer's Solution is essentially physiological saline. It is appropriate for immediate and short-term use. Its isotonic salt will help restore electrolytes and prevent hypotonic brain damage. It is lacking other salts—potassium in particular—so fluids used for longer times (e.g., in conditions with continuing bodily fluid loss) should contain that electrolyte, as well (DiBartola 2000). As with all aspects of veterinary care, consult with an avian veterinarian if you are unsure about the best protocol for any case.

Additions to Rehydration Fluids

Emaciated birds are deficient in all the water-soluble vitamins—i.e., the B-complex and C—which are not stored in the body. Biochemical functions cannot take place without them; thus refeeding will be futile unless the bird is first replete in vitamins. Even birds that can ordinarily make their own vitamin C will be depleted of it when sick, emaciated or otherwise stressed. Therefore, the first fluids orally administered to an emaciated bird must contain water-soluble vitamin supplementation. B-complex and C vitamins are necessary if food is to be metabolized. *Adding water-soluble vitamins to the rehydration solution is not optional; it is mandatory.*

Studies show that the amino acid glutamine is "fuel" for the GIT and the immune system, and is very helpful in regenerating the former and supporting the latter (van der Hulst et al. 1996), so the addition of 1 g L-glutamine per 100 cc of fluid is recommended. Gut flora populations are likely to be depleted or skewed, so we suggest including 5cc of plain live culture yogurt per 100 cc of fluid (Rolfe 2000).

The bird may also be depleted of fat-soluble vitamins. For example, Vitamin A will help maintain epithelial integrity and prevent respiratory, eye, or GIT infections. Cod liver oil (source of A and D) and vitamin E should be added in appropriate amounts. (Bacteria in the yogurt provide vitamin K; however, if there is evidence that the bird has experienced bleeding (internally, in particular), vitamin K should also be included. Add 10 IU (=1/10 of a 100 IU tablet) per 100 cc of fluid.)

The rehydration mix is shown in Table 2.

Rehydration Protocol

An emaciated bird can be assumed to be at least 10% dehydrated. That means that it is deficient in water by 10% of its body weight.

There are also daily, or maintenance, fluid needs. The amount of water that a bird needs daily varies according to its size and physiological state. Growing or small birds need more per body weight than larger adult birds; the range is about 5–30% of body weight needed in fluids daily (Quesenberry and Hillyer 1994). Ten percent (10%) might be a reasonable assumption for many birds, *but the smaller the bird, the greater percent of body weight in fluids is required for maintenance.* Birds whose natural diet supplies large amounts of water, such as frugivores and nectarivores, are also likely to require considerably more fluids.

A standard rehydration regimen for birds calls for giving half of the deficit, along with maintenance fluids, in the first 12–24 hours, and the remainder, along with maintenance amounts, in the next 48 hours (Quesenberry and Hillyer 1994). Three days of

aggressive rehydration is necessary to ensure reperfusion of the kidneys and full recovery (K. Robertson, DVM, pers. comm.). Thus, a minimum of 5% of the bird's weight in fluids *in addition to maintenance needs and any continuing losses, as through diarrhea, vomiting, bleeding, or burns,* should be given in the first day, and 2.5% on each of the following 2 days.

For example, for a 40 g passerine:

Because this is a small bird, we will assume that its daily fluid maintenance needs are 10% of bw.

First 12–24 hours: Maintenance need (=40g x 10%) + ½ deficit (=40g x 0.5 x 10%) = 4 cc + 2 cc = 6 cc total

Each of days 2 and 3: Maintenance need (=40g x 10%) + ¼ deficit (40g x 0.25 x 10%) = 4cc + 1cc = 5 cc total

Remember that these are merely guidelines, and in fact the authors have noted that greater amounts of fluid (or water, in animals able to choose) are often required. Another approach is to give the bird 5% of its body weight in fluids as often as it can empty the stomach and produce droppings (typically every 2–3 hours) for the first 12–24 hours, and then give amounts more similar to the above guidelines. The condition of the animal is the only reliable indicator of amount of fluids needed, and it is generally better to err on the side of giving larger amounts of fluid for longer times.

Medications

When the bird has passed a dropping of any description, it signifies that there is sufficient hydration such that the GIT is not completely in stasis.

Avian droppings consist of three parts: (1) feces, which are colored green to brown and are, in a healthy bird, discrete, well-formed tubular coils; (2) white paste of urates (the main nitrogenous waste product); and (3) urine, which is clear and usually colorless fluid, though it may be tinted by the feces, and will be a harmless yellow-orange in the presence of excess B vitamins.

If there are discrete feces and much clear fluid in addition, the bird is producing urine. During the rehydration process, there should be copious urine.

If the feces are not well-defined and are mixed with the other constituents, the bird has diarrhea. If the bird has diarrhea, remember that it is losing water and electrolytes through that route, and they must be replenished in addition to maintenance fluids and replacement of the pre-existing deficit

Instituting medications may now be considered. The decision about when, how, and on what basis to medicate is a complicated one, and veterinary consultation is appropriate. Ideally, every bird would be examined thoroughly, with oral, crop, fecal, and blood samples analyzed, before any medication is begun. In the world of rehabbing, that is unfortunately often not practical, but whenever and to whatever extent possible, it should be standard practice.

It may be some time until there are sufficient feces to yield a representative sample for examination, and even then many parasites are only intermittently evident. Some rehabilitators therefore choose to take a "shotgun" approach and treat for all likely pathogens in a bird that has no reserves or time to wait. The choice of medications must be case-specific. Obviously, any florid infection (e.g., pneumonia) should be treated. The rationale for treating undiagnosed pathogens is that there is some lag time between the administration of medication and the end to the infection. If the bird is extremely emaciated, and/or if it is relatively small (i.e., normal body weight of under ~200 g), there may be little time to "watchfully wait."

Other rehabilitators take a more conservative approach, which is certainly defensible, especially given the very real issue of antibiotic resistance. However, antihelmintics and some anti-protozoals are not antibacterial antibiotics, and thus might be considered for routine use in emaciated birds since they pose less microbiological risk.

Various species are prone to particular infections; season and age are also factors. Ground-feeding birds, for example, are likely to have been exposed to a number of parasites. Trichomoniasis is one of the most common natural causes of death in mourning doves (Ostrand et al. 1995), and possibly other columbids. It may also be the most common natural cause of emaciation. Some of the treatment choices (carnidazole or ronidazole) for "trich" are single-dose, and relatively safe for both the bird and the larger ecology.

The production of initial droppings also suggests that it is safe to begin a dilute elemental diet, which is the next step in refeeding.

N.B.: Sulfa-type medications such as Albon® (sulfadimethoxine), Corid® (amprolium), or medications containing sulfas and trimethoprim (Bactrim®, Sulfatrim®, Tribrissen®, etc.) must be given only to animals that are well hydrated, because sulfas can precipitate in the kidney. The authors have noted that whether or not the bird is dehydrated, such medications appear to cause dehydration and unusual thirst. As is the case for nearly all patients, birds on these medications *must* be given all the water they want, either free-choice, or offered by dropper hourly.

Making the Transition to Food

All whole foods (i.e, whole animals and plants) in their natural state contain a large amount of water. An animal's natural diet, and "complete" manufactured foods, also contain all the necessary electrolytes. However, concentrated or dehydrated foods (e.g., dry seeds, nuts, dry pet food, Vital HN® powder, animal digests) have had their water removed, either naturally or in processing.

A healthy, self-feeding animal that eats cat kibble will become thirsty and drink the amount of water it requires. An animal that is being tube-fed cannot do so, thus foods must be reconstituted to their natural levels of solids and water, so that water and electrolytes in the food are in required proportion. However, if one adds Lactated Ringers Solution (water, sodium, and chloride) to a dry food (e.g., kitten kibble), the sodium and chloride in the LRS, combined with the sodium and chloride in the dry food, are not compensated by the amount of water contributed by the LRS. The resultant mix is very high in salt (sodium chloride).

A bird fed any rehydration fluid to which any significant amount of *any hypertonic food, wet or dry,* has been added, is at great risk of a water deficit (i.e., further dehydration). As noted above, this has been observed numerous times. *As soon as any significant amount of hypertonic food is added to the tubing mix, use plain water* (or, for some cases/species as discussed above, dilute plain grape juice) *as a carrier; do not use rehydrating fluids.*

Choosing Refeeding Diets

Although starvation per se lowers an animal's metabolic rate (Quesenberry 1992, 1160–62) starving animals often have illnesses or injuries that create hypermetabolic states (reviewed in Orr et al. 2000). In hypermetabolism, many more calories than normal are required, while, of course, the animal is eating little or nothing. Energy is acquired from preferentially catabolizing fatty acids, and then proteins.

Thus, the bird has been breaking down its own protein and fat as exclusive sources of energy. There are at least two relevant consequences: (1) the bird is in immediate need of physically rebuilding the proteinaceous organs and muscles that it catabolized, and (2) the biochemical pathways that use carbohydrates for fuel may not be "up and running." In humans, refeeding solutions high in carbohydrates results in hypophosphatemia (a depletion of phosphate in the blood), which can be fatal (Solomon and Kirby 1990.) To the authors' knowledge, this phenomenon has not been studied in birds, but it is reasonable to assume that it may obtain to some extent.

Thus, refeeding diets should contain significant digestible protein (to reconstitute body structures) and some fatty acids for energy. The optimum amount of carbohydrate appears to depend largely on the species; as expected, those birds in which carbohydrates are a large part of the natural diet appear to do better with carbohydrate-rich refeeding formulas than do faunivores.

Elemental Diets

[Note that the foods suggested below are for fledgling to adult birds. In many species, nestlings require different foods. For example, columbids less than 1 week old cannot digest or use starch, and should be fed an animal-sourced crop milk replacer.]

Recall that the GIT of an emaciated bird does not possess the mechanical strength or enzymatic capability to digest normal food. Chemically whole foods are unused (Shimmel and White 1994; authors' unpub. obs.; pers. comm. with numerous rehabilitators), and, if fed, they can sit in the crop (causing "sour crop" and adding to stasis), or, more caudally, cause a blockage, provide food for pathogens, and/or cause diarrhea. *Ordinary whole foods can kill.*

The GIT itself must be regenerated before it can function normally. Therefore, *predigested* foods, consisting of *elements* (or subunits) of larger food molecules (Miller and Taboada 1975), must be fed to badly emaciated birds.

Some products should *not* be fed:

It is tempting to feed liquid human nutritional replacers out of cans. That is almost always a bad idea. Most of them are *high* in *sucrose.* Sucrose is not a major part of any bird's diet, except nectarivores, frugivores, and exudativores (sap eaters). For other birds, it is unlikely to be appropriate and is, in many cases, harmful.

For example, as discussed above, faunivores have low levels of carbohydrases. Sucrose is likely to go through unused (causing problems such as osmotic diarrhea), and/or it may significantly elevate blood sugar levels.

Some Mimids (mockingbirds, catbirds, and thrashers), Turdids (thrushes, robins), and Sturnids (starlings) lack sucrase and are therefore sucrose-intolerant.

A few nonelemental liquid human diets, such as Isocal®, have less sucrose, but their macronutrients are unsuitable for most trophic categories. Since they are not elemental and since they tend to cause diarrhea from lack of bulk, there is no reason to use them.

Other products such as Nutrical®, formulated for weight gain of mammals, are high in sugars and fats, and should not be used for the same reasons.

Thus, only elemental diets whose macronutrients are useful to the bird should follow the initiation of rehydration. Supplementation with water- and fat-soluble vitamins, L-glutamine, and yogurt should continue.

One of the more easily obtained commercial elemental diets is Vital HN® (first described for use in avian rehabilitation by Elliston and Gillett 1996), made by Ross Labs. This product is a complete human nutritional replacement. It is composed mostly of partially digested starch, with a modest amount of oligopeptides (partially digested protein) and free amino acids, and a small amount of fat, some of which is relatively digestible medium-chain fatty acids. It contains a wide range of micronutrients.

The proximate analysis (macronutrient ratio) of this product reveals that it is high in nonsugar carbohydrate, and is ideal for a healthy granivore, such as a columbid. However, it is less good for an omnivore and is unsuitable, without additions, for a faunivore. Note that it contains no taurine (an essential amino acid for carnivores), and the amount of choline is insufficient for all birds.

Vital HN® as a sole food source, then, should only be used for granivores and only for a limited time. Protein hydrolysate (predigested) additions such as tryptone (a partially elemental form of casein, available as a microbiological medium (Elliston and Perlman 2002)), or digests (available from byproduct companies) would make Vital a good base for omnivores or faunivores, and may be advantageous even for granivores since they, too, require extra protein to restore body structures. Because hydrolysates are composed of many small molecules, they may have an osmotic effect in the gut and could, in large amounts, cause diarrhea and dehydration. Add them in moderate amounts (i.e., start with no more than 1 g hydrolysate per 2 g of the dry weight of the Vital HN®) and monitor the patient's droppings carefully.

Poultry digests for carnivores or insectivores, or fish digests for piscivores, make good bases, themselves, for elemental diets. However, they are not complete foods, lacking vitamins, minerals, fatty acids, bulk, and more, so the tubing diet would need to be appropriately formulated to make it complete.

Throughout the refeeding process, the bird's condition, successful passage of elemental food through the GIT, and droppings dictate when to proceed.

A complementary approach to providing elemental food is the addition of pancreatic enzymes to an easily digested whole food. In general, starches and proteins are more digestible after they have been cooked, so repletion of a starving animal is an appropriate situation in which to use some human foods.

Digestive enzymes can be obtained as products such as Pancrezyme® and Viokase-V® (generically, pancreatin), which are essentially freeze-dried pureed pancreas—powders of very active digestive enzymes. They contain proteases, lipases, carbohydrases, nucleases, and more.

Do not use digestive enzymes from the health food store. They may be hundreds of times less active than pancreatin, and many are unsuitable for the purpose of predigesting food in any feasible amount of time.

For carnivores/insectivores, pancreatin can be mixed with chicken or turkey babyfood (corrected with calcium).

For piscivores, it can be mixed with pureed low-sodium water-packed tuna (with added calcium).

For omnivores, enzymes could be added to a product such as Hill's Prescription A/D.

For granivores, use baby cereal or cooked, strained, whole-grain cereal.

For frugivores, puree fruit.

For nectarivores or exudativores, use a sugar syrup as a base, but be sure to add a source of high-quality animal protein such as pureed insects or chicken baby food. (Table 3)

Use a maximum of ½ tsp (7.5 cc) pancreatin per half-cup (120 cc) of (pureed, wet) whole food. Incubate at body temperature for 15 minutes before feeding. Fully supplement these diets, as well.

The first feeding should be diluted to half-strength so that you can assess the bird's ability to process the food. If the crop (or proventriculus) empties and droppings continue, the next feeding(s) can be full-strength.

Estimating Caloric Requirements

According to Quesenberry (1992), the caloric requirement of an emaciated adult bird may be estimated to range from 0.5-2.0 [$BW^{0.75}$][x129] for passerines (or BW < ~150 g); or [x78] for nonpasserines (or BW > ~150 g). Remember that these formulas provide only approximations of what a bird may need, and should be used as starting points in determining how much is fed in a day. The bird's ability to hold and digest food is the first consideration, and is always the limiting factor. The true caloric requirement can only be assessed by daily weight measurements. Many variables will affect the requirements in any given case. The presence or absence of parasites, for example, can dramatically affect a bird's energetic needs.

An emaciated bird should be weighed daily, in the morning, before the first feeding, and a record kept. Rapid initial weight gain equal to the percent of dehydration is to be expected. For two or three days after that, there may be little or no gain, until the underlying problem is addressed and the GIT begins to recover. The goal during this (often frustrating) time is to incur no more weight loss, which is all that can usually be expected of

TABLE 3. REFEEDING DIETS FOR VARIOUS TROPHIC GROUPS

Carnivores: 1 jar (71 g) strained chicken baby food

Piscivores: 70 g pureed cooked fish filet (e.g., low-sodium canned tuna)

Omnivores: 70 g Hill's Prescription Diet A/D® and omit the calcium carbonate.

Strict granivores (e.g., most North American columbids): 70 g cooked strained multigrain cereal or Vital-HN® made as directed, or 17 g baby cereal and 53 cc water (for the latter two, omit calcium carbonate).

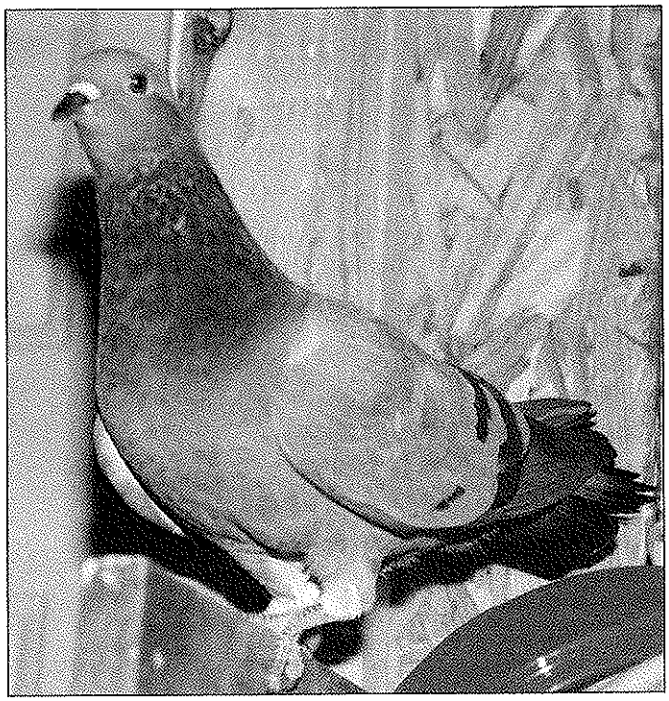
Frugivores: 60 g pureed mixed fruit and 10 g chicken baby food, with only 20 mg calcium carbonate.

And:
1/2 tablespoon (7.5 cc) plain low fat yogurt
2 tablespoons plain reconstituted gelatin (per package instructions)
2 drops cod-liver oil (0.1 ml)
1 drop vitamin E (0.05 ml)
1/10 tablet "B-50" B-complex tablet (= 5 mg niacin)
25 mg powdered vitamin C
90 mg powdered calcium carbonate

1 cc powdered digestive enzymes (Pancrezyme® or other pancreatin; do not use enzymes from the health food store)

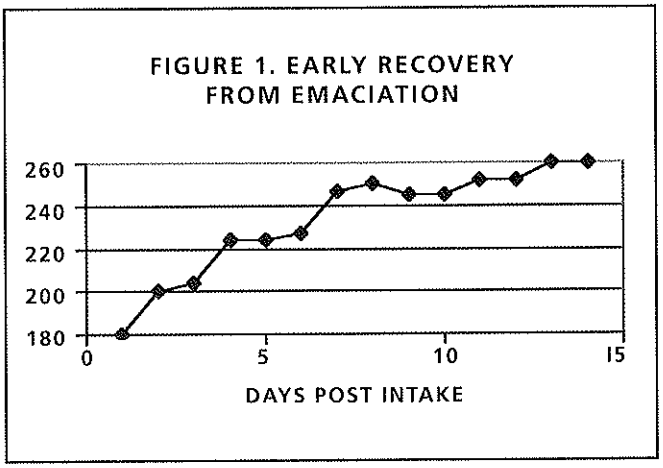
Combine food mixture with enzymes and incubate at body temp. for 15 minutes before feeding. Refrigerate leftovers and discard after 2 hours.

The bird will demonstrate that it is digesting and absorbing the elemental diet if its feces are of darker color and a different smell than the food.



JANINE PERLMAN

Rock pigeon, recovered from emaciation, after regaining nearly 100% of her intake weight and successfully raising two offspring.



elemental diets. Because they are high in osmoles (in this case, small dissolved molecules), their caloric content is limited.

Prey items, chicken baby food, and canned diets are approximately 75% water, as is full-strength Vital HN®. However, many birds cannot make well-formed feces on diets that are much lower in indigestible bulk than their natural diet, such as baby food or Vital HN® (authors' unpublished observations). A bird is likely to have moderate diarrhea and produce a large volume of urine on these diets, even though its GIT is recovering. The bird will demonstrate that it is digesting and absorbing the elemental diet if its feces are of darker color and a different smell than the food. It should also, of course, be producing white urates.

The addition of bulk is helpful, once it is clear that the GIT is functioning. Add bulk in small amounts, and be *sure* to predigest it with enzymes.

Bulk for granivores might be "creamed corn" baby food, or baby cereal.

For omnivores, it might be A/D or softened kitten kibble.

For faunivores, it could be pureed all-meat (or -fish) canned cat food.

If the feces indicate that digestion is taking place, gradually add pureed whole foods, with enzymatic predigestion.

The droppings should continue to look darker and smell different from the food, and the bird should start to gain weight. If, after 3–4 days, the gradual introduction of predigested whole foods is not workable, the bird probably either has an untreated underlying problem, or its GIT and other organs may be beyond salvation.

When the bird is stable, gaining weight, and able to digest predigested/elemental foods, pureed whole foods from the natural diet should be gradually introduced, while enzymes and supplementation (with vitamins, yogurt, and calcium if needed) are continued in the same amounts as in Table 3, per approximately one-quarter cup (70 cc) of food. For a raptor, whole food might mean pureed mice; for an omnivore, pureed insects; for a granivore, cooked multigrain cereal.

When the bird is doing well solely on a pureed natural diet, decrease the digestive enzymes. Once those are no longer required, whole natural foods should be offered for the bird to self-feed. Be sure that the bird has access to dirt, and multimineral and oystershell grits. If it is able and willing to self-feed, monitor droppings and weight carefully.

Supplemental feedings are likely to be required during the transition to total self-feeding.

Case study

An adult pigeon (*Columbia livia*; later revealed to be female) was presented for care. She was found at a public site, emaciated and unable to fly, although she was alert and able to stand. There were no apparent injuries. At intake, she weighed 180 g which, based on her release weight, was just under 52% of normal. She was therefore at the low-weight end of Category III emaciation. As with all emaciated columbids, she was assumed to have trichomoniasis and was treated for that, as well as for other likely parasites. She was given the above refeeding regimen, as described in Table 4. The time course of her increase in body weight is shown in Figure 1.

Subsequent to her release to the flight cage, a juvenile pigeon was presented with possible poisoning, inability to fly, and Category II emaciation. He was treated similarly to the bird in the case study, and, once he was in the flight cage, the two immediately bonded. They were kept for a few more months, during which winter became spring and the juvenile matured. The pair nested and raised two healthy offspring. They continued to lay eggs and attempt to raise more clutches until the family was released. At the time of release, the bird in the case study weighed 349 g, or twice her weight at intake.

Summary

Emaciated and ill birds face very difficult challenges, as do their caregivers. Just at a time when their nutritional needs are greatest, they may be least able to digest ordinary food,

TABLE 4. CASE HISTORY OF AN EMACIATED ROCK PIGEON (*COLUMBIA LIVIA*)

Day 0:
Weight: n/a
Fluid/food: LRS + Vital HN® 10–15 cc q4h
Notes: Found unable to fly. Kept in small, dark box w/heat. Feces lime-green, gritty paste on vent.
Medication: metronidazole (Flagyl®)

Day 1: Transfer
Weight: 180 g. 180/349 = 51.5% of normal body weight.
Fluid/food: 10% dehydration = 20 cc of fluid + 20 cc per day maintenance. Dilute Vital HN® +, yogurt, all vitamins. 20 cc, 3–4x/day
Notes: Bird standing, alert, unable to fly. Kept at ~90°F, in small, darkened cage. Little breast muscle palpable. Droppings scanty, dark green, relatively well-formed, urates present.
Medication: Carnidazole (Spartrix®), sulfadimethoxine (Albon®) x 5 d, pyrantel pamoate, ivermectin.

Day 2:
Weight: 200 g
Fluid/food: Full-strength Vital HN® + yogurt, vitamins; 25 cc 3x/day
Notes: Crop static, drained, refilled. Feces dark green, not well formed, urates present, copious urine. Bird thirsty.
Medication: Albon®, metoclopramide

Day 3:
Weight: 204 g
Fluid/food: Vital HN® + yogurt, vitamins+ baby cereal, pancreatin; 25 cc 3x/day
Notes: same as day 2
Medication: same as day 2

Day 4:
Weight: 224 g
Fluid/food: Discontinue baby cereal, add poultry hydrolysate
Notes: Feces dark green, not well formed, urates present, copious urine. Bird thirsty.
Medication: Albon®

Day 5:
Weight: 224 g
Fluid/food: same as day 4
Notes: Feces brown. Copious urine continues.
Medication: Albon®

Day 6:
Weight: 227 g
Fluid/food: Baby food peas, corn, sweet potato added to Vital HN®. Fed 25-30cc BID.
Notes: Feces indicate baby food not well digested.
Medication: None

Day 7:
Weight: 246.5 g
Fluid/food: Discontinue vegetables. Baby cereal, poultry hydrolysate, pancreatin, Vital HN®. Fed 25–30 cc BID.
Notes: Feces brown, well formed, copious urine continues
Medication: None

Day 8:
Weight: 250 g
Fluid/food: As above, except no Vital HN®; fed SID (night).
Notes: Eating on own. Ambient temp. gradually lowered.
Medication: None

Day 9:
Weight: 245 g
Fluid/food: Baby cereal, poultry hydrolysate, pancreatin; fed SID (night).
Notes: Eating on own. Ambient temp. gradually lowered.
Medication: none

Day 10:
Weight: 245 g
Fluid/food: Baby cereal, poultry hydrolysate, pancreatin; fed SID (night).
Notes: Eating on own. Ambient temp. gradually lowered.
Medication: None

Day 11:
Weight: 252 g
Fluid/food: Baby cereal, poultry hydrolysate, pancreatin; fed SID (night).
Notes: Allowed free on shelf in small room; windows open.
Medication: None

Day 12:
Weight: 252 g
Fluid/food: Baby cereal, poultry hydrolysate, pancreatin; fed SID (night).
Notes: Free to move about room, eating.
Medication: None

Day 13:
Weight: 260 g
Fluid/food: Baby cereal, poultry hydrolysate, pancreatin; fed SID (night).
Notes: Eating well on her own.
Medication: Ivermectin

Day 14:
Weight: 260 g
Fluid/food: self feeding (seeds, grains)
Notes: Released to aviary.
Medication: None

Day 28:
Notes: Eating well and maintaining normal weight (by palpation). Droppings plentiful, well-formed feces. Bird active, exploratory, flying/hovering, busy with projects, assertive.

Next seven months:
Bird mated, raised one pair of young, laid two more clutches of eggs (was prevented from raising young); was released at 349 g, or almost exactly double her weight at intake.

because the functioning of their gastrointestinal tract is severely impaired.

They must be warm, hydrated and given the catalytic tools—vitamins—needed for metabolism. Then they require an elemental, predigested diet of a composition that fills their requirements, with appropriate supplementation, so that the GIT can regenerate. As it recovers, natural foods can be introduced, and then enzymatic assistance decreased, until the gut can function normally.

Giving whole food to a bird that cannot digest it is a violation of the principle to "first do no harm." Using the described protocols, numerous rehabilitators report that they are able to save some birds that, in the past, were likely to have died.

An emaciated bird must be given the means...for stayin' alive.

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Available inexpensively at http://www.kornax.com/Merchant2/merchant.mv?Screen=PROD&Store_Code=KE&Product_Code=PCS&Category_Code=ENZ.

Carnidazole (Spartrix®; Janssen Animal Health)
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Tel: 800/659-5928
Website: http://www.jedds.com/Products.asp?MainCategoryID=64&SubCategoryID=537

L-Glutamine, product 005575
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Website: http://www.puritanspride.com

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Available in the baby foods section of most grocery stores

Tryptone
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Website: http://www.thesquirrelstore.com/moreinfo.cfm?Product_ID=169

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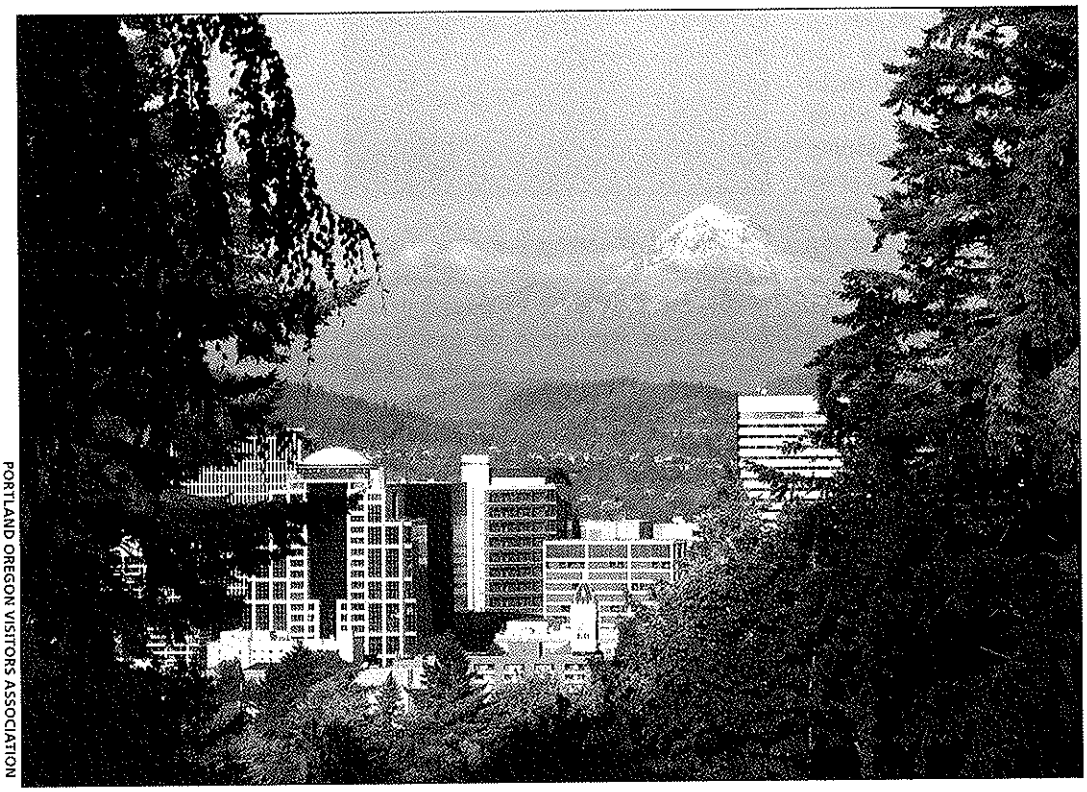

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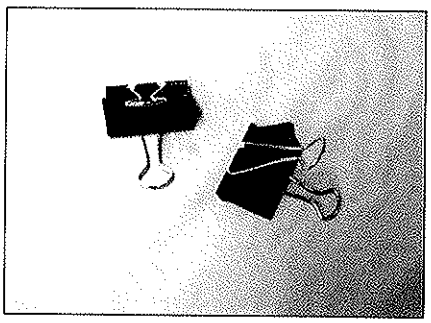
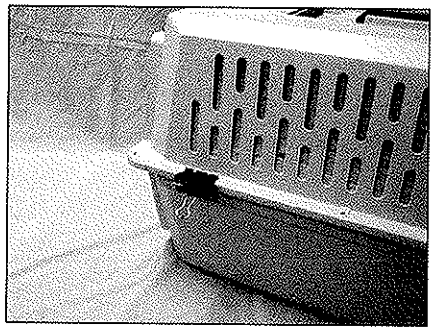
The Use of Large Binder Clips to Hold Hospital Crates Together

by Dody Wyman

Pet crates are used by many rehabilitators both as hospital cages and to transport birds and animals. For many years, I laboriously did and undid all those screws that hold the top and bottom of the cages together. The raptors I worked with dirtied the backs and sides with great regularity, which meant taking the crates apart sometimes daily to clean. I began lining the sides and back with newspaper, which made cleaning much easier, but I found putting the screws though the paper difficult. For convenience, I began using fewer screws to hold the crates together. Like most people, I also discovered that travel in the car can quickly jiggle the screws loose with potentially bad results.



PHOTOS: DODY WYMAN



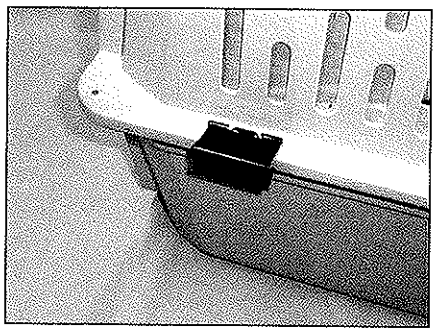
Then I discovered a new use for binder clips.

Binder clips come in several sizes. I use the large size, which are available by the dozen at any office supply store. After lining the back and sides of the bottom half of the crate with newspaper, I put a folded towel in the bottom.

Then, with the top and front grate in place, the whole crate can be held together with four binder clips—two on each side. For the very small crates, one clip on each side is sufficient.

For travel or to save space, the top and bottom clip handles can be easily taken out by pinching each clip handle together toward the center and removing it from the binder clip. This is recommended if you will be transporting the crate, since it reduces the chance of a binder clip being knocked off accidentally. When you need to take the entire binder clip off the crate, just put the top clip handle back in, remove the binder clip from the crate with downward pressure, and then replace the bottom clip handle.

Wrap the bird in a towel or place it in a box, while disassembling, cleaning, and re-assembling the crate. JWR



Dody Wyman has been rehabilitating wildlife since 1985 and has specialized in raptors and their reconditioning since 1992. She founded and is executive director of River Raisin Raptor center, located in Manchester, Michigan.

PEREGRINE FALCON CHICKS. PHOTO: USFWS

Do you have an easy answer to a frustrating rehab issue? A new way to resolve a common problem?

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Open Minds

MAKING THE RIGHT CONNECTIONS

by Beth Dillingham

Much of the way we live today is very disconnected from the natural world. Kids are playing with video games or on computers or watching DVDs. They are not as likely to be out building forts, wandering in the woods, or catching bugs. As the population increases, the built environment covers more and more land. There are fewer open fields and streams and places to tromp around. The fast-paced, technology-focused world is dissolving our sensitivity to the natural world that sustains us.

Those of us in the field of environmental or wildlife education feel a great passion and urgency about teaching people to be more respectful of wildlife and wild places. We work very hard to understand and learn about wildlife and the problems facing our planet. But all of that passion and knowledge is for naught if we are not able to connect with our audience.

We have all suffered listening to uninspiring lectures, or zealous preaching that makes you feel either bored beyond measure or run over by a truck. You can attend or participate in a talk or conversation about a topic that fascinates you, but if someone is lecturing off in their own world it can turn you off. There is no one way to successfully present information to *everyone*, but we must remember to teach to the audience at hand. In all of our gathering of information and preparing programs we can't forget that the whole point is to help other people learn and connect to what we are teaching. Try to think of yourself not as the person who has the knowledge, but rather a *facilitator* of learning. You must start where people are. All of your knowledge about migration routes of the sandhill crane, or hunting patterns of flamulated owls, or the medical conditions that result from feeding a wild animal an inappropriate food, fall flat if you don't engage your audience in a meaningful way.

A lot of success of getting people to learn something new is finding a way to make them care about the subject. And the best way to connect with an audience is through *their* experience.

You can connect with your audience by listening, encouraging questions, and making people feel comfortable and welcome. Find out what their interests are. What are they curious about? How much do they know? Once you learn this, you need to be able to think on your feet and immediately adapt the program you planned into one that will meet this particular audience's needs. Make sure you acknowledge their interests and contributions to the discussion so that they know your time together is focused on them.

Experience is a tremendous teacher. I think one of the ideal ways you can teach about nature is to take people on a hike in the wild and let them learn by immersion in the experience. Unfortunately, this is usually not an option. But we can offer little pieces of that kind of experience—for instance by bringing an education animal that you can tell a story about, or having tangible things people can handle or watch up close.

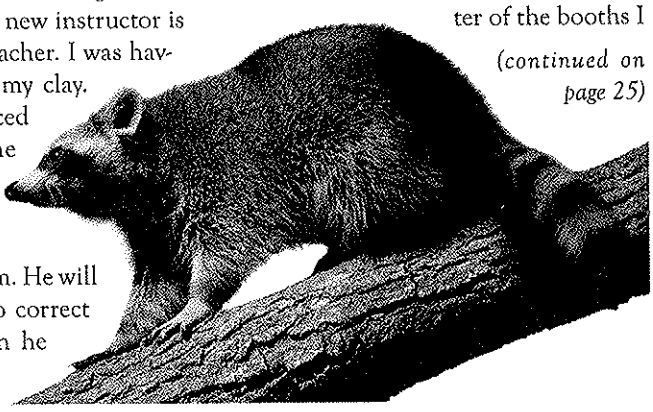
I am currently taking a pottery classes. For anyone out there who hasn't tried to throw pots on a wheel, let me tell you: there is a steep learning curve in the beginning. I have watched people demonstrate how to throw pots. I have read about it. Many people have been giving useful tips. But as a beginner I have a lot to learn. My new instructor is a really outstanding teacher. I was having trouble centering my clay. He came over and placed my hands around the clay to show me and allow me to feel how to center the clay and pull a pot from the form. He will often show me how to correct a problem once. Then he causes the pot to have the same problem again so that I really learn how to fix it. I may never be a great potter, but I respect the effort he is making to help me learn.

My pottery teacher's approach reminds me of *our* need to reinforce some basic concepts—for instance, that everything is connected—again and again so that people really get grounding in understanding how nature works.

Many educators are involved in public display tables at science fairs, nature center festivals, state fairs, and other venues. People stop at the tables that catch their curiosity and allow them to make something or to see something unusual. An education animal is always a showstopper, of course. But there are other things you can do to catch more than their passing interest. How about a display of problematic items that you have had to rescue animals from? Put up a board with a lead bullet, Coke can rings, pop tops, tangled fishing line, plastic bags, and other common items that can hurt wildlife. Use a positive, proactive message that says "Let's protect wildlife—make sure to dispose of your garbage properly." With just a glance, people see things they can address in their everyday life to help wildlife. That display next to a rehabilitated animal will have impact. (Don't make the display gruesome: an overpowering message will shut down someone who might otherwise get involved.)

I recently attended a nature festival and was struck by the different character of the booths I

(continued on page 25)



Food for Thought

AVIAN GAVAGE

by Astrid MacLeod and Janine Perlman

In an article in this issue of the *Journal of Wildlife Rehabilitation* ("Stayin' Alive...," pages 8–20), we describe regimens for rehydration and refeeding of dehydrated, ill, and/or emaciated birds. Because many rehabilitators may not have been exposed to some fine points of avian gavage, we present here a detailed description of the procedure.

Administering Fluids or Food by Tube

The primary principle in caring for animals is "first do no harm."

The goal of oral tube infusions is to safely deposit the fluid into the crop or proventriculus (glandular stomach), avoiding any aspiration into the lungs. A feeding/fluids tube should be larger in diameter than the glottis so that it is not possible to "go down the wrong way" with the tube.

The tube should be made of smooth, flexible, relatively soft and pliable rubber such as red "French" feeding tube/catheters (see product information below). In our experience, it is safer to cut off the tip so that the only opening is at the very end of the tube. Additional openings proximal from the tip only increase the chances of depositing fluid higher in the esophagus than is desirable and safe.

The target organ, when choosing between crop or proventriculus, should be the one that is larger, more caudal, and, of course, accessible. It is very helpful to know the anatomy of the bird you are tubing. The appropriate target for a dove is the crop, which is capacious and not easy to tube beyond; for an owl, which has little in the way of a crop, it is the proventriculus. In many passerines, it is possible and better to go into the proventriculus.

1. Estimate how far from the bill tip the caudal end of the target organ lies. It is always better to have too great a length of tubing than too little, so if you don't know the anatomy of the bird, hold the tube outside the bird and "measure" from bill tip to a little beyond the caudal end of the keel bone; mark the tube.

The maximum volume to initially infuse is 5% of the current body weight, converting grams to cc's.

2. Calculate that maximum volume. For example, if the bird weighs 60 g, the maximum infusion volume is:

0.05 x 60 g = 3 cc.

3. Prepare the apparatus and fluid. Attach the tube securely to the syringe. Withdraw the calculated volume into the syringe. Pulling the fluid up through the tube accomplishes two things—it makes it unlikely, when feeding a suspension, that any particles will block the tube while being infused (an occurrence both frustrating and dangerous), and it adds exactly the needed amount of air to the syringe to completely expel the fluid from the tubing.

Any tubed fluid should be body temperature. The safest and most effective way to achieve that is to immerse for several minutes the entire syringe and tube in water slightly warmer than body temperature. This also moistens and cleans the tube exterior, which is the condition it should be when inserted. A wet tube is desirably slippery, and it must be very clean so that no foreign material enters the glottis.

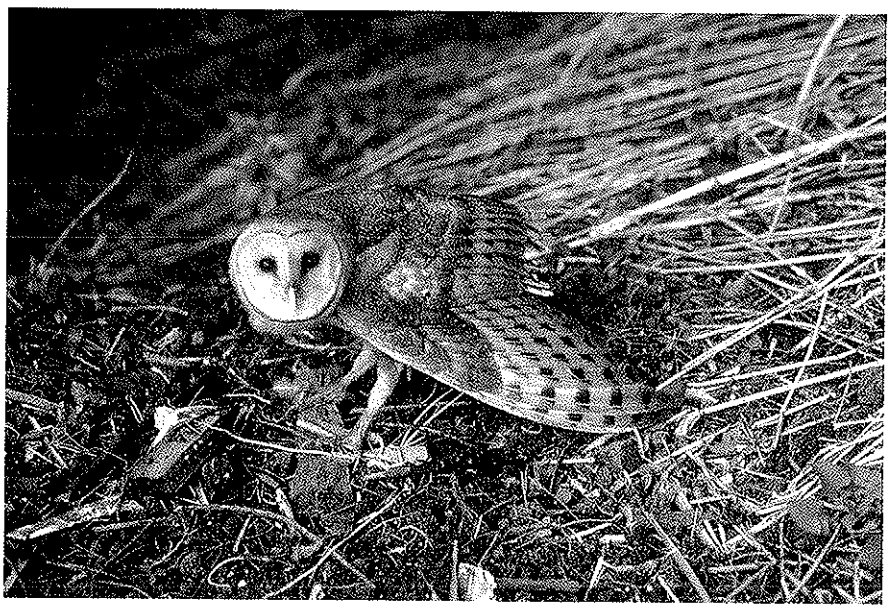
4. Hold the bird securely. Larger birds often benefit from being wrapped in a towel. Have the tube ready, and crimped to avoid leakage. Using a thumbnail as a wedge, *gently pry the bill straight open*, without twisting.

5. Assuming you're right-handed, hold the bill open with the thumb and index finger of your left hand, **insert the tube down the right commissure** (the "hinge" between mandible and maxilla) and toward the crop. Crossing over from the left commissure to the right side of the pharynx risks blocking the glottis, and resultant distress or aspiration.

Insert the tube *as far down the gastrointestinal tract (GIT) as the bird and its anatomy permit.*

Entry into the proventriculus is often helped by the bird swallowing, which you can encourage by ejecting a *very small* volume into the esophagus. Continue to exert gentle pressure as the bird swallows, and that will often give access to the proventriculus.

5. Once you are satisfied that the tube is as caudal in the GIT as possible, and that it has at least entered the crop, uncrimp the tube and ***very slowly*** **begin to discharge fluid from the syringe.** Watch the bird carefully for any sign that



BARN OWL (*TYTO ALBA*) PHOTO: C. F. ZEILLEMAKER/USFWS

the fluid is backing up into the pharynx. If you see the bird swallow while you are feeding, *stop immediately* because it is likely that it has sensed fluid in the esophagus, where it should not be!

6. After you have infused the fluid, **crimp the tube and withdraw it, gently and fairly quickly. Note the appearance and odor of any material that clings to it**; you have just sampled the GIT, and it can give you crucial information. A fermented or yeasty smell can indicate a yeast infection in the crop. Food or other matter can give you a clue as to what the bird has been eating, how long it's been present in the crop or stomach, and whether it may have contributed to the bird's problems.

Tube feeding presents a real possibility of the bird's inhaling what it is being fed. If it doesn't die acutely, aspiration pneumonia is very likely to ensue.

Aspiration can result from:

- Not passing the tube sufficiently far down the esophagus.
- Overfilling the organ into which you are infusing.
- The tube leaking during insertion or withdrawal.
- The bird regurgitating.

Great pains should be taken to avoid any of these occurrences. However, accidents do happen, and extremely compromised birds are at higher risk. Even healthy birds generally have weak cough reflexes compared to mammals (pers. comm. with K. Robertson, DVM.) If the bird does inhale fluid, as quickly as possible withdraw the tube and hold the bird upside down, allowing gravity to assist in expelling the aspirate, while quickly clearing the oral cavity with a tissue or clean cloth. Some rehabilitators actually swing the bird in an arc to create centripetal force, which helps with expulsion. JWR

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Red rubber French catheters for use as feeding tubes are available from Feeding Tech, Elwood, Indiana, USA.
Website: http://www.feedingtech.com.

The authors welcome feedback and suggestions for future columns.

Astrid MacLeod is a researcher, writer, and wildlife nutrition consultant. She serves on the nutrition advisory group of the American Zoo and Aquarium Association and the on the board of directors of Advanced Primate Ethical Studies. She works for Manitoba Conservation, and is an experienced rehabilitator of birds and mammals. She may be reached at sparrow@mts.net.

Janine Perlman, Ph.D., conducted laboratory research in biochemistry and molecular genetics for 20 years. She is now a comparative nutritionist and wildlife nutrition consultant. She serves on the nutrition advisory group of the American Zoo and Aquarium Association, and on the board of directors of Advanced Primate Ethical Studies. She rehabilitates birds and small mammals. She can be contacted at jpandjf@swbell.net.

(Open Minds–continued from page 23)

visited. There were fancy set-ups with polished brochures, books, and literature, as well as simpler booths. I have to say I spent the most time at the table with a teacher who had a few things on a small table, including rubber tracks, scat, hides and skulls, and a few handouts. I wanted to touch things and find out what things were.

Not long ago, my organization held an event for international migratory bird day. We had mountains of literature about keeping cats indoors to protect wild birds, buying shade-grown coffee to help protect habitat, and all the rest. The busiest part of our table was the area where kids got to make bird feeders out of toilet paper rolls, peanut butter, and birdseed. Those kids took those feeders home and, I will bet, have watched carefully to see if birds would come to feed. One small activity may lead to some lifetime bird watchers and conservationists who would never read a pamphlet without that connecting experience.

Best of luck to you with all of your audiences. JWR

Beth Dillingham has taught in both classroom and informal learning settings for 14 years. She ran an environmental education center in the Sandia Mountains in New Mexico, and is currently the education coordinator for the Rio Grande Zoo. She may be reached at thebnm@earthlink.net.

Bugs & Drugs

AVIAN INFLUENZA

by Kathy Dolan

In recent years outbreaks of avian influenza (AI) type A in domestic poultry flocks have been reported from various countries around the world, including the USA. Among these outbreaks were the first cases of direct bird-to-human transmission of the disease, which has resulted in 22 deaths in Southeast Asia since 1997 and one death in the Netherlands in 2003. Rehabilitators who work closely with birds or have contact with large numbers of birds have concerns and questions about this virus and its biology. This article will attempt to shed light on the threat of AI to wild bird populations and rehabbers, the differences between AI and human influenza, and the transmission of AI from bird to humans.

Influenza viruses are not restricted to birds, but are found and cause disease in other animals. Three types of influenza virus are known: type A, type B, and type C. Type A influenza viruses infect and cause mild to fatal illness in birds, pigs, humans, horses, seals, and whales, while type B influenza viruses cause disease in humans and seals. Type C influenza viruses cause a subclinical to mild infection in humans and pigs. Human influenza pandemics are usually caused by type A influenza viruses, which are descended from avian type A influenza viruses. Type B influenza viruses are infrequently responsible for human influenza pandemics, while type C influenza viruses are not known to cause human pandemics.

AI type A is a gastrointestinal viral disease of birds; it was first described in 1878. Within wild avian populations AI occurs as an asymptomatic to very mild disease. Wild birds appear more resistant to AI than domestic poultry. One notable exception was an outbreak of highly pathogenic AI that resulted in high mortality rates in common terns in South Africa in 1962. Among domestic poultry the disease can produce a variety of symptoms ranging from ruffled feathers, depression, and diarrhea to sudden death. Two signs that are particularly noteworthy among poultry are a decrease in feed consumption and a decrease in egg laying. Thus far, there is little or no evidence that the AI virus is present in the wild bird populations tested around Hong Kong. Of the 6000 wild birds tested around Hong Kong, one dead peregrine falcon found near two infected chicken farms tested positive for AI. It is not known how the bird became infected with the AI virus or if it died of AI.

AI type A viruses are maintained worldwide within populations of wild birds. The highest incidence of infection occurs along the major migratory flyways in populations of migratory waterfowl, which includes wading birds, shore birds, gulls, and especially ducks. The serotypes of AI virus that are isolated from wild bird populations are dynamic. Isolation of AI viruses from wild birds has shown that the AI serotypes can vary from flyway to flyway, and can change from one year to another. Among the different species of birds known to carry the virus, seasonal variations are also observed. AI viruses are most consistently isolated from ducks.

In infected birds, AI viruses are shed primarily in feces, but can also be shed in saliva and nasal secretions. These virus particles can remain infectious for long periods of time in feces or in waterways contaminated with fecal debris. Thus, the migratory flyways provide a continual source of re-infection for migratory birds via fecal-oral transmission. It is believed that domestic poultry are infected either directly by contact with feces from infected wild birds or indirectly from water, food, or other objects such as clothing or farm equipment contaminated with feces from infected wild birds.

Like all influenza viruses, AI viruses are a group of closely related viruses that belong to the Orthomyxoviridae family.

AVIAN INFLUENZA: A FACT SHEET

FACT: The AI type A H5N1 virus has not been identified in North America.

FACT: In the rare cases of the human disease caused by AI type A virus H5N1 or H7N7 there was close contact with many infected sick birds and their bodily fluids, namely fecal material.

FACT: Among people infected with AI H5N1, sustained human-to-human transmission of the virus has not been demonstrated.

FACT: Wild bird deaths (crows, peregrine falcons) in areas with high mortalities among poultry have not been directly linked to AI.

FACT: There have been no documented cases of wild bird-to-human transmission of any AI virus.

FACT: Surveillance and preventive measures are well in place.

ADVICE: When in doubt, err on the side of caution: contact your veterinarian.

ADVICE: Always practice good hygiene and have a disinfectant protocol in place for your facility.

The viral genome or chromosome of this family is unique: it contains eight separate, individual pieces of single-stranded RNA. For an orthomyxovirus to produce new viral offspring successfully in a host cell, all eight individual RNA segments must be present. The presence of eight separate genome pieces increases the potential for rapid change or mutation of the viruses with the possible generation of new, more virulent influenza strains.

The influenza type A viruses are subdivided further into different serotypes based on the identification of two proteins found on the surface of the viral envelope. Together hemagglutinin (HA) and neuraminidase (NA) are responsible for binding and entry of AI viruses into host cells, while NA is associated with the release of the virus from host cells. Fifteen different HA proteins, H1–H15, and nine different NA proteins, N1–N9, have been identified. Of the possible combinations of H and N surface antigens, only H5, H7, and H9 are known to be pathogenic to poultry. Even among these H serotypes varying degrees of pathogenicity ranging from low pathogenic (LP) to high pathogenic (HP) forms exit. It is believed that the change from low pathogenic strain to high pathogenic strain occurs within domestic poultry flocks.

Generation of new avian influenza HN serotypes and strains occurs when two different AI serotypes or strains infect one individual bird or animal. This co-infection provides the opportunity for genetic reassortment, the mixing and swapping of the gene segments between the different viral serotypes known as *antigenic shift*. Antigenic shifts are responsible for the generation of new AI serotypes. Within individual animals infected with only one viral serotype, smaller, more subtle mutations within the viral genome, referred to as *antigenic drift*, can also occur. These mutations can also alter the properties of the new viral progeny.

Until the 1997 Hong Kong outbreak of AI, the direct transmission of avian influenza viruses from bird to human was considered a very rare, anomalous event. Although human influenza type A viruses are derived from avian influenza type A viruses, the transmission is not direct. Transmission of avian influenza viruses from birds to humans usually occurs through a third intermediate species. Pigs commonly serve as the mixing vessel for avian influenza type A viruses and an already established human influenza type A virus. Within the pig, the infecting viruses undergo genetic reassortment and mutation resulting in new viral progeny that are better adapted to infecting and causing disease in humans. These new bird-human hybrid influenza viruses then jump from pig to human to become new human influenza viruses. Occasionally, these new viruses cause human influenza epidemics.

With the transmission of AI to humans, concerns have been raised about a possible new virulent form of human influenza derived from AI H5N1. Among people who study disease and disease trends, the worst-case scenario would be co-infection of either a pig or a human with both a high pathogenic AI H5N1 and an established human type A influenza virus. This sort of infection could result in viral progeny that would retain the extremely pathogenic properties of the AI H5N1 virus, while acquiring the ability to be easily transmitted from person to person, resulting in a major pandemic. Thus far, there has been limited person-to-person spread of AI.

As of this writing, the high pathogenic strains of AI virus H5N1 have resulted in the deaths or depopulations of millions of poultry birds in eight countries in Asia, along with numerous human fatalities since 1997. In the Netherlands in 2003, an outbreak of high pathogenic AI type A H7N7 occurred that also jumped the species barrier. Eighty-three people were infected and had primarily mild flu-like symptoms or conjunctivitis. Unfortunately, one death was associated with this outbreak. In Asia and in the Netherlands, the people who contracted AI were either farm workers or people who had contact with large numbers of infected birds. There is also speculation that several cases were person-to-person transmission, but data supporting this are still out. In the United States, AI was detected in early 2004 in the states of Delaware, Maryland, and Texas. The serotypes responsible for these outbreaks were determined to be low pathogenic H7N2 in Maryland and Delaware, and high pathogenic H5N2 in Texas. Thus far, in the U.S. there have been no reports of bird-to-human transmission of AI. In all countries, surveillance measures are in place. Infected poultry flocks are quarantined and killed to prevent further spread of the disease.

It should be stressed that the high pathogenic AI type A H5N1 is not present in the U.S. or Canada. There are no reported cases of wild bird-to-human transmission of AI. It is also interesting that when ducks (wild ducks) were infected with pathogenic AI serotypes they exhibited fewer and milder symptoms than did chickens or geese. Surveillance measures and preventive measures are well in place. JWR

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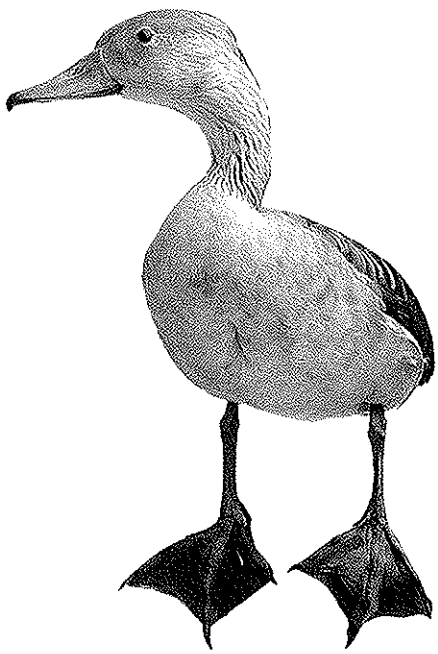
NOTE: "Bugs & Drugs" will not appear in the spring 2004 issue of the Journal of Wildlife Rehabilitation. *The column will return in the summer 2004 issue.*



Forester's Log

STRIVING TO FOLLOW IN THE FOOTSTEPS OF CARSON AND BRUCHAC

by Mary Stuever

Wooo-whaa-wooo. Heart song. The eerie notes draw our attention to the quiet man centered in front of the fireplace.

Wooo-whaa-wooo. Flute song. The hand-carved wooden flute greets us with its perfect tone.

Wooo-whaa-wooo. Word song. Sacred thoughts swirl in a language that transcends the spoken word.

First there is the voice of the flute. Seductive. Wise. A voice that speaks in the language of canyon wrens and canyon walls. And then he speaks, and before he has uttered the second line of his welcoming poem, my heart is crying "Old Friend!"

I know the recognition of friendship is one-sided. That is the way it is with these kinds of things. He is the storyteller. I am the listener. He is the presenter. I am the audience.

For many, many years, Joseph Bruchac has been telling stories, writing books, and traveling thousands of miles each year to share, through his Abenaki heritage, his message of caring for the earth. Tonight he is sharing his craft with a roomful of writers.

The workshop, which is perched on the edge of the Maine coast, is held in honor of Rachel Carson, another gifted storyteller who dedicated her life to sharing a message of caring for the earth. Like the complex food webs Carson wrote about, the writers at the workshop are connected through the common passions of environment and words.

Bruchac has joined us to remind us that we are telling stories that are larger than ourselves. In an hour and a half he does an elegant job of showing us, by example, that one can impart powerful guidance through the telling of stories.

We are enthralled.

After the talk, I stand in a long line to meet the speaker—this friend who does not even know my name. When it is my turn to exchange a handshake and a few words, I tell him of the incredible influence he has had on me, as a mother, and on my children.

I tell him that I had forgotten over the years the origin of our inspiration to tell stories. Storytelling has become such a large part of our family life. I said that when my children were in trouble—and they knew it—they would defensively plead "tell me a story," and I would usually do just that. It was only when he began to speak this evening that I remembered who had given me the advice to discipline my children through tales.

I tell him that Gluscabi tales were winter bedtime story fodder for many years. I tell him we told other stories from our own family events, our own traditions, our own imaginations, and our own research.

I thank him for sparking such rich experiences for our family. My children, who are now almost 15, have the gift of oral tradition. I am grateful to have a chance to personally thank him for that gift.

There is a sparkle in his eye, as if the dim light in the room had gathered in a forming tear, or perhaps the tear is in my own eye.

I walk out into the drizzly Maine night and go down to the water's edge. As the water laps the rocky shore, I think about connections. Despite the huge globe we saw today in the Delorme Map Store south of Freeport, the world is really a small place. I think about how I had watched this three-story high replica of the earth slowly revolve within the glass foyer of the store, and thought of how each inch of the structure represented 16 actual miles—getting lost in the enormity of the concept. Yet tonight I grasp this insight that one person, one teller of stories, could make a significant impact in this world.

Rachel Carson had done that 40 years ago when she published *Silent Spring*. Twelve years ago, Joseph Bruchac had touched my life making me a better mother, which in turn, made my children better people. Joseph Bruchac did not know he had touched *my* life. Surely he had must have known about me indirectly. Why else would a person dedicate his life to telling stories and teaching others to tell stories, if he did not have a fervent belief that he was making the world a better place?

Unless it is just because the stories want to be told.

I contemplate the passion of writing, especially writing about the outdoors, and the passion of people who write about the outdoors. There is a rich tradition of these writers, from Thoreau to Abbey, Emerson to Carson, Muir to Bruchac. All of these writers have made a lasting impact on the way others think about and care for the earth.

Like most aspiring writers, I dream that some day, someone will come up to me and say that my words have made their lives more full and the earth a better place. I hope on that day, I will have the wisdom to know that the credit is not mine, but belongs to the story. A story that insisted on being told. A story that is larger than myself.

Thump-thump, thump-thump, thump-thump. Heart beat. Bruchac reminds us this is the first sound we heard before we have even breathed our first breath.

Thump-thump, thump-thump, thump-thump. Drum beat. We are reminded of our origins and our connections.

Thump-thump, thump-thump, thump-thump. Word beat. The stories flow, and each of us is but a measure in the perpetual song of life.

Mary Stuever is a consulting forester specializing in forest ecosystems of the American Southwest. She can be reached at sse@nmia.com.

Life on a Little-Known Planet

by Howard Ensign Evans

Guilford, Conn.: Lyons Press, 1993 (first published in 1966); 330 pages; U.S. $14.95 (paperback)
ISBN: 1558212493

Reviewed by Elsa C. Bumstead

"The book that probably attracted more of us to the profession of entomology than any other."

—Louis B. Bjostad
Professor of Entomology
Colorado State University

I recently came across some undergraduate papers that I had written at the University of Connecticut, one of them for an introductory course on entomology. As part of the course requirements students were to read and report on a book by Howard Ensign Evans. Evans earned his undergraduate degree at UConn, and was highly regarded for his expertise. He later taught at Cornell, Harvard, and Colorado State University. Recognized as a world authority on Hymenoptera, he described more than 900 species and authored a number of scholarly articles and popular books. In 1976 he received the Daniel Giraud Elliot Medal from the National Academy of Sciences for his work in zoology. *Life on a Little-Known Planet* was first published in the mid-1960s. Since then, it has become a classic, appearing on required reading lists, and providing a solid introduction into the world of insects and the people who study them.

During a recent interview on PBS, Stewart Udall said that he does his best thinking on his porch, which faces the Sangre de Cristo wilderness. I do some of my best thinking from my porch as I view the various and sundry plants in my garden. I am privy to a very small portion of the web of life in my part of the world. So much of it is insect related. Hummingbirds and swallows catch insects on the fly. The bushtits glean aphids and other sucking insects from rose bushes and pinon trees. Spiders weave dreamcatchers. Ants go forth each day in search of things to bring back to their nests. Orioles seek out caterpillars and butterflies flit from flower to flower. Seemingly ordinary activities...yet profound.

Evans is a porch-sitter, finding his back porch "as good as place as any to contemplate the universe as any [*sic*], and better than some." It is from this perspective that he muses about a fly pivoting on his rail, about Thoreau and Walden Pond, pesticides, the chemistry and physics of life, about Mars, Venus, and the space program, and how little of our money and resources are spent on getting to know more about life on the planet beneath our feet.

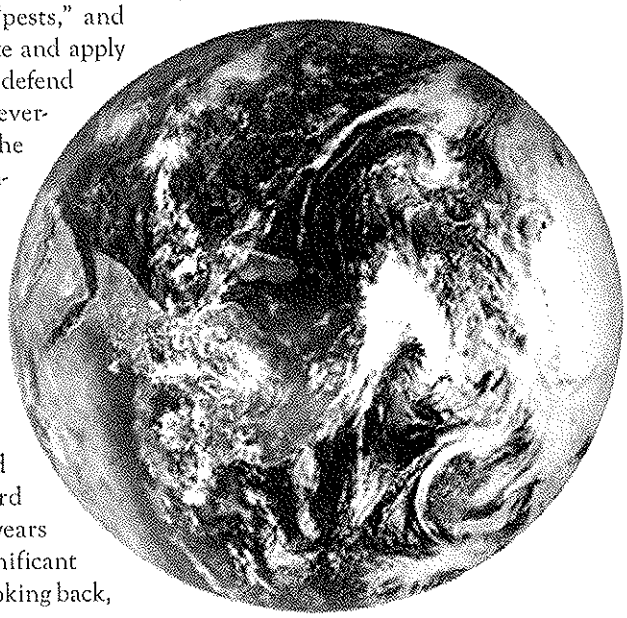
And so, in his book, Evans becomes our tour guide. He investigates the cities in the soil and the springtails that inhabit them. He explores the world of the cockroach, of water lizards and aerial dragons, and of the cricket as poet and pugilist. There are chapters about butterflies and fireflies, bedbugs and other cuddly creatures. Learn, too, about parasitic wasps and how "they made Peyton Place possible."

As the book draws to a close, Evans discusses human fears of "pests," and the effort expended to create and apply an arsenal of chemicals to defend crops needed to feed an ever-increasing world, and of the hazards to wildlife. His concern is that "the cumulative effects of these pollutants, their interactions and amplification can be fatal to the complex fabric of the biosphere." Remember, this book was written in the mid-1960s—the Rachel Carson *Silent Spring* era and before ecology was a word in our vocabulary. Forty years later we are experiencing significant changes in planet Earth. Looking back, Evans was indeed a presage of things to come. He writes with charming clarity, articulating life histories, imparting insights, and engaging parallels with the human world. Four decades later, it is an eminently readable resource.

Evans dedicated his book "to the book lice and silverfish that share my study with me. May they find it digestible!" I would encourage you, dear reader, to pick up this book. May you find it "digestible." It's got some wonderful musings about the space program and exobiology, and useful information about a variety of small things that may increase your appreciation for the work of those small things, seen and unseen, in your life. IWR

Reviewer Elsa C. Bumstead is an interpretive naturalist, writer, environmental scientist, and sometime wildlife rehabilitator who is based in Albuquerque, New Mexico.

Conservation Classics is intended to provide our readers with suggestions for building a collection of must-have wildlife and ecology reference books.



The Parrot Who Owns Me: The Story of a Relationship

by Joanna Burger

New York: Random House Trade Paperbacks, 2002; 253 pages; U.S.$13.95
ISBN 0-375-76025-3

I am owned by several parrots, and when a volunteer gave me this book recently, I thought it was about pet parrots. Silly me! Although it is about the relationship between the author and a red-lored parrot named Tiko, as it developed over 17 years and continues, it is far more than that. Joanna Burger is a leading ornithologist, the author of 14 books on avian behavior and natural history, and more than 300 articles on birds for professional journals. A distinguished professor of biology at Rutgers University, she serves on several national and international science and policy committees, including the National Academy of Sciences' Board on Biology. Tiko was 47 at the time of this book's publication.

Professor Burger writes about the development of her relationship with Tiko, who came to her depressed and upset, grieving and confused over the loss of the two elderly women with whom he had lived for his first 30 years. She reviews their relationship from the point of view of an animal behaviorist and scientist, relating Tiko's behavior and vocalizations in this suburban household in New Jersy back to wild behavior. Tiko's "flock" includes the author's husband, and his relationship with Mike is completely different than with Joanna.

This book is fascinating, first and foremost because Burger does not hesitate to ascribe motivations, thought processes, and emotions to Tiko, backing them up with observed behaviors among wild parrots and other birds. This is truly refreshing coming from a scientist, especially when Burger acknowledges the arrogance of our past view of nonhuman animal-kind. It's also just plain intriguing to see inside those little green minds and understand even a small part of what's behind what they do. It is humbling and has given me a fresh outlook on interactions with my own flock.

The Parrot Who Owns Me also includes interesting capsules on some of the research Burger has done over the past 17 years. She is known for her toxicology studies—particularly heavy metals—in birds around the world, as well as studies on vigilance behavior, pair bonding, and territorial aggression that were often inspired by her observations of Tiko.

The book is well written, very accessible, and hard to put down. Some of Burger's conclusions will, I hope, broaden minds everywhere. One of the most moving episodes was Tiko's solicitous behavior when Burger came down with a severe case of Lyme disease and was bedridden for weeks. (Tiko spent hours on the bed, preening her hair while she slept, refusing to leave her even to eat). From there she talks about flock behavior and altruistic actions when a member of a flock is injured. The sad and enraging aspect of this is her description of the extinction of the Carolina parakeet, in large part because hunters could shoot one or two, and the entire flock would then turn and come back to hover over the suffering one, making them all vulnerable to attack. (Similarly, today, poachers will catch one or two birds, maim them, and tie them in a tree where they scream with pain. When their flock comes down to support them, they are trapped.) Burger explores the survival value of this, noting that it might have worked with some predators before humans, but that its root may be in something larger than survival.

The author also looks at a toxics study she did with wild herring gulls, measuring lead levels in chicks and monitoring their growth, development, recognition of parents, and other survival factors. She did find that lead levels affected wild chicks much as it had chicks in the laboratory purposefully poisoned—but the outcomes were not the same. Burger was stunned to see the parent gulls taking extra time feeding the weaker babies, being extra vigilant to see that they did not wander away and approach other adults (a delayed ability to recognize their own parents was a proven effect of the toxicosis), who would attack and kill them. "It turned out the parents didn't spurn their weak off-spring; quite the reverse. In what we would think of as a very human gesture, they invested extra energy and attention to compensate for their chicks' disability, giving their weaker offspring that needed it a helping hand." It was not the survival of the fittest there on the beaches of New Jersey, at least among the herring gulls.

But the conclusion she makes from this and other incidents is, I think, at the core of the work that we all do:

> "We tend to think of empathy, altruism, and the capacity to love as characteristics that are innate, an indelible part of our personalities. We say that so-and-so is a loving person or a cold person; we admire, are even awed by, people who have a large capacity for compassion.... We think that our ability to love is the core of our humanity. We find out just how deep and powerful that core is in moments of crisis, pain, or joy. In these moments, the shell of our self can split open, and we find that our capacity for love suddenly seems limitless.
>
> "We are not alone in this. So it is with animals. Their capacity for intimacy and connection with one another and with us isn't fixed. It grows and develops. It has untapped depths and reserves. It can, perhaps, be taught. It is influenced by experiences and events. The relationships animals have with us are fluid and constantly forming and reforming. This was one of the most cherished lessons that Tiko taught me as I recovered from my illness. My fragility reconfigured and expanded him. It enlarged his capacity for love."

She quotes essayist and physician Lewis Thomas in his *Late Night Thoughts on Listening to Mahler's Ninth Symphony* in an attempt to urge others to extend this altruism to the rest of the world:

> "Altruism, in its biological sense, is required of us. We have an enormous family to look after, or perhaps that assumes too much, making us sound like official gardeners and zookeepers for the planet,

responsibilities for which we are probably not yet grown-up enough. We may need new technical terms for concern, respect, affection, substitutes for altruism. But at least we should acknowledge the family ties and, with them, the obligations."

The chapter "In Sickness and in Health" closes with a message of import for all of us nurturers and caregivers:

> "Tiko has taught me, a sometimes headstrong and often ferociously independent woman, the importance of interdependence, the importance of taking care, and the importance of being cared for. It's a necessary part of being human and being connected to the world around us that we realize and acknowledge our vulnerability and the vulnerability of all creatures, and that we act in accord with that knowledge. It is critical that we allow the empathetic and altruistic part of ourselves to be the guiding force behind the way that we conduct our lives, whether we give to those less fortunate than ourselves, take care of the magnificent creatures that share our world, work tirelessly to preserve native habitat, or separate each strand of an unruly mass of hair so gently that we do not wake our loved one as she sleeps."

This quiet, delightful, and wonderful book is well worth reading. JWR

Reviewer Louise A. Shimmel is director of the Cascades Raptor Center in Eugene, Oregon.

Among the Bears: Raising Orphan Cubs in the Wild

by Benjamin Kilham and Ed Gray

New York: Owl Books, 2003; 304 pages; U.S. $15 (paperback)
ISBN 0-8050-7300-0

I really, really (did I mention *really?*) like this book. A rehab friend read it first, raved about it, and let me borrow it. By the time you're about 50 pages into it, I defy you to not "like" Benjamin Kilham and wish you could spend a week with him, as well as his furry ursine charges. Kilham is a naturalist, a woodsman, and a licensed wildlife rehabilitator who suddenly has two orphaned bear cubs (that's the first litter—others follow) to rehabilitate so that they can be successfully released back into the northeast woods. The author tells an engrossing, light-hearted story, all the while ensuring readers retain a respect for the inherent wild nature of bears. There were so many humorous stories in this book I lost track of them all—how could there not be with such endearing pranksters as black bear cubs?

Kilham provides new insights into bear behavior (ethology) that may prove to be a milestone in the study of animal behavior. For instance, black bears exhibit intricate systems of communication, cooperation, insight, planning, deception, and even ethics like fair play, empathy, and altruism—behaviors previously thought to be found only in humans and great apes.

Do yourself a favor: find this book at your local library (better yet, go buy a copy—I'm sure all Kilham's profits go back into a good cause). Not only will you find yourself laughing a lot, you'll be changed forever in the way you look, think, and perhaps, even act, towards bears. JWR

Reviewer Kat Milacek is a raccoon rehabilitator at Rascal's Retreat Wildlife Rehabilitation Center in the Dallas-Fort Worth, Texas, metroplex area.

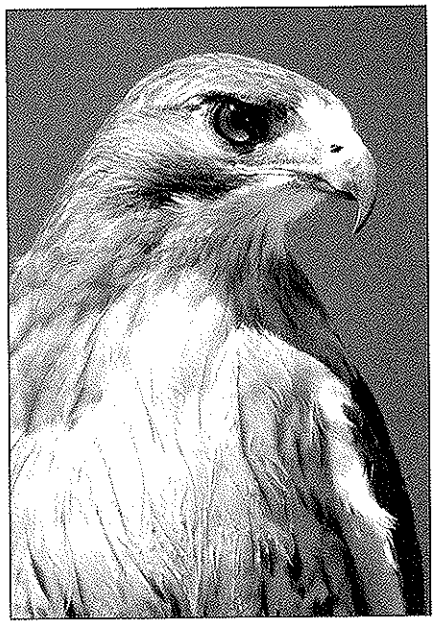
Arrowhawk

by Lola M Schaefer, illustrated by Gabriela Swiatkowska

New York: Henry Holt and Company, 2004; 32 pages; U.S.$16.95
ISBN: 0-8050-6371-4

Based on a true story (that was unfortunately repeated recently in Pennsylvania), *Arrowhawk* is a beautifully illustrated children's book about an immature red-tailed hawk that is shot with an arrow by a poacher. He survives the initial injury and starts his migration despite his handicap, which makes it difficult for him to bend over and eat, or land in anything other than the most open conditions. In fact, at one point when trying to land in a tree, he gets stuck and ends up breaking a leg. He is, seen by several concerned citizens, trapped, treated, and ultimately released. The story is told from the bird's perspective, and the small amount of text does not go into anything other than the experience the bird himself is having—no why's, or who's, or even how long's.

In the back, however, the true story on which the book is based is expounded in more detail. The author followed news releases of an incident that took place in Michigan and Indiana (no year is given)



RED-TAILED HAWK (*BUTEO JAMAICENSIS*) PHOTO BY BETH JACKSON/USFWS

of an immature hawk seen on migration. He survived some eight weeks, apparently, with this arrow, and once reports were received of his being in the same place for several days in a row, a "raptor biologist" (defined as a "person educated and trained to treat injured birds of prey"—what a lost opportunity!) enlists the help of a falconer to trap him. At a raptor center, he was X-rayed, operated upon, treated with antibiotics, had his feathers imped, was re-conditioned in a flight cage and on a creance line, and ultimately released six weeks later.

The author has sadly failed to grasp what wildlife rehabilitation is called and besides the mis-definition quoted above, she again loses a great chance to make our work a household term. In an otherwise excellent conservation message on the last page, she defines raptors, catalogues some of the problems they encounter, and talks about the importance of the education of our "future citizens" being done by "Conservation officials and raptor biologists ... licensed and trained professionals (who) visit schools and youth clubs with live presentations."

Despite this, *Arrowhawk* is a good book for younger readers. The illustrations are well done; the message is clear that poaching is bad, that this bird deserves to be free. The overall approach is straightforward and not at all syrupy or emotional, making it a good book to recommend to teachers before a class visit! JWR

Reviewed by Louise A. Shimmel.

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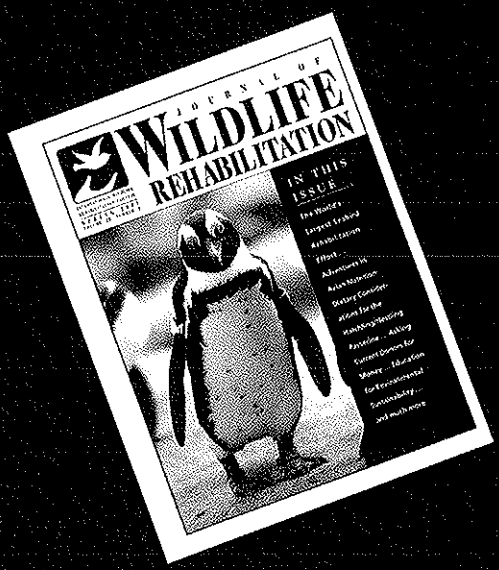
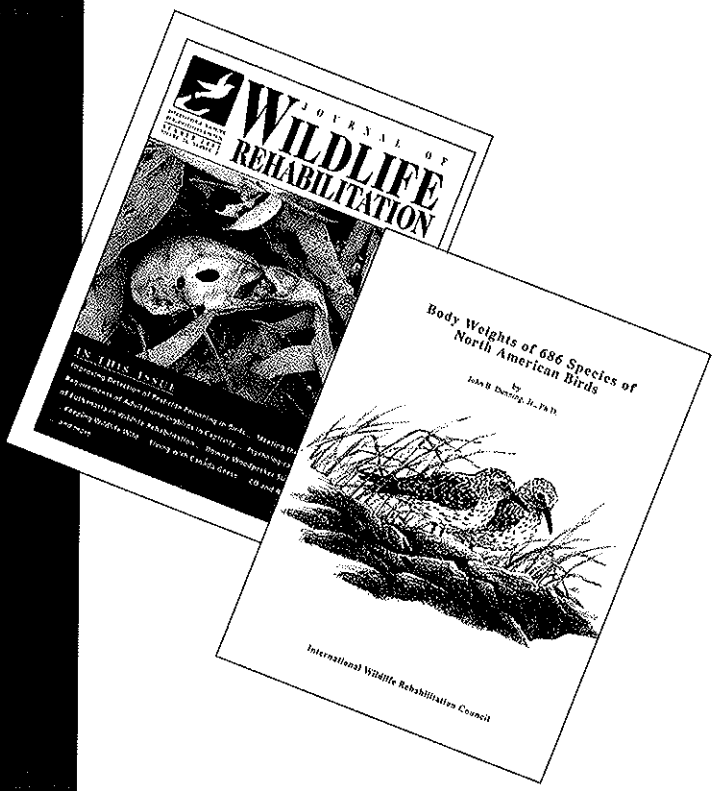




IWRC recently launched an online marketplace, dubbed The Online Store. You can now purchase journals, manuals, conference proceedings, and more with the click of a few buttons.

A few of the more difficult publications to find are also available, such as *American Wildlife Food & Plants—A Guide to Wildlife Food Habits,* which gives detailed information on the use of trees, shrubs, weeds and herbs by birds and mammals of the United States.

To access The Online Store, simply go to www.iwrc-online.org and click on THE ONLINE STORE link.

Fecal Parasite Likely Reponsible for Otter Deaths

The California Department of Fish and Game has discovered that *Sarcocystis neuronaa*, a single-celled parasite found in the feces of opossums, was the likely cause of death for 62 southern sea otters (*Enhydra lutris nereis*) along the state's central coast in April 2004.

The otters were found dead, in comas, or suffering from muscle tremors and seizures. The parasite travels to the brain, causing neurological damage.

Sea otters are also dying from another parasite, *Toxoplasma gondii*, found in cat feces. Scientists believe both parasites end up in storm runoff to the ocean, and then are concentrated by ocean filter feeders such as shellfish—which are eaten by the otters. The loss of wetlands, which filter pollutants, is critical in this cycle.

Scientists are unsure why so many otters were affected by the parsite this year; typically, up to six otters each year die from the opossum parasite. It is possible that a combination of the parasite and the marine toxin known as domoic acid led to the record 62 deaths.

Today only 2,500 southern sea otters remain in the wild. The number is down from the millions estimated before widespread hunting for pelts. The otter was placed on the U.S. endangered species list in 1977. JWR

Demand for Bushmeat Is Killing Great Apes

In the Democratic Republic of Congo, a thriving bushmeat trade is threatening to wipe out several species, including the eastern lowland gorilla and the bonobo, or pygmy chimpanzee. These apes are found only in Congo.

According to the California-based Bushmeat Project, "A few thousand commercial bushmeat hunters supported by the timber industry infrastructure will illegally shoot and butcher more than $2 billion worth of wildlife this year, including as many as 8000 endangered great apes." If the slaughter continues at the current pace, Africa's remaining wild apes will be extinct within 15 to 50 years, the project says.

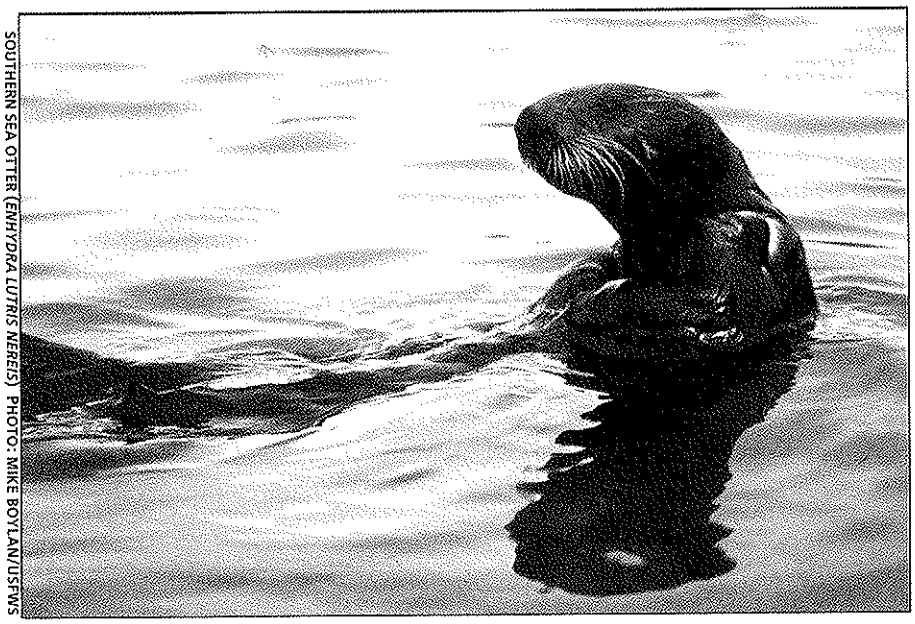
"Bushmeat" is the flesh of apes and other animals living in Africa's bush, or forests. Africa's immense poverty drives the illegal trade. For instance, per capita annual income in Congo averages just $100; however, bushmeat hunters can earn up to $1,100 a year.

With Africa's growing population, and logging and mining companies moving ever further into central Africa's forests, demand for bushmeat is expected to grow by 2–4% a year.

Today in central Africa, an estimated 1 million tons of wildlife is consumed annually by some 24 million people, 80% of whose meat diet comes from the bush.

The most vulnerable chimpanzee subspecies, the *Pantroglodytes vellerosus*, which is found predominantly in Nigeria, could be extinct in two decades. Only 8000 of these chimpanzees remain. The other three chimpanzee subspecies face slightly better odds, but all are expected to disappear in 41–53 years, at current rates of decline.

Illegal hunging is not the only threat these animals A recent United Nations study found that less than 10% of the forest home of Africa's great apes will be left relatively undisturbed by 2030 if road building, construction of mining camps, and other infrastructure developments continue at current levels. JWR



SOUTHERN SEA OTTER (*ENHYDRA LUTRIS NEREIS*) PHOTO: MIKE BOYLAN/USFWS

Finding Solutions to Wildfires

Fire experts from around the world gathered in Sigriswil, Switzerland, in May 2004 to discuss one of the biggest threats to forests today: wildfires. New research could help pinpoint potential fire hotspots, and identify major issues in dealing with large destructive fires and their implications for nature conservation worldwide.

Wildfires have become an important issue in recent years. Each year, major areas are burnt—with terrible consequences for both people and nature. According to the European Forest Fires Information System, 2003's summer heat wave saw more than 25,000 fires in Portugal, Spain, Italy, France, Austria, Finland, Denmark, and Ireland. The total area of forest burnt was 647,069 hectares. More than half—390,146 hectares—were in Portugal, making it the worst forest fire season the country had faced in 23 years.

In most cases, human activities are to blame for damaging wildfires. For instance, 80% of the 1997/1998 fires in Indonesia were due to forest clearance for plantations such as oil palm. In other countries—including the United States, Canada, and Australia, where fire is a natural and necessary process to sustain

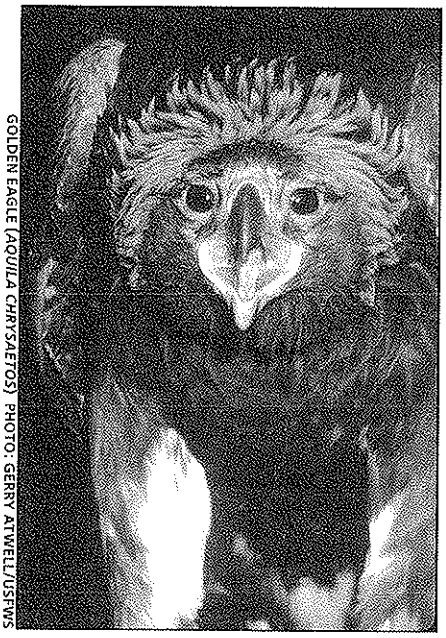
healthy ecosystems—decades of overzealous fire suppression have resulted in unnaturally high fuel levels. These fuels now support huge, intense fires that threaten ecosystems, property, watershed values, and firefighter safety. JWR

Windmills Take Toll on Wildlife

Wind turbines at the Altamont Pass Wind Resource Area (APWRA), located east of the San Francisco Bay, kill more birds of prey than any other wind facility in North America. Since the 7000 giant windmills began operation two decades ago, an estimated 22,000 birds have died after flying into the windmills' spinning blades.

The level of raptor mortality at Altamont Pass is due to its location on a major bird migratory route in an area with high densities of raptors, including the largest concentration of golden eagles in the world. Research indicates that each year Altamont Pass wind turbines kill an estimated 881–1300 birds of prey, including 75–116 golden eagles, 209–300 red-tailed hawks, 99–380 burrowing owls, 73–333 American kestrels, 8–10 great horned owls, 15–24 ferruginous hawks, and 36–49 barn owls. These kills are in violation of federal and state wildlife protection laws such as the Bald Eagle and Golden Eagle Protection Act, Migratory Bird Treaty Act, and several California Fish and Game Code provisions.

Raptor experts recommend the following measures to prevent, eliminate, or greatly reduce avian mortality at 20: retiring particularly lethal turbines; relocating turbines out of canyons; moving isolated turbines into clusters; increasing the visibility of turbines to birds; retrofitting power poles to prevent bird electrocutions; discontinuing the rodent poisoning program; and managing grazing to encourage rodent prey away from turbines.



GOLDEN EAGLE (*AQUILA CHRYSAETOS*) PHOTO: GERRY ATWELL/USFWS

The Center for Biological Diversity, Californians for Renewable Energy, and Golden Gate Audubon Society have appealed Alameda County's recent approval of 29 permits for wind turbines at Altamont Pass. The permits were approved with no environmental review, are either of indefinite duration or 20-year permits, have no requirement that the permit holders reduce bird mortalities, and contain no effective mitigation measures to reduce or compensate for ongoing bird kills.

The Alameda County Board of Supervisors will hear the appeal of the permits in September 2004. JWR

Groups Seek Trade Sanctions against Malaysia for Illegal Logging

In March 2004 a coalition of environmental groups formally requested the Bush Administration to impose trade sanctions against the government of Malaysia in response to that country's role in illegal logging. The logging is driving a critical number of endangered species toward rapid extinction. The organizations petitioned Secretary of the Interior Gale Norton under the Pelly Amendment, which authorizes the U.S. President to impose trade sanctions against any foreign country whose nationals are found to be undermining international measures to protect endangered species.

The petition, signed by the Environmental Investigation Agency, Defenders of Wildlife, Rainforest Action Network, Sierra Club, and the Orangutan Foundation International, points to evidence of widespread involvement by Malaysian citizens and companies in smuggling huge volumes of illegal ramin wood onto world markets from Indonesia, where it is being illegally cut in national parks and protected areas. These areas provide the most important remaining habitats for the world's dwindling orangutan populations and 125 other globally threatened species, including the Sumatran tiger and Asian elephant. Experts predict orangutans could disappear from the earth in as little as a decade if illegal logging and other threats aren't reversed.

Ramin is a valuable, blond hardwood in high demand for baby cribs, picture frames and pool cues in the United States, Europe, and elsewhere. It is listed on Appendix III of the Convention on International Trade in Endangered Species (CITES); the orangutan is listed on Appendix I. CITES requires exporting countries to provide proof that the ramin being shipped actually originated in the exporting country. Malaysia and Indonesia provide the only habitats for ramin, and Indonesia has banned export of its ramin logs since 2001. Illegal Indonesian ramin is being laundered through Malaysia onto global markets, accompanied by papers falsely declaring the wood to be of Malaysian origin. This illegal trade is conducted in plain view of Malaysian authorities, who have refused to support the CITES controls or take needed actions to stop the trade.

Under the Pelly Amendment, the Secretary must investigate the allegations in the petition and promptly decide whether actions by Malaysian nationals are "diminishing the effectiveness" of international programs for the protection of endangered species, such as CITES. If the Secretary determines that these international programs are being undermined, she must certify that fact to the President, who will then have 60 days to impose trade sanctions on Malaysia or else explain to Congress why sanctions are not appropriate. JWR

African Clawed Frogs in San Francisco

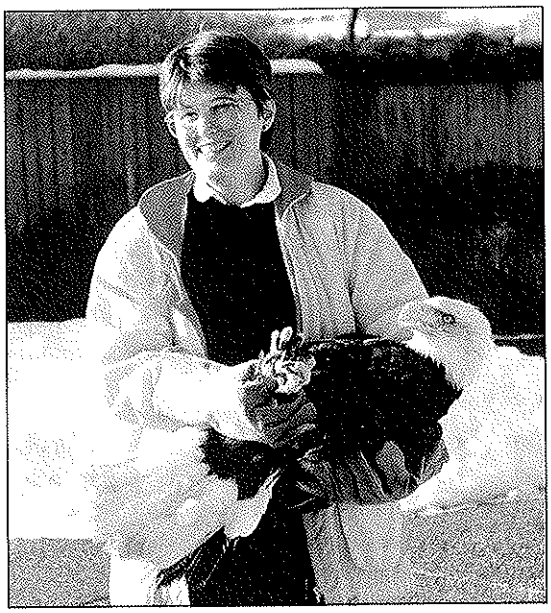
Biologists in San Francisco are alarmed over the latest invasive species to take up residence in this city: African clawed frogs.

Native to Kenya, the hardy frogs breed easily and are able to live under ice, in the ground, and in salty water. Their varied diet includes insects, fish, lizards and birds; they also prey on California's endangered red-legged frog.

Outlawed as pets in California several years ago, African clawed frogs, are used in medical and biological research. JWR

Remembering Marlys Bulander

by Marge Gibson, Raptor Education Group International (Antigo, Wisconsin)



Migratory birds, wildlife rehabilitation, and United States Fish and Wildlife Service (USFWS) lost a wonderful friend on 15 April 2004. Marlys Bulander, USFWS Region 3 Permit Administrator passed away after a valiant battle with cancer, just 12 days after she retired. Marlys will always be associated, in the eyes of many, with positive change in USFWS. She will be remembered as the person who gave credibility back to the agency following turbulent years.

I had the honor of knowing Marlys Bulander for nearly two decades. I will never forget my first meeting with her. I left confused, wondering if the person I experienced was *real*. I soon found Marlys was not only real but overflowed with attributes I, as a biologist and avian rehabilitator, longed for in the government agency charged with protecting migratory birds.

Marlys took her position with USFWS seriously. Simply put, she was there to do the best job possible protecting migratory birds while serving the public that relied on her. She chose to educate herself at every opportunity, not only in wildlife rehabilitation, but in all activities covered under the blanket of her permits position. She listened to individuals and made up her own mind as to their credibility. As rehabilitators strived to raise the bar for our profession, Marlys was raising the standard for the position she held as well.

Marlys genuinely cared about migratory birds and rehabilitation efforts. She understood, perhaps better than many of us at the time, that wildlife rehabilitation was at a critical stage. As we in the International Wildlife Rehabilitation Council and in the National Wildlife Rehabilitation Association struggled to clarify our mission and our role in wildlife professional communities, and to further develop minimum standards of self-regulation, Marlys was there, encouraging us, sharing our frustrations, and working tirelessly at our side. She translated our efforts to the federal agency, and underscored to both the USFWS and wildlife rehabilitators that we shared a common ground and mission when it came to migratory birds. Marlys laid the groundwork for our developing a mutual trust and understanding.

Those of us who had the privilege of knowing Marlys were very lucky. She led by example and made even the most resistant, better people because of it. She was honest, gentle, and compassionate—and at the same time was one of the most steadfast and tough USFWS employees ever encountered, particularly when it came to dealing with those who broke the law or inflicted harm on migratory birds. Because Marlys was so respected, her position and the federal agency also gained respect. Knowing you were going to be dealing with Marlys at the regional level was enough to make permit holders of many stripes make sure they were doing things *right*.

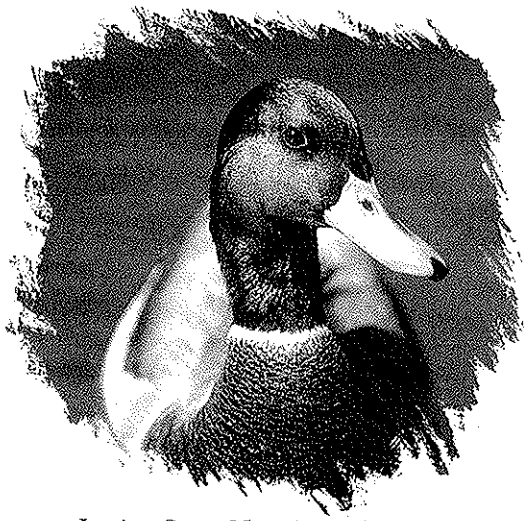
Marlys was a friend, a confidant, a professional partner. She shared her life, offered always sage advice and somehow skillfully integrated it into our life and profession. She managed to do it all while maintaining professional integrity above reproach. It was an impossible task, yet she managed.

Marlys Bulander will be remembered for many reasons. She was honored by both IWRC and NWRA for her contributions, however, no awards or accolades could truly reflect the depth of our appreciation or the impact she had on wildlife rehabilitation in the United States. We wildlife rehabilitators take pride in the progress our field has made in the past 20 years. It took the work of many of us to reach this point. Yet without this incredible woman smoothing the rough spots along the way, wildlife rehabilitation would not have the professional standing it presently enjoys

Rest in peace, Marlys. You have left your clear footprint and made a difference in this complex world. You made those that knew you or even knew of you, better people with your gentle guidance. We will never forget. JWR

HAL STOELTZLE

An eagle released on 25 April 2004 in Marlys Bulander's name, takes flight.



Laying-Stage Nest Attendance and Onset of Incubation in Prairie Nesting Ducks

by E. R. Loos and F. C. Rohwerb

The Auk 121(2): 587–99

The authors used microprocessor data logs to document patterns of nest attendance during the laying season to quantify temperatures of dummy eggs during laying for mallard (*Anas platyrhynchos*), blue-winged teal (*A. discors*), northern shoveler (*A. clypeata*), northern pintail (*A. acuta*), gadwall (*A. strepera*), green-winged teal (*A. crecca*), American wigeon (*A. americana*), and lesser scaup (*Aythya affinis*) nesting in southern Manitoba in 1994 and in northeastern North Dakota in 1995–1997 and 2000–2002. Females of all species increased the time they spent on the nest as laying progressed, but species differed in their pattern of increased attendance. Female blue-winged teal and northern shoveler that laid smaller clutches increased the time they spent on the nest more rapidly than conspecifics that laid larger clutches, but large- and small-clutch conspecifics had similar attendance at the end of the laying period. Attendance during laying was not influenced by low ambient temperature, precipitation, or nest initiation date. For all species combined, maximum egg temperatures increased as laying progressed. Eggs were heated to temperatures sufficient for embryonic development as early as the day that the second egg was laid. These findings contradict the prevailing paradigm that incubation in waterfowl begins after clutch completion and raise questions about how hatching synchrony is achieved. The authors relate their findings to two hypotheses (nutrient limitation and viability-predation) that have been proposed to explain the limits to clutch size in ducks. *[©2004 Am. Ornithologists' Union]*

Fruit Abundance and Local Distribution of Wintering Hermit Thrushes (*Catharus guttatus*) and Yellow-Rumped Warblers (*Dendroica coronata*) in South Carolina

by C. Kwit, D. J. Levey, C. H. Greenberg, S. F. Pearson, J. P. McCarty, S. Sargent, and R. L. Mumme

The Auk 121(1): 46–57

The authors conducted winter censuses of two short-distance migrants, hermit thrushes (*Catharus guttatus*) and yellow-rumped warblers (*Dendroica coronata*), over seven years in five different habitats to determine whether their local abundances could be predicted by fruit pulp biomass. Sampled habitats were stands of upland and bottomland hardwood, loblolly pine (*Pinus taeda*), longleaf pine (*Pinus palustris*), and young (< 10 years) longleaf pine. Hermit thrush abundance, which was highest in bottomland hardwood habitats, was positively related to total dry mass of fruit pulp. Those results are consistent with the hypothesis that resource availability affects the local distribution of migrant passerines on their wintering grounds. The results also indicate that bottomland hardwood habitats in the southeastern United States may be especially important to wintering hermit thrushes. Yellow-rumped warbler abundance was correlated with ripe-fruit pulp dry mass of *Myrica cerifera*, a major source of winter food for that species. However, because *M. cerifera* pulp dry mass was confounded with habitat type, it was not possible to distinguish the relative importance of fruit resources and habitat for yellow-rumped warblers. The results underscore the importance of fruit to wintering birds. However, the overall percentage of variation in winter bird abundance explained by differences in ripefruit biomass was modest, indicating that other factors are also important. *[© 2004 Am. Ornithologists' Union]*

Arthrodesis as a Treatment for Metacarpophalangeal Joint Luxation in Two Raptors

by A. J. Van Wettere and P. T. Redig

J. Avian Medicine and Surgery 18(1): 23–29

Two raptors, a juvenile prairie falcon (*Falco mexicanus*) and an adult female great horned owl (*Bubo virginianus*), were presented with luxation of the metacarpophalangeal joint. Additionally, the falcon had a distal metacarpal articular fracture, and the owl had an open wound at the luxation site. After supportive care, both birds were treated by arthrodesis of the metacarpophalangeal joint. A Type 1 external skeletal fixator was applied to stabilize the joint and to allow bony fusion to occur. Bony fusion occurred in 6 weeks in the falcon and 9 weeks in the owl. Full flight capacity was restored, and both birds were released into the wild. Arthrodesis represents a viable option for the treatment of metacarpophalangeal joint luxations or articular fractures of the associated bone in avian species when treatment by reduction and stabilization fails. *[©2004 Assn. of Avian Veterinarians]*

Avian Mycobacteriosis in Free-Living Raptors in California: Six Cases (1997–2001)

by L. A. Tell, S. T. Ferrell, and P. M. Gibbons

J. Avian Medicine and Surgery 18(1): 30–40

Avian mycobacteriosis has been documented commonly in poultry, companion birds, and birds in zoological collections or wildlife parks. However, reports in free-ranging raptors are relatively rare. The authors describe six cases of mycobacteriosis in free-living raptors. Four red-tailed hawks (*Buteo jamaicensis*), one red-shouldered hawk (*Buteo lineatus*), and one great horned owl (*Bubo virginianus*)

were presented for examination after being found on the ground unable to fly. Common clinical findings in these birds included coelomic distention or palpable coelomic mass, nonregenerative anemia, and leukocytosis characterized by heterophilia, monocytosis, and lymphopenia. Results of radiography, ultrasonography, coelomoscopy, and biopsy, in combination with acid-fast staining of specimens obtained by biopsy or fine-needle aspiration, provided evidence of a presumptive diagnosis of mycobacteriosis. All birds were euthanatized (n = 5) or died (n = 1). At necropsy, diffuse granulomas with intralesional acid-fast bacilli were present in all birds. Mycobacteriosis was confirmed by culture in four birds, and polymerase chain reaction testing confirmed *Mycobacterium avium* in three of these four birds. On the basis of clinical and postmortem findings, mycobacteriosis should be considered as a differential diagnosis in adult raptors that are found debilitated and in poor body condition. Detection of acid-fast bacilli in biopsy or necropsy specimens allows a presumptive diagnosis of mycobacteriosis; however, definitive diagnosis requires mycobacterial culture or polymerase chain reaction analysis. *[©2004 Assn. of Avian Veterinarians]*

MAMMALS

Experimental Infection of White-tailed Deer (*Odocoileus virginianus*) with *Ehrlichia chaffeensis* by Different Inoculation Routes

A. S. Varela, D. E. Stallknecht, M. J. Yabsley, V. A. Moore, W. R. Davidson, and S. E. Little
J. Wildlife Diseases 39(4): 881–86

The infection dynamics of the tick-transmitted organism *Ehrlichia chaffeensis* were investigated in white-tailed deer (*Odocoileus virginianus*) using different routes of inoculation. Six deer were each inoculated with 5.4Å~106 DH82 cells infected with *E. chaffeensis* (Arkansas strain) by three different routes: intravenous (n=2), subcutaneous (n=2), and intradermal (n=2). Two control deer were inoculated with uninfected cells. Infections were monitored for 54 days and were continued in one deer from each *E. chaffeensis*-inoculated group for an additional 31 days. All deer inoculated with *E. chaffeensis* seroconverted (1: 64) and became 16S rDNA polymerase chain reaction and/or cell culture positive by postinoculation day 15. There was no apparent difference in susceptibility to infection between deer inoculated by different routes for the first 50 days based on detection of *E. chaffeensis* infection by PCR assay of blood or culture isolation. These results demonstrate infection of deer by intradermal and subcutaneous routes for the first time.

Home Range and Movements of Long-Tailed Weasels in a Landscape Fragmented by Agriculture

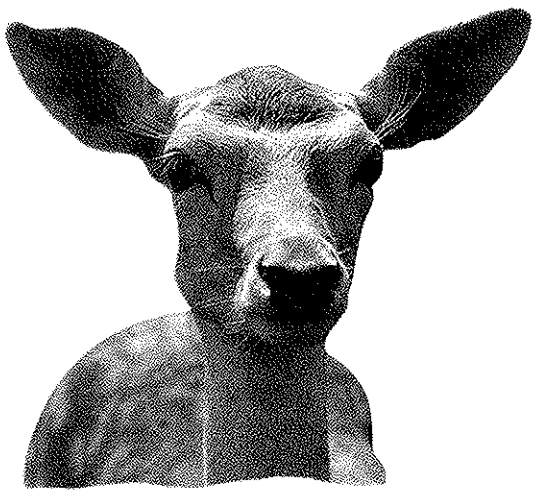
by T. M. Gehring and R. K. Swihartb
J. Mammalogy 85(1): 79–86

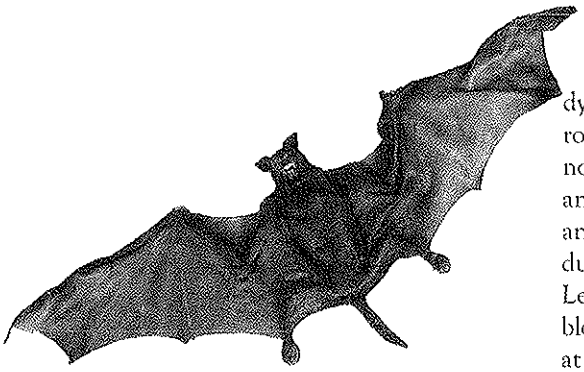
Quantitative assessments of home-range dynamics and movements of long-tailed weasels (*Mustela frenata*) are lacking, despite the importance of these data to understanding how habitat fragmentation influences behavior, ecology, and interspecific interactions. During autumn to late winter 1998–2000, the authors monitored 11 long-tailed weasels (seven male, four female) via radiotelemetry to examine home-range dynamics and movement rates in an Indiana landscape fragmented by agriculture. Mean (± SE) 95% adaptive kernel contour area for adult females and adult males was 51.8 ± 8.1 ha and 180.3 ± 60.3 ha, respectively, and differed significantly. Hourly rate of movement for male long-tailed weasels (130.5 ± 12.7 m) was greater than that of females (79.2 ± 13.5 m). Weasels demonstrated greater hourly rates of movement during the fallow season (138.2 ± 12.8 m) compared with the preharvest season (63.0 ± 11.2 m). Mean hourly rates of movement were lower in corridors, forest patches, and grassland patches compared to crop fields. Mean hourly rate of movement was positively related with home-range size ($P < 0.001$) with the greatest rates of movement in the largest home ranges. Mean hourly rate of movement varied inversely with prey biomass ($P = 0.07$). The results are consistent with the notion that long-tailed weasels may be sensitive to agriculturally induced fragmentation of habitat and the importance of maintaining landscape connectivity for species conservation. *[©2004 Am. Society of Mammalogists]*

Use of Tidal Marsh and Upland Habitats by the Marsh Rice Rat (*Oryzomys palustris*)

by B. L. Kruchek
J. Mammalogy 85(3): 569–75

Marsh rice rats (*Oryzomys palustris*) inhabit wetlands and occasionally occupy adjacent uplands. The author hypothesized that demographic factors, environmental factors, and/or prey availability influenced their use of upland habitats. Rice rats were monitored on livetrap grids that extended from low marsh through upland habitats near Galveston, Texas. Diet was determined from fecal samples, and regression models evaluated influence of environmental factors on upland use. Density was highest in wetlands during summer and autumn and highest in uplands during winter and spring when tides were high and temperatures low. Adults were more common in wetlands, and juveniles were more frequent in uplands, whereas abundance of subadults was similar in wetlands and uplands. Rice rats ate primarily aquatic organisms and wetland vegetation in both habitats; upland plants were a minor component of the diet of rice rats in uplands. I conclude that uplands were not primary foraging areas but served as sink habitats for dispersers and as refuges during high tides. Given the highly fragmented nature of these wetlands, uplands may have significant conservation value as sinks in a metapopulation. These results support views that current laws for wetland delineation are ecologically incomplete because uplands are not protected and that buffer habitats or transitional areas adjacent to wetlands should be included





in legislation and management plans. [©2004 Am. Society of Mammalogists]

Food Hardness and Feeding Behavior in Old World Fruit Bats (Pteropodidae)

by E. R. Dumont and R. O'Neal
J. Mammalogy 85(1): 8–14

Old World fruit bats (family Pteropodidae) are common throughout the Paleotropics, where they play an important ecological role as seed dispersers and pollinators. Although many regions host diverse assemblages of fruit bats, mechanisms of resource partitioning are only beginning to be documented. This study investigates the potential role of feeding behavior in patterns of resource use within a sympatric assemblage of pteropodids from Papua New Guinea. Individuals of *Syconycteris australis, Dobsonia minor, Pteropus conspicillatus, Nyctimene albiventer,* and *Paranyctimene raptor* were videotaped during feeding experiments designed to elicit shifts in feeding (biting) behavior by varying fruit hardness. Although significant variation exists among species in biting behavior, the clear association between trophic ecology and feeding behavior seen in New World fruit bats does not exist in this assemblage of Old World species. Rather, the combinations of behavior and morphology exhibited by these bats appear to represent two different solutions to the ecological challenge of feeding on relatively hard fruits. [©2004 Am. Society of Mammalogists]

Colony Dynamics of *Leptonycteris nivalis* (Mexican Long-Nosed Bat) Related to Flowering *Agave* in Northern Mexico

by A. Moreno-Valdez, R. L. Honeycutt, and W. E. Granta
J. Mammalogy 85(3): 453–59

The authors analyze the population dynamics of the migratory and nectarivorous *Leptonycteris nivalis* (Mexican long-nosed bat) in relation to food abundance and environmental factors (temperature and humidity). A 2-year study was conducted in the Mexican state of Nuevo Leon. Bat densities and the number of blooming *Agave* were estimated by month at El Infierno cave and surrounding areas. Temperature and humidity were recorded at 4.5-h intervals inside and outside the bat roost. Bat density was estimated visually, and the number of blooming *Agave* was counted in 70 fixed plots along three road transects within a 50-km radius of the cave. Examination of data indicates that abundance of *L. nivalis* at El Infierno cave is correlated with the frequency of blooming *Agave* and ambient temperature. However, cave temperature, humidity, and external humidity were not correlated with bat numbers. These findings suggest that conservation of this federally protected bat will require maintenance of relatively large areas of wild *Agave*. [©2004 Am. Society of Mammalogists]

Timing and Synchrony of Ovulation in Red Deer Constrained by Short Northern Summers

by R. Langvatn, A. Mysterud, N. C. Stenseth, and N. G. Yoccoz
Am. Nat. 2004. (163): 763–72

Iteroparous mothers often face a trade-off between further investments in current offspring at the expense of the start of the next reproductive cycle. In the strongly seasonal environments at northern latitudes, large herbivores are typically calving in early summer each year to get a long growth season and to hit peak protein levels of vegetation. Late-born offspring are more likely to die since they are smaller in autumn. Low female condition in autumn due to prolonged investment in current-year offspring may lower her ability to ovulate sufficiently early to get a good start for the calves the following spring. On the basis of autopsies of uteri from 10,073 red deer (*Cervus elaphus*), the authors show that ovulation was delayed as well as more synchronous with increasing population density. This suggests that ovulation beyond a certain date incurs some fitness costs. Ovulation occurs progressively earlier with increasing age up to around 13 yr of age, after which ovulation again occurs later. Low ovulation rates in young compared with prime-aged deer were correlated with late ovulation in the fall. Also, yearling groups with a low rate of ovulation (e.g., because of low weight) also ovulated later, and old senescent deer not calving the previous year ovulated less frequently and markedly later than those raising a calf. The findings suggest, that mothers unable to ovulate before a certain date fail to do so altogether that year. [©2004 University of Chicago]

CONSERVATION

The Limited Potential of Ecotourism to Contribute to Wildlife Conservation

by J. C. Isaacs
Wildlife Society Bulletin 28(1): 61–69

Ecotourism has been proposed as a viable economic activity that can minimize negative human impacts on wildlife habitat and provide an incentive to preserve natural areas. The potential of ecotourism as a wildlife conservation strategy is limited by its inability to insure the long-term protection of environmental assets and by its tendency to contribute directly to environmental degradation. Ecotourism is a proxy market designed to align consumers' preferences for recreation with the protection of environmental assets. Because it does not necessarily address the direct protection of those assets, it is prone to market failure. Pressures on governments and firms involved in providing ecotourism services will impair their ability to minimize detrimental effects of human economic behavior. Ethical appeals to minimize harmful practices face serious obstacles. Promoting ecotourism may actually distract from more appropriate means of environmental protection.

KEEP IT CLEAN!

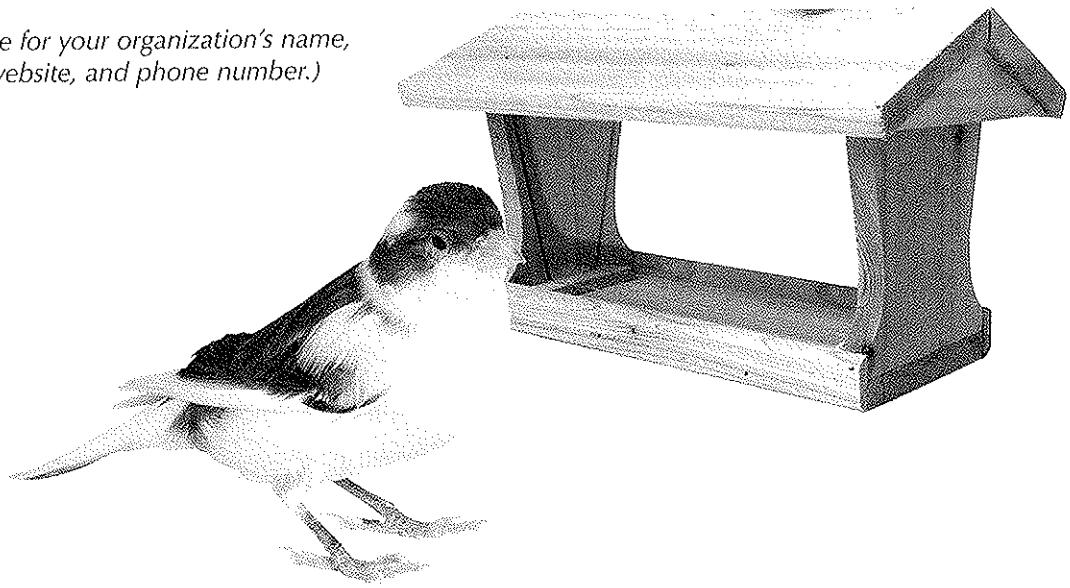
Bird feeders offer a wonderful way to observe the variety of birds in your area. But if they're not kept clean, feeders can help spread salmonellosis, trichomoniasis, avian pox, aspergillosis, and conjunctivitis—diseases that are fatal to birds.

So keep your bird feeders safe. **Clean the area around your feeders of waste food and droppings.** (A boom and shovel are good, but a heavy-duty vacuum cleaner is even better.)

Buy feeders that can be easily sterilized. **Clean and disinfect your feeders** by fully immersing them in a 10% bleach solution (1 part household bleach to 9 parts water) for 2–3 minutes. Allow them to air dry. Once or twice a month is generally often enough, but clean weekly if you notice sick birds at your feeders.

Finally, **spread the word!** Encourage neighbors who also feed birds to "keep it clean." Birds normally visit several feeders and can spread diseases as they go.

(This space for your organization's name, address, website, and phone number.)



The IWRC brings you this information from the National Wildlife Helath Center (www.nwhc.usgs.gov)

TAIL END

by Kieran Lindsey

GREAT EGRET (*CASMERODIUS ALBUS*) PHOTO: LEE KARNEY/USFWS

"This is what I get for canceling my chiropractic appointment!"