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IN THIS ISSUE

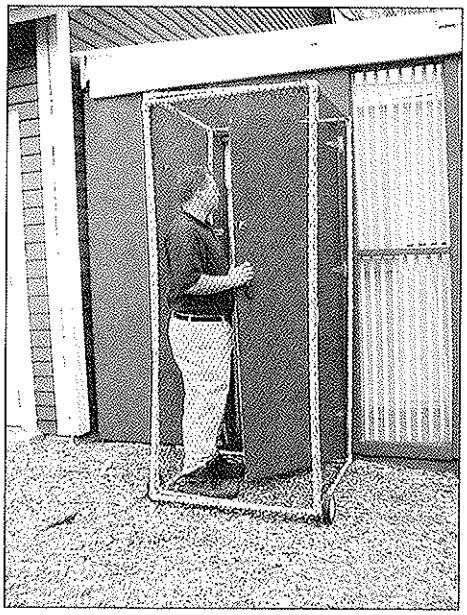
Food for insects and insects as food: Viable strategies for achieving adequate calcium ... Goals, impediments, and relationships in wildlife rehabilitation ... Building a mobile double door for your mews/aviary ... Two new columns: Forester's Log and Bugs & Drugs ... Sarcoptic mange in red foxes ... and more

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: Red fox (*Vulpes vulpes*) is the species most dramatically affected by sarcoptic mange. In the eastern United States, this disease has a significant impact on the red fox population. [see page 33; photo: U.S. Fish and Wildlife Service]

BELOW: This inexpensive mobile double door for a mews or aviary is lightweight and easy to move. Learn how you can build one on page 23. [photo: Debby Farley]



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EDITORIAL

The Only Constant Is Change

In the past several years wildlife and wildlife rehabilitation have been plagued with one problem after an other. West Nile virus, chronic wasting disease, exotic Newcastle disease...at times it seems that all the news is bad. Rehabilitators and others who work with wildlife have been shocked into a new reality: just when everything seemed to be going so well, invisible, pervasive enemies changed things over night and modified the playing field — perhaps forever. The losses are debilitating, the blow to confidence disheartening. It is sometimes difficult not to dwell on the bad news, because there seems to be so much of it.

But there is good news as well. Research is unveiling the most impenetrable of mysteries and yielding invaluable information about the functioning of our biosphere and all living things. Through research we learn. Through learning we teach. Through teaching we move forward together to better handle our crises, to develop more advanced techniques, and ultimately to complete the learning circle by engaging in newer and more innovative research.

There is more good news. Technology—in all its multidisciplinary incarnations—has made many areas of our lives easier, and wildlife rehabilitation is no exception. We have many tools with which to work today—from endoscopes to the Internet, from new treatments to improved dietary formulations, from successful enrichment protocols to new training techniques.

IWRC came into being 31 years ago, an organization born of the vision of its founders. The vision was about teaching and sharing—the passionate ideal of a dozen dedicated and like-minded individuals. For more than three decades, IWRC has been sharing knowledge with wildlife rehabilitators, giving rise to wildlife professionals who are increasingly better equipped to face the challenges of their profession. Basic Skills 1AB has been taught to many thousands of individuals in those 31 years; it has become the standard by which rehabilitators are judged, and by which they judge themselves. No idle boast, this comes from rehabilitators themselves.

But training can be a slippery slope. In every state, province, and region, someone is offering information; the Internet is awash with training courses, and more appear every month. Is the information reliable? Are techniques and protocols tested and up-to-date?

IWRC is about to steer a bold new course. Led by the successful Basic Skills 1AB seminar and supported by a completely reworked website, in the near future, IWRC will offer wildlife professionals and soon-to-be professionals a new set of possibilities and options. Students will be able to take instructor-led or Internet-delivered courses. They may choose to take continuing education courses for their own benefit, or to earn a certification in a particular area. New tracks will allow students to pursue their own interests—whether those interests are education, wildlife program development, or advanced rehabilitation for particular species or orders.

Throughout its history IWRC has always insisted on the peer-review process. It is only by careful and critical evaluation by one's peers that one's information becomes valuable, reliable, and trustworthy. The process that makes the *Journal of Wildlife Rehabilitation* such a respected periodical is being used to provide the critical review of our training development. A new committee has been charged with the responsibility of assuring that all IWRC seminars are as current as today's research findings.

We think you're going to like IWRC's direction in our next 31 years. Building on the foresight of our founders, we are bringing our organization up a notch. The message and mission remain the same: conserving and protecting wildlife and wildlife habitat through wildlife rehabilitation.

—*Joe MacLeod*
IWRC President

Submitting to the Journal

Dear Editor,

Can anyone submit an article to the journal? Why do the articles have all those references? I'd like to submit an article but don't feel I write well enough. Is there anyone who would help me write something?"

Dear Potential Submitter,

Yes, anyone can submit an article to the *Journal of Wildlife Rehabilitation*. Whether or not it can be accepted is another question, however. The journal publishes papers that fall into several categories. Some are rehabilitation notes, some are research papers, some are reviews, and some are descriptions of techniques. Each of these must be written based on a particular template, which can be obtained from the editor or the chair of the publications committee. (See inside back cover for contact information). These templates are provided so that papers will contain the kinds of information needed to provide a valuable document to our readers.

References are required for several reasons. The references that are just a list of resources at the end of a document are those that an author may have used to develop the submitted paper. They are useful in that they not only provide other suggested sources in which the reader may find additional information, but they also show the reader that the author is familiar with past literature on the subject and is relating this new information to previously created work. The new information may be adding additional support to previous work, or may be calling previous work into question. In any case, the credit for having done the previous work is given to those who did it. If that credit is not given, it may appear that the author believes he/she did it all, or has just fantasized the new information, which is usually not the case. We all build on previously observed material, we all look for support and confirmation of our own work, and it is important that we are familiar with the history of the subject.

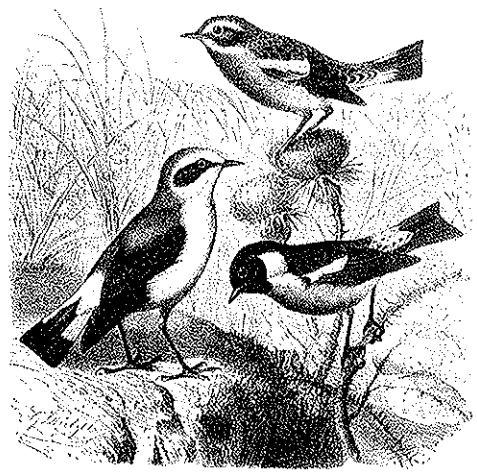
"In-text" references are those in which a statement of fact is supported by very specific identification of the previous source. When someone writes, "It has been said that the heavens revolve around the earth," the reader usually wants to know by whom and when, so the reference is included in parentheses immediately after the statement (The Vatican c1600). Then, in the list at the end of the paper, the more specific citation is included. This might appear as "The Vatican. 1500. Cardinal Bellarmine, under order of Pope Paul V." Someone who really wants to know more about the context in which "it has been said" can go directly to that discussion and learn more.

The journal publishes other kinds of papers too, papers that may not include many references. We encourage reports on case studies, and Success Stories which are a particular form of case study. Simple Solutions suggest innovative ways to answer problems met by rehabilitators and their associates. We have several columns for which certain people write four each year. These authors may change from year to year.

We welcome book reviews and news reports. We have opportunity for opinions to be expressed through editorials and letters from readers. The letters can ask questions, or just express an opinion on a relevant topic. Since the journal's editors choose the material that will be published, the letters that are chosen will benefit the interest of the community, as the editors see it.

We do have volunteers who can help people who have a tale to tell with the preferred presentation of the story. Many of the submissions from readers whose first language is not English have benefited from the efforts of these wonderful people. For those who feel that they are lacking in the skill to present their information, we will probably have help to offer or suggestions to make.

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.)*



TO OUR READERS

Please join us at the IWRC's 26th annual conference in Illinois this fall. (To submit a paper, see pages 24–25.)

In honor of Susan Meredith Fosco, the IWRC is offering a conference scholarship that provides support toward the cost of attending the conference. For more information and an application, please call 707/846-1761 or send an e-mail to director@iwrc-online.org.

Food for Insects and Insects as Food: Viable Strategies for Achieving Adequate Calcium

by Diane Winn, Shari Dunham, and Szymon Mikulski

ABSTRACT: The calcium deficiencies of insects as foods for captive insectivores are well documented. The corrective strategy of gut-loading insects with high-calcium diets results in poor viability, so can be implemented only for short periods of time prior to using the insects as food. This study examines the calcium and phosphorus levels that result from feeding mealworms, crickets, and waxworms diets with lower calcium levels that can be tolerated long term. Additionally, it empirically evaluates two strategies (dusting with calcium carbonate and dipping in calcium gluconate) for adjusting the calcium content of these insects to meet estimated requirements.

KEY WORDS: invertebrates, insects, calcium, phosphorus, calcium carbonate, calcium gluconate

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General Introduction

The importance of calcium in diets for captive wildlife has been widely noted; it is the mineral most likely to be deficient in these animals (Robbins 1993). Fowler's classic 1986 discussion of metabolic bone disease describes the cluster of conditions resulting from a diet that is low in calcium or that has an improper ratio of calcium (Ca) to phosphorus (P). Growing precocial birds, for example, require dietary levels of Ca as high as 1.3% on a dry-matter basis (DMB); Ca requirements may be even higher in the case of altricial birds (Klasing 1998). The ratio of Ca:P in the diet should be between 1:1 and 2:1 (e.g., Fowler 1986). Of particular concern for captive insectivores is the unfavorable Ca content of almost all insects; recent analyses (Barker et al. 1998, Finke 2002) of commonly cultured invertebrates confirm earlier conclusions that Ca levels of most insects are significantly lower than recommended. As reported by these investigators, the amount of Ca in species such as mealworms (*Tenebrio molitor*), house crickets (*Acheta domesticus*) and waxworms (*Galleria mellonella*) may be as low as, or even lower than, 0.1% (DMB), and the Ca:P ratio 1:10 or even more unfavorable.

There are several strategies for improving the Ca content of cultured insects; one is to "dust" them with a Ca-rich powder such as calcium carbonate ($CaCO_3$). However, as noted by several authors (see, e.g., Donoghue and Langenberg 1996, Wright 2001), it is unclear how much Ca this technique actually adds to the insects; further, unless the insects are consumed immediately, the dust may be removed by the insects' movements or grooming.

A great deal of attention has been paid to another strategy: feeding the insects Ca-fortified diets. This technique has become known as "gut-loading" because (as shown by Allen and Oftedal 1989) the ingested Ca appears to be concentrated in the insects' digestive tracts, rather than incorporated into tissues. The practice seems to have originated with Zwart and Rulkens' 1979 attempt to attain an appropriate Ca level and Ca:P ratio by giving mealworms high-Ca substances as their sole food for 24 hr. Since that study, others have shown that Ca levels and Ca:P ratios of insects vary (directly, if the base diet is standardized) with the level of Ca in the diets those insects consume. This research is summarized below (all insect Ca levels are presented on a DMB).

Gut-Loading Mealworms

As noted, Zwart and Rulkens (1979) may have been the first researchers to feed insects high-Ca foods. Mealworms in their study did not appear to find pure $CaCO_3$ "palatable," but seemed to accept two vitamin/mineral preparations. A Ca level of 0.8% and a Ca:P ratio of about 1.4:1 was achieved by feeding mealworms a substance having about 12% Ca and a Ca:P ratio of 20:1.

A much more comprehensive study was that of Klasing et al. (2000). They created a series of diets based on either wheat bran (0.14% Ca; Ca:P = 1:8) or corn-soybean-meal chick starter (1% Ca; Ca:P = 1.4:1) and supplemented with $CaCO_3$ to achieve levels up to 12% Ca. Overall, substrates based on chick starter produced higher levels of Ca in insects than those based on wheat bran; with the highest level of dietary Ca, mealworms achieved almost 1% Ca and a Ca:P of approximately 1:1. However, because of poor viability at the highest level, the authors recommended restricting dietary Ca to 8%. Time was also a variable in this study; mealworms appeared to fill their digestive tracts within one day. Finally, the Ca in these mealworms was found to be highly available for supporting growth in chickens.

Another investigation published in 2000, this one by Anderson, examined the effects of feeding insects several commercial products having Ca levels ranging from

3–35%. Most of these products produced increases in insect Ca levels relative to the comparison group of insects raised on a "standard" diet of wheat bran and wheat flour, but only the one highest in Ca (a vitamin/mineral supplement) produced insects whose Ca levels were at or near 1% and whose Ca:P ratios were at least 1:1. Insects were maintained on the diets for 24, 48, or 72 hr; the effects were comparable at all durations.

Finke (2003) added varying amounts of $CaCO_3$ to wheat bran to produce diets that contained up to 8% Ca. The Ca in mealworms fed those diets (for 48 hr) increased with dietary Ca up to about 0.55%; Finke presented a regression equation to predict the Ca in mealworms from the Ca in their diets.

Gut-Loading Crickets

Allen and Oftedal (1989) varied the amount of $CaCO_3$ added to a basic diet comprising ground corn, dried alfalfa, soybean meal, and ground wheat; the highest Ca level was about 12%. In general, the concentration of Ca in the crickets increased with the level of Ca in the diet; those maintained on the highest-level diet achieved 1.4% Ca and a Ca:P ratio of 1.7:1. However, the authors noted that very high-Ca diets would compromise viability. Effects of the diets stabilized by 48 hr. Allen, Oftedal, and Ullrey (1993) reported similar findings in a study that examined only two diets having Ca levels of 1% or 8%. Crickets fed the high-Ca diet achieved 1.3% Ca and Ca:P = 1.4:1.

Anderson also examined several cricket diets in her 2000 study. Both high-Ca commercial cricket diets and the vitamin/mineral supplements also used in the mealworm portion of the study increased the Ca levels in the insects relative to a standard feeding condition (a pellet formulated for captive birds in the United Arab Emirates), especially after 48 hr. The best results (approaching 1% Ca and Ca:P = 1:1) were obtained for crickets that had been fed the commercial cricket diet with 12% Ca.

Finke (2003) varied the Ca in diets for adult and nymph crickets in a manner similar to his manipulation of mealworm diets described above (this time, the base diet was a commercial cricket food). As was the case with mealworms, the Ca in insects varied directly with the Ca in their diet (to about 1.3% in adults and 1.8% in nymphs with a diet of about 8% Ca); a regression equation predicting insect Ca from dietary Ca was also presented for crickets.

Gut-Loading Waxworms

Strzelewicz et al. (1985) prepared four diets by adding different amounts of $CaCO_3$ to a basic diet comprised of baby cereal with added honey, glycerol, and water. As expected, the highest levels of Ca in the insects (about 0.3%) and the most favorable Ca:P ratio (about 1.3:1) were achieved with the highest level of dietary Ca (about 8%). Most of the effects increased up to the third day on the diet (the duration limit of the study).

Overview and Rationale for Present Study

Although a solution to the problem of insect Ca levels may appear to have been found in the above-cited papers, that solution comes at the expense of the health of the insect. As noted by Wright and Whitaker (2001), gut-loading diets are not meant to promote insect growth and development; on the contrary, insects may die if fed such diets for more than 48 hr (in fact, Wright [2001] comments that crickets, at least, will die within hours if not given access to sufficient water to allow them to excrete Ca). Insects in general appear to have extremely low requirements for Ca; for them, Ca has a status approaching that of trace minerals (Dadd 1985). Mineral mixtures formulated for vertebrates are typically added to standardized artificial insect diets, but these mixtures are "grossly overladen with . . . calcium vis-à-vis the usages of minerals by insects. The fact that such salt mixtures generally suffice says more for the versatility of insects in coping with mineral imbalances than of their true mineral needs" (Dadd 1985, p. 375). These "salt mixtures" comprise 1% or less of the total weight of the diet, with the amount of Ca in the mixture ranging from about 0.5% to about 14% (Reinecke 1985). McFarlane (1991) reported that cricket growth was optimal at a dietary Ca level of 1366 ppm—about 0.1%.

Although most rehabilitators might not be concerned with promoting optimum insect development, because live insects are expensive, neither would rehabilitators want diet-related fatalities. Further, it may not be practical for many rehabilitators to remove daily from their stock cultures the number of insects they expect to feed out over the next 48 hr and place them in a gut-loading medium. The authors of this paper reasoned that a compromise could be achieved by exploring the effects of diets that may be higher in Ca than the 0.1% or less ideal for insects, but not as high as in gut-loading diets that produce short-term gains in Ca but longer-term losses of viability. Aside from the Ca content, the insect diets explored here comprise natural foodstuffs that are widely available to rehabilitators (who may not have access to specialized materials used in commercial or "purified" insect diets). Some of them were derived from literature promoted within the rehabilitation community (e.g., Abate 2000); others were formulated from more esoteric sources (e.g., reports summarized in Singh 1977). All seemed to satisfy the basic nutritional requirements of the insects; because insects are widely fed as a protein source, particular attention was paid to whether the diets met the protein requirements of the insects themselves. It was assumed from the outset that the diets examined here would not produce adequate Ca levels in the insects; we reasoned, however, that once it was determined what could be achieved with the diets that met the above criteria, ways to add Ca to the insects (such as dusting) could also be explored empirically.

Experiment I: Mealworm Diets

Mealworms are the larvae of the grain beetle; as implied by the common name for the species, grain is its primary food. This insect is a pest in flour mills and granaries where, apparently because of the riboflavin in fragments of bran or seed coat, it is more likely to infest floor sweepings than stored grain or flour (Fraenkel et al. 1950). Wheat bran and wheat flour are the substrates in which commercial mealworms are most commonly cultured (Klasing et al. 2000), but they may also be fed other grains. A complete purified growth medium for mealworms described in Martin et al. (1976) was about 16% protein. Fraenkel et al. (1950) found that growth was best at about 17% protein, but nearly optimal at about 9%.

Method

Five mealworm substrates were used; basic components are given below. (Exact compositions are given in Appendix 1.)

Because all diets had about the same percentage of dry matter, protein and Ca are expressed on an as-fed basis. Composition analyses in this and the following sections were based on information from the United States Department of Agriculture (1999), the National Research Council (1994), and fact sheets from product manufacturers.

Diet MA (derived from Abate 2000): primarily wheat bran; about 16% protein, 0.1% Ca, and 1:14 Ca:P.

Diet MB (adapted from Elliston et al. [no date], primarily game-bird starter plus alfalfa; about 25% protein, 1.3% Ca, and 2:1 Ca:P.

Diet MC (adapted from Elliston et al. [no date]: mostly feline kibble plus mixed grains, and alfalfa; about 23% protein, 0.7% Ca, and 1:1 Ca:P.

Diet MD (derived from Frye 1992): wheat bran plus poultry mash, alfalfa, and baby cereal; about 15% protein, 1.3% Ca, and 2:1 Ca:P.

Diet ME (formulated by author D.W., previously unpublished): mixed cereals and grains plus alfalfa, brewer's yeast, and $CaCO_3$; about 15% protein, 1% Ca, and 3:1 Ca:P.

Approximately 500 ml (2 cups) by volume (the complete "recipes" shown in Appendix 1, ranging in weight from 127–479 g) of each diet was placed in a different plastic dishpan (about 28 cm x 33 cm) in an environment that was about 21°C (70°F) and 30% relative humidity (RH). Approximately 50 "medium" mealworms (purchased from Grubco, Inc., Hamilton, Ohio) were placed in each container. Moisture was provided in the form of apple slices placed on the surface of the medium. Although the studies cited above suggest that dietary effects may be achieved in mealworms in as little 24 hr, these insects were left in the medium for an arbitrary period of approximately four days.

At the end of the feeding period, insects were removed from their respective substrates and killed by freezing (a control group of insects had previously been transferred directly from the shipping box to the freezer). Frozen insects were then dried, microwave digested, and analyzed for Ca and P on a Leeman Laboratories PS 1000 Inductively-Coupled Plasma Atomic Emission Spectrometer using Modified AOAC Method 985.01 (AOAC 1990; additional methodological details are available from the authors). Analyses were done in triplicate, with 11–17 insects in each portion.

Results and Discussion

Across all conditions, the mealworms averaged 111 mg each before drying (except for the as-shipped controls, which weighed about 70 mg each) and contained about 39% dry matter. Percents of Ca and P in the three dried samples per diet were units of analysis in a 1 x 6 Analysis of Variance (ANOVA) that evaluated the impact of diet. For %Ca, $F=62.9$, $df=5$, and $p<.0001$; mealworms raised on Diet ME had the most Ca, while those raised on Diet MA and those tested as shipped had the least. For %P, $F=1.1$ was not significant; P levels were not appreciably impacted by diet, although mealworms raised on Diet ME had the least P. Dry matter %s of Ca and P for the six conditions, and also the resulting Ca:P ratios, are shown below ("MAS" represents "mealworms as shipped").

TABLE 1. MEALWORM %Ca, %P, AND Ca:P FOR DIETARY CONDITIONS

Condition:	MAS	MA	MD	MB	MC	ME
% Ca	.06	.07	.12	.16	.16	.33
% P	.79	.79	.79	.82	.76	.74
Ca:P	1:13	1:11	1:6	1:5	1:5	1:2

As expected, Ca levels were not raised to P levels by these diets. However, mealworms fed Diet ME had more Ca not only than those fed very low Ca diets, but also those fed diets with similar amounts of Ca (namely, Diets MB, MC, and MD). We speculate (as had Finke [2003] regarding a nonlinearity in his regression line) that the explanation may lie in the particle size of the ingredients; the components of Diet ME had been chosen to allow mealworms to be quickly sifted out of the medium. We were unable to support a statement attributed by Elliston et al. (no date) to White (1993) that mealworms raised on Diets MB and MC would achieve a Ca:P ratio of 1:1; Elliston (pers. comm.) has been unable to trace the empirical source of that statement, which seems to have originated prior to the 1988 version of White's manual. Although growth of the insect was not a direct focus, we noted that the average wet mass per insect was slightly higher for insects fed Diets MB and ME than for insects in the other dietary conditions.

Experiment II: Cricket Diets

Crickets are opportunistic omnivores (e.g., Frye 1992). Captive diets typically are mixtures of ingredients such as corn meal, alfalfa, wheat bran, dried milk, brewer's yeast, and liver powder. McFarlane et al. (1959) found several purified diets to be inferior to rabbit pellets, but also recommended some materials of animal origin in the diet. Lyon (1996b) suggested either poultry mash or ground dog kibble. In Patton's 1967 comparison of 16 diets for crickets, the best results were obtained from those having protein levels between 20–30% (as fed). Compared to these diets, both growth and survival were reduced in crickets reared on a diet also containing a mineral mix.

Method

Four cricket foods were used; basic components are given below. (Exact compositions are given in Appendix 1.) Because all diets had about the same percentage of dry matter, protein and Ca are expressed on an as-fed basis.

Diet CA (derived from Abate 2000): a mixture of corn meal, rolled oats, and wheat bran; about 13% protein, 0.04% Ca, and 1:12 Ca:P.

Diet CB (derived from Frye 1992): a mixture of baby cereal, corn meal, and poultry mash, with added ground dog kibble; about 13% protein, 1.2% Ca, and 3:1 Ca:P.

Diet CC (based on comments in McFarlane et al. 1959): ground rabbit pellets; about 18% protein, 1% Ca, and 2:1 Ca:P

Diet CD (formulated by author D.W., previously unpublished; similar to mealworm diet ME above, with added dry milk and ground kitten kibble); about 19% protein, 1.2% Ca, and 2:1 Ca:P.

Approximately 100 three-week-old (3/8 in) crickets purchased from Fluker Farms (Port Allen, Louisiana) were placed in each of four plastic buckets approximately 30 cm in diameter and 40 cm tall. Each bucket also held two small sections of egg crate and two small shallow round trays (about 8 cm in diameter)—one filled with food and the other containing sections of white cotton cloth soaked in water. A section of orange slice (for additional moisture) was also placed in each bucket. All buckets were set on heating pads; at the bottom of the containers, temperature was about 21°C (70°F) and about 25% RH. Food and water were changed at least once daily. After a period of five days, insects were removed from the feeding bins and killed by freezing (a control group of insects had been frozen directly from the supplier's box).

Frozen insects were dried, digested and analyzed via ICP-AES as described above for mealworms; about 11 dried insects comprised each microwave-digestion portion for each of the diet conditions, and about 33 of the as-shipped controls.

Results and Discussion

Across all dietary conditions, the crickets averaged 185 mg each before drying (except for the as-shipped controls, which weighed about 54 mg each) and contained about 26% dry matter. As above for mealworms, the %s of Ca and P in the three dried samples per diet were units of analysis; here, a 1 x 5 ANOVA was used to evaluate the impact of diet on these two dependent variables. For %Ca, $F = 74.1$, $df=4$, $p<.0001$; the highest Ca levels were found in insects raised on Diet CD; the lowest resulted from Diet CA. For %P, $F=5.52$, $df=4$, $p<.05$; P levels were lowest for Diets CB, CC, and CD, and highest for Diet CA. The dry-matter %s of Ca and P, as well as Ca:P for the five conditions ("CAS" represents the "crickets as shipped") are shown below.

TABLE 2. CRICKET %Ca, %P, AND Ca:P FOR DIETARY CONDITIONS

Condition:	CA	CAS	CB	CC	CD
% Ca	.08	.14	.22	.28	.56
% P	.94	.90	.84	.86	.90
Ca:P	1:13	1:6	1:4	1:3	1:2

In this data set, the most favorable Ca:P ratio (1:2) was not obtained for insects raised on the diet with the highest Ca:P ratio (Diet CB, also the diet on which the insects achieved the highest average mass). As was the case with mealworms, crickets raised on the diet giving the best results (CD) had more Ca than would have been predicted on the basis of the overall Ca content of the diet per se, which was similar in Diets CB and CC. A possible explanation is an observation by Patton (1967) that younger crickets tend to select food on the basis of particle size; because it was impossible to completely homogenize the ingredients, it may be that crickets rejected one of the high-Ca components of Diet CB. Differences in palatability of ingredients (see, e.g., comments in Anderson 2000) may also have played a role.

Experiment III: Waxworm Diets

Waxworms are the larvae of the greater waxmoth, a parasite of bee hives, where larvae feed on honey, pollen, cocoons of bee larvae, and bee feces (see, e.g., Brues 1946, Charrière and Imdorf 1999, Jindra and Sehnal 1989). Although they ingest wax in the process of obtaining these nutrients, they do not require wax in an artificial diet. Many foods for laboratory or home rearing have been described (Marston and Campbell 1973); two that are often mentioned (e.g., Lyon 1996a) involve baby cereal or granular dog meal mixed with honey, water and/or glycerine. The medium that gave the best results in Marston and Campbell (1973) appears to be about 9% protein as fed; Jindra and Shenal's (1989) best medium was about 10% protein as fed. Most diets involve ingredients such as baby cereal, flour, powdered milk, brewers' yeast, honey, and glycerine.

Silken threads are spun by larvae as they eat (Charrière and Imdorf 1999); when the larvae are mature, they spin silk cocoons and pupate (subsequently, moths emerge from the cocoons). Almost all commercial growers of waxworms treat larvae before shipment to prevent them from spinning. This processing renders them more convenient as food sources; the larvae are easily picked from the wood shavings in which they are shipped and stored. It is pointless to provide nourishment for them, as they do not eat after processing. Untreated larvae are highly mobile and difficult to contain; further, the food substrate will quickly become laced with silk, and larger larvae will spin cocoons, from which they must be extracted if they are to be used as food before they pupate. Some suppliers may be either unaware or reluctant to reveal that they are shipping larvae that have been processed by the grower. Larvae that have not been treated will leave easily discernable tunnels of silk in the medium.

Method

Three waxworm substrates were used; basic components are given below. (Exact compositions are given in Appendix 1.) The protein and Ca are given below on an as-fed basis.

Diet WA (adapted from Abate 2000 and Frye 1992): wheat bran with added honey, water, and glycerine; about 10% protein, 0.05% Ca, and 1:14 Ca:P.

Diet WB (adapted from Abate 2000; very similar to Frye 1992): baby cereal with some soy flour, plus honey, water, and glycerine); about 8% protein, 0.5% Ca, and 1:1 Ca:P.

Diet WC (formulated by author D.W., previously unpublished; adapted from several sources including those cited above): primarily baby cereal with added dried milk, bee pollen, and brewer's yeast as well as honey, glycerine, and $CaCO_3$; about 11% protein, 1.3% Ca, and 4:1 Ca:P.

Roughly 500 ml (2 cups) by volume (the complete "recipes" are shown in Appendix 1, 183–243 g by weight) of each substrate were placed into round plastic containers about 15 cm in diameter and 12 cm high. Waxworm cultures were purchased from Fluker Farms (Port Allen, Louisiana). About 100 larvae of varying sizes were separated from the shipping medium and placed in each container of experimental diet. The containers were capped with netted lids and kept in an incubator that provided a temperature of about 29°C (85°F) and

50% RH. A fourth group was kept under similar conditions in the culture medium (primarily wheat bran and honey) in which the larvae were shipped. Research by Strzelewicz et al. (1985) suggested that dietary effects on waxworm Ca contents may continue to accumulate up to a duration of three days; waxworms in our study were maintained on medium for six days. At the end of the feeding period, the largest larvae that had not spun cocoons were removed from their respective substrates and killed by freezing. Frozen insects were dried, digested, and analyzed using ICP-AES as described above for mealworms; on average, about six dried insects made up each portion for each diet condition. Because unprocessed waxworms are shipped as a culture (i.e., in a growing medium), the control condition in this experiment did involve a diet.

Results and Discussion

Across all conditions, the waxworms averaged 200 mg each before drying and contained about 42% dry matter. Once again, the %s of Ca and P in the three dried samples per diet were units of analysis; here, a 1 x 4 ANOVA was used to evaluate the effect of diet on Ca% and P%. For Ca%, $F=28.4$, $df=3$, $p<.001$. Ca levels were lowest for the larvae maintained in the shipping medium and on Diet WA; they were highest for Diet WC. For P%, $F=4.5$, $df=3$, $p<.05$; P levels were highest for Diet WA and lowest for Diets WB and WC. Average dry-matter %s of Ca and P for the four conditions, as well as the approximate ratio of Ca:P, are shown below ("WSM" refers here to the larvae maintained in the shipping medium).

TABLE 3. WAXWORM %Ca, %P, AND Ca:P FOR DIETARY CONDITIONS

Condition:	WSM	WA	WB	WC
% Ca	.09	.07	.11	.16
% P	.68	.66	.58	.58
Ca:P	1:8	1:10	1:5	1:4

As expected, the worms with the highest Ca levels, and the best Ca:P, were those fed the diet with the most Ca. The worms on Diet WC had largest average wet mass, with worms on Diets WA and the shipping medium having the smallest average mass.

Experiment IV: Achieving Additional Calcium

Calcium may be added to insects immediately before they are fed to birds (or other insectivorous predators). We explored two general strategies: dusting with $CaCO_3$, and dipping in a liquid solution of calcium gluconate ($Ca[HOCH_2[CH(OH)]_4CO_2]_2$ but abbreviated herein more simply as CaG).

Donoghue and Langenberg (1996) described dusting as a "risky venture" (p. 159); the question of how much dust actually adheres to the insect is difficult to answer, particularly because it may not adhere for any length of time (Trusk and Crissey 1987). Strzelewicz et al. (1985) noted that the fine setae on the bodies of waxworms may help to retain dust on these insects; by contrast, however, the bodies of mealworms are quite smooth. Some dusting products are designed to maximize adhesion by especially fine grinding, creating a static electrical charge and adding natural gums; a well-known example is Bone Aid Microstick™ by T-Rex®. Although the proportion of gums to $CaCO_3$ is not specified on the label, a sample tested by ICP-AES as described above was found to contain 38% Ca (as contrasted to the 40% of pure $CaCO_3$). With that information available, we sought to estimate how much elemental Ca could be added to mealworms, crickets, and waxworms by dusting with $CaCO_3$ that either had or had not been modified to increase adhesion.

An alternative to a dry form of Ca is a liquid version. A 23% solution of CaG contains 21 mg of elemental Ca per ml; according to data summarized in Soares (1995), CaG is at least as bioavailable to birds as $CaCO_3$. Insects may be grasped with forceps and dipped just prior to hand-feeding them to nestling birds, or insects may be placed in a jar of solution and fed out with forceps as needed. Immersion in liquid will eventually kill ("drown") insects, but this process takes longer than might be expected; even after 1 hr or more, motionless insects may revive if removed from liquid. It has been suggested (e.g., by Kyle and Kyle 1996) that mealworms may absorb vitamins and minerals in a "drowning" solution. We sought evidence that drowned insects accumulate internal liquids (perhaps, e.g., through their spiracles), and also to estimate how much liquid would be present on the exterior of a dipped insect.

Method

Crickets, mealworms, and waxworms were weighed individually on a Mettler C-150 laboratory scale accurate to 0.1 mg before and after applying a liquid Ca supplement (23% CaG) or a powdered one (Now® brand $CaCO_3$, or Bone-Aid™). Thirty live insects were used in each condition. To apply the Ca, the insect was dropped into a small container of the supplement (containers of powdered supplements were lightly shaken to coat the insect), then removed with forceps; tapping the forceps on the side of the container removed excess from the insect before it was weighed.

In order to determine whether "drowned" insects absorbed any liquid internally, a group of 10 live crickets, mealworms, or waxworms was weighed collectively, then placed for 30 min in a container of CaG. Subsequently, the insects were drained and gently blotted dry with surgical dressing and cheesecloth wipes to remove exterior liquid; then they were weighed again, as a group. The procedure was repeated with different insects for the solution suggested in Kyle and Kyle (1996): 15 ml of Avimin® (plus 200 mg Avicon® vitamin mix) in 250 ml of water.

Results and Discussion

The weight of each insect after supplementation via dipping or dusting was subtracted from its prior weight; then the difference was divided by the initial weight to obtain % weight added by the supplement. These percents were the units of analysis in the ANOVAs that follow.

For the dipping conditions, a one-way ANOVA with insect type as the independent variable and % added weight as the dependent variable was significant ($F = 10.9$, $df = 2$, $p<.0001$). Waxworms retained significantly less liquid than either crickets or mealworms. Cell means (of 30 insects) are shown below (Table 4).

TABLE 4. WEIGHT INCREMENT FOR DIPPED INSECTS

mealworms	crickets	waxworms
20.6%	20.7%	11.8%

For the dusting conditions, a two-way ANOVA with type of insect and type of powder as independent variables revealed a significant main effect for insect ($F = 153.2$, $df=2$, $p < .0001$) and a significant interaction ($F = 13.9$, $df = 2$, $p < .0001$). The cell means (with 30 insects per cell) are shown below (Table 5).

TABLE 5. WEIGHT INCREMENT FOR DUSTED INSECTS

	mealworms	crickets	waxworms
$CaCO_3$	0.8%	6.3%	1.3%
Bone-Aid™	2.5%	5.2%	1.9%

Crickets retained substantially more powder overall than mealworms or waxworms. The interaction resulted from Bone-Aid™ being retained in significantly greater quantities than plain $CaCO_3$ only for mealworms; crickets actually retained marginally less Bone-Aid™ than plain $CaCO_3$. There was no significant main effect due to type of powder.

Insects that were immersed in CaG for 30 min and then blotted dry were not heavier than they had been before "drowning." Crickets actually lost about 3% of their body weight, conceivably from voiding their GI tracts as they died (mealworms and waxworms did not die in the 30 min time period); alternatively, water may have diffused out of the insects if the osmolarity of the solution was higher than that of the insects. Results were virtually identical with the Avimin® solution. A possible explanation for the failure to accumulate internal fluids is that spiracles may be closed and opened by muscular action; the spiracles of some insects also have modifications that apparently function to prevent dust or liquid from entering the tracheal system (Mill 1985).

Results Overview and General Discussion

One way to present an integrated overview of the results of all four experiments is a table showing, for each type of insect, the amount of Ca and the Ca:P ratio expected if each type of supplement were added to live feeder insects. Because these figures depend on the insect Ca and P already achieved by dietary means, the effect of supplementation is shown as a range from "worst" to "best" diets (defined as diets resulting in the least versus most amount of insect Ca). The calculations that produced these figures are given in Appendix 2.

TABLE 6. APPROXIMATE Ca (DMB) AND Ca:P OF INSECTS + SUPPLEMENTS ACROSS RANGE OF DIET CONDITIONS

	CaG	$CaCO_3$	Bone-Aid™
Mealworm (Diets)	**(MA–ME)**	**(MA–ME)**	**(MA–ME)**
Ca	1.1% –1.4%	0.9%–1.1%	2.4%–2.7%
Ca:P	1.4:1–2.0:1	1.1:1–1.6:1	3.0:1–3.7:1
Cricket (Diets)	**(CA–CD)**	**(CA– CD)**	**(CA–CD)**
Ca	1.7%–2.2%	9.4%–10.2%	7.4%–8.1%
Ca:P	1.7:1–2.4:1	9.8:1–11.1:1	7.7:1–8.9:1
Waxworm (Diets)	**(WA–WC)**	**(WA–WC)**	**(WA–WC)**
Ca	0.6%–0.8%	1.1%–1.5%	1.5%–2.1%
Ca:P	0.9:1–1.4:1	1.7:1–2.6:1	2.3:1–3.5:1

As can be seen from Table 6, the best choice among supplements depends on both the type of insect and its prior diet. In the case of mealworms, CaG provides a bit more elemental Ca than $CaCO_3$; Bone-Aid™ adds more to mealworms than $CaCO_3$—but it adds more than is needed, even with the worst diets. Waxworms also appear not to require supplementing with Bone-Aid™; a correction can be approximated by CaG or $CaCO_3$, with the latter more appropriate for larvae raised on the lower-Ca diets. Crickets also can be adequately corrected by CaG; at least in the short term, they retain so much powder that dusting may add as much as 7 times what is needed, an amount that may be considered toxic over a period of long-term use (see discussions in, e.g., Klasing 1998). It is important to recall, however, that the insects in the present study were dusted individually and weighed immediately after dusting. Crickets that are group-dusted with a limited amount of powder would retain smaller amounts; further, those that are released after dusting into an environment for predators to capture will shed that dust over time.

It should also be noted that the specific brand of $CaCO_3$ used (NOW®) may or may not have the same particle size—and therefore, perhaps, adherence—as laboratory or other commercial products. Because the effects of dusting may vary with the particular $CaCO_3$ product used, dusting is an unreliable strategy compared to dipping. Dipping is also more reliable across types of insects, with the amount retained varying by a factor of less than 2 as contrasted to a dusting variation of as much as a factor of 8 (see Appendix 2). Of course, however, dipping in mineral solutions other than CaG would add different amounts of Ca to the insects; for example, the Avimin® preparation mentioned above contains less than 1 mg of Ca per ml (as contrasted to 21 mg/ml for CaG).

As can be deduced from Table 6, the effects of the diets used in this study, while having high statistical significance, have more modest practical significance. The amount of Ca added by any supplement is always greater than the amount

that can be added by even the best of the tested diets. However, the Ca provided by dipping in CaG offers a good combination with the Ca and P levels of insects raised on the best diet in each group; the slight undercorrection in waxworms is compensated by the slight overcorrection in crickets, so that practitioners dipping all three types of insects may expect to achieve about 1.5 %Ca and Ca:P = 2:1 overall. A further important point is that the diets resulting in the best Ca levels in mealworms and crickets performed comparatively better than might have been expected on the basis of their Ca levels per se. We believe that the relatively fine particle size in Diets ME and CD facilitates the consumption of added $CaCO_3$; future research is planned to clarify the role of texture in captive insect diets. Finally, the higher-Ca diets in this study did not compromise insect survival, which was close to 100% in every condition.

Of the three types of insects, waxworms' Ca levels improved least with diet. Further, data from our lab suggest that processed waxworms have Ca and P levels within the range achieved by the diets in this study, and therefore may be adequately corrected by the same strategies. Finally, of the three types of insects, unprocessed waxworms are by far the most expensive and time-consuming to maintain. However, a significant advantage of purchasing them is to acquire smaller-sized larvae that may be fed to smaller birds, especially (because waxworms have a high fat content—see, e.g., Barker et al. 1998 and Finke 2002) if those birds have high caloric requirements.

In summary, our results indicate that insect Ca%s as high as 0.5% and Ca:P ratios of up to 1:2 can be achieved by offering insects appropriately-textured foods having Ca levels of about 1%. Although these Ca levels and Ca:P ratios fall short of what can be accomplished by gut-loading insects with high-Ca diets, they neither compromise insect survival nor require sorting into separate feeding bins for short-term consumption of the gut-loading diet. A fairly simple procedure (dipping in CaG prior to feeding) appears to adequately supplement the Ca in mealworms, crickets, and waxworms considered as a group of feeder insects.

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Product Information

Now® brand calcium carbonate powder is available through health food stores. It may be ordered online through Green Canyon Products (www.greencanyon.com).

Calcium Gluconate 23% Solution is available through farm supply stores such as Agway; it also may be ordered through Omaha Vaccine; www.omahavaccine.com, 800/367-4444.

Mealworms, crickets, and processed waxworms are available through several suppliers, including Grubco, Inc. (www.grubco.com, 800/222-3563) and Fluker Farms (www.flukerfarms.com, 800/735-8537). Unprocessed waxworms ("waxworm cultures") should be available through Fluker Farms by the fall of 2003.

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APPENDIX 1: DIET INGREDIENTS

MEALWORMS

Diet MA (adapted from Abate 2000)
100 g (~1 3/4 cup) wheat bran
5 g (~1 Tb) rolled oats
6 g (~1 Tb) oat bran
7 g (~1 Tb) wheat germ
9 g (~1 Tb) corn meal

Diet MB (adapted from Elliston et al. [no date], with some improvisation required from recommendations to add specified amounts of some ingredients to others mixed in presumably volumetric "parts"):
255 g (~1.5 cups) game bird starter (Agway brand)
60 g (~1/2 cup) ground alfalfa pellets
14 g (~1/8 cup) wheat germ
8 g (~1 Tb) brewer's yeast
1 g $CaCO_3$

Diet MC (adapted from Elliston et al. [no date], with improvisation as described for Diet MB):
125 g (~1 cup) Science Diet® adult feline maintenance, ground
40 g (~1/2 cup) rolled oats
23 g (~1/4 cup) oat bran
14 g (~1/4 cup) wheat bran
60 g (~1/2 cup) ground alfalfa pellets
8 g (~1 Tb) brewer's yeast
1 g $CaCO_3$

Diet MD (adapted from Frye 1992)
58 g (~1 cup) wheat bran
40 g (~1/3 cup) ground alfalfa pellets
40 g (~1/3 cup) poultry mash
28 g (~1/2 cup) mixed baby cereal

Diet ME (formulated by author D.W., previously unpublished)
141 g (~1 cup) Wheatena®
94 g (~1 cup) oat bran
138 g (~1 cup) yellow corn meal
60 g (~1/2 cup) ground alfalfa pellets
32 g (~1/4 cup) brewer's yeast
10 g $CaCO_3$

CRICKETS

Diet CA (adapted from Abate 2000)
50 g (~1/3 cup) corn meal
40 g (~1/2 cup) rolled oats, ground
40 g (~1 cup) wheat bran

Diet CB (adapted from Frye 1992)
40 g (~ 3/4 cup) mixed baby cereal
50 g (~ 1/3 cup) corn meal
40 g (~ 1/3 cup) poultry mash
20 g (~ 1/4 cup) Eukanuba® Maintenance Dog Food, ground

Diet CC (as suggested in, e.g., McFarlane et al. 1959)
ground rabbit pellets (Pro-Pet® Supra-Blend Rabbit Diet)

Diet CD (formulated by author D.W., previously unpublished)
70 g (~1/2 cup) Wheatena®
47 g (~1/2 cup) oat bran
69 g (~1/2 cup) yellow corn meal
30 g (~1/4 cup) ground alfalfa pellets
16 g (~1/8 cup) brewer's yeast
40 g (~ 1/4 cup) Eukanuba® Kitten Food, ground
30 g (~ 1/4 cup) instant nonfat dry milk
6 g $CaCO_3$

WAXWORMS

Diet WA (adapted from Abate 2000 and Frye 1992 "for larger larvae"; more liquid was added to the original formulation in order to keep the proportion of liquid to dry ingredients approximately constant in all three substrates)
120 g (~2 cups) wheat bran
40 ml honey
20 ml water
2 ml glycerine
0.5 g brewer's yeast
0.5 g multiple vitamin powder

Diet WB (adapted from Abate 2000, very similar to Frye 1992 "for smaller larvae" except for the inclusion of soy flour; additional amounts of liquid ingredients added for reasons stated above)
120 g (~ 2 cups) rice baby cereal
20 g (~ 1/4 cup) soy flour
20 ml honey
20 ml glycerine
20 ml water
0.5 g multiple vitamin powder

Diet WC (formulated by author D.W., previously unpublished; adapted from information in several sources, including Jindra and Sehnal 1989, Marston and Campbell 1973).
115 g (~2 cups, or ~half a box) mixed baby cereal
15 g (~1/8 cup) instant nonfat dry milk
15 g (~1.5 Tb) bee pollen granules
8 g (~1 Tb) brewer's yeast
5 g $CaCO_3$
40 ml honey
40 ml glycerine

APPENDIX 2:
CALCULATIONS FOR TABLE 6

The dry-matter basis results shown in Tables 1–3 and the as-fed basis results shown in Tables 4–5 were integrated using the following procedure:

First, within each dietary condition, the average insect mass after drying was divided by the average insect wet mass (prior to drying); this calculation gave the insects' % dry mass, which varied somewhat between conditions. It also gave the dry mass of 1 g of live insects; multiplying by 1000 expresses the dry mass in mg. Multiplying this figure by the DM %Ca (from Tables 1–3) gives the number of mg of Ca expected to be present in 1 gm of live insects previously maintained on a particular diet.

Next, the amount of supplemental Ca expected to be added per g of live insect was calculated by multiplying the concentration of Ca in each supplement by the % of insect body weight retained in the supplement (from Tables 4–5). Results are shown in the table below.

Amount of Ca (mg) Added by Supplement

Per 1 g of:	CaG[a]	$CaCO_3$[b]	Bone-Aid™[c]
Mealworms	4.3	3.2	9.5
Crickets	4.3	25.2	19.8
Waxworms	2.5	5.2	7.2
	[a]21 mg/ml	[b]400 mg/g	[c]380 mg/g

Finally, to obtain the DM %Ca present in a supplemented insect that had been fed a particular diet, the amounts of Ca obtained in the two previous steps were added, and the sum divided by the dry weight in mg of 1 g of live insect.

To obtain the Ca:P in a supplemented insect, Step 1 was repeated for P to give the mg of P expected in 1 g of insects fed each diet; the amount of Ca per unit amount of P is obtained by Ca/P.

NEO-REHABILISMS...

artificial restiration
a "self-release"

cortical steroids
a treatment for egomaniacs

lollygagging
definitive symptom exhibited by raccoons that have swallowed a Tootsie Pop whole

lugomorph
rabbit carrier

Conversations with Stakeholders, Part I: Goals, Impediments, and Relationships in Wildlife Rehabilitation

by Sara Dubois and David Fraser

ABSTRACT: Forty semistructured interviews were conducted with individuals involved in wildlife rehabilitation in British Columbia, Canada, including 27 rehabilitators, five veterinarians, and eight provincial and federal government wildlife officials. Participants reported their perceptions of the goals of, and impediments facing, wildlife rehabilitation, and of their respective roles and the relationships among the three groups. Participants in all three groups saw the primary goals of rehabilitation as the humane care of injured and orphaned animals and public education. Rehabilitators, but not government officials, also cited many additional goals, including contributing to research, the development of expertise, reducing human impact on wildlife, and contributing to the monitoring of emerging diseases and environmental problems. Most participants cited money as an important impediment to these goals; however, more than half of the rehabilitators felt that a lack of nonmonetary support or acknowledgement by government were important impediments that may be more realistically overcome. Increased awareness of these differing beliefs and perceptions could promote more effective communication and coordinated action within the rehabilitation community.

KEY WORDS: stakeholders, goals, impediments, roles, communication

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Introduction

The practice of wildlife rehabilitation generally began in the homes of compassionate, well-meaning, but often inadequately trained individuals (Hass 1998). Rehabilitation practices have evolved over the years, through trial and error and the adaptation of care protocols for companion and zoo animals, emerging as a distinct field with specific techniques for animal handling, medical and surgical care, nutrition, housing, and release. Wildlife rehabilitators have various levels of training, with many rehabilitators relying on personal experience and knowledge shared with their peers to upgrade their skills. Additionally, many rehabilitators work to some degree with veterinarians. Rehabilitators also operate within a regulatory framework created by government wildlife agencies that permit and monitor rehabilitation activities. Therefore, to be effective, many rehabilitators need to have satisfactory relationships with other rehabilitators, veterinarians, and government wildlife officials.

However, these three stakeholder groups (rehabilitators, veterinarians, and officials) may not see wildlife rehabilitation in the same way. Based on their experience, education, and training, these groups may have different perceptions of the value of wildlife, the goals of rehabilitation, and the impediments to successful rehabilitation. Such differences may create barriers to communication and cooperation among stakeholders. In a comprehensive survey of New York wildlife rehabilitation stakeholders, Siemer and Brown (1992a and 1992b) described two subgroups of rehabilitators based on their attitudes and values regarding wildlife management. About one-third of respondents expressed attitudes similar to those of wildlife officials who believe humans are rightful stewards of wildlife and are entitled to use wildlife in traditional ways. The remaining two-thirds of rehabilitators, in contrast to officials, opposed many traditional forms of wildlife management such as recreational hunting and trapping (Siemer and Brown 1993). Although these different standpoints can create barriers to rehabilitator-government communication, the researchers emphasized that the two groups held some common fundamental beliefs and values, one of which was that human interactions with wildlife should be considerate of the pain and suffering of individual animals, suggesting opportunities for cooperation on at least some issues (Siemer and Brown 1993).

Although there have been several surveys of the practices, views, and constraints of wildlife rehabilitators (Siemer and Brown 1992a and 1992b, Thrune 1994, Borgia 2000, TEWRWG 2002), there has been only limited research comparing these stakeholders, how they communicate, and how they perceive their respective roles. The present study gathered information from rehabilitators, veterinarians, and wildlife officials involved in wildlife rehabilitation in British Columbia, Canada. The aims of this study were (1) to identify the goals of wildlife rehabilitation as perceived by rehabilitators, veterinarians, and government wildlife officials, (2) to identify what the three groups view as major impediments to successful wildlife rehabilitation, and (3) to explore how the different groups perceive each others' roles and the relationships among the groups.

Study Population

Wildlife rehabilitators in British Columbia (BC) serve a vast and diverse area from the Pacific Ocean to the Rocky Mountains. The approximately 40 rehabilitation facilities in BC treat migratory species passing through the Pacific Flyway plus a variety of species from marine, agricultural, wetland, forest, alpine, and urban ecosystems. Rehabilitation facilities vary in size and staffing levels, background and experience of rehabilitators, annual number of cases, types of species treated, and treatments used. The Wildlife Rehabilitators Network of British Columbia (the

"Network") was founded in 1989 to provide a forum for the diverse and often isolated rehabilitators in the province. The Network aims to engender the cooperation of professional and government agencies; improve the profession of rehabilitation through the development of high standards of practice, ethics, and conduct; disseminate knowledge through meetings, reports, publications, and symposia to members and the public; and foster affiliation with the National Wildlife Rehabilitators Association and the International Wildlife Rehabilitation Council (WRNBC 2002). Membership in the Network is not mandatory for BC rehabilitators, but is recommended by permitting agencies.

Annual permits for BC rehabilitators are administered by federal and provincial agencies. Federal agencies are the Canadian Wildlife Service (for migratory birds designated under the Migratory Birds Convention Act, 1994; Government of Canada 1994), and the Department of Fisheries and Oceans (for marine mammals governed by the Fisheries Act; Government of Canada 1985). The provincial BC Ministry of Water, Land and Air Protection regulates rehabilitation of other species (amphibians, reptiles, nonmarine mammals, and birds not under federal authority) under the Wildlife Act (Province of British Columbia 1996a). The Prevention of Cruelty to Animals Act, enforced by the BC Society for the Prevention of Cruelty to Animals, also applies to wildlife in captivity in BC (Province of British Columbia 1996b).

Methods

In the summer of 2000, author S. D. volunteered one day a week at a rehabilitation facility to actively participate in wildlife rehabilitation and gain insight into its goals and obstacles. Volunteering also allowed informal discussions with rehabilitators, to hear about their personal experiences, how they arrived in their positions, and the daily expectations and pressures that they faced. In November 2001 a questionnaire on facility demographics was administered to a representative of each facility at the annual meeting of the Network. The survey also requested the participation of a senior rehabilitator from each facility in an interview. Rehabilitators who did not attend the meeting were contacted by telephone and asked to participate. Eight government wildlife officials, affiliated with rehabilitation through permitting or enforcement, were sought based on their high level of interaction with rehabilitators and to achieve a wide geographical representation. These officials, and five veterinarians associated with rehabilitation, were contacted by telephone and asked to participate in an interview regarding their view of rehabilitation in BC and its stakeholders. The purposive nature of the sampling and the small sample size of government officials and veterinarians meant that the study did not aim to be representative of these respective populations of stakeholders, and rather served to elicit a range of views from these two groups.

Interviews and Analysis

The interview used open-ended questions that focused on individuals' views and interpretations of rehabilitation goals and impediments, their own role in rehabilitation and that of other rehabilitation stakeholders, and the nature of communication and relationships with other stakeholders (Dubois 2003). Instead of giving participants options to choose from, the interviewer discussed the points raised by the participants themselves in response to the questions. Due to the semistructured format of the interviews, not all questions may have been asked in the flow of the conversation, but the format permitted the exploration of new ideas raised by participants.

Thirty-nine interviews, lasting 1 to 2 hours, were conducted between December 2001 and June 2002. Most of the 30 in-person interviews were held at the participants' facilities or offices. These interviews were recorded on audiocassette and transcribed verbatim for analysis. Nine participants were interviewed by telephone due to location or time limitations. Notes were taken during these conversations and typed into a format similar to the transcribed interviews. One additional participant responded by mail to written questions.

The analysis of the interviews was mostly descriptive, focusing on the language used and key concepts, values, and themes raised by participants. Interview transcripts, coded to ensure confidentiality of participants, were read and re-read. Emerging ideas in the text were recorded through a process known as "open coding," whereby individual sentences are assessed and notes are made alongside the text (Crang 1997). Relationships and patterns within and between general interview topics, and those that related to certain rehabilitation subjects, were identified. As reoccurring themes developed, they were assigned to categories by codes that helped to organize the texts. Quotes are used in the results to illustrate a typical attitude or an extreme view about an issue, or to demonstrate the variety of participant experiences and beliefs. Categories for main goals and impediments (Tables 1 and 2) were developed either from direct phrases mentioned by participants, such as "public education," or from interpretations of the transcripts; for example, "getting pleasure out of it yourself" was coded as "personal satisfaction."

Participant Description

In order to maintain confidentiality, participants will be referred to by group association: veterinarians, officials, and rehabilitators. The five veterinarians, each with 17 to 25 years of veterinary experience, were either Network members or recommended by Network members due to their current or past involvement in rehabilitation. Three practiced mainly small animal medicine and occasionally treated wildlife brought by the public. Two practiced wildlife medicine, one in a nonclinical setting and the other full-time in a rehabilitation facility. Of the eight government wildlife officials, seven were from the BC Ministry of Water, Land and Air Protection, each representing one provincial management region; the eighth was a Canadian Wildlife Service (federal government) official. Officials included technicians, biologists, and enforcement officers. They had been employed 10 to 28 years with their respective agencies in wildlife capacities.

The 27 rehabilitators included 17 facility founders. Of the 27, 16 lived on the facility site or provided in-home care; four were no longer directly involved in animal care but performed duties such as director, office manager, or naturalist; and three had retired from practice. The 24 rehabilitators who practiced in a nonzoo or aquarium setting will be called primary rehabilitators. These individuals had been involved in rehabilita-

TABLE 1. NUMBER OF PARTICIPANTS (REHABILITATORS, OFFICIALS, AND VETERINARIANS) THAT IDENTIFIED VARIOUS GOALS OF WILDLIFE REHABILITATION

GOALS IDENTIFIED[a]	PARTICIPANT GROUP		
	Rehabilitators (27)	Officials (8)	Veterinarians (5)
Humane care until release or euthanasia	21	6	5
Public education and awareness	19	7	5
Public service	7	4	1
Providing opportunities for research	6	0	1
Developing rehabilitation expertise	5	0	1
Reducing human impact on wildlife	4	0	0
Personal satisfaction	4	0	0
Serving as an environmental indicator	3	0	1
Conservation of species and rare species	3	0	0

[a]Participants could respond with multiple goals; hence, column totals do not sum to the number of individuals per group.

tion for 3 to 30 years (average 14 years). Eighteen of the 24 primary rehabilitators were women. Currently or when last active, 19 of the 24 primary rehabilitators participated full-time in rehabilitation, although some had additional part-time employment, and eight of these individuals were paid for their rehabilitation activities.

Overall, 21 BC facilities and one facility in a neighboring jurisdiction with ties to the Network participated in the research. Seventeen facilities had permits to rehabilitate species regulated by both the provincial government and the Canadian Wildlife Service, and one of these facilities also had a Department of Fisheries and Oceans permit. Four facilities had only provincial rehabilitation permits and one facility had only a Department of Fisheries and Oceans permit. Sixteen facilities were registered as nonprofit organizations. At the time of research, 20 facilities had current Network memberships, 12 had International Wildlife Rehabilitation Council memberships, and 11 had National Wildlife Rehabilitators Association memberships.

Results

Main Goals and Impediments of Rehabilitation

All participant groups showed a strong preference for humane care of injured and orphaned animals until release or euthanasia, combined with public education and awareness to prevent such problems in the future, as the primary goals of rehabilitation (Table 1). However, the groups differed in the breadth of additional goals they identified. Numerous rehabilitators identified public service (by receiving and treating animals brought by the public), providing opportunities for research in wildlife medicine and biology, developing rehabilitation expertise, and serving as an environmental indicator by monitoring diseases and problems in the environment, as additional goals of rehabilitation. Other goals, namely reducing human impact on wildlife, personal satisfaction for the rehabilitator, and contributing to conservation of species, were stated by a few rehabilitators, but not by any participants from the other groups. All veterinarians cited humane care to release or euthanasia and public education (in order to address the causes of injury and "not just treat the symptoms, damaged animals") as the main goals of rehabilitation. Government officials identified public education, humane care, and public service ("by satisfying the public demand not to kill injured animals") as the main goals of rehabilitation.

Lack of funding for facilties, supplies, and staff was cited by most rehabilitators as a major impediment to achieving rehabilitation goals (Table 2); however, more than half of the rehabilitators either felt that a lack of nonmonetary government assistance or a lack of awareness, acknowledgement, and philosophical support by government were important impediments that may be more easily overcome than financial constraints. Public ignorance, causing wildlife to be injured and young wildlife to be picked up and taken into care unnecessarily, as well as a lack of public awareness about wildlife and rehabilitation were also seen as impediments by six rehabilitators. Several rehabilitators believed a lack of time and lack of trained people impeded their ability to achieve their goals. Veterinarians believed the primary impediment to rehabilitation was a lack of funding because "wild animals don't come with owners." Public ignorance about rehabilitation was also mentioned by two veterinarians. Officials saw impediments being mostly finan-

TABLE 2. NUMBER OF PARTICIPANTS (REHABILITATORS, OFFICIALS, AND VETERINARIANS) THAT IDENTIFIED VARIOUS IMPEDIMENTS TO THE GOALS OF REHABILITATION

MAIN IMPEDIMENTS IDENTIFIED[a]	PARTICIPANT GROUP		
	Rehabilitators (27)	Officials (8)	Veterinarians (5)
Lack of funding for facilities, supplies, staff	20	6	5
Lack of nonmonetary government assistance	7	2	1
Lack of awareness, acknowledgement and philosophical support by government	8	0	0
Public ignorance leading to animal injuries, lack of public awareness and education about wildlife and rehabilitation	6	1	2
Lack of time to care for animals	5	0	1
Lack of trained staff, new rehabilitators, good volunteers	5	1	0
Lack of training opportunities	2	2	1
Bad rehabilitators, marginal facilities	2	1	1
Rehabilitators' personal issues	1	1	0
Lack of postrelease studies, feedback after release	0	1	1
Burn out	1	0	1

[a]Participants could respond with multiple impediments; hence, column totals do not sum to the number of individuals per group.

cial, stating that money could be used for training, facilities, and hiring staff. Two officials indicated there is a need to provide more training opportunities. Limited government assistance for rehabilitation was also mentioned as a possible impediment to rehabilitation by two officials.

Rehabilitators' View of Their Role and Their Peers

Given that rehabilitators recognized a broad range of goals for rehabilitation, they saw themselves fulfilling many roles in promoting wildlife welfare and conservation. Although they believed that rehabilitation "has come far," they suggested that it still needs a more professional, scientific basis. They believed it will only be respected as a profession if formal training and standards are accepted and universally employed by rehabilitators, and further recognized by permitting bodies and the public. Almost all the rehabilitators had been to facilities that they felt should not have been operating, and they stressed the importance of addressing these concerns because problems reflect badly on all facilities. Several rehabilitators suggested that this situation should be addressed from the start with new rehabilitators, since some beginners may think they "can do it on their own" and, consequently, animals can suffer.

Eleven rehabilitators discussed rehabilitation's poor communication and internal politics, which they believed to result from conflicting passions and beliefs. They identified communication issues such as competition, personal jealousy, rumors, and bad reputations. These "traditional rivalries" were generally thought to be based on differences of opinion on the key contentious issues of treatment techniques, euthanasia, and use of nonreleasable animals (Dubois and Fraser 2003). Three rehabilitators stated that they preferred to "stick to [themselves], do [their] own thing" and did not want to become involved with others. Many rehabilitators believed that this reflects a common belief among many that they are not "people-people."

Fifteen rehabilitators communicated regularly with other rehabilitators and did so generally with nearby facilities and with large or specialized facilities for the purposes of transferring animals, sharing information and resources, seeking advice or opinions on treatment, and for social reasons. The frequency of communication varied from daily and weekly by some rehabilitators, to one or two times per year by others. Although most rehabilitators were Network members, several stated that they also had contact with nonmembers in their area. Despite the 10-year history of the Network, eight rehabilitators felt that there is still a lack of communication among BC rehabilitators. Although most rehabilitators felt positive about the

Network, three suggested that the Network is currently static, floundering, and that it "still hasn't quite decided on its role." Most Network members had participated in several meetings and many had served on the board of directors or participated in Network discussions on a variety of issues. Five rehabilitators stated that they have reduced their participation in the Network for political reasons or lack of time. Two member rehabilitators rarely or never participated in Network activities; several reported that it is often hard to get away and that the meetings, although educational, were inaccessible. One rehabilitator felt they did not "need" the meetings and a few stated they preferred spending time with their animals rather than with other rehabilitators.

Rehabilitators also discussed how they began their rehabilitation activities. Eight of the 24 primary rehabilitators started when they found an injured or orphaned animal and could not find anywhere to take it, or they saw a need in their community for such a service. Another eight became involved in wildlife rehabilitation as an extension of their activities in domestic animal care. Rehabilitation was an extension from academic animal studies for another four primary rehabilitators, while another four began their involvement as volunteers at existing facilities. Nine of the 27 rehabilitators spoke of animals as being a large part of their young lives, as several took in injured wildlife and unwanted pets from a young age. Twenty-one rehabilitators (either currently or in the past) were also caregivers for their own children, special-needs children and adults, ailing parents, spouses, medical patients, or domestic and zoo animals. The majority of these rehabilitators were women and few were paid for these additional caregiving activities.

Rehabilitators' Views of Veterinarians

Rehabilitators reported various degrees of contact with veterinarians. Most often, small or mixed-animal vets acted as consultants, providing services on a monthly or even weekly basis. Three facilities had vets on staff, two facilities had one or two veterinary visits per year, and two stated they did not have veterinary contact. Overall, rehabilitators viewed their relationship with their consulting vets as positive. A few mentioned having encountered vets that were not "keen on rehabilitators," since rehabilitators were not trained in recognized programs. One such rehabilitator stated that "some vets out there think that they are gods and that rehabilitators have no place on this earth." Rehabilitators suggested that in many cases, vets do not have much experience with wildlife, and often learn from and with rehabilitators. One rehabilitator stated that it was very important for rehabilitators to support and inform veterinarians of what rehabilitators can do and what facilities exist for animal placement. Rehabilitators recognized that veterianarians have businesses and that their services cannot always be provided at no or little cost, but as one rehabilitator pointed out, the wildlife "belongs" just as much to the veteriarian as to the rehabilitator. A few rehabilitators felt that those veterinarians willing to work with rehabilitators should have consistent fee schedules, and perhaps offer their time at a reduced or no cost.

Rehabilitators' Views of Government

Five rehabilitators shared the view that both provincial and federal government agencies see rehabilitation as "kind of a joke" and do not recognize rehabilitation as a worthy or legitimate activity. Three rehabilitators reported encountering very negative attitudes toward rehabilitation by government officials; one stated that to government, rehabilitation is a "total waste of money, time, and effort." Many rehabilitators blamed this attitude for the unwillingness of certain government personnel to assist rehabilitators. Rehabilitators recognized that the government wildlife agencies have mandates for population and species protection, and all agreed that rehabilitation has little impact on species conservation. However, rehabilitators stated that they regard animals as individuals, not just as members of populations. Additionally, many rehabilitators felt they also promoted environmental and species conservation in their practice and interaction with the public; as one rehabilitator suggested, "through rehabilitation, people become sensitized to the needs of wildlife and from there it is a very short step to habitat and water conservation, forest protection, and the need for a healthy environment that includes wildlife."

Rehabilitators held mixed attitudes toward government agencies and personnel, generally based on their experience with local officials. Many rehabilitators believed that the government agencies "govern [wildlife], but they don't value it." Of the 20 rehabilitators who discussed their relationship with the provincial government, 15 believed that they currently have a good relationship with their local representatives, but several of these had poor relations in the past, and many were aware of rehabilitators who did not have good rapport with their own local officials. Further, nine of these rehabilitators felt that the provincial government policies and nonmonetary support for rehabilitation were not sufficient, and that officials' attitudes and involvement varied greatly by region. Of the remaining rehabilitators who commented, four strongly felt that they received no support from the provincial government, and another stated that they had no regular contact with the provincial government. Four of these five had very positive relations with other rehabilitators. For those facilities with federal permits, most rehabilitators reported much less frequent interaction with these agencies than with the provincial government, and had no strong feelings about the federal agencies. However, one rehabilitator stated that the Canadian Wildlife Service has "no clue" as to what is going on at their facility and several others indicated that they had never been inspected by a Canadian Wildlife Service representative.

Rehabilitators saw the role of the government agencies as establishing guidelines, conducting inspections, issuing permits, and addressing complaints about facilities. However, 20 rehabilitators suggested that rehabilitation guidelines are below standard or inconsistently regulated, or that inspections are not regularly conducted. Rehabilitators also discussed other examples of the lack of nonmonetary support for rehabilitation, stating that in some regions permits are not issued promptly or at all in some years, and complaints about marginal facilities or the public keeping wildlife are not adequately addressed. They called for the enforcement of standards in order to maintain the quality of rehabilitation efforts. One rehabilitator stated, "the government by-and-large is not enforcing their own legislation," and pointed out that although the government has expectations of rehabilitators based on the permits and Acts, when rehabilitators have a problem with a

person or organization not abiding by the Act, they are not supported by the government. As an example, one rehabilitator reported receiving an "emaciated" animal from a nonpermitted individual conducting rehabilitation, but did not receive government support in trying to end this individual's activities.

Ten rehabilitators also wished they had practical assistance from government, including aid in animal transportation, resource materials, and advice on release sites and on non-native species. Two others recommended that government agencies should encourage the public to use only properly permitted facilities, and should clarify that rehabilitators are permitted but not funded by government. Three also recommended that the government should cooperate with the Network in developing nontechnical pamphlets on wildlife laws for the public. Although the need for nonmonetary support was highlighted by some rehabilitators, others just wanted a sense of validation from government agencies that their efforts were a legitimate option for injured and orphaned wildlife. However, one rehabilitator did not want any further government involvement, as that might increase government control over their activities.

Veterinarians' Role and View of Other Stakeholders

According to the veterinarians, their role in rehabilitation is to provide direct medical care, whereas rehabilitators provide first aid and long-term care until release. Veterinarians emphasized that both groups are important. Three veterinarians claimed that too many rehabilitators have poor relationships with vets. Veterinarians recognized that the public, rehabilitators, and they themselves get "warm fuzzies" from helping wildlife. However, four veterinarians emphasized the importance of rehabilitators having appropriate motives; one criticized those doing it for personal gratification as merely "feeding their wildlife ego." All veterinarians saw rehabilitators as good-hearted, wanting to help wildlife, performing a tough job for little return, and often making personal sacrifices. One veterinarian stated that rehabilitators are fiercely independent and do not like criticism of their practices, and further suggested that some "cannot handle" euthanasia. Another veterinarian criticized some rehabilitators for "practicing veterinary medicine without a license."

In their experience, three veterinarians saw rehabilitator-to-rehabilitator relations as a power struggle, caused by different ideas about the best treatments, and suggested that this can lead to poor communication of practices and limited resource sharing. Overall, those veterinarians familiar with the Network held a positive view of it and cited its role in communication and education. However, two veterinarians emphasized that the people most in need of upgrading their skills are not involved in the Network and may not be aware of the outreach programs that exist.

Veterinarians saw the government as the "owner" of wildlife and as decision-makers concerned about species protection but not individual animals. Two veterinarians indicated that because of this mandate, and because not all government wildlife personnel are "keen" on rehabilitation, there is often no recognition of "front line activities." They felt that, in many instances, the government creates impediments to rehabilitation. Generally, veterinarians viewed the permitting system as having a good framework but lacking in enforcement and monitoring. Due to this lack of supervision and unknown levels of veterinary involvement, they suggested a need for cooperative efforts of all stakeholders to prevent the current "free-for-all," where rehabilitators treat and release what and how they want. Three veterinarians recognized that there are few resources in government, but emphasized that government does not necessarily need to fund rehabilitation directly; instead the veterinarians suggested that government could provide supplies, release sites, or educational opportunities for rehabilitators. Finally, one veterinarian suggested there is a need to educate government on rehabilitation's benefical role in monitoring emerging animal diseases and environmental problems.

Government Officials' Role and View of Other Stakeholders

Officials saw their role in rehabilitation as setting its parameters, issuing permits, enforcing permit conditions and facilities, and receiving an annual report. They can also receive animals from the public, dispose of carcasses, address complaints, and, for some provincial officials, find homes for legitimate nonreleasable animals and give release-site guidance. Although government enforcement officers are intended to monitor activities through inspection, six officials recognized that little inspection is conducted. Seven officials stated they have no role in the standardization of care practices such as diet or euthanasia protocols, but regulate policies and procedures on possession, acceptable facilities, and caging guidelines. One provincial official said that animal care standards had previously been provided and monitored in their region. Further, four officials stated they would like to be able to provide guidelines on what is allowed to be released, humane methods of euthanasia, and standardized care guidelines. Two officials felt that the provincial office is weak at providing rehabilitation information to the regions; in one case, an official stated they felt that the caging standards were outdated and asked the provincal office to reassess them several times. Other officials stated there is minimum involvement in rehabilitation training and that, generally, rehabilitators must seek out their own information.

All officials stated that there is little communication among provincial regions on rehabilitation, and that they are unaware of other regional policies and permit requirements; consequently, they recognized that regional inconsistencies exist. The provincial officials were unaware of the number of rehabilitators in their region that had Canadian Wildlife Service permits, since they generally had no communication with the Canadian Wildlife Service. Communication with veterinarians was generally limited to the opening of a facility, as veterinarian support is required to obtain permits, but officials stated that there is little ongoing monitoring of veterinary participation.

Officials saw rehabilitators having a genuine interest in saving wildlife and recognized that some rehabilitators are very professional. They believed that rehabilitators are highly dedicated and generally do a good job with what they have. Five officials stated they have confidence in rehabilitators and believe that they are more knowledgeable about their practices than most government officials. Officials acknowledged that rehabilitators invest their own money and time, but point out

that they get personal enjoyment from their activities as well. Three officials suggested that rehabilitators are motivated by emotions and that they do not always think about their work's purpose. Further, these officials questioned whether rehabilitation is done to benefit the animal or to "make the rehabilitator feel better." Four officials believed that some rehabilitators can have unreal expectations; one noted that "some want to save everything" and can have difficulty euthanizing animals. All officials felt they have a good working relationship with their rehabilitators, but they recognized that "some government people could not care less about rehabilitation and make it known."

Two officials saw relationships among rehabilitators as competitive, and they felt that some rehabilitators can be defensive, secretive, and take criticism personally. The level of interaction that officials reported with their local rehabilitators varied from once a month to a few times per year. Rehabilitators' perceptions of the frequency of this interaction were reported only by a few and also varied from once a month to once a year; however, overall 14 of the 27 felt that nonmonetary government assistance was insufficient.

Most officials believed rehabilitation will continue to be a low priority for government in the future. All officials agreed that government wildlife agencies focus on total populations and not individuals. They also believed that rehabilitation has no impact on population or species conservation, and since there is generally no postrelease monitoring to show any conservation effect, the government cannot justify funding rehabilitation. Other stakeholder groups agreed that there is little data to support any claims concerning postrelease impact, on individuals or populations. Although several officials stated that the provincial government had previously been more involved, with cutbacks and new government policies, they are moving away from direct protection and direct contact with the public and rehabilitators.

Discussion

Wildlife rehabilitation has been defined as "the process of rescuing, raising, and arranging for veterinary medical care of orphaned, sick, displaced, or injured wildlife with the goal of releasing them back to their natural habitats" (Pokras 1997). Although all three groups saw this goal, combined with public education, as the primary goals of wildlife rehabilitation, most rehabilitators and some veterinarians saw a wide range of additional goals. This difference may contribute to the perceptions each group has of their own role, that of others, and the value of rehabilitation efforts. For instance, rehabilitators saw themselves fulfilling many roles beyond caregiver and educator. By contributing to research, developing expertise, and acting as an environmental indicator, rehabilitators believed they are not only serving injured animals and the public, but are also benefiting wildlife and the environment overall.

In contrast, officials may not attach the same value to rehabilitation efforts because they do not associate these broader aims with the practice; rather, officials saw their own traditional wildlife management role, acting at the population and ecosystem level, as serving to benefit wildlife and the environment. Although rehabilitators' values lead them to care for wild animals at the individual level, they also value the conservation of healthy environments and wildlife populations, and see themselves as benefiting populations and habitat indirectly through education and research. Similarly, a New York survey found that government personnel underestimated the importance rehabilitators placed on the conservation of ecosystems (Siemer and Brown 1993).

Differences in views on rehabilitation may also arise because most rehabilitators were care-oriented women volunteering their time and often money, whereas government officials were mostly men in paid positions in an organization originally founded to manage animals for hunting and consumption. Although government wildlife departments now focus on protecting the health of environments, rehabilitators feel that they should be accountable for individual animals as well.

Most participants recognized the limitations set by a lack of funding, but generally only rehabilitators cited a lack of nonmonetary assistance or acknowledgement by government as a major impediment. In a National Wildlife Rehabilitators Association survey, communication or interaction with local officers and headquarters staff of government agencies were each cited as an impediment to rehabilitation by fewer than 10% of respondents (TEWRWG 2002). In contrast, in this study, over half of the rehabilitators saw low government involvement as an important impediment. These rehabilitators generally felt that their interactions with local government officials directly affected their practices since this relationship, plus the value officials place on rehabilitation, often determined the level of cooperation on issues of care, permitting, and enforcement. In contrast, only two officials acknowledged that a lack of government assistance could impede rehabilitation.

Some veterinarians and officials in the study questioned whether rehabilitation was done for the benefit of the animal or the rehabilitator. While they acknowledged both personal and humane motives of rehabilitators, overall, veterinarians and officials tended to over-simplify the motivation of rehabilitators based on a narrower view of rehabilitation goals. Although a few rehabilitators acknowledged personal satisfaction as a goal for their activities, rehabilitators generally cited much more diverse motivations.

In the New York survey, Siemer and Brown (1992a) used Kellert's (1996) classification of attitudes toward animals to identify four main motivational themes: a moralistic concern for the ethical treatment of animals and reduction of human harm; a humanistic concern about the suffering of animals; a naturalistic focus that values human contact with wildlife and nature; and an ecologistic concern that sees biodiversity as critical to human survival. Siemer and Brown (1992a) reported that a majority of New York rehabilitators felt morally obligated to help injured and orphaned wildlife, while fewer expressed humanistic, naturalistic, or ecologistic motivations. In the study reported here, although not specifically asked, moralistic motivations were explicitly observed in eight rehabilitators as a reason for involvement; these rehabilitators felt that since the majority of rehabilitation cases were human-caused, humans have a duty to reduce or compensate for this harm. Humanistic values were also observed in two of these rehabilitators and in an additional four rehabilitators, as exhibited by one who stated that "our whole rationale for doing it is purely

for humane reasons, to reduce suffering." Ecologistic and naturalistic values were observed less frequently but were reported by three rehabilitators who stated that "if we don't save our wildlife we are killing ourselves" and that despite their intimate contact with wildlife, "I didn't want to make pets of them, I respected and admired their wildness."

The findings show that in addition to their rehabilitation responsibilities, more than three-quarters of wildlife caregivers in the study also cared for domestic animals and people in their families or, in a few cases, at paid jobs outside rehabilitation. Although burn out was mentioned by only one rehabilitator and one veterinarian as a major impediment to rehabilitation in BC, Slotkin (1991) discussed compulsive caregiving in the animal welfare field, referring to such individuals as "humaneiac." Typically, such individuals are vulnerable to burn out, and although they have a strong ability to sense the needs of animals, they rarely recognize their own needs, which can put themselves and the animals they care for at risk (Slotkin 1991). Veterinarians and officials were concerned that those rehabilitators who want to "save everything" may fall into this category of compulsive caregivers who, if acting without guidance, veterinary support, and outreach services, can cause animals in their care to suffer.

Veterinarians and officials recognized the professional abilities of many rehabilitators despite a lack of guidance on animal care standards and monitoring from permitting agencies. Nonetheless, veterinarians expressed concern over the limited amount of veterinary support and outreach services that some rehabilitators seek out. Insufficient veterinary support, care standards, and enforcement appear to be further compounded by inconsistent and scarce communication between veterinarians, rehabilitators, and government, and within and between government wildlife agencies. The inconsistency in provincial dealings with rehabilitators has led to the current situation where government supervision varies greatly among regions. Although regional supervision of rehabilitators was designed to allow local government officials flexibility, the lack of consistency in communicating standard policies and practices to stakeholders is seen by rehabilitators as preventing them from achieving the level of professionalism they desire for their practice.

Better communication and coordination between rehabilitators and government could benefit both parties. Rehabilitators could assist government agencies to further their own conservation messages because rehabilitators generally reach nonhunting audiences that wildlife officials may not contact (Marion 1989). Governments could also use rehabilitators as resources for research and as "eyes in the field" for enforcement purposes. Rehabilitators can also help governments develop care guidelines and resource packages (identified to be lacking by several officials, veterinarians, and many rehabilitators), so that new and current rehabilitators can be assisted in promoting wildlife welfare. Conversely, rehabilitation in BC could benefit from governments connections to all BC rehabilitators, to promote consistent standards and training. Rehabilitators might also gain confidence and respect from the public if their activities were effectively monitored, and their educational messages were endorsed by government bodies.

A major aim cited by many rehabilitators is to increase the level of professionalism within their community and gain respect as a legitimate profession. To achieve these goals, and to address the identified impediments to rehabilitation, rehabilitators can promote training, ethics, and communication within their own community. The Network can play an important role in increasing the level of consistency, by involving members and nonmembers, and continuing to work toward standardized provincial practices and accessible training opportunities. Veterinarians can help rehabilitators achieve these goals by providing training. Further, the Network and individual rehabilitators need to be supported by government agencies in order to achieve these goals. Although rehabilitation may remain a low priority for government agencies, it is still possible that government acknowledge rehabilitation as a valid option for injured and orphaned wildlife, and support rehabilitators in finding current information and resources. However, in distancing themselves from direct protection and contact, government agencies are becoming unaware of the needs of rehabilitation stakeholders. In order to create effective relations between policy makers, researchers, and rehabilitators, it may be beneficial to have a designated government representative linked to rehabilitation at the provincial and federal levels.

Acknowledgements

The authors are grateful to the rehabilitators, veterinarians, and government officials who participated in the study and for the assistance of the Wildlife Rehabilitators Network of British Columbia, Wild Bird Trust, R. Wayne Campbell, Lynne Short, Elizabeth Thunstrom, Susan M. Cox, Fern Brunger, Dan Weary, and David Shackleton. Sara Dubois gratefully acknowledges the financial support of the National Wildlife Rehabilitators Association, the Vancouver Foundation, and the UBC Animal Welfare Program, which is funded by the Natural Sciences and Engineering Research Council of Canada, the BC SPCA, the BC Veterinary Medical Association, and other sponsors listed on the program website at www.agsci.ubc.ca/animalwelfare/.

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NEO-REHABILISMS...

hemostab
alternative instrument when you don't have a scapel

remages
wise men who can foresee date of fledging based on flight feathers

starveling
that featherless Sturnus vulgaricus *that arrives emaciated and dehydrated each spring*

SIMPLE SOLUTION

A Mobile Double Door

by Debby Farley

Most of the education and rehabilitation mews/aviaries at Spring Brook Nature Center (Itasca, Illinois) were not designed to have a double door. Many options were tried to prevent accidental escapes; however, none were effective. If a double door was installed, it was done so internally for cosmetic purposes, which compromised the bird's living space. For some mews, a sheet was hung internally, which in a few cases startled the bird when the mew was entered; some of our more creative birds simply enjoyed destroying the sheet.

I cannot take credit for the design of the mobile double door described here, and unfortunately cannot give full credit as to its source. A volunteer brought in a photocopied picture of it from an article in the journal *Watchbird*, published by the American Federation of Aviculture.

The double door is made of PVC pipe, which frames out the two sides, roof, and door. Cut the pipe to length with a saw or PCV pipe cutter. The total length of each side and roof should be at least 1 in longer than the top and sides of your largest mew door. The two sides and roof are jointed at the corners by curved PVC "T" joints to make one unit. The door is a separate piece that is attached to the main unit by three hinges on one side and an eyehook on the other. PVC elbow joints are used for the door. PVC pipe glue is used to hold the pipe in the joint. One wheel is attached to each side in the back where the door is located. Game bird netting covers the two sides, roof, and door, and is attached with plastic cable ties. Be careful not to pull the netting too tight, which will cause the sides to bow inward.

Height and width of the door are determined by your largest cage/mews door. Ours is 3 ft deep. (Depth may depend on whether the door opens in or out.) Most of the doors at our center open in, but we have used it without a problem on those (small) doors that open out.

When the door is needed, the unit is tilted back and wheeled into position. The open side is butted up against the frame of the mews door. One can then open the back door, walk in, lock the door with the eyehook, and then enter the mews safely without the threat of an escape.

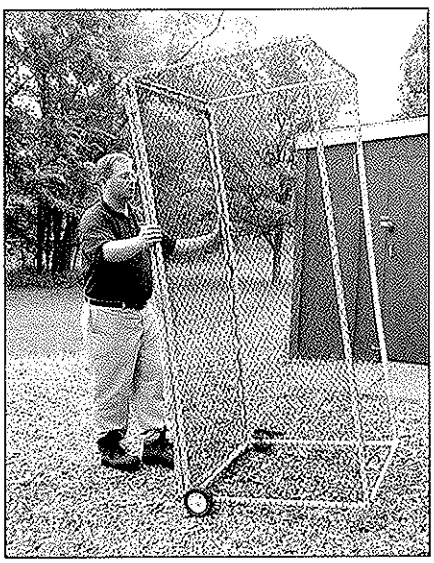
(The only birds that have attempted escape are kestrels and Cooper's hawks, which have flown into the double door, where they are easily recovered. It is possible that if a red-tailed hawk or great horned owl flew into the double door, they might hit hard enough to move it away from the cage/mews—and thus escape. If you are rehabilitating larger birds, attach the unit to the wall or doorframe with metal "U" brackets—making it secure, though temporarily nonmobile.)

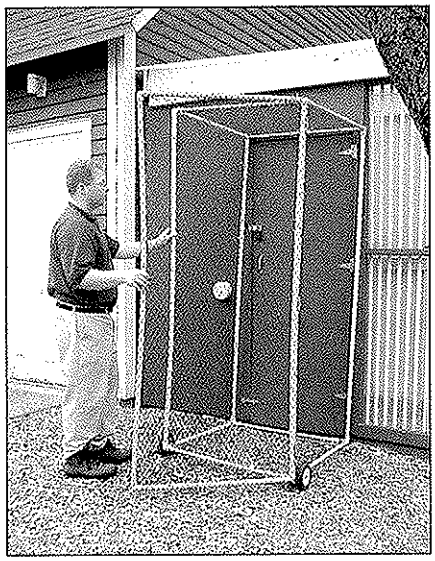
The double door is lightweight and easy to move. We have sized it to fit our largest door, and, therefore, it fits every mews. It is external and does not compromise the bird's living space. The game bird netting is flexible so the bird does not stop suddenly and it is soft enough not to damage feathers. The materials are relatively inexpensive with the exception of the game bird netting; this could be replaced with a less expensive material if needed.

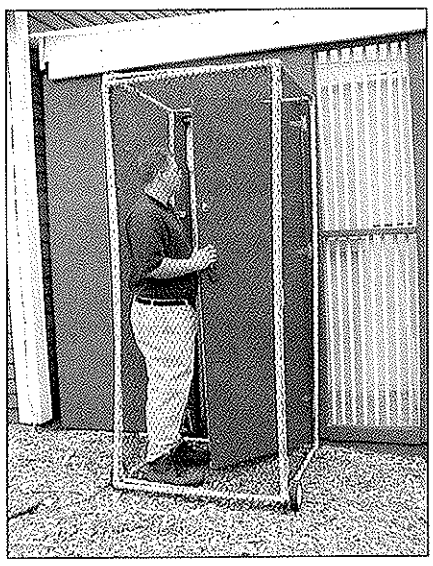
Note: *This double door is intended for use with raptors. If used for songbirds, squirrels, or other small animals, be sure that the door assembly is perfectly tight against the mews/cage/aviary so that the bird/animal cannot squeeze out.* JWR

Debby Farley has worked as a raptor rehabilitator, educator, and propagator at Spring Brook Nature Center for more than 10 years. A master falconer, she holds her own rehabilitation permit, from which she has gained experience with multiple species of migratory birds. She can be reached at dfarley@itasca.com or at 630/773-5572.

Photos, from left: Moving the double door; opening the double door; entering the mews.







PHOTOS: DEBBY FARLEY

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Forester's Log

DYING PIÑONS: VISIBLE RESULTS OF A "FASCINATING PHENOMENON"

by Mary Stuever

Throughout the piñon-juniper woodlands of the American Southwest there is an epidemic of brown trees. If you conduct a casual windshield survey as you drive through these short-statured forests, you will soon lose count of these dead or dying trees. Most are piñon pine, but there are several dying junipers as well.

I first noticed a significant number of dead piñon trees during the summer of 1996, following that year's drought. Again, in 2000 many more trees turned brown. Neither of these years compare to the extent of mortality we are witnessing this year. Still, I have remained relatively calm and almost pleased to witness this death in the forest.

There are many and various causes of this mortality, the most frequent being bark beetles (*Ips*) or twig beetles (*Pityophthorus*). The argument can be made that it is the drought, not the insects, that is truly accountable for this heavy tree mortality. The related drought stress makes these trees more susceptible to insect outbreaks. I would argue that the drought should not take the major rap. The real culprit is the condition of the woodlands, which over most of the piñon-juniper range, is crowded with too many trees.

It is becoming a familiar tale. We have too many trees in forests, primarily due to a long history of excluding fire from the ecosystem. Last summer, however, it was fascinating to watch the combination of drought and insect outbreaks try to bring some balance to the forest woodland. I live in the piñon-juniper belt and for years have been watching and waiting for this phenomenon.

Many piñon in my neighborhood are relatively young trees. Although large "grandfather"-size piñon are scattered throughout the neighborhood, a good number of our neighborhood trees are still within "Christmas tree" criteria. I suspect that in my neighborhood, as well as many other areas in the Southwest, large numbers of piñons died during a several-year drought in the 1950s. Many of today's trees have probably established since then.

Julio Betancourt, a Tucson-based scientist with the U.S. Geological Survey, suggests that the drought of the 1950s significantly disrupted the piñon-juniper woodland, causing changes in nutrient and carbon cycling and shifting boundaries of vegetation communities that had been stable for thousands of years. In many places in the Southwest, he and his colleagues have demonstrated shifts in tree occurrence as much as 100 meters (330 feet) upslope. Now, fifty years later, drought is taking another stab at reducing the piñon population.

A friend recently showed me a pair of aerial photos of a mesa near the Jemez Mountains, taken in 1935 and 1998. In the 1935 photo, there are clearly fewer trees. The telling observation, however, was the white halo around each tree in both photos. My friend had been out ground-truthing the photos and confirmed my suspicion that each of the trees is surrounded by bare soil. The roots of the trees dominate available moisture and make it difficult for grasses or other plants to grow. The scary observation was the immense increase in this bare ground in the 1998 photo due to an increase in the density of the trees. Not only does more bare soil mean less grass and habitat for wildlife ranging from insects to browsers, but bare soil is also subject to erosion.

In the piñon-juniper woodlands, soil development is very slow due to the semi-arid conditions. In fact, much of the soil in these regions developed 10,000 to 100,000 years ago when wetter climates supported mixed conifer forests. The soil that washes off the hill slopes during our monsoon storms is, at least from a human time perspective, irreplaceable. Therefore, it is easy to get concerned about the "encroachment" of trees in this fire-excluded landscape.

I have long favored active forest management in woodlands. I have encouraged fuel-wood cutting, thinning and chipping, and burning to reduce the density of trees on the landscape, and hopefully slow the soil erosion that leaves tell-tale pedestals of plants in the wake of rills and gullies. I have felt that if we did not take the responsibility for adjusting the "unnatural" conditions we had created in the woodlands through our fire suppression policies, nature would make an adjustment some day and we might not like the results.

Nature seems to be speaking up now in the form of drought-induced bark beetle attacks. The jury is still out on the impacts this will have in the woodlands. There will probably be significant changes going on this summer. Piñon may be "edited" out of the ecosystem in some drainages and draws where the bark beetles populations explode. The occurrence of piñon trees could even shift by hundreds of feet in elevation. Extra fuels from dead and dying trees may accelerate fire behavior and spread where fires do occur. Perhaps the reduction in trees will allow grasses and other plants to establish and hold the soil on the site.

For me, it is exciting to watch this happening. We have front row seats to this performance. Yet, when asked if I am concerned about the number of dying trees in our woodlands, I can not respond with a resounding "yes" or "no." Rather, I find the "phenomenon" fascinating. JWR

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

Open Minds

RECRUITING AND KEEPING THE BEST VOLUNTEERS

by Beth Dillingham

Do you ever feel so swamped with work you have no idea how you'll get everything done? Even if you are yourself a volunteer, you can recruit others to help you. Many people have a deep need to be involved in meaningful work. These potential volunteers may be retired, have a flexible schedules, are available on weekends, or not need to work for income. They are oftentimes highly skilled, and can be a tremendous help to your organization. Finding, training, and retaining good volunteers can help you avoid burn out—and can help your organization reach beyond its goals.

To recruit volunteers well you need clear job descriptions so that everyone understands exactly what you need them to do. These documents can save you from having to explain your needs over and over again to potential volunteers. They can also help weed out people who want to help but do not have the necessary skills and interests. Writing job descriptions takes time but helps clarify your needs; in the long run they can save you time and trouble. A good job description should include the following:

1. Your organization's mission. Let them know what you are all about.

2. Volunteer duties. List the specific duties they will do for you. Create a job description for each volunteer position.

3. General volunteer requirements. These include age minimum, skills, and the kind of attitude you require.

For example, "We need a dependable, team-oriented person who has an interest in teaching conservation and enjoys communicating with the public." You can teach volunteers a lot—but they must have the basic interest and personality.

4. Minimum time commitment: For your training to be worth your time, volunteers need to be with you long enough to justify your efforts. You hope that they will remain with your organization for years to come, but specify a minimum commitment for the coming 12 months, whether it's 20, 40, 60, hours or more.

5. Training. Volunteers need training to do work consistent with what you are trying to accomplish. Whether you train volunteers once or several times a year, set specific dates and times you will do the training, and advertise these dates. Training can require a lot of time, and you may need people to train for several sessions before they are ready to work on their own. Do group trainings if possible, and then schedule individual sessions if necessary. Decide how flexible you will be if someone cannot attend one of the training sessions. (Can they can make it up?) Put together a training manual.

It is helpful to put together materials that can be used as a reference for volunteers. A notebook full of information about how to direct calls would be great for a volunteer who works the phones. A slide show with a script will help make your education program's message and delivery consistent every time someone gives a program. Put these materials in a training manual and give them to your trainees. Train your volunteers to be self-sufficient once they are trained.

6. Support. List the ways that you can support your volunteers in their jobs. If they need additional help getting started, ask them to "shadow" an experienced volunteer before doing the job for the first time on their own.

7. Benefits for the volunteer. List the tangible benefits a volunteer will get working for your organization. For example, "Do meaningful and gratifying education work on behalf of wildlife," "Meet like-minded people who share your love and respect for wildlife," "Help stop wildlife injuries through education," "Learn more than you thought possible about native wildlife...".

8. Costs. List any out-of-pocket costs your volunteers will incur. Do they need shots? Will they have to purchase a uniform? Will you charge them to cover the costs of your training materials?

9. Application. Your volunteer application form should ask for all the information you need, including education background, work experience, and special skills, interests, and hobbies. This can help you know what additional skills you can tap into. Be sure to get their e-mail address and emergency contact information in case they become sick on the job.

10. Include a contract release form that covers any legal concerns. Also include a sentence stating that if either party is unhappy with the situation, either the volunteer can resign or the organization can ask the volunteer to resign. Hopefully your screening process will make resignations rare.

Advertise your need for volunteers through flyers posted on bulletin boards; put your job description on your website. Send press releases to the local media and have volunteer information at every display table or program you give. Gather names and addresses of interested people and send them a reminder about upcoming trainings.

After you have found your volunteers it is important to keep in close touch with them. Put together a database with your volunteer addresses and e-mails. A monthly or quarterly meeting—make it a potluck!—and printed or electronic newsletters help them to stay focused on working for you. Let your volunteers know of special needs or programs ahead of time, and encourage them to "sign up now." Invite guest speakers to your meetings, share rehab successes and any new information. Use meetings to build community and volunteer investment in your organization. If you are lucky enough to have a facility, put up a communications bulletin board.

Working with volunteers requires a substantial investment of time and resources. But a good, stable volunteer program with a clear infrastructure can help your organization to accomplish more than you ever dreamed possible. IWR

Beth Dillingham has taught in both classroom and informal learning settings for fourteen 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.

Food for Thought

NUTRITIONAL NO-NO'S

by Astrid MacLeod and Janine Perlman

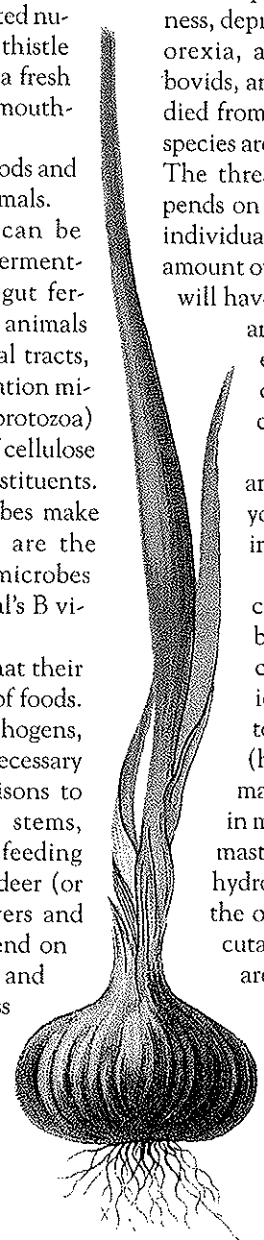
What's good for the goose may be good for the gander, but what's good for the human is not necessarily good for the hummingbird, hippopotamus, or hyena.

"Human" foods are tasty to us, and it's tempting to feed them to other animals, as well. Those that are whole and natural would seem to be particularly good choices. Wouldn't a rabbit enjoy a slice of sweet potato? Wouldn't a deer prefer corn to hay? Surely a macadamia nut, or a nice ripe avocado, offers a seed- or nut-eater more concentrated nutrition than would a stalk of thistle or a bland, raw acorn. Isn't a fresh green onion tastier than a mouthful of dandelions?

On the contrary, those foods and others can poison many animals.

Starches and sugars can be anathema to both hindgut fermenters (e.g., rabbits) and foregut fermenters (e.g., deer). These animals host, in their gastrointestinal tracts, exquisitely evolved fermentation microbes (bacteria, fungi, and protozoa) that require large amounts of cellulose and other fibrous plant constituents. From plant fiber, the microbes make *volatile fatty acids*, which are the animal's actual fuel. The microbes also synthesize all the animal's B vitamins.

These gut flora require that their host eat very specific kinds of foods. Starches and sugars feed pathogens, whose byproducts kill the necessary flora. They are literally poisons to animals that require grass, stems, leaves, and/or bark. Thus, feeding **fruit or grain** to rabbits or deer (or other animals such as beavers and porcupines that largely depend on fermentation) is very risky, and regularly results in their illness and death due to enteritis.



The *Allium* plant genus includes a large number of species, including all types of **onion and garlic**. These plants in any form—dehydrated, powdered, cooked, or fresh—have chemicals that cause oxidative damage (see Food for Thought, *J. Wildlife Rehab.* 24[4]) to the hemoglobin that is dissolved in red blood cells. The damage causes the hemoglobin to precipitate and form clumps, called Heinz bodies, within the cell. The cells are then perceived by the body as defective and are destroyed, resulting in anemia and even death. Clinical signs of severe Heinz body hemolytic anemia include pale mucous membranes, weakness, depression, hypoxia, vomiting, anorexia, and diarrhea. Canids, felids, bovids, and primates have become ill or died from onion toxicosis, and affected species are probably not limited to these. The threshold for serious toxicity depends on the animal's size, species, and individual biochemistry. However, any amount of an *Allium sp.* almost certainly will have some effect on many or most animals. Large amounts of other edible plants, such as kale, also contain sufficient oxidants to cause anemia.

If you use baby food meats and pet foods for the animals in your care, check the labels. Some include onion and/or garlic.

Avocado can be toxic to cattle, horses, goats, rabbits, and birds, among others. The principal toxin has not yet been identified, but it has a direct toxic effect on the myocardium (heart muscle) and on lactating mammary glands. Clinical signs in mammals include noninfectious mastitis, congestion of lungs and hydropericardium (swelling around the outside of the heart), and subcutaneous edema in the pectoral area. Birds that ingest avocado fruits and seeds experience respiratory distress; sudden death can occur 1 to 2 days after consumption.

Death by **chocolate** is more than a fantasy that some of us entertain regarding our own eventual demise. Chocolate contains theobromine and caffeine; both are methylxanthines, and small amounts can prove fatal. Methylxanthine toxicosis (or death by chocolate) has killed many dogs, cats, and birds; it can also affect rodents and reptiles. Other animals do not detoxify these chemicals nearly as quickly as we humans do; their blood levels remain very high for extended periods. Biochemical processes are thereby pushed into "overdrive," with the kinds of effects that might be expected from an overdose of amphetamines. Clinical signs include vomiting, diarrhea, polyuria, polydypsia, hyperactivity, ataxia, tachycardia, hypertension, weakness, tremors, seizures, coma, and death.

Macadamia nuts are a surprising source of toxicity, but large amounts of the nuts cause poisoning in dogs. Symptoms usually begin a few hours after ingestion and include lethargy, vomiting, and hyperthermia; hindlimb weakness, ataxia, and inability to stand; abdominal pain, lameness, and pale mucous membranes. The mechanism of the effects is not presently known.

Leaves of parsley, parsnip, carrot, and celery are quite nutritious for many animals, and in moderate amounts they are good inclusions for many diets. However, they contain furocoumarins, which are phototoxins. Phototoxins are chemicals that are activated by sunlight and then cause harmful biochemical reactions in the body. Ingestion of large amounts of these plants, coupled with significant exposure to sunlight, can cause serious problems.

Medicinal herbs, or herbal remedies, must also be used with *great* caution. Medicinal herbs *are*, as the term indicates, medicines, albeit not synthetic ones. They contain powerful chemicals. Every one of them has hazardous side effects; see a reliable website such as: http://www-personal.umich.edu/~mshlafer/Lectures/herbdrug.pdf.

Soy is a common ingredient in many human and pet foods. There is evidence that it may be a healthful food for adult humans at risk for certain maladies. It is easy to grow, inexpensive, and, because of its chemical defenses, fewer animals naturally consume it than many other crops. In fact, raw soy is toxic to many wild (and domestic) animals, and has anti-nutritive properties. Cooked soy products, too, can be highly problematic.

Soy contains phytoestrogens (e.g., isoflavones), compounds with structures and functions similar to those of estrogenic hormones. Two phytoestrogens, genistein and daidzein, occur at particularly high levels.

Phytoestrogens can have negative effects on reproduction in animals. In psittacines, diets high in soy resulted in precocious maturation of chicks; decreased fertility; deformed, stunted, or stillborn hatchlings; and premature deaths, especially in females. Studies of several animal species (including mice, cheetahs, quail, pigs, sheep, and rats) showed reproductive problems, infertility, and thyroid and liver disease due to high dietary intake of isoflavones, which were found to inhibit synthesis of estradiol and other steroid hormones.

Isoflavones in soy are also goitrogens that affect thyroid function. One group of parrots had beak and bone deformities, goiters, immune system disorders, and pathological aggressive behavior.

Necropsies performed on young birds fed soy-based diets, notably passerines, psittacines, hummingbirds, and doves, have revealed lumps of undigested food in crops and guts, and irritation of other parts of the GI tract. Older birds had poor muscle mass and abnormal feathering.

Excess soy also interferes with calcium uptake and causes vitamin D deficiencies.

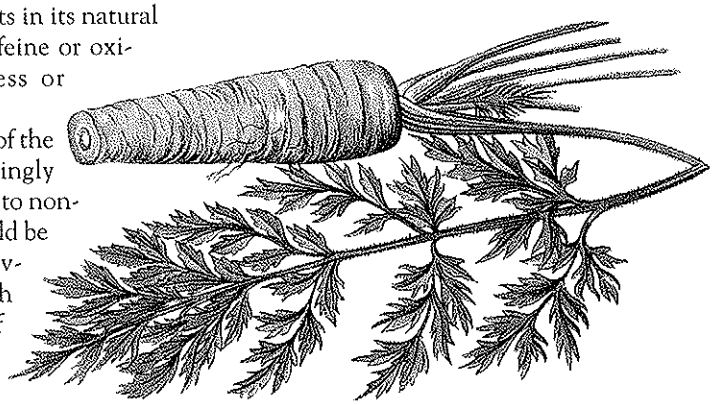
Soy's much-touted protein has a poor amino acids profile compared to that of animal-sourced proteins. This results in a higher dietary protein requirement, which can be deleterious to some animals. Clinical research has shown that soybean cereal interferes with the growth of young rodents. Soy causes stunted growth and deposition of excessive body fat; the animal may weigh as much as a wild conspecific but have abnormal body composition.

The extent and nature of the effects, positive and negative, of soy on humans are still being studied. However, some of its harmful effects on other animals are known. Better pet food companies are now marketing and promoting some foods as "soy free." Nonetheless, many premium (and expensive) foods for dogs, cats and birds do contain soy, and often a food that now has "more protein!" has been newly formulated with that inexpensive additive. Err on the side of caution; when choosing foods, examine ingredients lists, and avoid anything that says, "soy bean mill run," "soy flour," "protein isolate," "soy protein", etc. Don't add soy protein to milk replacers or to bird diets. Instead, use a food that these animals have evolved to eat.

Other **legumes** such as **alfalfa** also contain high levels of powerful phytoestrogens. As is the case with soy, it appears that these may be either harmful or healthful, depending on species, age, sex, season, and amount consumed. Since few animals evolved eating mostly alfalfa (or any other single plant), the practice of feeding large amounts of this common feedstuff to wild creatures bears examining.

There is sometimes more faith than fact in our ideas about human nutrition. Grandma may have dosed us with onions and garlic at the first sign of a cold, the latest magazine may say that chocolate helps depression, and the clerk at the health food store may insist that we will avoid the flu if only we take our echinacea. Some beliefs contain grains of truth. Often, they're at least relatively harmless. But in some cases, that's because we are large omnivores who can tolerate the results of a little misinformation. A cup of coffee or a green onion may be but a drop in our metabolic bucket. To a small creature, or any animal that has evolved to require and metabolize only the nutrients in its natural diet, that amount of caffeine or oxidants may mean illness or death.

What are we to make of the fact that so many seemingly good foods are hazardous to non-human animals? We would be wise to remember that every food, particularly each type, and age, and part of a plant, is a unique and incalculably complex collection of chemicals. Animals co-evolved with plants. Animals need, use, avoid, or detoxify phytochemicals in their natural diet. Coyotes did not evolve eating macadamia nuts. Squirrels did not evolve eating chocolate, or rabbits apples, or rodents or birds soy. We are reminded, as always, that the best way we can feed our charges is with a variety of whole, natural foods—foods that they have evolved to need and to be able to use; foods they would eat in the wild. IWR



The authors welcome feedback and suggestions for future columns. Please feel free to write to them.

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INSIGHT

Bugs & Drugs

THINGS MICROBIAL

by Kathy Dolan

Emerging diseases, resistance to antibiotics, benefits and risks of vaccination are receiving much public attention. All these have relevance to wildlife as well as human health. The following column is the first in a series addressing some of the complexities of microbial studies.

Bugs? Bacteria? Germs? Microbes? Parasites? What are they? Most microbes are single-celled living organisms that are too small to be seen with the naked eye. In fact, some are so small that they can only be visualized with an electron microscope. Because microbes are so small, most people ignore them or don't even realize that they are all around us and on us. Except for algae and viruses, many of these organisms live in and on us as part of our normal flora as well as in and on the animals in our care.

Most microbes with the exception of viruses are not pathogenic, or capable of causing disease. The majority of microbes lives and works in relative obscurity within all niches of the environment. They are both the beginning and the end of the food chain, serving as food at the start of the chain and as decomposers at its end. Without the actions of microbes, the world in which we live would be very different. Despite their ubiquity, very few species of microbes have been studied in great detail. The best-studied species are either those that in some way have a negative impact on us, or those that have been useful to us. Human disease, food spoilage, and disease in livestock, are examples of negative activities of microbes. The benefits of microbes are vast and include antibiotic production, food preservation, and food production. Bread, beer, wine, and even early medicines are the direct results of microbial actions, without which the foundations of civilization could not have been laid.

Bacteria

Bacteria are single-celled microbes that live in a variety of habitats. Bacteria range in size from 0.2–2.0 microns in width to 2–8 microns in length. Bacteria are prokaryotic organisms, meaning they lack internal membrane-bound structures such as a nucleus, mitochrondria, or chloroplasts. A basic characteristic used to identify and describe bacteria is morphology: shape and arrangement of the individual cells. Bacteria occur in a variety of shapes that include coccus, bacillus, spiral/spirochetes, and pleomorphic. Coccus bacteria are round or spherical in shape, like small beads. Bacilli are bacterial rods. Rods can be long and slender, long and robust, or short and stubby, almost coccus-like. Spirals range from shapes that are comma-like to shapes that look like rotini pasta. Pleomorphic bacteria are bacteria that can assume a variety of shapes in a single culture. "Arrangement" refers to the spatial orientation one cell has to another cell and, again, is usually a unique feature of a given genus of bacteria. Individual cells can be found in pairs (diplo), in groups of fours (tetrads) or eights (sarcinea), or in irregular groupings or in chains. For example, a bacterial species that on microscopic examination appears mostly as pairs of beads would be referred to as "diplococci," whereas a bacterial species appearing predominantly as beads in a chain would be described as a "streptococcus," and chains of rods would be recorded as "streptobacilli."

The shape of a bacterial cell is primarily determined by an external structure known as the bacterial cell wall. With the exception of *Mycoplasma*, bacteria have a cell wall that is external to the cytoplasmic membrane. The cell wall is composed of many strands of a rigid linear macromolecule known as "peptidoglycan." Peptidoglycan is a unique compound found only in bacteria. In addition to providing shape to the bacterial cell, the cell wall also provides protection against abrupt osmotic changes within the environment. When bacteria grow or reproduce, more cell wall must be made. Antibiotics that interfer with or stop the synthesis of the bacterial wall, such as penicillins or cephalasporins, have a lethal effect on the bacterial population, resulting in the death of cells.

Based on the arrangement of the peptidoglycan strands in the bacterial cell wall, bacteria can be divided into two large groups: gram-positives such as *Staphylococcus aureus* or *Bacillus cereus* and gram-negatives such as *Escherichia coli*. Gram staining is used to determine if a bacterial species is gram-positive or -negative. Gram-positive bacteria contain multiple layers of tightly linked peptidoglycan strands, forming a tight mesh-like structure around the cell. This structure prevents the deep purple crystal-iodine violet dye complex from diffusing back through the cell wall and hence the cells appear purple when viewed with a microscope. Gram-negative bacteria have a single, more open layer of peptidoglycan through which the crystal-iodine violet dye complex is easily washed away; when counterstained with the red dye safranin, these cells appear pink. The structure of the bacterial cell wall plays an important role both in the identification of bacteria and in determination of treatment therapies. Penicillins and some cephalosporins are more effective against gram-positive bacterial than they are against gram-negative bacteria.

In addition to having a thin peptidoglycan layer, the cell wall of gram-negative bacteria also has a unique second membrane structure that is not found in gram-positive bacteria. This second or outer membrane is external to both the cell wall and the cytoplasmic membrane. The outer membrane provides some innate resistance to antibiotics and disinfectants and contains lipopolysaccharide (LPS), also known as endotoxin. The release of endotoxin from dead and dying gram-negative bacteria is the primary cause of septic shock.

Fungi

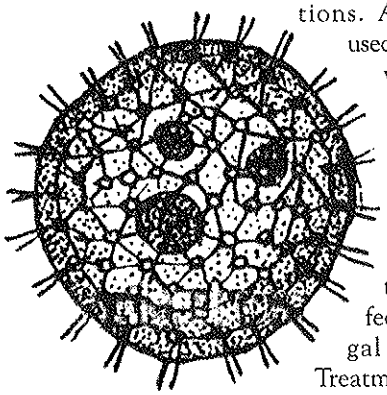
Fungi differ from bacteria in that they are eukaryotes. Eukaryotic organisms include reptiles, birds, mammals (animal and human), and fish. Both prokaryotes (bacteria) and eukaryotes have a cellular cytoplasm enclosed by a cytoplasmic membrane, but the eukaryotic cytoplasm

contains membrane-bound organelles where specific molecules are found or where specific cellular activities occur. The DNA (the hereditary informational molecule) in a eukaryotic cell is found within a membrane-bound structure known as the nucleus. Bacteria lack a nucleus; instead, their DNA is found more randomly distributed in the bacterial cytoplasm. (Other organelles found within eukaryotic organisms are beyond the scope of this column and will be discussed in context with other topics in subsequent columns.) The fungi include unicellular yeasts, such as *Candida*, and filamentous molds, such as *Aspergillus*.

Microscopically, yeasts appear as oval bodies with smaller oval buds extending away from the main cell, while molds appear as long strands known as "hyphae," occasionally interrupted with elaborate reproductive structures projecting off a main filament.

Candida is frequently a harmless part of the normal flora of many different species, but when given a chance through an oral wound or a change in the immune status of the host, a *Candida* infection, candidiasis, can result. *Aspergillus*, a very common environmental fungus, is another opportunistic pathogen of host organisms, immunologically weakened through physical trauma, an underlying disease, or stress.

Fungi, like bacteria, have a cell wall, but it contains chitin instead of peptidoglycan. Fungal chitin is very similar to the chitin that makes up the tough durable exoskeleton of insects and crustaceans. This chitinous cell wall makes fungi very resistant to osmotic changes and to other adverse environmental conditions. The differences in the cell wall composition between fungus and bacteria have significant consequences with regard to treatment options. Antibiotics used to interfere with bacterial cell wall synthesis have no effect on a fungal cell wall, and thus no effect on a fungal infection. Treatment options for fungi are more limited than options available for bacteria due to similarities to their eukaryotic hosts.



Parasites

Parasitic protozoa are single-celled eukaryotic organisms, such as *Giardia* or *Trichomonas*. They are frequntly referred to as "simple animals," and like animals lack a cell wall. Many protozoa are motile, using whip or hair-like external structures, flagella, and cilia, respectively, to dart quickly about. Others, like ameoba, crawl and ooze slowly along. And, of course, a few protozoa are nonmotile. Life cycles among the protozoa range from very simple, requiring only one host in which to complete its life cycle (such as *Giardia)* to very complex life cycles requiring passage through intermediates before finally infecting its ultimate host. Passage of a protozoa from one host to another can again range from a very simple fecal-route route, requiring ingestion of fecal-contaminated water by the unsuspecting next host, or the passage might involve an arthropod vector such as a tick or a mosquito. The host and where in the host a protozoa lives depends on the protozoa itself. Some live within specific organ tissue, others in the blood stream either extracellularly, such as *Trypanosomes*, or intracellularly, like *Haemoproteus*, or within the gastrointestinal tract, like *Giardia*. Diagnosis and identification of protozoal infections usually includes microscopic examination of the appropriate infected material, a blood smear for *Trypanosomes* or *Haemoproteus*, or a fecal examination for *Giardia*.

Viruses

Before viruses were visualized with the electron microscope in the 1930s, they were referred to as "filterable infectious agents" because they are so small they passed through the filters used to retain bacteria. The standard unit of measure for viruses is the nanometer, which is 1/1,000,000,000 of a meter! Not only are viruses tiny, but also they are structurally simple. The basic structure of a virus is an outer protein coat or capsid that surrounds an inner core of viral nucleic acid. The viral nucleic acid is either DNA or RNA, but never both. A virus is like a hard-shelled candy: a tough exterior of protein protects the nucleic acid center. In addition to the capsid and nucleic acid, some viruses have an outer membranous structure called an "envelope." The shape of the capsid, the presence of DNA or RNA, the structure of the nucleic acid, and the presence or absence of an envelope are among the characteristics that are used to classify viruses.

Viruses lack the cellular machinery needed to produce new viral particles. To produce more viruses, they invade a living host cell and use the viral nucleic acid to reprogram the host cell to synthesize viral components. The new viruses are assembled inside the host cell and released, by either extruding the virus through the membrane or lysing the cell. These processes ultimately kill the host cell. More successful viruses walk a tightrope and do not dedebilitate the host enough for it to die out from under the virus. Treatments for viral infections are limited even in human medicine because these organisms live inside host cells and use host machinery. To kill or damage a virus means to kill or damage the host cell. Frequently, the best treatment is supportive therapy for the host while the virus runs its proverbial course.

Control and Treatment

How are microbial infections controlled? The answer lies in the concept of "selective toxicity." The strategy is to find a component in the microbe that is lacking in the host—in other words, a unique target at which to aim the treatment. An ideal antimicrobial agent is one that kills or damages the infecting microbe while leaving the host relatively undamaged. A drug that kills the host as well as the microbe is of limited value. Bacteria have several unique features that can be exploited by antimicrobial drugs. For example, peptidoglycan is found in the cell wall of bacteria, but not in eukaryotic organisms. This unique structure and its production are reflected in the large number of antibacterial agents that interfere with the synthesis of peptidoglycan. Other targets within bacteria that allow for more limited selections of antimicrobials include ribosomes and various metabolic pathways. As infectious eukaryotic organisms, fungi and protozoa are more challenging because of their similarities to their host organisms, reducing the possible targets for antimicrobial agents. Also with increased similiarities between host and pathogen there are increased chances of side effects associated

with the treatments. With these organisms, unique features of their metabolism are targeted. For example, the fungal membrane has an unique lipid generating pathway that can be exploited for treatment. The more comon treatments that are available for viruses involve tricking the viral assembly lines into putting in bogus non- functioning parts. These drugs are reserved for life-or-death cases. Unfortunately, there is no "silver bullet." There is no drug that will hunt down and kill only the pathogenic organisms. Frequently, normal flora is killed off during drug treatment. Sometimes there are side effects that need to be monitored; sometimes drug resistances develop. Drugs play an important in treatment and control of microbial infections, but they need to be used judiciously. JWR

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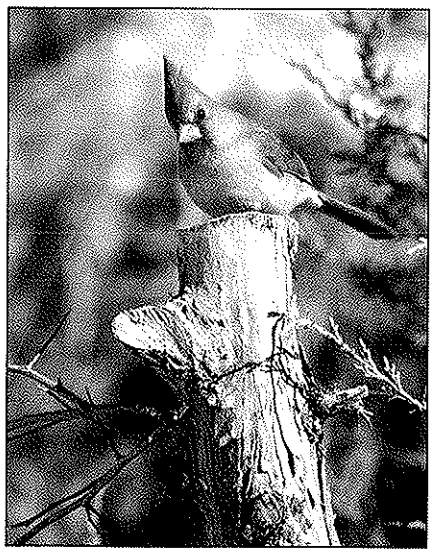
SELECTED ABSTRACTS

A Habitat Island Approach to Conserving Birds in Urban Landscapes: Case Studies from Southern and Northern Europe

by E. Fernández-Juricic and J. Jokimäki

Biodiversity and Conservation 10(12): 2023–43

Wildlife conservation in urban habitats is increasingly important. The authors review the different approaches to studying birds in urban landscapes, and point out the importance of the habitat island ecological theory as a research framework for the management and conservation of urban birds. Based on two comprehensive research projects conducted at urban parks in Spain and Finland, several issues related to bird conservation in cities are discussed, main findings of these projects are presented, and future research needs are suggested. Urban parks are important biodiversity hotspots in cities. Fragmentation has the same deleterious effects to urban birds as in other fragmented landscapes. Park size accounts for species accumulation in urban parks, this pattern being highly nested. Urban parks of 10–35 ha contain most of the species recorded in cities, but other indicators related to the probabilities of persistence of the target species should be obtained. Wooded streets can increase urban landscape connectivity by providing alternative habitat for feeding and nesting during the breeding season. Because increasing the size of city parks is difficult, enhancement of habitat diversity and resource availability for birds within parks can increase bird diversity. However, human disturbance (pedestrians) should be controlled, since it can negatively influence many birds. *(Abstract© 2001 Kluwer Academic Publishers)*



DAVE MENKE/USFWS

Avian Population Trends Within the Evolving Agricultural Landscape of Eastern and Central United States

by M. T. Murphy

The Auk 120(1): 20–34

State-level Breeding Bird Survey (1980–1998) and USDA statistics were used to test the hypothesis that changes in agricultural land use within the eastern and central U.S. have driven population trends of grassland and shrub habitat birds over the past two decades. The degree to which population trends differed between grassland and shrub habitats was evaluated with respect to migratory and nesting behavior. Grassland birds declined significantly 1980–1999 but, on average, shrub habitat species did not. Grassland-breeding, long-distance migrants exhibited the strongest negative trends. Most species (78%; n = 63) exhibited at least one significant association between population trends and changes in agricultural land use, and in most, land use "explained" 25–30% of the variation in population trends among states. Changes in the farmland landscape accounted for more of the interstate variability of population trends of short-distance migrants than of both long-distance migrants and residents, and that variability was greater in grassland than shrub species. Declines in the area of rangeland and cover crops were followed by population declines and increases, respectively, by many species. Increases of land in the Conservation Reserve Program had negative associations with population trends of some shrub species. The results indicate that grassland birds have declined strongly over the past two decades, and that regardless of migratory behavior or nesting habits, avian population trends are linked strongly to changes in agricultural land use within North America. JWR

FACT SHEET

Rehabilitation Notebook:
SARCOPTIC MANGE IN RED FOXES (*Vulpes vulpes*)

Causitive Agent
Sarcoptic mange in red foxes is caused by the mite *Sarcoptes scabiei*. This is an external parasite that lives in the skin. It is the most common disease in red foxes (*Vulpes vulpes*) in the southeast U.S.A. and probably accounts for substantial mortality. Sarcoptic mange is also a common and important disease in coyotes.

Clinical Signs and Lesions
- Scratching, chewing, or licking of infested skin
- Weakness
- Emaciation
- Loss of hair (face, neck, feet, tail, back, or all the body)
- Wrinkled skin
- Loss of fear of humans
- Foul odor

Common Hosts
- Red foxes
- Coyotes

Transmission
Animals become infested by contact with other infested animals or by contact with contaminated areas such as dens or burrows.

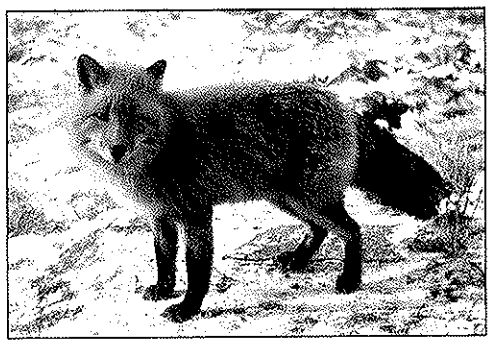
Sarcoptic mange can cause temporary infestation of the skin with itching when people handle mange-infested animals. The disease can also be transmitted to domestic dogs.

Diagnostics
- A presumptive diagnosis can be made upon finding typical skin lesions
- Skin scrapings examined under the microscope may reveal the mites

Treatment
Ivermectin (an antiparasitic drug) as a single injection and a second injection in 2 weeks, can control the mites. All in-contact animals should be tested at the same time. As mite-infested animals are often very debilitated, supportive care, including appropriate hydration and nutrition, is essential in combating acute conditions.

Infested animals should be isolated, as this is a contagious disease. Bedding will be contaminated and mites can infest the clothing of humans that handle it. Incineration of infected bedding is effective disposal.

This Fact Sheet is based on one prepared by the Wildlife Center of Virginia and is published with the center's approval.



V. BERN/USFWS

Cellphones Harming Envionment

A recent article in the New York Times reports that the growing use of cellphones is harming the environment.

Cellphone use in the U.S. surged to more than 128 million subscribers in 2002, up from 340,000 in 1985. Typically, each phone is used for 18 months before it is dropped for a newer model.

This is starting to add up to a huge amount of waste, says the environmental organization Inform, in a recent report. The U.S. Environmental Protection Agency helped finance the study.

The report estimates that by 2005, 130 million cellphones will be thrown out each year. Counting the phones, batteries and chargers, that comes to 65,000 tons of waste a year, the report said. Most will end up in landfills or be incinerated. According to Eric Most, director of Inform's solid waste prevention program, the associated chemicals "will accumulate and persist in the environment. They get in the plants, soil, and water."

More than a billion cellphones are used worldwide, and Japan and several European countries have started pressuring manufacturers to eliminate toxic chemicals. Companies can help limit waste by creating take-back programs that offer discounts on new phones or service in exchange for returned equipment. Australia has a nationwide take-back program, and Europe is about to mandate that companies take back their electronics.

While some U.S. companies do have take-back programs, the main industry group, the Cellular Telecommunications and Internet Association, opposes mandatory programs.

The EPA is working with Inform on a follow-up study to examine the effectiveness of reusing and recycling cellphones. JWR

New Endangered Species Report

According to the World Conservation Union (IUCN), 121 plants and animals have been added to the Switzerland-based group's Red List of Threatened Species since 2000—bringing the total number to more than 11,000. Among the most endangered animals on the list, which was compiled by thousands of species experts around the globe, are the Chinese alligator; a fruit bat found only on remote Japanese islands; the Brazilian guitarfish, and the Philippine eagle.

Says IUCN Director General Achim Steiner,

> **"On the Red List, all species are treated with equal importance—the humble Bavarian pine vole stands alongside the African rhino. It provides the international benchmark to help guide effective biodiversity conservation."**

To view the list and learn more about the planet's most vulnerable populations, visit http://www.redlist.org/. JWR

Reserve to Protect Ocean Wildlife

In a major victory for the protection of ocean wildlife, the California Fish and Game Commission voted in October 2002 to establish 175 square miles of marine reserves around Santa Barbara's Channel Islands. Fishing will be banned in the reserves to allow depleted populations of once-abundant species—including white abalone and Pacific red snapper—to rebound. A chain of eight islands near Los Angeles, the Channel Islands are home to more than 2,000 species of plants and animals, ranging from microscopic plankton to the endangered blue whale, the largest animal on earth. The decision, which comes after four years of negotiations, sets an important precedent for creating protected areas in other critical coastal habitats. JWR

Roads, Development Harm Wildlife

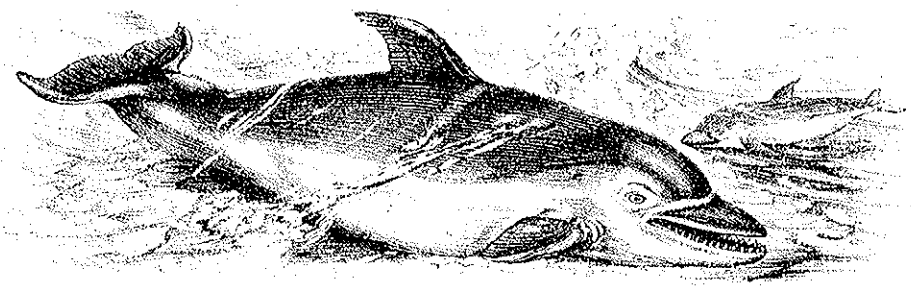
A new report suggests that U.S. natural environment and wildlife habitats are at significant risk from both development patterns and the roads that impacts.

"Second Nature: Improving Transportation Without Putting Nature Second" names transportation as an important factor in the loss of species at a time when conservation biologists are predicting that one-third of the world's plant and animal species will be lost in the next 50 years.

Roads and highways directly affect wildlife habitat, ecosystems, endangered species, and water quality thorough land consumption, habitat fragmentation, and replacement of natural cover with impervious surfaces. The U.S. is criss-crossed by four million miles of roadways, covering 19,000 square miles with asphalt. One million animals are killed every day on these roads, including endangered species such as the Florida panther.

However, conflicts over the environmental impacts of traditional transportation projects can be avoided. The report points to several states that have struck a "win-win" on transportation and environmental protection, utilizing better governmental cooperation, more comprehensive up-front planning, more detailed use of technologies to map natural habitats, and greater stakeholder involvement in early on in the planning of transportation projects.

The report is available on-line at www.defenders.org/habitat/highways and www.transact.org. JWR



Reason for Hope: A Spiritual Journey

by Jane Goodall with Philip Berman

New York: Warner Books, 1999 (First trade printing, October 2000); 282 pp.; U.S. $14.95 (paperback)
ISBN: 0-446-67613-6

Red: Passion and Patience in the Desert

by Terry Tempest Williams

New York: Pantheon Books, 2001; 262 pp.; U.S. $23 (hard cover)
ISBN: 0-375-42077-0

Books reviewed by Elsa C. Bumstead

"Of course, as long as I live I shall continue to spread awareness about the true nature of animals, the extent of their suffering, and our responsibilities towards them. I shall go on speaking out against animal experimentation, intensive farming, fur farming, trapping, sport hunting, the exploitation of animals in entertainment, as beasts of burden, and as pets."

—Jane Goodall

These two books "spoke" to me in the bookstore. Yes, they spoke to me—about hope, and the role that a single person can play in shaping the world. They practically jumped off the shelf into my hands, saying, "Take me home and read me." Which I did, and hopefully, you will, too.

Reason for Hope, the heartfelt and provocative memoir from field biologist Jane Goodall, explores the relationship between spirituality and consciously living. From her early days in war-torn England to the Leakey digs in Olduvai Gorge to her field work in Gombe and worldwide travels, Jane Goodall recounts the spiritual threads that led her to do her work with chimpanzees. You learn about her challenges in the scientific world as she undertakes the study of chimpanzees, deals with the politics of war in Africa, and struggles with the emotional ups and downs of personal relationships.

Her soulful journey leads her to form "Roots & Shoots," a program for young people. She firmly believes in empowerment. "Young people, when informed and empowered, when they realize that what they do truly makes a difference, can indeed change the world. They are changing it already." She tells why the name for her program:

> *roots* creep underground everywhere, and make a firm foundation; *shoots* seem new and small, but to reach the light can break apart brick walls. Brick walls of overpopulation, deforestation, soil erosion, desertification, poverty, hunger, disease, pollution; and human greed, materialism, cruelty, crime, warfare—all the problems we humans have inflicted on the planet.

It is through Roots & Shoots that there is hope. The value of the individual is emphasized: "every single one of us matters, has a role to play, makes a difference." Knowing that youth are being taught the power of choice and the consequences of decision making, indeed, are reasons for hope in this world wrought with cultural chaos, religious divisiveness, terrorism, and acts of warfare.

"As the world becomes more crowded and corroded by consumption and capitalism, this landscape of minimalism will take on greater significance, reminding us through its blood red grandeur just how essential wild country is to our psychology, how precious the desert is to the soul of America."

—Terry Tempest Williams

Terry Tempest Williams's book of essays and stories is about passion, passion for the canyon country of southern Utah. Williams was born into a Mormon family that traces its heritage back through Utah, Texas, Mexico, Iowa, Illinois, and New York to England. It is through eyes shaped by Mormon values that Terry views the landscape. She works fervently to preserve wilderness areas, at one point submitting testimony that included four generations worth of personal letters and statements about why her family cares about wilderness. It is in the canyonlands that she finds inspiration and strength. It is here that she connects to the past, to ancestors, to the Anasazi, to the Navaho, to Mary Austin, to Aldo Leopold, and more. Her writing is rich in cross-cultural storytelling. At times her pieces are reminiscent of Mary Austin's work.

Here are two remarkably humble books written by two strong women with strong convictions from two strong families, Both work in tribal settings and are open to learning different attitudes and perspectives. They raise their voices from the wilderness as they do their life's work in indigenous cultures. You feel the influence of the landscape on their psyches. And you learn what draws each woman to a particular place and keeps her there.

Questioning the political decision-making process, Williams asks, "If we listen to our politicians we must ask some serious questions. Who is speaking on the side of time? *Deep time*. And who is considering the soulful existence of other creatures?" Jane Goodall and Terry Tempest Williams are. Read their books, share their spirited journeys through time, and come away with reasons for hope. JWR

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.

When Raccoons Fall through Your Ceiling

The Handbook for Coexisting with Wildlife

by Andrea Dawn Lopez

Dallas: University of North Texas Press, 2002
192 pp; U.S.$21.95
ISBN 1-57441-154-3

This book is written from a strong position of personal experience. A former manager of a wildlife rehabilitation organization in Texas, Andrea Dawn Lopez addresses a broad variety of situations and offers advice on solutions that benefit the public without harming the animal. Written for a lay audience, the book calls on the author's experiences dealing with the public struggling with just such situations as she describes—and acknowledges the many hours each year any wildlife rehabilitator spends doing the same.

The book is not a "how to" manual and is not, in fact, written very concisely. It is full of case histories and is written in a purely narrative style. The description of the various potential wildlife/human conflicts and advice are not well separated out from the actual case experiences she presents (which are, needless to say, interesting in their own right). However, each chapter closes with a summary list of the advice provided and there is a detailed index at the back. The author also provides a resource list of wildlife agencies and organizations, although it is far from comprehensive. It does, however, include most state wildlife agencies and some equipment suppliers, as well as information resources on special topics or types of animals.

The advice given is good, though somewhat time-consuming to extract. What is most appealing to this reviewer is that Lopez does not pretend to have the perfect answer to every situation. She makes a compelling case for the possibility of coexisting, and her attitude of the need to do so shines through clearly. "Animals have always been a part of our environment, a part of our world. I believe they are also a part of our soul and that we need them to survive. If we don't learn to coexist with one another, modern civilization will eventually destroy all of the precious wildlife, and our souls will be empty because of it."

This book is a good resource for any rehabilitator who receives calls from the public (which takes in just about all of us!). JWR

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

A Flying Chance

A Manual for Rehabilitating North American Passerines and a Survival Guide for the North American Passerine Rehabilitator

Authors/editors: Nancy Eilertson and Astrid MacLeod et al.
Illustrations: Bethe Myers *et al.*

Phoenix: East Valley Wildlife, 2001
240 pp; U.S. $45
(Currently out of print; may be revised/reprinted in 2004 or 2005)

"The rehabilitation of passerines is one of the most difficult challenges a wildlife rehabilitator can face." The opening passage of this book accurately describes the challenging experiences of most songbird rehabilitators. With this in mind, the authors have compiled a comprehensive, easy-to-read manual that will prove useful to both the newcomer and the veteran rehabilitator. This book is written for home-based avian rehabilitators, by home-based rehabilitators who have sought input from professionals and specialists of all kinds.

The book opens with discussion of some basic, critical issues often never imagined by those first considering wildlife rehabilitation. Topics include the definition of wildlife rehabilitation and laws protecting migratory birds. Human considerations are introduced, including human health and safety; the importance of networking with other rehabilitators; the need for standards of care; the crucial question of species identification; the human conflict and pain associated with euthanasia; and burn out. Helpful suggestions for coping are offered, not the least of them learning how to "just say no."

Chapter II is an introduction to dealing with the public by phone. A rehabilitator's first contact with an injured animal is often by phone, and there is real skill required in asking the right questions in order to give the best advice. Many types of situation are detailed in this chapter. Clues to phone identification by asking about shapes and behaviors will help one discriminate between a squab and a baby vulture. (Yes, really! It's a fairly common mistake)

Following identification with anatomy and physiology results in a smooth transition into the nuts and bolts of rehabilitation, or past the virtual reception desk. Very helpful are the highlighted chapter headings on the lower outside corner of each page. One can quickly and easily go to the large chapter on Emergency Response, Care and Housing or Nutrition to find the help needed at any particular moment

Throughout these chapters, excellent charts provide clarification of content, and color plates located in the appendix offer the reader a chance to see "real" photos of frequently encountered passerines and medical conditions.

In addition to all this, the book's funny. The authors manage, by example, to emphasize a critical commodity sometimes in short supply during the baby season. Without humor, a rehabilitator is in serious trouble, risking alienation, burn out, and isolation. This book includes plenty of humorous sketches in addition to illustrative drawings and photographs. The language is largely conversational, the authors' wry remarks sparking a grin.

Although each chapter is full of useful information, I particularly enjoyed the chapter on passerine profiles. This chapter is a compilation of the many contributors' expertise, research efforts, and "what has worked for them" in rehabilitating the several species of songbirds and honoraries presented in the manual.

This highly recommended book has a good glossary of terms and a nice, washable cover, important when working with birds. It gives solid basic rehabilitation information for the novice, and offers the veteran rehabilitator clues and insights into the current information available in rehabilitating these diverse species. JWR

Reviewer Meg Dahrling, RN, is a permitted rehabilitator, WRINM, IWRC.

Manual of Raptors, Pigeons, and Waterfowl

General editor, Peter H. Beynon
Scientific editors, Neil A. Forbes, and Nigel H. Harcourt-Brown

Ames: Iowa State University Press, 1996
364 pp., illus.; U.S. $89.95
ISBN 0-8138-2876-7

Part One of this manual provides general information applicable to many species beyond the ones intended. Topics include physical examination, emergencies, nursing care, principles of therapy, diagnostics, anesthesia, radiology, postmortem exams, and zoonoses. Diagnostic chapters include cytology, biochemistry, hematology, and sampling techniques appropriate to each.

Part Two covers raptor husbandry, different problems by body system (skin, head, feet/legs, wings, respiratory, etc.) as well as digestive upsets and neurological symptoms. Breeding and neonate husbandry are also discussed.

Part Three on pigeons is organized in a similar manner to Part Two, with additional information on performance. Part Four covers waterfowl with similar organization to previous parts.

The appendices include formularies, U.S. Wildlife Law, and 1995 Accredited Laboratories in the U.S. and Canada.

The book is well organized with good use of flow-charts, history forms, line drawings, and organizational charts to assist the text in clarity of explanations. Color photos are used generously and effectively, sometimes even illustrating step-by-step how to perform certain techniques. In many places the photos will aid in diagnosis of certain conditions.

Charts include a basic formulary, symptoms by body system, and an explanation of biochemical blood values. The chapter on anesthesia includes a very detailed chart with specific information on many common sedatives and anesthetic drugs. Line drawings of anatomy are included in several chapters and are clearly labeled. Another chart of common postmortem findings organized by body part is concise but quite complete. A glossary of falconry terms and a list of falconry clubs in the UK is included. The waterfowl section includes extensive information on the treatment of oiled birds. A few surgical techniques are also illustrated.

Overall, veterinarians serving wildlife rehabilitators, and wildlife centers with well-trained staff or volunteers should find this book extremely educational and helpful. It is perhaps more detailed and more technical than some people might wish, as a certain basic understanding of medical terminology and techniques is assumed. However, the information included is so complete that even a private rehabilitator might be pleased to own this book and willing to use a medical dictionary to clarify terms when needed, or offer as a reference to their veterinarian. IWR

Reviewer Sandi Leonard, DVM, is with the Lakeside Nature Center in Kansas City, Missouri.

Prey

by Michael Crichton

New York: Harper Collins, 2002
384 pp; U.S. $26.95; Can. $39.95 (hardcover)
ISBN: 0-0662-1412-2

From the pen—and brain—that brought us *The Andromeda Strain* and *Jurassic Park* comes a novel that integrates the evolving fields of artificial intelligence, nanotechnology, genetic manipulation, behavior and evolutionary theory. If you have any background in biology, this is not the book to read in bed: you might not sleep well.

The book is set in competitive Silicon Valley, where venture capitalists have been more than twice stung by dreams, prophesies, and failed expectations.

At Xymos Technology, employees are desperate to come up with an innovative way to perform endoscopies on medical patients. Instead of putting a small camera tied to an umbilical cord down one orifice or up another, Xymos has perfected an entirely new approach, and is seeking funding for tiny cameras, one-tenth the size of a red blood cell, that can be injected into a patient. There is a small problem with these nanocameras, however: their field of vision is so restricted that the picture is not very informative. To address this situation, thousands of the nanocameras are used to produce a composite picture analogous to the pixels on a computer printout.

The megaprobem for which they need massive funding, is that making each nanocamera requires a huge investment—and they need millions of them. "One of the first things scientists learned about molecular manufacturing was how phenomenally difficult it was to carry out....It took IBM researchers a whole day to move 35 atoms....The new technology would rely on molecular machines that could turn out specific molecules to make molecular products." And, of course, these machines would need to be much more complex than the molecules they created.

Prey includes a bibliography of the scientific/technologic literature that supports the material Crichton uses. Then he extends those already much-explored ideas one step further. This is good science fiction.

Faced with the technological hitch in commercially implementing their idea, the scientists in *Prey* recognize that "there already existed proven molecular factories capable of turning out large numbers of molecules: they were called cells." They chose a cell line that was an industry standard, well documented in the literature—our old friend and ally, *E. coli*. Maybe they were using genetic engineering, not nano technology. Maybe they thought of it as a hybrid technology. Maybe they were only interested in the company's survival.

"For at least ten years, observers had been predicting that genetic engineering, computer programming and nano technology would eventually merge. There wasn't that much difference between using a computer to decode part of a bacterial genome and using a computer to help insert new genes into the bacteria to make new proteins. And there wasn't much difference between creating a new bacteria to spit out, say, insulin molecules and creating an artificial micromechanical assembler to spit out new molecules."

So there you have the skeleton of the plot: thousands of tiny molecular machines working together to do a job, with ancestry in bacterial cells, and thereby linked to the cell's prime directives. Were the molecules alive? Life requires nourishment and reproduces; it evolves, optimized by it's own best interests. Sometimes these interests are understood by the scientists that study them; sometimes details or strategies are overlooked by the enthusiastic humans who, with their own vested interests, put things in motion. IWR

Reviewer Penny Elliston is and chair of the IWRC's publications committee.

MEMORIAL

Remembering Jeff Lewis

by Louise Shimmel
Cascades Raptor Center, Eugene, Oregon



The work we do,
the community we've created among ourselves,
the service we've provided
the communities in which we live...
All go on—and all are richer
for Jeff's participation.

There seems to be something intrinsically wrong when a parent must bury a child—no matter how old. I think a mother's psyche would demand that she go first, gaining some satisfaction from knowing her beloved offspring continues his life, even leaving her legacy, her mark on the planet, through her child. It also seems so wrong when young children need to bury a parent. I know it happens—it has happened throughout time—it just doesn't seem right.

It was bad enough knowing Jeff Lewis was so dangerously ill, so suddenly and unexpectedly.... And when Jeff died so inexplicably, just when it was thought he had turned the corner and was on the upswing, it was heart breaking.

Jeff is someone I have "known" for several years, through the ether of the Internet, on raptor rehabilitation and falconry lists. Though we hadn't met in person, his personality showed through his writing. Jeff was very caring and involved, patient and forgiving. Even when expressing frustration with an institution that should have modeled concern and caring, he didn't blister anyone with his venting: it was just that, allowing himself to share his frustration, to get it out of his system.

Jeff's skills and patience with his birds were inspiring—and his relationship with his mother, Dody Wyman, also a raptor rehabilitator, was awe-inspiring. Dody and Jeff bantered easily back and forth, the respect and caring between them obvious to everyone. Neither has a tendency to waste words, to use six words when two will do. Both are more likely to simply read and learn or wonder along with the rest of us, chiming in only when they have something appropriate to say. Both have made their love of wildlife a huge part of their life and have contributed that love by being in service to raptors and our field.

Although it saddens me deeply to know all of Jeff's family needs to live the rest of their lives without him, I am glad that we knew him for awhile. I believe he was having a last laugh, listening in on conversations at his "viewing" while his wife asked his mother about an orphaned screech owl call she'd just received. It doesn't let up, you guys, even when we are gone! The work we do, the community we've created among ourselves, the service we've provided the communities in which we live go on—and all are richer for Jeff's participation.

You've earned your wings, Jeff. May you fly high and free. JWR

Important Notice!

In response to feedback from our members, the NWRA/IWRC Standards Committee is preparing the fourth edition of *Minimum Standards for Wildlife Rehabilitation*. We would like to expand this edition to include additional information, species, and supportive material, but do not plan to change the standards provided in the third edition. We anticipate having the new edition available by March 2005 and look forward to your input.

PLEASE MAIL ITEMS TO:

Standards, c/o Woodlands Wildlife Refuge, PO Box 5046, Clinton, NJ 08809, USA

or e-mail (with subject line "Standards 4th") to wildlife@eclipse.net or robyn@statecollege.com.

DEADLINE: 1 October 2003.

Keeping baby wild animals in your home is bad for them and bad for you!



W. J. BERG/USFWS

Keeping baby wild animals at home is bad for *them* because...

1. Commercial milk replacement formulas, even if they claim to be suitable for wild animals, are designed for kittens and puppies. Natural milk varies substantially between species. Providing the correct balance of protein, fat, and carbohydrates is critical during early growth for any baby. What is good for a kitten may not be good for a raccoon.

   Commercial bird foods contain a large amount of grain. Young birds need insects; their adult diets range from those of vegetarian to carnivore, depending on the species.

2. Juvenile animals spend much of their early growing period learning what is "normal" for them. They learn from their experience and associations in the wild. If they are raised in protective custody they do not learn the skills they need to survive, and may learn dangerous behaviors such as seeking food from humans and "friendships" with domestic pets—which are normally natural predators.

Keeping baby wild animals at home is bad for *you* because...

1. Babies grow up and defend themselves with teeth and claws. A squirrel can bite a finger to the bone; a raccoon's bite can equal that of a much larger dog.
2. When they grow up wild animals will consider the area part of their territory. They can be territorial and dangerous to you, through familiarity, as well as very destructive of what you may consider to be your home.
3. Wild animals carry diseases transmissible to people and their pets. External parasites, and many familiar internal diseases can be passed to humans from animals. Bubonic plague, rabies, hanta virus, and baylisascaris can all be found in animal populations in North America.

Alternatives...

1. Leave a baby, concealed, where you found it to avoid kidnapping
2. If it is a true emergency (e.g., a naked bird, an injured animal, something the cat brought in) place the animal in a dark, closed box. Place the box in a warm, quiet place and find a local wildlife rehabilitator to care for the animal legally and properly.

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

Ditto content contributed by Willowbrook Wildlife Center, Forest Preserve District of DuPage County (Glen Ellyn, Illinois)

TAIL END

by Astrid MacLeod



EASTERN GREY SQUIRRELS PHOTO: PAT ISAACS

"Come on, Fred. I'll pay you back on Tuesday."

INSTRUCTIONS FOR AUTHORS

POLICY Original manuscripts concerning any aspect of wildlife rehabilitation are welcome. Articles on topics including administration, law, education, veterinary medicine, animal husbandry, and public relations as they relate to wildlife rehabilitation are all invited. Book reviews are also welcome. Submissions are not confined to the North American continent.

Associate editors and anonymous reviewers judge each submitted manuscript on appropriate subject matter, originality, accuracy, conciseness, clarity, and contribution to existing literature. Concurrent submission to other peer-reviewed journals may preclude publication in the *Journal of Wildlife Rehabilitation* (JWR). IWRC retains copyright on all original articles published in JWR, but will grant permission to reprint articles upon request, with credit given to IWRC.

MANUSCRIPT Copy should be typewritten and double-spaced. Include the name of each author, addresses, phone numbers, e-mail addresses, a one-paragraph biography for each author, an abstract, and several keywords. Templates have been developed for the following categories of submissions: Species paper (i.e., rehabilitation notes), case study, technique, research paper, and review; authors may request a copy of one or all of these templates from the Editor or the IWRC office before developing work for submission in JWR.

SUBMISSIONS All submissions should be accompanied by a cover letter stating the intent of the author(s) to submit the manuscript exclusively for publication in JWR. Double space throughout, with 1 inch margins. The author(s) should keep at least one copy of the manuscript.

ELECTRONIC SUBMISSIONS Electronic submissions (PC or Macintosh platforms) are preferred but not required. The manuscript should be attached to the submission letter and sent to ALL of the following:

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TABLES Start each table on a separate page and continue long tables onto 2 or more pages. Double-space throughout and leave margins of at least 1 inch. Annotate abbreviations.

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