

USEFUL REFERENCES IN ZOO AND WILDLIFE NUTRITION

Mike Maslanka, MS,^{1} Barbara Henry, MS,² Shannon Livingston, MSc,³ Barbara Toddes, BS,⁴ Kerri Slifka, MS,⁵ Howard Frederick, PhD,⁶ Shana Lavin, PhD,⁷ Ann Ward, MS,⁸ and Jason Williams, PhD⁹*

¹National Zoological Park, 3001 Connecticut Ave NW, Washington, DC 20008; ²Cincinnati Zoo and Botanical Gardens, 3400 Vine St, Cincinnati, OH 45220; ³Disney's Animal Kingdom, 1180 Savannah Circle, Bay Lake, FL 32830; ⁴Philadelphia Zoo, 3400 West Girard Ave, Philadelphia, PA 19104; ⁵Dallas Zoo, 6500 S. RL Thornton Freeway, Dallas, Texas 75203; ⁶University of Arizona, Veterinary Diagnostic Lab, PO Box 1890, Cortaro, AZ 85652; ⁷Lincoln Park Zoo, 2001 Clark St, Chicago, IL 60614; ⁸Fort Worth Zoo, 1989 Colonial Parkway, Fort Worth, Texas 76110; ⁹Indianapolis Zoo, 1200 W Washington St, Indianapolis, IN 46222

Introduction

Zoo and wildlife nutritionists apply their nutrition expertise daily to a variety of situations, ranging from the most applied to the most basic. These include commissary operation, inventory maintenance, staff direction, laboratory management, diet formulation and evaluation, consultations with other zoo personnel and other zoos, and budget supervision. Beyond this, they interact with professionals on topics outside of their profession, but still germane to overall zoo animal management, such as veterinary medicine, animal acquisition and disposition, and animal reproduction. Regardless of these varied roles, the professional zoo nutritionist should be well informed in his specialty, yet both discerning and skeptical when using published literature. Unfortunately, all information that has been published is not of equal veracity. The goal of this report was to list sources of information that generally have been found useful and reliable. The information contained within these sources still requires scrutiny and judicious application, and inclusion in this report does not represent unanimous endorsement by the report's authors. Access to these works and the ability to read them is not a substitute for skilled, professional nutritionists on the zoo staff. However, we hope that identification of these resources will be useful to professionals and non-professionals, alike.

Selected Works by Topic / Classification

National Research Council (NRC) Nutrient Requirements (National Academy of Sciences, National Research Council, Washington, DC)

- Non Human Primates (2003)
- Horses (2007)
- Dairy Cattle (2001)
- Beef Cattle (2000)
- Small Ruminants: sheep, goats, cervids, and new world camelids (2007)
- Laboratory Animals (1995)
- Swine (1998)
- Poultry (1994)
- Dogs and Cats (2006)

- Fish (1993)
- Mink and Fox (1982)
- Rabbits (1977)

Guidelines and Regulations

AAFCO (Association of American Feed Control Officials). 2009 . Pet Food Regulations. *In* AAFCO Official Publication. AAFCO, Inc. Atlanta, GA.

Conference Proceedings

- AZA Nutrition Advisory Group Conferences on Zoo and Wildlife Nutrition (1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009)
- Comparative Nutrition Society Proceedings (1996, 1998, 2000, 2002, 2004, 2006, 2008)
- Dr Scholl Conferences on the Nutrition of Captive wild Animals (1980, 1982, 1983, 1984, 1985, 1986, 1987, 1989, 1991)
- EAZA European Zoo Nutrition Conference Proceedings (1999, 2001, 2003, 2005, 2008)
- Crissey Zoological Nutrition Symposium Proceedings (2003, 2004, 2005, 2007, 2008)
- International Symposium on Pet Bird Nutrition (1997, 2007; see also*)
- American Society of Animal Science. Proceedings I through VI of the International Symposium on the Nutrition of Herbivores

Nutrition Advisory Group Fact Sheets / Technical Papers (www.nagonline.net)

- 001 – Hay Quality Evaluation
- 002 – Vitamin D and Ultraviolet Radiation: Meeting Lighting Needs for Captive Animals
- 003 – Feeding Captive Insectivorous Animals: Nutritional Aspects of Insects as Food
- 004 – Elephants: Nutrition and Dietary Husbandry
- 005 – Feeding Captive Piscivorous Animals: Nutritional Aspects of Fish as Food
- 006 – Hay to Pellet Ratios: Considerations in Feeding Ungulates
- 007 – Leaf-eating Primates: Nutrition and Dietary Husbandry
- 008 – Assessment of Nutritional Status of Captive and Free-ranging Animals
- 009 – Micronesian Kingfishers: Nutrition and Dietary Husbandry
- 010 – Quality Control of Feedstuffs: Nutrient Analysis
- 011 – Asian Small Clawed Otters: Nutrition and Dietary Husbandry
- 012 – Penguins: Nutrition and Dietary Husbandry
- 013 – Callitrichids: Nutrition and Dietary Husbandry
- 014 – Fruit Bats: Nutrition and Dietary Husbandry

Energetics

- Blaxter, K. 1989. Energy Metabolism in Animals and Man. Cambridge University Press, Cambridge, UK. Pp. 336.
- Hudson, R.J. and R.G. White. 1985. Bioenergetics of Wild Herbivores. CRC Press, Boca Raton, FL. Pp. 314
- Nagy, KA, IA Girard, and TK Brown. 1999. Energetics of free-ranging mammals, reptiles, and birds. *Annu Rev Nutr.* 19:247-277.

Meat Handling

- Bechtel, P.J. 1986. Muscle as Food. Academic Press, San Diego, CA, Pp 459.

Crissey, SD, KA Slifka, P Shumway, and SB Spencer. 2001. Handling Frozen Thawed Meat and Prey Items Fed to Captive Exotic Animals. United States Department of Agriculture, National Agriculture Library, Beltsville, MD. Pp. 23.

Fish Handling

Crissey, SD. 1998. Handling Fish Fed to Fish-eating Animals: A Manual of Standard Operating Procedures. United States Department of Agriculture, National Agriculture Library, Beltsville, MD. Pp. 21.

Whole and Invertebrate Prey

Allen, ME. 1989. Nutritional Aspects of Insectivory. Doctoral Thesis. Michigan State University, Lansing. Pp 205.

Allen, ME and OT Oftedal. 1989. Dietary Manipulation of the Calcium Content of Feed Crickets. *J Zoo Wildl Med* 20(1): 26-33.

Finke, MD. 2002. Complete Nutrient Composition of Commercially Raised Invertebrates Used as Food for Insectivores. *J Zoo Biol.* 21:269-285.

Food Service Sanitation

McSwane, D., N.R. Rue, and R. Linton. 2005. Essentials of Food Safety and Sanitation. Pearson Prentice Hall, Upper Saddle River, NJ. Pp. 440.

Digestive Physiology

Chivers, DJ and P Langer. 1994. The Digestive System in Mammals: Food, Form, and Function. Cambridge University Press, Cambridge, UK. Pp. 446.

Holmgren, S and S Nilsson. 1999. Digestive System. In *Sharks, Skates, and Rays: The Biology of Elasmobranch Fish*. Hamlett, WC, Ed. Johns Hopkins University Press, Baltimore, MD.

Orosz, S. 1997. The Gastrointestinal Tract. In *Avian Medicine and Surgery*. Altman, RB, SL Clubb, GM Dorrestein, and K Quesenberry, Eds. WB Saunders, Co, Philadelphia, PA. Pp 412-453.

Stevens, CE and ID Hume. 1995. Comparative Physiology of the Vertebrate Digestive System. Cambridge University Press, Cambridge, UK. Pp. 400.

General Nutrition

Ammerman, CB, DH Baker, and AJ Lewis. 1995. Bioavailability of Nutrients for Animals – Amino Acids, Minerals, and Vitamins. Academic Press, San Diego, CA. Pp. 440.

Barboza, PS., KL Parker, and ID Hume. 2009. Integrative Wildlife Nutrition. Springer-Verlag, Berlin, Germany. Pp 342.

Crawford, M.A. 1968. Comparative Nutrition of Wild Animals. Symposia of the Zoological Society of London. No 21. Academic Press, New York, NY. Pp. 427.

Fahey, Jr, GC, M Collins, DR Mertens, LE Moser (eds). 1994. Forage Quality Evaluation and Utilization. American Society of Agronomy, Crop Science Society of America, Soil Science Society of America. Madison, WI. Pp 988.

Fowler, M.E. and R.E. Miller. 1999. Zoo & Wild Animal Medicine Current Therapy 4. W.B. Saunders Company, Philadelphia, PA. Pp. 747.

Hand, M.S., C.D. Thatcher, R.L. Remillard, and P. Roudebush. 1983. Small Animal Clinical Nutrition. 4th Ed. Walsworth Publishing Co., Marceline, MO. Pp 1192.

- Hess, L., N. Atinoff, and A.E. Rupley. 2009. Exotic Animal Practice: Nutrition and Behavior of Uncommon Species. Veterinary Clinics of North America, W.B. Saunders, Philadelphia, PA. Pp. 400.
- Hume, ID. 1999. Marsupial Nutrition. Cambridge University Press, Cambridge, UK, Pp 434.
- Kaneko, JJ, JW Harvey, and ML Bruss. 1997. Clinical Biochemistry of Domestic Animals, 5th Ed. Academic Press, San Diego, CA. Pp. 932.
- Linder, MC (Ed). 1991. Nutritional Biochemistry and Metabolism with Clinical Applications. Second Ed. Appleton and Lange, East Norwalk, CT.
- McDowell, LR. 1989. Vitamins in Animal Nutrition, Comparative Aspects to Human Nutrition. Academic Press, San Diego, CA. Pp. 486.
- McDowell, LR. 1992. Minerals in Animal and Human Nutrition. Academic Press, San Diego, CA. Pp. 524.
- McDowell, LR 2000. Vitamins in Animal and Human Nutrition. Iowa State University Press, Ames, IA. Pp. 793.
- Robbins, CT. 1993. Wildlife Feeding and Nutrition. Second Ed. Academic Press, San Diego, CA. Pp 352.
- Sandoval-Castro, CA, FD Hovell, JFJ Torres-Acosta, and A Ayala-Burgos. 2006. Herbivores, the Assessment of Intake, Digestibility, and the Roles of Secondary Compounds. Nottingham University Press, Nottingham, UK. Pp. 312.
- Ullrey, DE. 1996. Skepticism and Science: Responsibilities of the Comparative Nutritionist. J Zoo Biol. 15: 449-453.
- Zoological Society of London. 1976. International Zoo Yearbook. Olney, PJS, R. Biegler, and P. Ellis, Eds. Vol 16. Pp. 484. (Also volumes 6 and 39)

Hand Rearing

- Gage, L.J. 2002. Hand-rearing Wild and Domestic Mammals. Blackwell Publishing, Ames, IA. Pp. 279.
- Gage, L.J. and R.S. Duerr. 2007. Hand-rearing Birds. Blackwell Publishing, Ames, IA. Pp. 441.

Fish Nutrition

- Guillaume, J, S Kaushik, P Bergot, and R Metailler. 1999. Nutrition and Feeding of Fish and Crustaceans. Springer-Praxis, Ltd., Chichester, UK. Pp 408.
- Janse, M, B Firchau, and P Mohan. 2004. Elasmobranch Nutrition, Food Handling, and Feeding Techniques. *In* The Elasmobranch Husbandry Manual: Captive Care of Sharks, Rays, and Their Relatives. Smith, M, D Wormolts, D Thoney, and R Hueter, Eds. Ohio Biological Society, Columbus, OH.
- Lovell, T. 1998. Nutrition and Feeding of Fish. Kluwer Academic Publishers, Norwell, MA. Pp 267.

Avian Nutrition*

- Angel, CR. 1996. A review of ratite nutrition. An Feed Sci Tech 60: 241-246.
- Klasing, KC. 2000. Comparative Avian Nutrition. CABI Publishing, New York, NY. Pp. 350.

Ruminant Nutrition

- Church, D.C. 1988. The Ruminant Animal. Prentice Hall, Englewood Cliffs, NJ. Pp.564.

- Givens, D.I., E. Owen, R.F.E. Axford, and H.M. Omed. 2000. Forage Evaluation in Ruminant Nutrition. CABI Publishing, New York, NY. Pp. 480.
- Hacker, J.B. and J.H. Ternouth. 1987. The Nutrition of Herbivores. Academic Press, Orlando, FL. Pp. 552.
- Van Soest, P.J. 1994. Nutritional Ecology of the Ruminant. Cornell University Press, Sage House, Ithaca, NY. Pp. 476.

Reptile / Amphibian Nutrition

- Chapman, R.F. 1998. The Insects Structure and Function. Cambridge University Press, New York, NY. Pp.770.
- Jacobson, E.R. 2003. Biology, Husbandry, and Medicine of the Green Iguana. Krieger Publishing Company, Malabar, FL. Pp. 188.
- Murphy, J.B., K. Adler, and J.T. Collins. 1994. Captive Management and Conservation of Amphibians and Reptiles. The Society for the Study of Amphibians and Reptiles, Ithaca, NY. Pp. 408.
- Wright, KM. 2001. Diets for Captive Amphibians. *In* Amphibian Medicine and Captive Husbandry. Wright, KM and BR Whitaker, Eds. Krieger Publishing Co, Malabar, FL.

Human Resources

- Fischer, R. and W. Ury. 1981. Getting to Yes – Negotiating Agreement without Giving In. Penguin Press, NY, NY.
- Gladwell, M. 2005. Blink. Little, Brown Publishers, NY, NY.
- Lundin, S.C., H. Paul, and J. Christensen. 1996. Fish. Hyperion, New York, NY. Pp. 112.
- Pryor, K. 1984. Don't Shoot the Dog – The New Art of Teaching and Training. Bantam, NY, NY. Pp 202.

Toxic Plants and Browse Identification

- Burrows, G.E. and R.J. Tyrl. 2001. Toxic Plants of North America. Iowa State Press. Ames, IA. Pp.1342.
- Core, E.L. and N.P. Ammons. 1958. Woody Plants in Winter. Boxwood Press, Pacific Grove, CA. Pp. 218.
- Kirschner, A.C., A.M. Martinson, N.A. Irlbeck, M.M. Moore, and E.S. Dierenfeld. 2000. Zoological Browse Identification Handbook. Colorado State University, Fort Collins, CO.
- Uva, R.H., J.C. Neal, and J.M. DiTomaso. 1997. Weeds of the Northeast. Cornell University Press, Ithaca, NY. Pp. 397.

Body Condition Scoring

- Burkholder, WJ. 2000. Use of body condition scores in clinical assessment of the provision of optimal nutrition. J Am Vet Med 217: 650-654.

Up and Coming Publications

Wild Mammals in Captivity, Second Edition – July 2010

Acknowledgements

The authors wish to thank Dr. Duane Ullrey for his critical review of the manuscript.