Introduction

WHAT IS A MAMMAL?

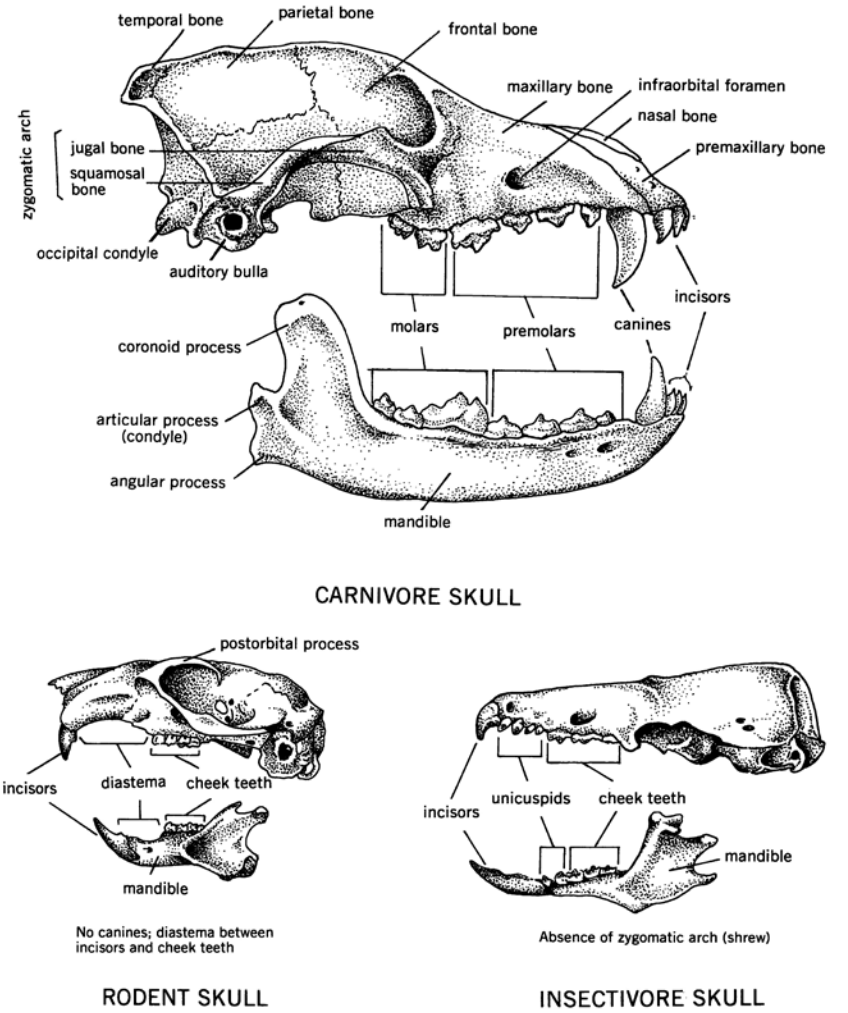
Mammals constitute the class Mammalia in the phylum Chordata, subphylum Vertebrata (animals with a vertebral column or backbone). Mammalia, with approximately 6,500 species, is small compared to other classes of vertebrates; for example, there are approximately 7,000 species of amphibians, 10,000 species of both reptiles and birds, and 32,000 species of fish. However, mammals show remarkable diversity in morphology and body size, more so than any other class of vertebrates. Consider, for instance, the structural differences evident between kangaroos, bats, seals, elephants, and antelope. Moreover, the largest mammal, the blue whale (*Baleoptera musculus*), at up to 190,000 kg (209 tons), is more than seven orders of magnitude larger than the smallest, the pygmy shrew (*Sorex hoyi*), at 3 g (0.1 oz).

Much of the diversity evident in the 29 orders of living mammals evolved following the extinction of dinosaurs at the end of the Cretaceous period, about 65 million years ago (mya), but the origin of mammals is far more ancient, stemming from an amphibian-like common ancestor to both reptiles and mammals, the amniotes of the Carboniferous period (360 mya). A descendant amniote group, the Cynodontia, with distinctive mammalian characteristics (such as three bones in the middle ear) is present in fossil deposits of the late Triassic period (220 mya). Thus, mammals diversified and coexisted with reptilian forms (birds and dinosaurs) throughout the Jurassic and Cretaceous periods. Mammals diversified rapidly during the early Cenozoic, such that most modern orders are evident in fossil deposits of the early Eocene (50 mya) (chapter 9, table 9.1).

All mammals except monotremes (duck-billed platypus and echidnas) are viviparous—that is, their embryos and fetuses are nourished from a placenta in the uterus. Nearly all are covered with hair; notable exceptions include whales, seals, hippos, and elephants. Mammary glands, unique to and present in all mammals, provide nourishment for neonates following birth. The lower jaw, or mandible, is composed of a single bone known as the dentary, which articulates with the squamosal bone at the base of the zygomatic arch of the skull. Dentary-squamosal articulation is evident in ancestral mammals from the Triassic and all

their descendants. Teeth are set in sockets and arranged in a row, with differentiation in form and function from front to rear. Incisors, used in nipping, biting, or gnawing, are large in some mammals, such as rodents, but relatively small in most. Canines are typically long, pointed, and used for holding and killing prey and tearing flesh. Canines are most well developed in carnivores and absent in rodents and rabbits. Food procured by the action of incisors and canines is transferred with the tongue to the premolars and molars, where it is cut or ground into pieces appropriate for ingestion. Premolars are typically smaller but similar in morphology to molars; a prominent exception is the large, last upper premolar of carnivores, which occludes with the first lower molar in slicing flesh. Mammals have two sets of teeth, deciduous and adult. Deciduous teeth (or "baby teeth"), which erupt from front to back in the growing infant, are replaced by permanent teeth as the individual reaches adulthood. Molars differ from other teeth in that they erupt only in the adult form and are not replaced.

FIG. 0.1. The bones and four types of teeth in the mammalian skull are well represented in carnivores, as illustrated in the canid skull. The skull and teeth have evolved different forms and functions to meet the feeding habits of herbivores (rodents) and insectivores like shrews (from Gottschang 1981).



Mammals attract considerable attention from the public as well as the scientific community. The bond we sense with these, our closest living relatives, often begins with pets but typically extends to primates and other large, observable species in the wild, such as white-tailed deer. Scientists are intrigued by behavioral, physiological, and ecological adaptations of mammals to a wide variety of habitats and environments, including arid deserts, arctic cold, deep oceans, and subterrestrial conditions. Mammals have evolved remarkable adaptations for nearly every conceivable mode of locomotion, including walking, running, digging, burrowing, gliding, powered flight, and swimming. Their social systems and modes of communication are equally diverse, akin to those of humans in some species and very different in others. Domesticated as well as wild species of mammals are important sources of food and fiber for humans worldwide. Laboratory species play essential roles in basic biology and medical research, while wild mammals, especially tropical rain forest species, are potential sources of viral infectious diseases such as SARS and COVID-19. Finally, decades of ecological research, particularly with small mammals, provide a baseline for assessing the impact that climate change and human disturbances of the earth's habitats have on natural communities. (Burgin et al. 2018; Feldhamer et al. 2015)

METHODS USED IN THE STUDY OF WILD MAMMALS

The majority of mammals in Ohio are small, cryptic, and nocturnal, leaving only a few species (about six) that can be studied by direct visual observation, as one might with birds. Much has been learned about the social and feeding behaviors in squirrels and white-tailed deer with this approach. The remaining species are studied through tracks and feces or, most commonly, by a variety of techniques based on trapping. Snap traps and pitfall traps, which kill, are commonly used on small, nonvolant mammals (< 100 g), such as shrews and mice. The resulting data provide evidence of relative abundance based on captures per unit effort, typically expressed as captures per trap night (TN); thus, for example, 10 traps set for 10 nights = 100 TN. A variety of box-type traps or live traps are often preferred because, when properly used, mortality is low; blood and tissue samples can be collected; and animals can be measured, marked, and released for further study. The recapture of marked animals can be used to estimate home range size (see appendix D) and provide statistical estimates of the actual number of individuals living within a study area.

Animals can be fitted with radio transmitters and released in the wild, which allows for tracking individuals over space and time and, consequently, the study of habitat use, home range size, overlap in use of habitat among individuals, and short-term survival. Here are two examples: data from radio transmitters placed on fawns captured soon after birth have given us a good understanding of postnatal survival in white-tailed deer, and mammalogists have also learned through radiotelemetry that rodents of one species are socially monogamous while a related species is polygamous. Wide-ranging animals (among them jaguars, mountain

lions, moose, and black bears) whose movements are difficult to follow with radiotelemetry can be fitted with collars containing GPS-enabled tags. Then, their movement patterns over days, months, and sometimes years can be monitored by satellites or Google Earth, with the resulting data downloaded to investigators. Passive integrated transponders (PIT tags, as used on pets) inserted below the skin can be used to record (via PIT receivers) movement of individual small mammals along narrow passages or into burrows or nest sites. Infrared-triggered cameras, popularly known as game cameras or camera traps, placed along trails and feeding sites have been used for decades to study ungulates and carnivores, and more recently, they have provided data on abundance, microhabitat use, behavior, and social interactions in a variety of smaller mammals. Camera traps are particularly valuable in studies of predators, such as cats, that are rarely observed, are often nocturnal, and are difficult to capture but can be attracted to a prey carcass under surveillance by a remote camera.

Bats represent a unique challenge in small mammal ecology because they fly at night. However, their habit of roosting in large numbers at known sites (in caves and mines) and their tendency to forage in predictable habitats have facilitated research on this important component of small mammal communities. Traditional roosting sites used by hibernating bats can be surveyed and counts can be made to determine the abundance of the species that are present. Long-term data sets from such surveys enable biologists to detect changes in relative abundance related to environmental factors such as wind turbines or diseases such as white-nose syndrome. Mist nets of the sort used to capture small birds in flight are also employed for live captures of bats. Large (3×5 m) expanses of black, thin-filament, 2 cm mesh netting are suspended from poles set in habitats used by foraging bats—for instance, over streams, ponds, or mine and cave entrances—to capture bats on the wing. Because the frequency patterns of sound pulses emitted by echolocating bats are more or less species specific, computer analysis of such recorded emissions can be used to determine the time and location of habitats used by different species of foraging bats.

The development of polymerase chain reaction (PCR) and related techniques since the mid-1980s has revolutionized nearly all areas of biology. With PCR, a small amount of DNA from a few hair follicle cells or epithelial cells found in saliva or feces can be amplified for analysis, so that individuals or groups of individuals from a given geographic region can be identified. Because the parentage of offspring can be determined with some certainty, molecular techniques have revealed previously unknown aspects of social and breeding behaviors. Analysis of DNA in hair and fecal samples also has been used to document the presence and relative abundance of species in a given area. In a remarkable example of conservation genetics and forensic analysis, DNA extracted from elephant tusks (confiscated from poachers) revealed the specific geographic region of the Congo in which the elephants were killed.

Molecular techniques have been applied in the construction of phylogenic trees that depict evolutionary relatedness among groups of mammals and help

us understand how mammalian traits evolved. DNA techniques have been instrumental over the past several decades in determining the actual number of species of living mammals, an estimate that grows each year with more and more accurate techniques. For instance, the number of extant species of mammals was 4,170 in 1982, 4,629 in 1993, and 5,416 in 2005—and it now exceeds 6,500.

Because epidermal cell morphology and patterns on plant leaves are nearly species specific, microscopic analyses of plant fragments found in animals' stomachs or feces provide reliable estimates of the plant species composition of their diets. This information can be correlated with the nutrient content of ingested plants to estimate the quality of the diet of mammalian herbivores. Such studies have determined that some rodents, in particular, ingest certain species of plants based upon their nutritional content—similar to the way humans might select a balanced diet. A relatively new technique, stable isotope analysis, uses ratios of isotopes of carbon, nitrogen, and oxygen (isotopic signatures) applied to individual species in a food chain or food web to determine the extent to which top predators such as wolves prey on other carnivores, herbivores, and plants depending on the season and habitat. (Burgin et al. 2018; Joly et al. 2015; Oyler-McCance and Leberg 2012; Vynne et al. 2011)

CONSERVATION

The Ohio Division of Wildlife (ODW) is responsible for the welfare of all wildlife species in the state. According to their mission statement, ODW is "dedicated to conserving and improving the fish and wildlife resources and their habitats, and promoting their use and appreciation by the people so that these resources continue to enhance the quality of life for all Ohioans." At approximately five-year intervals, ODW conducts an extensive review of the conservation status of state-listed wildlife, including mammals. This review considers results of recent studies and seeks input from staff biologists, noted professionals, and experienced citizens. ODW may change the conservation listing status of particular mammals depending on the outcome of this periodic review (table 0.1). Six categories of conservation status are used with regard to native species or subspecies, as defined in ODW (2019a):

Endangered—A native species or subspecies threatened with extirpation from the state. The danger may result from one or more causes, such as habitat loss, pollution, predation, interspecific competition, or disease.

Threatened—A species or subspecies whose survival in Ohio is not in immediate jeopardy but to which a threat exists. Continued or increased stress will result in it becoming endangered.

Species of Concern—A species or subspecies which might become threatened in Ohio under continued or increased stress. Also, a species or subspecies for which there is some concern but for which information is insufficient to permit an adequate status evaluation.

Special Interest—A species that occurs periodically and is capable of breeding in Ohio. It is at the edge of a larger, contiguous range with viable population(s) within the core of its range. These species have no federal endangered or threatened status, are at low breeding densities in the state, and have not been recently released to enhance Ohio's wildlife diversity.

Extirpated—A species or subspecies that occurred in Ohio at the time of European settlement and has since disappeared from the state.

Extinct—A species or subspecies that occurred in Ohio at the time of European settlement and has since disappeared from its entire range.

Updated status information on Ohio's listed species is available at http://wildlife.ohiodnr.gov/species-and-habitats/state-listed-species. In addition, the relative abundance of nonlisted species may be described as follows: Uncommon (localized, infrequent occurrence), Common (widespread, frequent occurrence), and/or Game (can be legally harvested), as designated in the *Mammals of Ohio* field guide (ODW 2016c). Copies are available from the Ohio Division of Wildlife.

Table 0.1. Checklist and conservation status of extant Ohio mammals

ORDER[1]	FAMILY	SPECIES	CONSERVATION STATUS[2]
Didelphimorphia	Didelphidae	Virginia opossum (*Didelphis virginiana*)	
Lagomorpha	Leporidae	Eastern cottontail (*Sylvilagus floridanus*)	
Rodentia	Castoridae	American beaver (*Castor canadensis*)	
	Cricetidae	Prairie vole (*Microtus ochrogaster*)	Concern
		Meadow vole (*Microtus pennsylvanicus*)	
		Woodland vole (*Microtus pinetorum*)	Concern
		Allegheny woodrat (*Neotoma magister*)	Endangered
		Muskrat (*Ondatra zibethicus*)	
		White-footed mouse (*Peromyscus leucopus*)	
		Deer mouse (*Peromyscus maniculatus*)	Concern
		Eastern harvest mouse (*Reithrodontomys humulis*)	Threatened
		Southern bog lemming (*Synaptomys cooperi*)	Concern
	Muridae	House mouse (*Mus musculus*)	
		Brown rat (*Rattus norvegicus*)	
	Sciuridae	Southern flying squirrel (*Glaucomys volans*)	
		Thirteen-lined ground squirrel (*Ictidomys tridecemlineatus*)	
		Woodchuck (*Marmota monax*)	
		Eastern gray squirrel (*Sciurus carolinensis*)	
		Eastern fox squirrel (*Sciurus niger*)	
		Eastern chipmunk (*Tamias striatus*)	
		Red squirrel (*Tamiasciurus hudsonicus*)	
	Zapodidae	Woodland jumping mouse (*Napaeozapus insignis*)	Concern
		Meadow jumping mouse (*Zapus hudsonius*)	

Table 0.1. Checklist and conservation status of extant Ohio mammals *(continued)*

ORDER[1]	FAMILY	SPECIES	CONSERVATION STATUS[2]
Eulipotyphla	Soricidae	Northern short-tailed shrew (*Blarina brevicauda*)	
		Least shrew (*Cryptotis parva*)	
		Cinereus shrew (*Sorex cinereus*)	
		Smoky shrew (*Sorex fumeus*)	Concern
		Pygmy shrew (*Sorex hoyi*)	Concern
	Talpidae	Star-nosed mole (*Condylura cristata*)	Concern
		Hairy-tailed mole (*Parascalops breweri*)	
		Eastern mole (*Scalopus aquaticus*)	
Carnivora	Canidae	Coyote (*Canis latrans*)	
		Gray fox (*Urocyon cinereoargenteus*)	Concern
		Red fox (*Vulpes vulpes*)	
	Felidae	Bobcat (*Lynx rufus*)	
	Mephitidae	Striped skunk (*Mephitis mephitis*)	
	Mustelidae	North American river otter (*Lontra canadensis*)	
		Ermine (*Mustela erminea*)	Concern
		Long-tailed weasel (*Mustela frenata*)	
		Least weasel (*Mustela nivalis*)	
		American mink (*Neovison vison*)	
		American badger (*Taxidea taxus*)	Concern
	Procyonidae	Northern raccoon (*Procyon lotor*)	
	Ursidae	American black bear (*Ursus americanus*)	Endangered
Cetartiodactyla[3]	Cervidae	White-tailed deer (*Odocoileus virginianus*)	
Chiroptera	Vespertilionidae	Big brown bat (*Eptesicus fuscus*)	Concern
		Red bat (*Lasiurus borealis*)	Concern
		Hoary bat (*Lasiurus cinereus*)	Concern
		Silver-haired bat (*Lasionycteris noctivagans*)	Concern
		Eastern small-footed myotis (*Myotis leibii*)	Concern
		Little brown bat (*Myotis lucifugus*)	Concern
		Northern long-eared bat (*Myotis septentrionalis*)	Threatened
		Indiana bat (*Myotis sodalis*)	Endangered
		Evening bat (*Nycticeius humeralis*)	Special Interest
		Tri-colored bat (*Perimyotis subflavus*)	Concern

Species listed without conservation status are designated as Common or Uncommon based upon their relative abundance as determined by the Ohio Division of Wildlife.

[1] Orders are listed according to Feldhamer et al. 2020. Families and genus species names are listed alphabetically.

[2] ODW 2019a.

[3] Includes whales, formerly Cetacea.

GUIDE TO USING THIS BOOK

This book presents current information on the status and biology of 55 species of mammals living wild in Ohio. Of these, 3 are state-listed as Endangered, 2 as Threatened, and 18 as Species of Concern (table 0.1). Although organized around individual species accounts, our book is more than a field guide, a resource that typically focuses on identification and provides only a brief description of natural history. Species within each of the seven orders of mammals in Ohio share modes of reproduction, locomotion, and nutrition that characterize each order and offer a framework for review of the fascinating world of mammalian biology. Each species account in this book begins with descriptive information on external features and dentition, followed by sections on distribution and abundance, diet, habitat, reproduction, mortality, behavior and physiology, and conservation.

This book is intended for college students, their teachers, professional biologists in wildlife and conservation agencies, and naturalists serving in parks and nature preserves. Our book also is intended for members of the public who are interested in nature and are increasingly well informed about mammals from multiple media sources and personal experiences. It is meant to provide all readers with an informative, updated review of the wild mammals of Ohio.

Body Measurements

Standard length measurements and body mass are given in each species account or in a table for families with more than two species. These and other values are presented in metric units (e.g., millimeters [mm]), throughout this book. Standard measurements are presented in sequence from longest to shortest as follows:

Total Length: Measured from the tip of the nose to the end of the tail vertebrae when the specimen is laid on its back, excluding hairs that extend beyond the last tail vertebrae.

Tail Length: With the animal on its belly, the tail is bent at a 90° angle from the body and measured from the base of the tail to the end of the tail vertebrae.

Hind Foot Length: Measured from the heel to the tip of the claw on the longest toe.

Ear Height: Distance from the lowest notch at the base of the ear to the highest point of the pinna, excluding hairs.

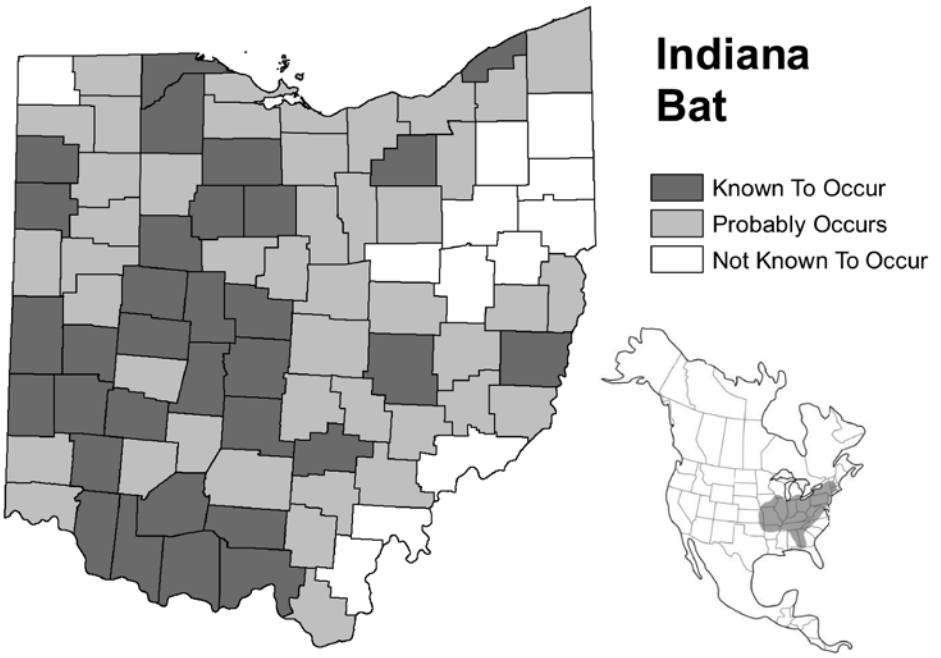
Body mass: Weight of the specimen in grams (g) or kilograms (kg).

Appendix A lists dental formulas for Ohio mammals, and appendix B provides a table for converting metric weights and measurements to imperial units. The metric system is used universally in science and is in common use worldwide; the United States is the only major exception to this rule. Readers

are encouraged to consult appendix B as needed to become familiar with metric units of measurement and their abbreviations and to envision the quantitative values presented. Appendix C gives the common and scientific names of plants and animals mentioned in this book, and appendix D is a glossary of terms that might not be familiar to the reader. Common expressions of time are occasionally abbreviated to conserve space, including year (yr), hour (hr), and minute (min).

Distribution and Abundance

Distribution or range maps in this book are based almost entirely on museum records of when and where, by county, specimens of a given mammalian species were collected. A county shaded dark gray, for "known to occur," indicates that one or more specimens of a species have been collected in that county. Because all counties have not been sampled or received equal attention in past surveys, the absence of a museum record does not mean that a species is absent from a county. In fact, it is likely that counties bordering a county in dark gray have been occupied by the species in question. Those counties are shaded light gray and designated as "probably occurs." For example, the Indiana bat is known to occur in less than half the 88 counties in Ohio, but it probably also occurs in counties bordering those in which it is known to occur. The position of Ohio in the continental distribution of each species is evident in the North American range map inserts. See page xviii for a county map of Ohio.



Abundance is a general, qualitative term that ecologists may use in reference to quantitative expressions such as a census, which provides a complete count of all individuals in a population. A census is seldom feasible with free-ranging mammals, but a statistical analysis of mark-recapture data can yield an estimate of the number of animals per unit area, often expressed as density—for instance, the number of mice per hectare (as in 20/ha). Measures of relative abundance, based on counts per unit effort, are most often used in conservation and ecological studies in which the goal is to compare abundance over time or between habitat types. Examples include the number of animals observed by bowhunters per hours of observation or the number of a given species found dead per kilometer of highway (often referred to as "roadkill"). The most widely used measure for small mammals is the number captured per trap nights (TN) (e.g., 10/100 TN, where 100 trap nights indicates 100 traps set out for one night, 50 traps set out for two nights, or 25 traps set out for four nights, etc.).

Classification and Nomenclature

The listing of orders in table 0.1 follows the classification of Feldhamer et al. (2020). However, we have elected to list families within orders and species within families alphabetically, rather than in any phylogenetic sequence. Genus and species, so-called scientific names, provide unique and universally accepted names for species, but they may be esoteric for the general reader. We use scientific names to introduce each species, but we most often use common names for plants and animals throughout the text. Common names can be confusing because two or more may be applied to the same species. We have used the common names of mammals from Wilson and Cole (2000), who surveyed professional mammalogists and selected the most frequently used common name for each species. Common names for other animals and plants are found in appendix C.

Sources of Information

Information presented in our species accounts is heavily based on the primary literature, and we searched for the most recent research reports to bring our species accounts up to date. However, we also relied on secondary sources such as *Mammalian Species,* which is published by the American Society of Mammalogists and can be accessed at www.mammalsociety.org/publications. Sources of information presented in the text are indicated by author(s) and date at the end of each section of a chapter or account (e.g., "Reproduction"), which will allow the interested reader to efficiently identify relevant publications in the "Literature Cited" section at the end of each species account. Other secondary sources that have been cited frequently are listed in the next section, "References of General and Historical Interest." Greek and Latin derivations of genus and species names may be found in *Mammalian Species* accounts or in Greek and

Latin dictionaries online. The text and literature citations follow the style of the *Journal of Mammalogy.*

References of General and Historical Interest

The following are general interest references and publications that are cited frequently in this book. They are not included in the "Literature Cited" sections of the species accounts but are provided here for easy access.

Bole, B. P., Jr., and P. N. Moulthrop. 1942. The Ohio Recent mammal collection in the Cleveland Museum of Natural History. Science Publications, Cleveland Museum of Natural History 5:83–181.

Burgin, C. J., J. P. Colella, P. L. Kahn, and N. S. Upham. 2018. How many species of mammals are there? Journal of Mammalogy 90:1–14.

Feldhamer, G. A., L. C. Drickhamer, S. H. Vessey, J. F. Merritt, and C. Krajewski. 2015. Mammalogy—adaptation, diversity, ecology. 4th ed. Johns Hopkins University Press. Baltimore, Maryland.

Feldhamer, G. A., J. F. Merritt, C. Krajewski, J. L. Rachlow, and K. M. Stewart. 2020. Mammalogy—adaptation, diversity, ecology. 5th ed. Johns Hopkins University Press. Baltimore, Maryland.

Gottschang, J. L. 1981. A guide to the mammals of Ohio. The Ohio State University Press. Columbus, Ohio.

Harder, J. D., J. K. Kotheimer, and I. M. Hamilton. 2014. A regional study of diversity and abundance of small mammals in Ohio. Northeastern Naturalist 21:210–233.

Kirtland, J. P. 1838. Report on the zoology of Ohio. Second annual report. Ohio Geological Survey 2:157–200.

Kurta, A. 2017. Mammals of the Great Lakes Region. University of Michigan Press. Ann Arbor, Michigan.

Merritt, J. F. 1987. Guide to the mammals of Pennsylvania. University of Pittsburgh Press. Pittsburgh, Pennsylvania.

ODW [Ohio Division of Wildlife, Ohio Department of Natural Resources, Columbus, Ohio]. 2006. Managing Ohio's deer.

———. 2012a. Eastern fox squirrel—wildlife population status report.

———. 2012b. Coyote population status report.

———. 2012c. American beaver—wildlife population status report.

———. 2014a. Rural mail carrier survey.

———. 2014b. Quality vs quantity, a closer look at deer herd condition trends in Oho.

———. 2015. Diseases in wildlife, chronic wasting disease.

———. 2016a. Ohio Wildlife Diversity Database.

———. 2016b. Bowhunter survey report.

———. 2016c. Mammals of Ohio field guide. Publication 5344RO216.

———. 2016d. Spring 2016 furbearer roadkill survey.

———. 2018a. Summary of 2017 bobcat observations in Ohio.

———. 2018b. Ohio bobcat management plan.

———. 2019a. Ohio's listed species. Wildlife that are considered to be endangered, threatened, species of concern, special interest, extirpated, or extinct in Ohio. Publication 5356 (RO919).

———. 2019b. Annual fur dealer report summary.

———. 2019c. 2019 river otter bridge survey results.

———. 2019d. River otter harvest report.
———. 2019e. Ohio hunter questionnaire summary, 2018–19.
———. 2019f. Ohio black bear monitoring report, 2018.
———. 2019g. Summaries of Ohio deer seasons.
———. 2020. Beaver population report—2019.
Reid, F. 2006. A field guide to mammals of North America. 4th ed. Houghton Mifflin Company. New York. (an auxiliary reference for body measurements)
Schwartz, C. W., and E. R. Schwartz. 2016. The wild mammals of Missouri. 3rd rev. ed. (D. K. Fantz and V. L. Jackson, eds.). University of Missouri Press and Missouri Department of Conservation. Columbia, Missouri.
Whitaker, J. O., Jr., and W. J. Hamilton Jr. 1998. Mammals of the eastern United States. 3rd ed. Comstock Publishing Associates, Cornell University Press. Ithaca, New York.
Wilson, D. E., and F. R. Cole. 2000. Common names of mammals of the world. Smithsonian Institution Press. Washington, DC. (used to select common names for all Ohio mammals)
Wilson, D. E., and S. Ruff. 1999. The Smithsonian book of North American mammals. Smithsonian Institution Press. Washington, DC.

Sources for Additional Information about Mammals

Animal Diversity Web (www.animaldiversity.org)
American Society of Mammalogists (www.mammalogy.org)
Bat Conservation International (www.batcon.org)
Merlin Tuttle's Bat Conservation (www.merlintuttle.com)
Ohio Biological Survey (www.ohiobiologicalsurvey.org)
Ohio Division of Wildlife (www.wildlife.ohiodnr.gov)
Schupe, S. 2018. Ohio wildlife encyclopedia: an illustrated guide to birds, fish, mammals, reptiles, and amphibians. Skyhorse Publishing. New York.

Literature Cited

Joly, K., S. K. Wasser, and R. Booth. 2015. Non-invasive assessment of the interrelationships of diet, pregnancy rate, group composition, and physiological and nutritional stress of barren-ground caribou in late winter. PLoS ONE 10(6). https://doi.org/10.1371/journal.pone.0127586.
Oyler-McCance, S., and P. Leberg. 2012. Conservation genetics and molecular ecology in wildlife management. Pp. 526–546 in The wildlife techniques manual: research. 7th ed. (N. J. Silvy, ed.). Johns Hopkins University Press. Baltimore, Maryland.
Vynne, C., et al. 2011. Effectiveness of scat-detection dogs in determining species presence in a tropical savanna landscape. Conservation Biology 25:154–162.