Introduction

This book is a review and compilation of the identification, taxonomy, zoogeography, ecology, and conservation of wild mammals native to Wyoming. It includes species accounts for naturalized introduced (or recently range-expanded) North American species, and includes accounts for several species currently in the state, but of uncertain residency status, and one species—the fisher—that evidence shows is neither a resident nor a native, but that is worthy of review. The book is intended as a reference resource for mammalogists, wildlife biologists, resource management professionals, and lay naturalists, and the information on which it is based comprises published accounts, museum specimens, online databases of museum holdings, unpublished reports, and unpublished data from the mid-nineteenth century to the present. The unpublished data sources provide some of the best information on current distributions that could be presented, and the generosity of agency and academic scientists who shared these data has been fundamental to the value of this book. The species depicted in these unpublished data sets are diverse: shrews, jumping mice, flying squirrels, pocket gophers, bats, wolves, grizzly bears, wolverines, and mountain goats; the contributed data have allowed depictions of distributional dynamics of unprecedented detail in Wyoming for a number of species. All state-level distribution maps that feature point data are supported by supplemental online appendices that present data on each locality mapped. Those appendices can be found at http://www.wyomammals.com.

Aside from those presented here, other resources specific to particular taxa will be needed for some problems of identification to species.[1] Tracks or other field signs can be useful in identifying some mammals to species; excellent field guides to animal tracks and field sign cover the geographic area of Wyoming.[2] Keys to genera and species are provided following the relevant order or family introduction, but museum reference collections and help

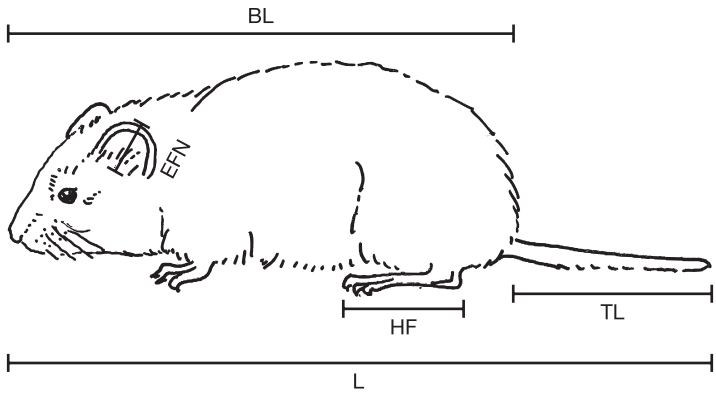

FIG. 2.1 Standard field measurements of a typical small nonflying mammal. L = total length, BL = body length, minus tail, TL = tail length, SH = shoulder height, HF = hind foot length, EFN = ear length from notch. Tail length is typically measured with the tail held perpendicular to lumbar spine.

from a specialist will be needed to identify such morphologically similar taxa as shrews, some ground squirrels, harvest mice, pocket mice, and chipmunks. Some Wyoming mammals can be reliably identified to species only through analysis of their DNA, and likely some valid biological species in Wyoming have yet to be described using molecular markers. Molecular markers for the identification of a steadily increasing number of Wyoming mammals are available now, and I refer to them where possible.

Field measurements are provided of mammals from Wyoming or as close to Wyoming as possible as an aid in identification, and as an important life history characteristic. If measurements were not available for five females and five males from Wyoming, then measurements were taken from adjacent states, and finally from the nearest area from which such sample sizes could be drawn. Locations for field measurements are given as Wyoming counties or other contributing states. Standard field measurements differ among taxa; the coding used is L = length or total length, BL = body length (length minus tail length), TL = tail length, SH = shoulder height, HF = hind foot length, EFN = ear length from notch, FA = forearm length (bats), and WT = body weight (fig. 2.1). Sources for data on morphology come from published and unpublished accounts and museum records: University of Wyoming Museum of Vertebrates, Laramie (UWMV); University of Kansas Museum of Natural History, Lawrence (KUMNH); Denver Museum of Nature and Science (DMNS), Colorado; Museum of Southwestern Biology, Albuquerque, New Mexico (MSB); University of Nebraska State Museum, Lincoln (USNM); and University of Colorado Museum, Boulder (UCM).

The apparent distributions of many mammalian species in Wyoming have changed over the last 150 years, in some cases dramatically. Some of these perceived changes are due to better information, collected by better-trained biologists with improved survey tools. Other

changes are real and have come about as a result of human-caused environmental change, including land use, a changing climate, and altered vertebrate community members. Still other changes have been directly at the hand of humans: mammals have been eradicated, introduced, and reintroduced to Wyoming. Some of these actions have had cascading effects that are well understood, while other effects are only suspected. In the following accounts, the known and hypothesized changes in geographic ranges are presented, and the most plausible mechanisms underlying them identified. Some specialized vocabulary in the areas of anatomy, taxonomy, and biogeography is assumed, and key terms are defined in the glossary.

DISTRIBUTION MAPS

The continental-scale distribution maps presented here are based on maps produced by NatureServe, modified for some species to reflect approximate distributions at the time of European settlement, and to reflect currently recognized species boundaries.[3] The state-scale distribution maps were produced to reflect current distributions, in some cases distributions from earlier in the historical period, and other geographical information. Two kinds of distributional information are presented. The distributions mapped as solid color areas are intended to show an inferred pattern of occurrence of the species. Point data are used to depict localities where a species was collected, observed, or tracked via telemetry. Some species did not permit mapping of their current or past distributions; this was the case for the common gray fox and fisher.

Whether point data or an area is used to depict a distribution is a function of several factors. If the species is not distributed according to known, mapped habitat associations, or if no clear distributional boundary is apparent, and if locality data are available for the few observations available, then the distribution is depicted via points. If the species is either weakly represented in collections or other point data sources, or if its distributional boundaries are known to be sharp and habitat-based, then a smoothed polygon was used to represent its distribution. Using the coyote as an example, identification from a specimen is straightforward, and the species occurs in most or all habitats in the state, but almost no specimens or published data are associated with places where coyotes have been detected in recent decades. Coyote specimens are seldom prepared and preserved in museums. So, the distribution of the coyote is depicted here as statewide, recognizing that the species may be absent from a few sites, for example, alpine zones in winter. The state-scale distribution map for the canyon mouse illustrates the case for the use of points; the species has been collected from only a few locations in southwestern Wyoming, and those locations are documented, but how the species or its habitat is distributed between or beyond those points is not clear.

For a few species for which Wyoming data are scarce, the depicted geographic range was modified from the modeled geographic range presented in the Northwest GAP Species Explorer, a project of the University of Idaho and US Geological Survey.[4] The Northwest

GAP Program produces modeled distributions of vertebrate species, which are representations of where species are predicted to occur based on point data for the species, and environmental information about the sites where the species was observed. The species is predicted to occur where it has been found, and in places with similar environmental conditions—elevation, cover type, topography—nearby. Of course, modeled distributions are only as good as the information entered into the model. For example, a site could be a perfect match for the habitat of a species, but the site could be isolated from the current geographic range by a geographic barrier, have competitors or predators of the species of interest that prevent it from occurring at a site, or harbor diseases that affect the species of interest. In general, modeled distributions tend to be more extensive than the corresponding true species distributions, and the latter is the kind of distribution that I have depicted here, where possible.

Taxonomy and systematics are additional core topics of this book. Taxonomy refers to how taxa (kinds of organisms, such as genera, species, and subspecies) are named, and systematics is the organization of those named types into branching arrangements that reflect phylogeny: patterns of evolutionary divergence. The names and phylogenetic positions of many Wyoming mammals have changed since the seminar work on Wyoming mammals in 1965, and the latest accepted or strongly supported taxonomic and systematic revisions available are used. The standard reference for mammals worldwide is that of Wilson and Reeder (2005), but for common names for mammals north of the Mexican border I have used Bradley et al. (2014). Using standardized common names allows a biologist to communicate about species with a biologist in Eurasia or South America, without ambiguity or reference to the scientific name. In daily use where the regional context is clear, a Wyoming biologist might use such common names as "elk," "beaver," "marten," or "gray fox." However, to communicate with a broader audience, it would be necessary to specify "wapiti," "American beaver," "Pacific marten," or "common gray fox," and I have used the latter conventions here. In colloquial usage in a Wyoming context, the abbreviated common name is customary.

It is important to consider what constitutes a valid record of a species for the purpose of this work. In earlier times, the basic unit of mammalogical investigation was the museum specimen, typically in the form of a stuffed skin and a cleaned skull or skeleton, along with associated field notes. This was the basic tool of the museum mammalogist, who relied on measurements of freshly killed mammals, their cleaned skeletons, and particularly their skulls and dentition to identify them to species, or to recognize and describe new species. This approach has merit in the sense that bones and teeth are important adaptive features, and form a permanent physical record. However, we limit ourselves if we only study prepared bones and skins. First, collecting and preserving mammal specimens has been largely restricted to small-bodied species. Few museum specimens of grizzly bears, wolverines, and porcupines from Wyoming are available for study, especially from a century ago. Secondly, conservation concerns and humane animal treatment require that mammal occurrences be documented without killing them, whenever possible. For some mammal groups, particularly bats, most species can be identified and measured in hand in the field, and the animals

released unharmed. For shrews, this is not possible, because few shrews can withstand the trauma of capture and examination in hand. Other methods, including remote photography, hair collection, and DNA extraction and identification, are in some cases just as reliable as capture or collection of specimens, and are increasingly used.

The literature review is limited to Wyoming or areas as close to Wyoming as possible, working from the premise that most aspects of the biology and ecology of mammals vary geographically. Still, because there are no intensive field studies of Virginia opossums from Wyoming or adjacent states, it has been necessary to draw from states as far away as Pennsylvania and Florida for basic biological data. This is in spite of the fact that studies from such different ecological settings may tell us little about the life history, population biology, diet, or behavior of the species in Wyoming. The reader is cautioned that the information presented from elsewhere about Virginia opossums—and other species never studied in Wyoming—may not reflect the species' biology here.

The conservation and management of most species are documented to the extent that the literature allows. A great majority of state and federal wildlife management efforts are directed towards a relative few species: ungulates, large carnivores, State Species of Greatest Conservation Need, and threatened and endangered species.[5] For many other species, little knowledge of their conservation status is available, and expressions of conservation concern are often nonspecific and call for further information.