United States
Department of
Agriculture

Forest Service

**Intermountain
Forest and Range
Experiment Station
Ogden, UT 84401**

General Technical
Report INT-154

September 1983

Pocket Gophers in Forest Ecosystems

**Cynthia Lea Teipner, Edward O. Garton,
and Lewis Nelson, Jr.**

THE AUTHORS

CYNTHIA L. TEIPNER, graduate research assistant at the University of Idaho, is working toward her master's degree in wildlife biology and communications. She earned a B.S. degree in wildlife biology from Colorado State University in 1980. Her graduate work emphasis is on public relations and interagency communication to facilitate wildlife management and planning.

EDWARD O. GARTON, associate professor of wildlife resources at the University of Idaho, came to Idaho in 1977 after completing graduate and postdoctoral studies at the University of California, Davis. His primary interests are in population dynamics and feeding ecology of mammals and birds and the application of knowledge in these areas to biological control of pests.

LEWIS NELSON, JR., is associate professor of wildlife resources at the University of Idaho with major responsibilities in teaching, continuing education, and communications. He earned a B.S. degree in wildlife management from Colorado State University in 1966, and M.S. and Ph.D. degrees in wildlife biology from Utah State University in 1970 and 1973. From 1972 to 1978 he was a wildlife specialist with the University of California Cooperative Extension Service with Statewide responsibilities in wildlife management, inland fisheries, and outdoor recreation.

RESEARCH SUMMARY

This publication is a state-of-the-knowledge report on available information on gopher biology, ecology, damage, and control. Habits and related problems are reviewed for gopher species throughout the United States, but attention is focused on the northwestern forest environments. A bibliography containing over 1,000 literature citations is included.

The report is not intended as a field guide for control practices, but is meant to familiarize the land manager with the nature and extent of pocket gophers, damage potential, and available control methods. It also discusses areas where research is needed.

PREFACE

The digging, burrowing, and feeding activities of pocket gophers (Geomyidae) frequently conflict with land management goals. In the Pacific Northwest, gopher depredation to conifer seedlings on forest lands is a particularly important economic concern. The following is a state-of-the-knowledge report on gopher biology, ecology, damage, and control. Gopher habits and related problems are reviewed for geomyid species ranging throughout the United States, but more attention is focused on pocket gophers found in northwestern forest environments. This report is not intended as a field guide for control practices, but is meant to familiarize the land manager with the nature and extent of pocket gopher problems, damage potential, and available control methods.

To facilitate access to existing literature, a bibliography of over 1,000 literature citations is included. This section is expanded from a bibliography compiled by Anderson and others (1976:GR). Citations are designated into categories by subject and listed alphabetically by author. Letter abbreviations are assigned to each subject category, and citations used within the text will be found by referring to the appropriate section.

The Intermountain Forest and Range Experiment Station provided funding for the project. Helpful criticism and editorial advice were provided by the following: Robert J. Anderson, Weyerhauser Company; Victor G. Barnes, Eric A. Peacock (retired), and Vincent H. Reid from USDI Fish and Wildlife Service; Lowell E. Birch (Region 4), Hugh C. Black (WO) and John Borreco (Region 5) from USDA Forest Service; Walter E. Howard and R. E. Marsh from the University of California, Davis; Richard C. Konopacky and Gerry Wright from the University of Idaho; Glenn L. Crouch from Rocky Mountain Forest and Range Experiment Station; and Dean E. Medin and Russell A. Ryker from the Intermountain Forest and Range Experiment Station. Special thanks go to various other people who contributed articles and information, and to Greg Hayward, University of Idaho, for providing assistance with the literature search.

CONTENTS

Pocket Gophers in Forest Ecosystems

Cynthia Lea Teipner, Edward O. Garton, and Lewis Nelson, Jr.

IDENTIFYING CHARACTERISTICS

General Description

A number of distinctly subterranean attributes equip pocket gophers (Geomyidae) for their fossorial existence. These qualities developed convergently in at least five completely unrelated lineages. Characteristics other than their morphological adaptations for burrowing include reduced individual movement, distribution patterns that vary with soil conditions, parapatric distribution, and a social system in which individuals rigorously defend lone territories (Patton and Yang 1977:G).

General morphological characteristics include: compact musculature, powerful forearms, long claws on the forefeet, and sharp, curved, continuously growing incisors that aid in digging and burrowing (Tryon 1947:NH; Howard and Childs 1959:HRR; Hall and Kelson 1959:GR; Downhower and Hall 1966:DT). Gopher lips close behind the incisors preventing soil from entering their mouths when foraging and digging. Gophers have small eyes, set wide and high on their heads, and small external ears (fig. 1). Two external, fur-lined, eversible cheek pouches used in carrying food and nesting material give the word "pocket" to their name.

Among the three genera within the United States, morphological and ecological characteristics appear to be most generalized in *Thomomys* (Hill 1937:PHM). *Geomys* spp. characteristics connote a higher degree of specialization with a more massive, flattened skull, smaller eyes, inconspicuous ears, and exceedingly prominent forefeet with heavy nail and limb development (Miller 1964:DT).

Guard hairs are sparsely scattered and occur mainly in the rump region on the body and tail. They may function as sensory units to guide the gophers forward and backward through dark tunnels. The almost naked tail and feet may be thermoregulatory and the gophers respond to heat stress by increasing blood flow to these extremities (McNab 1966:GH).

The environment may play a role in fur color. Darker species occur in darker soils and lighter colored populations inhabit drier, lighter colored soils (Ingles 1950:PHM; Getz 1957:PHM; Walker 1955:DT). Gophers uncommonly display color aberrations, although several studies report various instances of pelage color mutations (Storer and Gregory 1934:PHM; McCarley 1951:PHM), including occasional sightings of albinism (LaVoie and others 1971:PHM).

Pocket gophers annually undergo variable and irregular molts. Semiannual molts result in distinctive summer and winter coats (Bailey 1915:DT; Howard and Childs 1959:HRR). Gophers may experience an early summer molt that spreads down to the tail and is evidenced by a "molt line" at various stages (Tryon 1947:NH).

The gophers occasionally produce soft squeaks, and teeth "clicking" may serve as a warning mechanism. The solitary behavior of pocket gophers may not necessitate a more complex system of vocal communication (Howard and Childs 1959:HRR).

Figure 1.—The pocket gopher has small eyes, set wide and high on the head, and small external ears.

Taxonomy

Pocket gophers comprise a highly fossorial group of rodents found only in the Western Hemisphere. They occupy habitat types from sea level to above timberline. Their taxonomy is based mainly on groove patterns of the upper incisors. Classification may be complicated by groove patterns that have developed similarly in different lineages (Akersten 1973:PHM). Within this family, Hall and Kelson (1959:GR) identified eight living genera: *Thomomys*, *Geomys*, *Pappogeomys*, *Cratogeomys*, *Orthogeomys*, *Heterogeomys*, *Macrogeomys*, and *Zygogeomys*. Revised classification schemes detail only five genera, three of which occur within the United States: *Thomomys*, *Geomys*, and *Pappogeomys* (=*Cratogeomys*) (Russell 1968b:DT; Hall 1981:GR) (fig. 2). *Pappogeomys* and *Cratogeomys* are used interchangeably throughout this text, depending on the way individual researchers classified them.

Complex distribution patterns and extreme geographical variation of pocket gophers cause classification difficulties at the species and subspecies levels (Patton 1973:G). The three U.S. genera display varied morphological and ecological requirements. Based on these variations, Hall (1981:GR) identified five species and almost 300 subspecies of *Thomomys* within North America. In addition, he lists seven species and 38 subspecies of *Geomys* and nine species and 54 subspecies of *Pappogeomys*. Only one species of *Pappogeomys* occurs in the United States.

Characteristics of Age, Sex, and Development

Proper sexing and aging is important in the assessment of gopher population dynamics. Investigators generally use characteristics denoting reproductive activity as an indicator of age. Gophers are normally separated into two age classes: young and adults. Researchers have not developed reliable techniques for aging animals beyond 1 year of age (adulthood) (Hansen and Reid 1973:DT).

The presence of a pubic gap in a female generally indicates participation in at least one breeding cycle. The pubic gap forms with the resorption of the pubic symphysis just prior to the first breeding season. At this point the female is termed adult. Investigators term animals lacking such a gap as young (Hisaw 1924:PHM; Miller 1946:RGA; Hansen 1960:RGA). Hansen (1960:RGA) also found the size of the uterine horns to be of limited value in distinguishing young from adults or determining reproductive activity. The horns remain small in young until approximately 6 to 7 months. The presence of placental scars, lactation or enlarged mammary tissue, and size of uterus in nonpregnant females

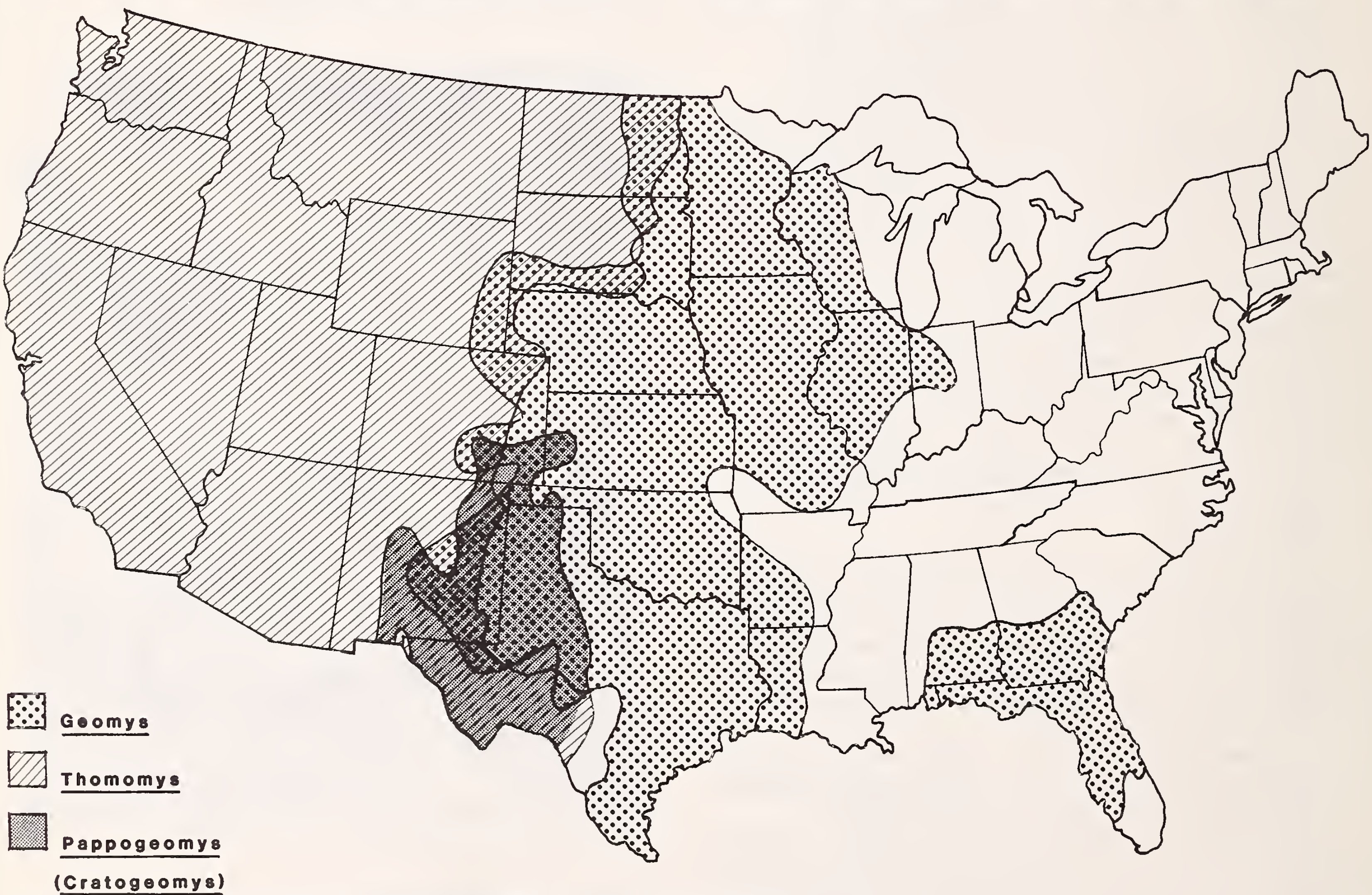

Figure 2.—General distribution of the three genera of pocket gophers within the United States. Prepared from distribution information in Hall (1981:GR).

give further evidence of past and present reproductive activity (Lay 1978:RGA).

Male aging criteria are more ambiguous. Investigators consider males producing sperm or living through at least one breeding season as adults, and class nonsperm producers as young (Vaughan 1967:DT). The position, size, and condition of the testes often serve to indicate male status (Hansen 1960:RGA; Vaughan 1967:DT; Brown 1971:RGA; Lay 1978:RGA). The length of the baculum also serves as a distinguishing characteristic up to age 7 months (Vaughan 1967:DT). Overall baculum length varies considerable among species (Ingles 1965:DT; Vaughan 1967:DT). Hansen (1960:RGA) provides data on age-length relationships for *T. talpoides* in Colorado.

In Florida, Brown (1971:RGA) distinguished three age groups (juveniles, subadults, and adults) of *G. pinetis* based on body size and condition of molt. Howard and Childs (1959:HRR) also used characteristics of pelage but found it relevant only for the very young. They used body length and weight to age *T. bottae mewa* in California up to age 3 or 4 months. Weights fluctuated widely after that. They distinguished 8- to 10-month-old males from 20- to 22-month-old males using body weights. Body length was more diagnostic for females. Adult males usually weigh more than adult females (Howard and Childs 1959:HRR; Wilks 1963:HRR; Hegdal and others 1965:NH; Best 1973:DT; Reid 1981:RGA).

Difficulty is encountered in the field when trying to distinguish young from adults. Researchers can distinguish between young and adult males by palpation of the os penis (baculum). Aging of females is considerably easier through external examination of the pubic gap. Distinction becomes increasingly difficult as physical development progresses (Hansen 1960:RGA).

Newborn pocket gophers are blind and naked (Hill 1937:PHM). Andersen (1978:RGA) details developmental characteristics and rate of growth for *T. talpoides* based on laboratory observations (table 1). The average weight at birth of individuals in litters of five was 0.126 oz (3.58 g), while in litters of six, young averaged 0.098 oz (2.77 g) each. Animals apparently reached adult size in 100 days. Reid (1981:RGA) observed that *T. talpoides* in Colorado averaged four young per litter with individuals weighing approximately 0.1 oz (4 g) each at birth. Individuals did not attain a "near-adult" weight of 2.6 oz (75 g) until approximately 180 days. Reid claimed young became vulnerable to trapping at 1.4 oz (40 g) or about 50 days. He suggested the delaying of annual recruitment measurements until fall when all current young attained a trappable size. Barnes (personal communication, 1982), however, believes gophers weighing less than 1.4 oz (40 g) could be captured.

Table 1.—*Age indicators for captive northern pocket gophers* (T. talpoides) *in Utah*[1]

Age	Description
Days	
1	Hairless; eyes visible as dark spots under skin; pinnae pinhead-sized buds on side of head.
9	Dorsal pelage grey-black; sparse white ventral hair; both upper and lower incisors gapped; young move about cage predominatly using a backward crawl.
16	Incisors gap closed; foreclaws pronounced; pinnae protrude from head; young move about actively.
17	Solid food eaten.
20	Pockets visible but appear closed at exterior; auditory canal closed.
23	Foreclaws 0.16 inches (4 mm) long.
24	Eyes closed; ears probably closed; pockets appear open at exterior; postjuvenile molt in progress-brown replacing grey-black in dorsal pelage.
26	Eyes, ears open.
39	Pouches used to carry food.
60	Fighting among siblings; separation required.
100	Immature molt into adult pelage up to half completed.

[1]Reproduced from Anderson (1978:RGA).

REPRODUCTION

The breeding season for pocket gophers varies throughout their range and depends on physical characteristics of the environment (table 2). Gophers take advantage of abundant food periods to fulfill energy requirements. Both mother and young adapt cycles to maximize survivability. *T. bottae novis* may breed year-round in California. The major reproductive effort, however, takes place in spring, coinciding with a period of abundant green growth and optimum soils for burrowing (Miller 1946:RGA). Andersen and MacMahon (1981:RGA) studied the energy demands of pocket gophers in Utah and energy supplied by various habitat types, and concluded that *T. talpoides* females advantageously delay breeding until a relatively snow-free period when aboveground plants again become available. Reproduction, however, can occur before snowmelt. In a Colorado study, Hansen (1960:RGA) found dead young in snow nests above the ground. Age, microclimate, population characteristics (that is, availability of males), and recent reproductive history can influence the actual time of conception (Desy and Druecker 1979:RGA). An extensive population dynamics study on Colorado rangelands showed that most pocket gophers breed during 4 to 5 months from the beginning of March to the end of June or July (Reid 1973:RGA, 1981:RGA). The majority of births take place between the beginning of May and the end of June. This extended period results from the presence of two classes of reproducing gophers: adults older than a year that bear young first in the spring; and young of the previous year that bear during late spring and summer.

Some studies indicate that breeding or sexual maturity occurs earlier in females than in males (Wilks 1963:HRR; Lay 1978:RGA). However, Tryon (1947:NH) reported that males came into the breeding condition first. The age at which females become a reproductive

Table 2.—*Fecundity rates among pocket gophers by area and habitat type*

Species	Habitat	Location	Breeding season	Litter size	Number litters/ year	Source
Thomomys talpoides	Mountain meadow	Colorado	Mid-March—Mid-May	4-5	1	Hansen 1960:RGA
		Bridger mts., Montana	Mid-April—Mid-May	4.4 ±.13	1	Tryon 1947:NH
		Utah	Early summer	5-6	1	Andersen and MacMahon 1981:RGA
		Utah	Early summer	3.23	1	Ellison and Aldous 1952:HRR
Thomomys talpoides quadratus	Mountain meadow	Oregon	Spring and early summer	5-10 (6.6)	—	Moore and Reid 1951:HRR
	Fruit orchards surrounded by uncultivated pasture	Oregon	Peak: Mid-March	5-9	2	Wight 1930:RGA
Thomomys bottae	Annual grassland	California	Late Jan.—April	4.6	1-2	Howard and Childs 1959:HRR
	Mountainous area	South central Colorado	March—August	3.5 ±1.2	1	Vaughan 1967:DT
Geomys bursarius	Shortgrass prairie	Colorado	April—May	3.5	1	Vaughan 1962:RGA
	Sandhill	Texas	Oct.—June	—	2-3	Wilks 1963:F
	Rangeland	Texas	Feb.—Aug.	2.7	1-2	Wood 1949:RGA
Geomys pinetis	Tampa Bay area	Southern Florida	Year-round Peaks: June—July Feb.—March	1-3 (1.74)	2-3	Brown 1971:RGA

part of the population varies among species and locale. Females reach puberty as early as 3 months (Miller 1946:RGA; Wood 1949:RGA; Wilks 1963:HRR). Brown (1971:RGA) reported *G. pinetis* became sexually mature at 4 to 6 months. Vaughan (1962:RGA) reported an 8-month span prior to puberty for *G. bursarius*.

Limited information exists on gestation. Estimates vary from 18 to 30 days for *Thomomys* (Scheffer 1938:RGA; Howard and Childs 1959:HRR; Reid 1973:RGA). Schramm (1961:RGA) observed gestation to last 19 days for *T. bottae* in the laboratory. Andersen (1978:RGA) determined an 18-day gestation for captive *T. talpoides*.

Adult animals (*Thomomys* spp.) produce only one litter per year on most western range and forest lands. Animals from these litters will not mature sexually until the following year. Reasonably stable reproductive patterns are genetically determined, but age and seasonal environmental conditions can influence fertility (Miller 1946:RGA) (table 2). Litter size varies with locality and habitat type Wight 1930:RGA; Tryon 1947:NH; Aldous 1957:F; Reid 1973:RGA, 1981:RGA). Females bear from three to more than six young at a time. Numerous authors have reported average litter size (particularly for *Thomomys* spp.) for a variety of habitats (Tryon 1947:NH; Wirtz 1954:RGA; Hansen 1960:RGA; Hansen and Ward 1966:HRR; Youmans 1979:HRF; Andersen and MacMahon 1981:RGA).

Extended breeding seasons may occur in areas with stable climates. *T. bottae novis*, living in the irrigated fields of the Sacramento Valley, bred year-round and produced up to three litters annually with four to six individuals in each (Miller 1946:RGA). In contrast, Miller found that in northern California at higher elevations gophers generally restricted their breeding to spring. *Geomys bursarius* breeds over a longer time in the southern part of its range (Hisaw 1925:PHM). Farther north, females do not usually mature sexually until the year after birth.

Brown (1971:RGA) reported the lowest litter sizes for any species of pocket gopher. *G. pinetis* produced from two to three litters annually with one to three young born in each. This species displayed an unusually low turnover rate. A high rate of survival apparently compensated for low reproduction.

Sexual development, fertility, and nutritional factors often correlate positively. Hansen (1960:RGA) noted an increase in sexual organ development and breeding activity when *Thomomys* diet consisted primarily of alfafa roots. Miller (1946:RGA) reported significantly more breeding taking place in summer on irrigated land than on nonirrigated. Reproduction depended greatly on soil moisture and green vegetation. On a chemically treated Colorado range, Hansen and Ward (1966:HRR) reported that female pocket gophers produced slightly smaller mean litter sizes than females on untreated range. Herbicide use reduced broadleaf forb production on the treated range.

DISPERSAL

Weaned pocket gophers may disperse from the nest at about 5 to 6 weeks of age (Miller 1946:RGA; Brown 1971:RGA). Howard and Childs (1959:HRR) reported dispersal of *T. talpoides* at about 8 weeks. Other species (*G. bursarius*) mature sexually as early as 3 months and disperse (Wood 1949:RGA). Young and mother coexist peaceably until increasing agonistic behavior forces dispersal (Wight 1930:RGA). Distances recorded for gophers when dispersing or traveling vary (table 3). Howard and Childs (1959:HRR) noted that some dispersal occurred over the surface. Marked animals traveled at least 400 ft (122 m) before recapture with funnel nets.

Hickman and Brown (1973:B) recorded a maximum dispersing distance of 260 ft (79 m) for *G. pinetis*. The gopher spent at least 20 minutes above ground. Vaughan (1963:M) noted that *T. talpoides* moved up to 1,000 ft (305 m) at a time with an average of 545 ft (166 m). In 1967, Vaughan (1967:DT) compared the distance traveled by released individuals of *T. talpoides* and *T. bottae*. *T. talpoides* moved a mean distance of 785 ft (239 m) although one individual went 2,590 ft (789 m). *T. bottae* dispersed a mean distance of 197 ft (60 m). One individual traveled a maximum of 900 ft (274 m).

Burrowing through snow facilitates pocket gopher dispersal. Animals gain access over obstacles normally blocking movement during snow-free periods (Hansen and Reid 1973:DT). Extensive movement may take place in the snowpack (Hansen 1962:M; Ingles 1949:M).

Gophers may rapidly repopulate control areas, especially when improperly treated (Keith 1961:CHH; Buchner and Rorabaugh 1979:DTF). On the Ashton District in Idaho, overwinter reinvasion occurred on 30-acre (12-ha) clearcuts when surrounding timber was not treated at least 60 ft (18 m) past the clearcut boundary (Birch 1982, personal communication). Uncut buffer strips may slow reinvasion. In Colorado, gophers repopulated fall-trapped 1-acre (0.4-ha) plots by the following summer. Hansen and Reid (1973:HRR) suggested a 200-ft (61-m) buffer zone to prevent reinvasion by gophers burrowing in snow. Gophers also exhibit homing tendencies after displacement (Howard and Childs 1959:HRR).

ECOLOGICAL DISTRIBUTION

In general, unsuitable soil and/or flora types limit pocket gopher distribution. Soil type tolerance, climatic conditions, or intraspecific competition may limit the range of individual species (Miller 1964:DT). McNab (1966:GH) suggested that minor physiological differencess between species could influence distribution.

The gophers display physical and behavioral adaptations best suited to their respective habitats (Buchner and Rorabaugh 1979:DTF). Species consequently maintain almost total allopatric or parapatric distributions (Bailey 1927, 1931:GR; Kennerly 1959:DT; Vaughan 1967:DT; Best 1973:DT; Dalquest and Kilpatrick 1973:DT; Bradley and others 1974:PHM). Allopatry generally prevails where ranges meet, although a local population may include different species. Vaughan (1967:DT) described range overlap between *T. talpoides* and *T. bottae* in Colorado. Populations of one species coexisted with individuals or colonies of the other; however, both populations maintained reproductive isolation. Vaughan believed species achieved separation through differences in dispersal abilities and reproductive cycles.

Patton (1973:G) described hybridization occurring among *T. bottae* and *T. umbrinus* in southern Arizona but found no evidence of genic introgression. Sterility in male hybrids coupled with reduced reproductive potential in female hybrids established a "postmating barrier." Patton and Yang (1977:G) hypothesized that chromosomal organization in *T. bottae* was more important than genic variation in events leading to speciation and reproductive incompatibility.

Contiguous allopatry may occur in some areas with the competitive exclusion of one species by another. Miller (1964:DT) found a pattern of hierarchy established among four species of gophers in Colorado. Populations with the largest individuals outcompeted other populations for superior habitat. Tolerance to the soil type dictated a species' ability to compete. Superior species with the most restrictive niche requirements displaced other species to less favorable habitats. Patton (1973:G) observed that *T. umbrinus* appeared limited in distribution as a result of direct competition from larger, more aggressive members of *T. bottae*. However, he suggested that limited soil tolerance and poor physiological adaptability of *T. bottae* prevented them from displacing *T. umbrinus* even further.

In general, larger species are more restricted by soil type and occur at lower elevations in deeper, more tractable soils. Smaller species inhabit higher elevation, and shallower, rocky soils (Davis 1938:PHM; Dalquest and Scheffer 1944:DT). But Tryon and Cunningham (1968:NH) found smaller individuals in deeper, low elevation soils while larger bodied animals inhabited high elevation habitat. In this case, animal size seemed related to population density and the quality of forage in animal diets. Larger species may displace smaller ones where ranges meet (Miller 1964:DT; McNab 1966:GH). In a conflict situation, larger individuals may dominate, but smaller species forced to occupy less favorable habitats may more readily adapt (Howard and Childs 1959:HRR). However, Miller (1964:DT) did not find that larger individuals dominated. *Pappogeomys castanops* was competitively inferior to the smaller members of *G. bursarius*.

Extreme temperatures may limit fossorial rodents in shallow soils (Howard and Childs 1959:HRR; Kennerly 1964:BE). Gophers excavate deeper during hot and dry periods (Crouch 1933:DC; Wilks 1963:HRR). In this way, they may avoid heat stress. Larger animals may burrow proportionately deeper because of their size (Kennerly 1954, 1959:DT; McNab 1966:GH). Howard and Childs (1959:HRR) reported that burrows tended to collapse when constructed in soils averaging 4 inches (10 cm) or less in depth.

Table 3.—*Movements and home range sizes among pocket gopher populations*

Species	Location	Method	Scope of study	Distance traveled ♂	Distance traveled ♀	Distance traveled Juvenile	Distance traveled Average	Distance traveled Maximum	Home range ♂	Home range ♀	Home range Juvenile	Home range Average	Source
				Meters					Square meters				
Thomomys Talpoides	Utah experimental forest	Extensive trapping on arranged plots	Annual shifts				10	>40					Andersen and MacMahon 1981:RGA
			Over winter			99	15						
	Colorado: a) Mima mound habitat	Mark recapture with		100	81								Hansen 1962:M
	b) Thurber-fescue-forb rangeland	maximum distances between captures	Successive captures - snow-free periods	43	83				36				Hansen and Reid 1973:DT
	Northern Idaho Forb-shrub complex	Radio-isotope tracking	Daily	3	4	4	3–13		356	281	261	606	Kuck 1969:DTF
	Colorado range	Mark recapture					238	785					Vaughan 1967:DT
T. talpoides and T. mazama	Central Oregon Logged– slash burned	Winter cast survey	April					121					Barnes 1974:HRF
Thomomys bottae	Colorado range	Mark recapture					60	273					Vaughan 1967:DT
	California range	Mark recapture	Winter & Spring						818	394			Howard and Childs 1959:HRR
Thomomys monticola	Sierra Nevada mountain meadow			36		121			24-451	27-572	28-572		Ingles 1952:HRR
Geomys pinetis		Captured and release					78						Hickman and Brown 1973:B

Pocket gophers prefer light, friable, well-drained soils. They select porus, sandy soils. Clay types may be too compact for burrowing. (Davis and others 1938:S; Davis 1940:DT; Kennerly 1954:DT, 1958:NH, 1964:BE; Howard and Childs 1959:HRR; Wilks 1963:HRR; Miller 1964:DT; Andersen and MacMahon 1981:RGA). Andersen and MacMahon (1981:RGA) proposed differences in "burrowing efficiency" as opposed to agonistic displays of behavioral dominance as the best explanation for parapatry among pocket gophers.

Gophers may live in soils where mean moisture content ranges from less than 10 to more than 50 percent (Hansen and Beck 1968:HRR). Andersen and MacMahon (1981:RGA) noted that *T. talpoides* apparently could not dig in dry, compact soils and showed aversion to burrowing in wet soils. Burrowing became impossible when moist soils froze. Youmans (1979:HRF) noted that swales in Montana contained too much moisture for gopher inhabitance until late summer. Dispersing juveniles would then establish territories in those areas. Ingles (1949:M) noted that pocket gophers abandoned burrows during active snowmelt and/or runoff. Narrow strips of wet, soggy soil often acted as barriers to dispersal.

Pocket gophers require high rates of gas exchange in their burrows (Kennerly 1964:BE; McNab 1966:GH). Clay soils with high water-holding capacity may not permit an adequate exchange of oxygen and carbon dioxide (McNab 1966:GH).

Chemical properties of the soil may not directly affect pocket gopher distribution except through modification of existing soil structure and plant composition or production. Soil fertility may become increasingly important as it affects the presence or absence of preferred vegetation (Hansen and Reid 1973:DT). Davis (1938:PHM) placed little importance on soil pH.

Patterns of distribution reflect other physiological and morphological adaptation by gophers to their environments. Bradley and others (1974:PHM) compared metabolic rates and thermal conductance between mountain meadow dwelling species (*T. talpoides*) and gophers (*T. umbrinus*) living in the deserts of Nevada. The smaller size, longer tails, and reduced insulation of *T. umbrinus* contributed to lower metabolic rates and higher thermal conductance. The investigators felt these adaptations to different environmental conditions explained their ecological distributions.

BEHAVIOR

Food Habits

Pocket gopher food preferences show marked geographic variation. Strictly herbivorous gophers use all the plant parts during the course of active year-round feeding (Ward 1973:FF). Aldous (1951:FF) reported pocket gophers feeding in the immediate vicinity of their mounds but could not determine how far gophers ranged to forage aboveground. Ward (1960:FF) noted that pocket gophers gathered aluminum-coated grain on the surface, indicating that aboveground foraging may be more extensive than previously thought. The Colorado Cooperative Pocket Gopher Project (1960:DT) also documented aboveground feeding in summer.

Tryon and Cunningham (1968:NH) believed gophers could "select" foods based on proportionately higher quantities of proteins and fats found in their stomachs than in habitat vegetation. Some species select and rely on forbs, as indicated by studies in Colorado (Keith and others 1959:DC; Ward 1960:FF; Ward and Keith 1962:FF; Vaughan 1967:FF; Turner 1973:HRR), Montana (Tryon 1947:NH), Oregon (Moore and Reid 1951:HRR), and Utah (Aldous 1951:FF). Grasses, even if abundant, often comprise only a minor proportion of *Thomomys* diet (Ward 1973:FF). In feeding trials of *T. talpoides*, Teitjen and others (1967:HRR) reported that only those grasses high in moisture content or with food storage structures could provide diets capable of sustaining gophers. Vaughan (1967:FF) said grasses comprise 72 percent of the vegetation in his Colorado study area, but composed only 30 percent of the annual diet for *T. talpoides*.

In south-central Oregon, *T. mazama* preferred the annual forbs that comprised 57 percent of the vegetative cover, but they subsisted on perennial grasses when forbs were not available (Burton and Black 1978:FF). Preferred forbs include common dandelion (*Taraxacum officinale*), lupine (*Lupinus* spp.), penstemon (*Penstemon rydbergii*), western yarrow (*Achillea millefolium lanulosa*), agoseris (*Agoseris* spp.), hairy goldaster (*Chrysopsis villosa*), slenderleaf gilia (*Gilia linearis*), aspen peavine (*Lathyrus leuconthus*), fremont geranium (*Geranium fremontii*), and beauty cinquefoil (*Potentilla pulcherrima*) (Ward 1960:FF, 1973:FF; Hansen and Ward 1966:HRR).

Forbs and shrubs constituted 67 percent of the annual diet on shortgrass prairie in Colorado. Pocket gophers relied most heavily on pricklypear (*Opuntia polyacantha*), which serves as a primary source of nutrition and water. A combination of weather and intensive gopher consumption of pricklypear probably influences local abundance of this plant (Vaughan 1967:FF). On forest lands in California, *T. monticola* preferred lupine but consumed proportionally high quantities of whitethorn ceanothus (*Ceanothus cordulatus*), gooseberry (*Ribes roezoli*), and some red fir (*Abies magnifica*) (Buchner and Rorabaugh 1979:DTF).

Pocket gophers are adaptable in their feeding habits, and food preferences are responsive to changes in the availability of forage species (Ward 1973:FF; Burton and Black 1978:FF). They primarily select green, succulent, aboveground leaves and stems during the growing season. Depending on the habitat, underground plant parts, roots, or grasses become most important during the dormant season (Ward 1960:FF; Myers and Vaughan 1964:FF; Burton and Black 1978:FF).

The variable feeding preferences of pocket gophers do not preclude any plant species from attack in certain situations (Canutt 1970:DTF; Working Group of the Northwest Forest Pocket Gopher Committee 1976:DTF; Crouch 1979:DC). Studies of gopher preferences for specific conifer species showed weak correlations or none at all. Crouch (1971:DTF) found no significant difference in gopher preference among ponderosa pine (*Pinus* *ponderosa*), jeffrey pine (*P. jeffreyi*), and lodgepole pine (*P. contorta*).

Andersen and MacMahon (1981:RGA) studied energy requirements of *T. talpoides* and relationships between forage availability in different environments along a successional gradient. The species displayed catholic food habits and ate anything nonnoxious. High energy costs of securing foods made these actions seem reasonable.

Pocket gophers store food in lateral tunnels that branch from the main runway. These food caches may exceed their needs (Ward 1973:FF). Ward located the caches of *T. talpoides* in Colorado 3 to 4 inches (8 to 10 cm) below surface. Idaho studies on *T. talpoides* showed caches to be deeper, usually from 7 to 12 inches (17 to 30 cm).

Activity Periods

Gophers remain active year-round (Scheffer 1931:B; Hansen and Reid 1973:HRR; Andersen and MacMahon 1981:RGA). In temperate regions, gophers appear to be most active during spring and fall (Scheffer 1931:B; Criddle 1930:NH). In drier areas, activity peaks during the rainy season (Miller and Bond 1960:B). Miller (1948:B, 1957:BE) found digging activity related to soil moisture in the Sacramento Valley and other climatically similar regions. Activity remains lowest in summer and early fall, then rises abruptly after the first heavy autumn rains. Kuck (1969:DTF) used radioisotope labeling on gophers to follow their activities throughout the summer. He noted that activity occurred 24 hours a day but intensified during daytime. He also related intensified seasonal activity with increased soil moisture. More active females and juveniles moved farther than adult males.

Miller and Bond (1960:B) discovered that mountain populations of *T. talpoides* remained inactive in late spring and summer during presumably ideal soil moisture and burrowing conditions. Seasonal activities appeared to be the result of changes in breeding behavior and feeding habits.

Howard and Childs (1959:HRR) found that pocket gophers maintained deeper burrows during hot, dry summer conditions. They observed some gophers in a "profound sleep" under laboratory conditions. They speculated that *Thomomys* might undergo a period of torpidity when conditions become exceedingly warm or dry. Kuck (1969:DTF) found that radiotracked gophers often became inactive for long periods during late summer. Some underwent a period of estivation. One adult male remained inactive for 13 days in mid-August.

The literature contains limited knowledge of daily activity patterns of pocket gophers. Andersen and MacMahon (1981:RGA), employing radiotelemetry, found *T. talpoides* remaining active during all hours of the day. They could not define the type of activity being performed but assumed gophers spent 50 percent of each day in nonresting. Two weeks of continual monitoring revealed that individuals spent approximately 34 percent of their time in activity (Vaughan and Hansen 1961:PHM). Tryon (1947:NH), finding that *T. talpoides* in Montana excavated about 60 percent more soil at night, deduced that most activity probably occurred at dawn and at dusk. Hungerford (1976:FF), however, disclaimed reliance on surface sign as an indicator of total daily activity patterns based on laboratory findings. Mound building occurred most frequently in the morning and at night. Other activities took place around the clock with intermittent rest. Gophers, when secure in their burrows, may not leave any aboveground sign for months. Kuck (1969:DTF) found activity varied throughout the summer, although the actual distances traveled by gophers did not change. Evidence indicated that activity did not correlate with seasonal movement. Environmental conditions influenced daily activity but not total distance traveled to defend territory. In addition to defense, movement in search of food may continue regardless of environmental conditions.

Territoriality

Pocket gophers actively defend individual territories most of the year. Their home ranges usually correspond with the burrow system. Kuck (1969:DTF) and others noted that home ranges tend to be linear in shape, with activity usually concentrated in certain portions of the territory. Hansen and Remmenga (1961:F) found that relationships existed between pocket gopher densities and the size and distribution of territories. At low populations, territories remained clustered with a good deal of vacant land between colonies. At intermediate densities individual territory size approaches a normal distribution. A regular distribution pattern with territories similar in size existed at high densities.

Males generally maintain larger territories than females (Kuck 1969:DTF). In California, Howard and Childs (1959:HRR) estimated that burrow systems covered 8,860 ft^2 (823 m^2) for males and 4,260 ft^2 (396 m^2) for females. Larger territories existed when population densities were lower. On Black Mesa, open tunnel length for *T. talpoides* ranged from 80 to 105 ft (24 to 32 m). Individual burrow systems could cover some 6,530 ft^2 (600 m^2) (Hansen and Reid 1973:HRR).

Dispersing subadults quickly take over vacated burrow systems. Young animals looking for a home site may occupy marginal habitats until better areas become available when older animals die or move. Howard and Childs (1959:HRR) believed that *T. talpoides* established territories for a lifetime in the California foothills where snow is uncommon. Hansen and Reid (1973:DT) noted that gophers abandoned belowground territories during Colorado winters and burrowed solely in the snowpack. When forced back to their subterranean habitats, gophers did not necessarily return to previously occupied burrows. Similarly, gophers displaced by snowmelt and rising groundwater tables did not always return to their original systems.

Gophers become tolerant enough of one another to intermix in individual burrow systems only during the breeding season. Investigators most often recorded plural occupancy of burrow systems by the same species during this time (Miller 1946:RGA; Hansen and Miller 1959:B; Howard and Childs 1959:HRR; Vaughan 1962:RGA). Plural occupancy involving two adult individuals of different species happens less often. Vaughan (1967:DT) reported three separate cases of multispecies occupancy in Colorado. He concluded that inter- and intraspecific tolerance did not differ during periods of breeding.

BURROW SYSTEMS

Numerous authors describe the burrow systems of various species (Scheffer 1931:B, 1940:BE; Tryon 1947:NH; Smith 1948:BE; Downhower and Hall 1966:DT; Hansen and Reid 1973:HRR; Hickman 1977:BE). Best (1973:DT) compared and contrasted characteristics of tunnel systems and mounds of *T. bottae, P. castanops*, and *G. bursarius*. He felt confident in identifying species' presence by observing mounds and other ground surface features.

Generally, main tunnels run parallel to the ground. Downhower and Hall (1966:DT) classified them as either "deep" or "subsurface." Main tunnels contain numerous lateral branches that often terminate at the surface in characteristic fan-shaped mounds.

Tunnel diameters vary between 2 and 4 inches (5 and 10 cm) depending on species and animal size (Scheffer 1940:BE; Smith 1948:BE; Moore and Reid 1951:HRR; Best 1973:DT; Hansen and Reid 1973:DT). Best (1973:DT) used tunnel diameter coupled with depth and shape characteristics to distinguish burrow systems of different species.

"Plugs," although difficult to see, also indicate gopher presence. Plugs remain after gophers seal feeding tunnels or repair open breaks in their burrows at ground level (Hansen and Reid 1973:DT; Buchner and Rorabaugh 1979:DTF).

Pocket gophers use subsurface tunnels for feeding. Such tunnels usually occur in the top 4 to 12 inches (10 to 30 cm) of soil. Soil and vegetation structure may control tunnel depth (Davis and others 1938:S; Moore and Reid 1951:HRR; Downhower and Hall 1966:DT; Hansen and Reid 1973:DT). Tryon (1947:NH) reported *T. talpoides* constructed feeding burrows 12 to 16 inches (30 to 40 cm) below patchy areas of sagebrush. Tunnel length varies and can run several hundred feet in all (Moore and Reid 1951:HRR; Downhower and Hall 1966:DT). Richens (1966:B), following and recording the activities of one *T. talpoides* released in Utah, noted that this gopher constructed 480 ft (146 m) of feeding tunnels over 5 months. Tryon (1947:NH) believed pocket gophers could maintain a maximum of 150 to 200 ft (45 to 60 m) of feeding tunnels. Food availability in an area may partially determine the degree of burrowing activity (Scheffer 1931:B; Moore and Reid 1951:HRR).

Deep tunnels often lead to nests and may attain depths of 5 ft (1.5 m) or more (Moore and Reid 1951:HRR). Nests are usually chambers lined with dry leaves and grasses (fig. 3). In Kansas, Downhower and Hall (1966:DT) noted that gophers did not construct nests at the deepest point of the burrow system. A run usually extended deeper from a chamber, suggesting that it may serve to drain other portions of the burrow system.

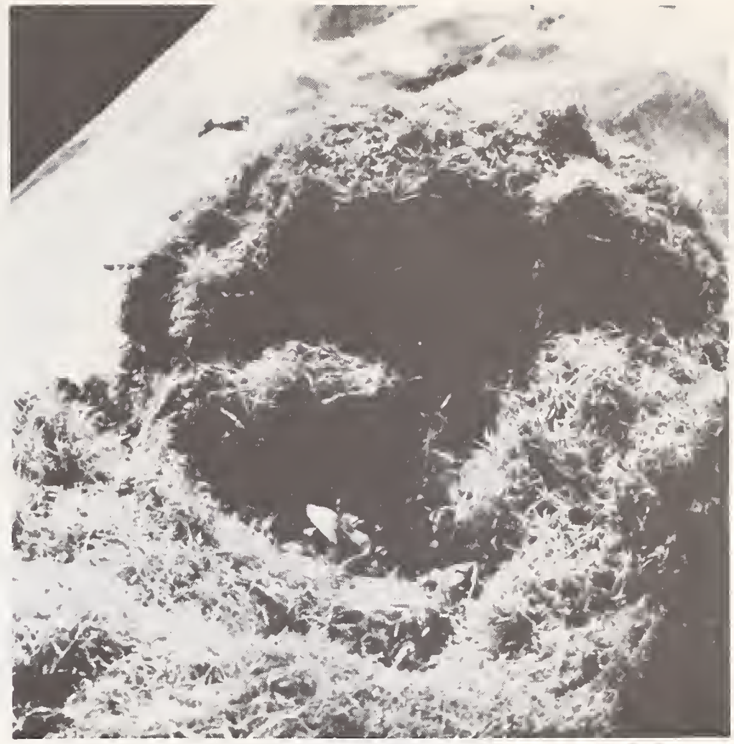

Figure 3.—A winter nest made by the gopher under the snow.

Gophers burrow through the snowpack in winter (Scheffer 1931:B; Ellison 1946:S; Tryon 1947:NH; Miller 1948:B; Ingles 1949:M, 1952:HRR; Hansen and Reid 1973:DT). Snow tunnels may reach a length of more than 100 ft (30 m) (Ingles 1949:M; Hansen and Reid 1973:DT). Gophers form soil casts by pushing soil up from their burrow system into tunnels dug in the snow. These cylindrical casts settle to the ground during spring snowmelt, leaving evidence of winter activity (Hansen and Reid 1973:DT) (fig. 4).

Several reports discuss the microenvironment of the burrow system including characteristics of temperature, light, and humidity. Past research includes: the effects of microclimate on thermoregulatory capacities of pocket gophers (Kennerly 1964:BE; McNab 1966:GH; Gettinger 1975:PHM); comparison of metabolic and thermoregulatory patterns between desert and mountain species of *Thomomys* (Bradley and others 1974:PHM); and examination of the physiological and morphological differences and adaptation of one species in two distinct environments. Andersen and MacMahon (1981:RGA) related features of microclimate and metabolic rates to the energy requirements of *T. talpoides* and subsequent survival limitations.

Other animals will use the gopher burrow systems, but the extent of interaction between gophers and other species remains unclear. Hickman (1977:BE) lists the parasitic and nonparasitic invertebrates, amphibians, reptiles, and small mammals found in these systems and discusses some interactions observed in the laboratory.

Vaughan (1961:BE) recorded 22 species of vertebrates using geomyid burrows for shelter, protection, or as access routes for feeding. He noted that geomyid rodents and tiger salamanders (*Ambystoma tigrinum*) appear to be tolerant of each other. In fact, the existence of the

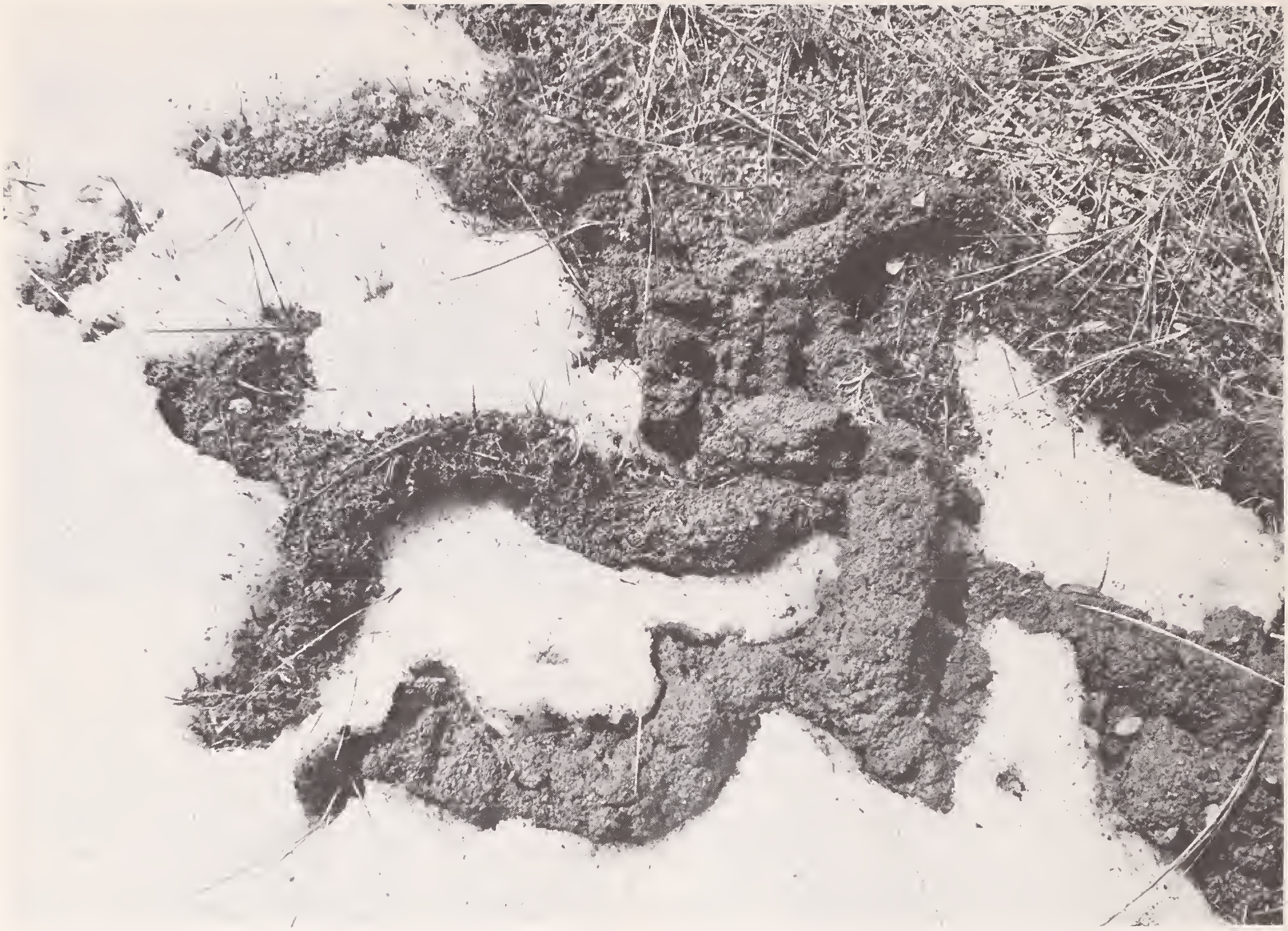

Figure 4.—Winter casts are left intact as the snow melts.

salamander in certain semiarid habitats may be dependent on the presence of burrows. In other instances, gophers and other animals may compete directly for food and space (Turner 1973:HRR).

ABUNDANCE AND POPULATION FLUCTUATION

Pocket gopher populations may change due to the effects of weather, soil, flora, recruitment, competition, diseases, natural enemies, and land use practices (Frank 1975:DC; Turner and others 1973:HRR; Anderson 1976:HRF). Because geomyids are so adaptable in their feeding habits, plant composition and abundance are probably the primary regulators of gopher density in a habitat (Walker 1949:DT; Moore and Reid 1951:HRR; Keith and others 1959:DC; Turner and others 1973:HRR; Barnes 1974:HRF; Buchner and Rorabaugh 1979:DTF). Gopher densities usually increase on lands disturbed by fire, roadbuilding, logging, site preparation, or other events that open the canopy or disturb the soil. Preferred early successional forbs and grasses often thrive in these areas (Crouch 1969:DTF; Volland 1973:HRF; Anderson 1976:HRF; Capp 1976:DTF; Burton and Black 1978:FF), and this may increase the carrying capacity in gopher-occupied areas or may encourage the establishment of new populations (Barnes 1974:HRF).

Andersen and MacMahon (1981:RGA) studied populations of *T. talpoides* in four stages of a montane sere ranging from subalpine forb meadow to climax Engelmann spruce (*Picea engelmanii*) forest. Usable plant energy decreased with each successive stage. The availability of palatable underground vegetation correlated with the rodent populations. Climax spruce forest could not meet their year-round energy requirements, and intermediate seral stages were not likely to meet the energy needs associated with reproduction in females. In early seral stages, Andersen and MacMahon (1981:RGA) thought weather patterns that restricted burrowing efficiency influenced population growth more than the abundance of food.

Pocket gophers avoid areas with heavy brush, slash, or deep shade (Buchner and Rorabaugh 1979:DTF). Overstory removal that leads to brush encroachment and limits herbage growth also discourages gopher inhabitation (Barnes 1974:HRF). Similarly, when herbicide treatments reduce vegetation, significant reductions in gopher densities follow (Howard and Childs 1959:HRR; Keith and others 1959:DC; Hansen and Ward 1966:HRR; Tietjen and others 1967:HRR).

Population densities may not directly relate to elevation, but soil and vegetation, as they vary with altitude, influence them indirectly (Best 1973:DT; Reid 1973:RGA). Tryon and Cunningham (1968:NH) compared an alpine population of *T. talpoides* with one existing 2,200 ft (670 m) lower. Fewer animals occupied the high elevation habitat. Forage, however, was of a higher quality in the alpine zone and individuals there were larger.

Abundance

Anderson (1976:HRF) characterized *T. talpoides* populations in their Oregon habitats with 19 variables measured on 157 sites. Gopher activity and numbers caught increased with elevation and slope and in more mesic conditions. A large number of forbs in disturbed areas provided the best habitat. In Yellowstone National Park, Youmans (1979:HRF) studied populations of *T. talpoides* and relationships to vegetation, soil texture, soil moisture, and snowmelt phenology. His data suggested that soil depths and temperatures, not forb production, primarily limited gopher densities. Soil moisture limited their distribution.

Volland (1973:HRF) describes preferences of pocket gophers for certain habitat types in central Oregon. He divided 1,798,900 acres (728 000 ha) into 23 identifiable community types then consolidated the communities into three classes: moderate to high incidence of gophers; low incidence, but a great potential for occupancy; and little activity. Most preferred communities were lodgepole pine sites supporting lush stands of long-stolon sedge, forbs, or both. Gopher activity in natural nondisturbed stands was minimal or nonexistent.

Irregular and rapid fluctuations commonly occur in the rodent populations from year to year (Ingles 1952:HRR; Tietjen and others 1967:HRR; Tryon and Cunningham 1968:NH; Julander and others 1969:HRR; Andersen and MacMahon 1981:RGA). However, populations exhibit a relative degree of stability over time that is often attributed to intraspecific territorial behavior (Howard and Childs 1959:HRR; Hansen 1962:M; Vaughan 1967:DT). Andersen and MacMahon (1981:RGA) hypothesized that intraspecific competition suppressed growth in subalpine populations when they reached some threshold density. Maximum densities vary with locale (table 4), but studies show *T. talpoides*

Table 4.—*Late summer and fall pocket gopher densities by area and habitat type*

Species	Habitat	Location	Number years censused	Density (individuals/ha) Range	Max.	Mean	Source
Thomomys talpoides	Mountain meadow	Bridger Mts., Mont.	1	—	74		Tryon 1947:NH
		Beartooth Mts., Wyo. (Canadian Zone Sta.)	6	15-44	44		Tryon and Cunningham 1968:NH
		Grand Mesa, Colo.	9	20-52	52	37	Reid 1981:RGA
		Black Mesa, Colo.	15	12-79	79	52	Ibid.
		Wasatch Mts., Utah	2	67-96	96		Richens 1965:PD
		Bear River Mts., Utah	3	10-62	62		Andersen and MacMahon 1981:RGA
	Aspen-dominated forest	Utah	3	2-35	35		Ibid.
	Subalpine fir forest	Utah	3	0-10	10		Ibid.
	Engelmann spruce climax	Utah	3	0-2	2		Ibid.
	Grazed ponderosa pine bunchgrass	Colorado	7	—	—	10	Reid 1973:RGA
	Ungrazed	Colorado	7	—	—	22	Ibid.
Thomomys monticola	Mountain meadow	Sierra Nevada Mts., Calif.	4 combining data for two meadows: autumn only	10-36	36		Ingles 1952:HRR
Thomomys bottae mewa	Annual type range	California	6 year long census	49-101	101		Howard and Childs 1959:HRR
Geomys breviceps	Open pasture	Eastern Texas	1 spring counts	—	17[a]	3	Davis and others 1938:S

[a]This maximum density is based on a report they note from another study in the same area.

populations consistently peak at between 24 and 36 individuals per acre (60 to 90 per ha). (Andersen and MacMahon 1981:RGA).

Density-independent factors most likely regulate population densities below peak levels.

Longevity, Age, and Sex Structure

Andersen and MacMahon (1981:RGA) did not find fertility rates to vary with density, and attributed variation in population levels wholly to factors influencing mortality rates. Longevity varies among gophers. Maximum lifespans range from 3 to 5 years with an average close to 2 years (Ingles 1952:HRR; Reid 1973:RGA). Young-of-the-year may replace 75 percent or more of the population annually (Tryon 1947:NH; Hansen 1960:RGA; Youmans 1979:HRF).

Juvenile survivorship strongly impacts population densities (Vaughan 1967:DT). In the Pacific Northwest, juveniles comprise a greater percentage of the population in fall (Youmans 1979:HRF) while adults constitute a larger proportion in spring and summer (Tryon 1947:NH; Hansen and Ward 1966:HRR) (table 5). In Colorado, Reid (1973:RGA) found a general correlation between the age structure in fall and gopher density the following year. Increased adult body weights and high juvenile populations in fall (greater than 50 percent) usually indicated high densities the following year. Conversely, when fall populations exhibited a preponderance of adults (greater than 50 percent), abundance tended to decline the next year.

Rising ground water tables during snowmelt create the period of greatest vulnerability for young (Vaughan 1967:DT; Hansen and Reid 1973:DT). Populations showed abrupt declines when adverse snow conditions resulted in poor juvenile recruitment. Reid (1981:RGA) suggested that the water content of the snowpack and the date at which snowmelt was complete could be used to indicate population trends.

Male to female sex ratios vary in gopher populations and usually relate to the sampling season (Howard and Childs 1959:HRR). Estimates often show a preponderance of adult females to adult males, with juvenile ratios generally more balanced (Wood 1949:RGA; Hansen 1960:RGA; Lay 1978:RGA; Andersen and MacMahon 1981:RGA) (table 6).

Andersen and MacMahon (1981:RGA) hypothesized that males may experience higher mortality because of increased activity during the breeding season, resulting in prolonged exposure to wet, saturated soils. Brown (1971:RGA), studying *G. pinetis* in Florida, believed males travel aboveground to search out females for

Table 5.—*Age structure of pocket gopher populations*

Species	Number years sampled	Time of sampling	Percent adults	Percent juvenile	Total number of gophers sampled	Source
Thomomys talpoides	15	Fall		57	2,531	Reid 1981:RGA[a] (Black Mesa)
	5	Fall		64	1,083	Ibid. (Grand Mesa)
	1	June		7	69	Youmans 1979:HRF
		Aug.		78	9	
		Sept.		80	64	
	4	Year round during snow-free periods		34	1,738	Hansen 1960:RGA
	4	June		14		Tryon 1947:NH
		Aug.		55		
		Sept.		72		
Geomys pinetis	1	(Monthly May-April)				
		July	48.2		505	Brown 1971:RGA[b]
		Oct.	67.4			
		Feb.	82.4			
Geomys bursarius	3	Monthly				
		total		23	1,218	Vaughan 1962:RGA
		Aug.-Dec.		48		
		Feb.		40		
	1	Sept.		42.3	585	Wood 1949:RGA[c]
		Nov.		3.3		
		Dec.		0		

[a]Generally, young of the year dominated in fall populations and their densities often determined population sizes—particularly in years when they were near the mean high population level.
[b]Brown distinguishes 3 age classes: adults, subadults, and juveniles.
[c]This figure includes females only.

Table 6.—*Sex ratio for different populations of pocket gophers*

Species	Number years censused	Time of sampling	Percent males: Adult	Percent males: Juvenile	Percent males: Adult and juvenile combined	Number sampled	Source
Thomomys talpoides	9	July-Sept.	54.4			68	Ellison and
				53.4		116	Aldous 1952:HRR
	4	Early summer breeding season	32.3	50[a]		129	Andersen and MacMahon 1981:RGA
	4	Fall: (12-32 gophers/acre)		50	42	2,531	Reid 1981:RGA[b]
	11	Fall: (40-79 gophers/acre)		50	54		
	5	Fall		50	47	1,083	Hansen 1960:RGA
	4	Year-round during snow-free periods	47			1,157	
				43		376	
Thomomys bottae	1	April - May			37	505	Lay 1978:RGA
			26			199	
				45		406	
Geomys bursarius	1	Sept. - Aug.	40.4[c]	44.8		561	Wood 1949:RGA
	3	Monthly:			43	1,218	Vaughan 1962:RGA
		May - Aug.		51		125	
Geomys pinetis	1	Monthly:			44	505	Brown 1971:RGA
		May - April	40			339	
				51		166[d]	

[a]Sex ratios "believed" equal prior to the breeding season.
[b]Females were significantly more abundant at low population levels and males were more abundant when densities were at higher levels.
[c]This figure combines data for adults and subadults.
[d]This represents combined data for juveniles and subadults.

mating and become more susceptible to predation. Males moving farther and occupying larger territories than females may influence capture and sex ratio estimates (Howard and Childs 1959:HRR).

Lay (1978:RGA) found significantly more females than males among *T. bottae* of breeding age and suggested the existence of polygyny. Male mortality may increase if polygyny leads to increased intraspecific aggression among males competing for females. In an earlier study, Howard and Childs (1959:HRR) discussed polygyny in *T. bottae mewa* and formulated similar conclusions.

Data collected in Colorado over several years revealed more adult females than adult males present during low population years (Reid 1981:RGA). Males dominated sex ratios during high population years. Young-of-the-year demonstrated a mean sex ratio of 50:50 for all observed years.

Hansen (1960:RGA) found an abundance of males and lower susceptibility of pregnant females to trapping during the early spring. However, as indicated by capture, females comprised a greater segment of the population later in the summer. Hansen concluded that females increase their activity when engaged in postnatal care of the young and become more susceptible to trapping. Balanced sex ratios generally existed at other times of the year.

Predation

Pocket gophers fall prey to a number of avian, mammalian, and reptilian species (Hegdal and Gatz 1976:BE), but predators alone do not have a significant influence on gopher densities (Tryon 1947:NH; Howard 1953:DC; Howard and Childs 1959:HRR). Weasel (*Mustela* sp.) invasion of gopher territory may slow population growth or even contribute to a decline, but weasel impact in regulating density is thought to be minimal (Hansen and Ward 1966:HRR; Andersen and MacMahon 1981:RGA). Coyote (*Canis latrans*) predation, studied for its role in possible biological control, apparently did not influence the rodent populations (Colorado Cooperative Pocker Gopher Project 1960:DT). Other mammalian predators include ermine (*M. erminea*), foxes (*Vulpes* spp.), bobcat (*Lynx rufus*), badger (*Taxidea taxus*), skunks (*Mephitis* spp. and *Spilogale putorius*), and grizzly bear (*Ursus arctos horribilis*) (Moore and

Reid 1951:HRR; Downhower and Hall 1966:DT; Hansen and Ward 1966:HRR; Reid 1973:RGA).

Common avian predators include great horned owl (*Bubo virginianus*), red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*B. swainsoni*), common barn-owl (*Tyto alba*), great gray owl (*Strix nebulosa*), long-eared owl (*Asio otus*), burrowing owl (*Speotyto cunicularia*), northern goshawk (*Accipiter gentilis*), and American kestrel (*Falco sparverius*) (Fitch and others 1946:PM; Tryon 1947:NH; Howard and Childs 1959:HRR; Downhower and Hall 1966:DT; Hansen and Ward 1966:HRR; Marti 1969:PM).

Noted reptilian predators include the bullsnake (*Pituophis sayi*) (Hisaw and Gloyd 1926:PM), gopher snake (*P. melanoleucus*), and rattlesnake (*Crotalus* spp.), but other species may also take gophers (Reid 1973:RGA).

Parasites

Although pocket gophers host numerous species of internal and external parasites, there is little concern to public health, and infestation does not generally affect gopher population levels (Tryon 1947:NH; Reid 1973:RGA).

Ectoparasites include mites and ticks (*Acarina*), lice (*Mallophaga*), and fleas (*Siphonaptera*) (Miller and Ward 1960:PD; Price 1972:PD; Tuszynski and Whitaker 1972:PD; Rust 1973:PD). The degree varies to which estoparasites show host-specificity to pocket gophers (Miller and Ward 1960:PD). Because these rodents lead relatively solitary lives in subterranean environments, transfer of ectoparasites to other animals is minimized. Characteristics of gopher molt and grooming behavior may further restrict parasitic distribution (Rust 1973:PD).

Internal parasites include roundworms (*Nematoda*), tapeworms (*Cestoda*), and some protozoa (Tryon 1947:NH; Todd and Lepp 1971:PD). Liver parasites (*Capillaria hepatica*), most often prevalent in high density gopher populations, can cause significant atrophy of the liver (Tryon 1947:NH; Tryon and Cunningham 1968:NH).

POPULATION ESTIMATION

Surface Sign

Investigators use surface signs such as mounds, earth plugs, and soil casts as indices to gopher burrowing activity and abundance (Miller and Bond 1960:B; Richens 1965:DC; Reid and others 1966:PE) (fig. 5). Numbers of fresh mounds per acre (hectare) or per mile (kilometer) of transect can denote relative abundance of the animals on a unit area (Phillips 1936:HRR; Mohr and Mohr 1936:B; Julander and others 1959:HRR; Hansen and Ward 1966:HRR). Mound counts can also indicate damage potential on a site and the necessity for control efforts.

Beck and Hansen (1966:PE) detailed a method of expressing gopher abundance based on frequency of mounds along transects. Richens (1965:DC) derived an index to population density based on a simple program of trapping and mound counts. High correlations existed between gopher density and the number of fresh mounds observed bimonthly throughout the summer. Cumulative mound counts made annually in early August also correlated with gopher abundance. A poor relationship existed between population levels and mounds constructed in short 72-hour periods. Reid and others (1966:PE), however, found a significant correlation between numbers of pocket gophers and the number of fresh mounds and earth plugs appearing on sample plots in 48-hour periods. All mounds and earth plugs on sample plots were initially erased by flattening, then 48 hours later all new mounds and plugs were counted. Immediately after this, each plot and 20 ft (6 m) of surrounding buffer zone were saturated with kill traps to

A B

Figure 5.—(A) Earth plugs are one of the surface signs of gopher activity. (B) Fresh mounds can be observed during the summer and fall.

determine the number of active pocket gophers present. It is important to determine this animal-to-sign relationship for each different area because the amount of surface sign per gopher may vary with time of year, herbage composition, and gopher species. Sample plots trapped should encompass the burrow systems of several animals. Sign counting to inventory pocket gophers should take place after young-of-the-year disperse and establish burrow systems, usually in late summer and early fall. In Montana, Youmans (1979:HRF) placed limited value on mound counts to census gophers prior to late July. The advantages of sign counting include minimum site disturbance, rapid analysis, and relatively few worker-hour requirements (Reid 1973:RGA).

Trap-Outs

Trap-out techniques arrive at population counts more directly by attempting to capture all animals on a unit (Ingles and others 1949:PE; Howard and Childs 1959:HRR; Richens 1965:DC). Fall trapping produces the most accurate estimates after young attain trappable size (Reid 1981:RGA). The advantages of this technique include count accuracy and rodent availability for immediate examination (Reid 1973:RGA).

Winter Soil Casts

Winter soil casts evident after snowmelt may provide an index to populations prior to reproduction in early summer (Richens 1965:DC; Reid and others 1966:PE; Reid 1981:RGA) (fig. 6). Youmans (1979:HRF), however, reported soil casts represented summer and fall populations the previous year but did not indicate current spring densities. Erroneous population estimates can result from soil cast indices because winter activity depends on the initial winter population, overwinter survival, duration of continuous snow cover, and the presence of frozen soil beneath the snowpack (Reid 1973:RGA).

Open Hole

The open hole technique is used to express relative population abundance or to evaluate postcontrol treatment success (Miller and Howard 1951:DC; Richens 1968:DC; Barnes and others 1970:DC; Birch 1978:DC). Certain behavioral traits of gophers form the basis for this method's use. The method relies on gophers' solitary habits and on their general tendency to plug holes in burrow systems within 24 hours. Personnel open

Figure 6.—Winter casts often remain intact for several weeks after the snow melts.

marked burrows, then check the number of replugged holes 24 hours later for indications of activity. Control treatment evaluation involves using this survey in establishing pretreatment activity levels, treating burrow systems with some control agent, and then repeating the survey 7 to 14 days later. Reopened holes left unplugged 24 hours after this followup survey probably indicate a dead gopher. Rainy periods may invalidate this technique because gophers may not plug holes when relative humidity at ground level reaches 94 percent or more (Hungerford 1976:FF). Plural occupancy may result in conservative density estimates (Miller 1953:DC; Richens 1968:DC).

Aerial Photography

Low or sparse vegetative cover permits the use of 1:600 and 1:1,200, large-scale, normal color, or infared aerial photography to make mound counts. Accuracy of this method compares favorably (97 percent) with ground count estimates (Driscoll and Watson 1974:PE).

Trapping Transects

Animals trapped along transect lines provide relative abundance estimates (Keith and others 1959:DC; Hansen and Ward 1966:HRR; Tietjen and others 1967:HRR). Personnel locate tunnels by probing at 3- to 4-inch (8- to 10-cm) intervals along predetermined lengths of transects, then set traps within the tunnels. Captured animals provide an index to area population, and specimens are readily available for life-history studies.

Capture-recapture techniques employ marking live-trapped animals with either metal bands or by toe-clipping on the hind foot (Ingles and others 1949:PE; Andersen and MacMahon 1981:RGA). This technique requires many hours of trapping, but it also provides good information on survivorship and on other characteristics for demographic analysis.

Nearest Neighbor

A Colorado range study used the "nearest neighbor" concept to estimate gopher population densities and to determine the relationship of density to territory size (Hansen and Remmenga 1961:F). The method correlated the number of gophers per acre with the average distance to the nearest four captures. The average distance between catches decreased as density increased. Method results appear similar to those of simple trap-outs. Assumed random distribution can bias this method because populations may exhibit uniform or clumped distributions.

DAMAGE

For many years land managers have recognized pocket gophers as damaging pests. Gophers have been reported to gnaw underground electric cables (Howard 1953:DBM), but vegetation damage is the major problem. *Thomomys*, the most widely distributed genus in the United States, causes the majority of resource damage and economic loss. Six species of *Thomomys* occur in the Pacific Northwest. Among these *T. talpoides* and the nearly identical *T. mazama* range the widest (Ingles 1965:DT). These two species cause the majority of conifer damage in commercial forest plantations (Capp 1976:DTF).

Agricultural Lands

Agriculturalists first recognized the significance of gopher problems in many root, fruit, and bulb crops (Lantz 1918:DTR; Crouch 1933:DC). Early literature documented canal breaks costing thousands of dollars in crop losses and repairs because of gopher burrowing activities in the banks (Day 1931:S; Scheffer 1931:B; Downhower and Hall 1966:DT). Periodic flooding of cropland often discourages rodent populations, but nonirrigated crops may become particularly susceptible to gopher inhabitation (Scheffer 1931:B). *Thomomys quadratus* caused serious root damage and significant economic loss in Oregon orchards (Wight 1930:RGA). In addition, vast numbers of gopher mounds and dirt heaps on a field can cover large areas of growing crops and later obstruct harvesting operations. As many as 1,200 to 1,500 mounds per acre (3 000 to 3 700 per ha) may occur on a field of average infestation (Scheffer 1931:B).

Rangelands

The abundance of gophers on rangelands can drastically reduce ground cover and herbage production as a result of burrowing, mound building, and foraging (Turner 1973:HRR). Mounds and castings can cover 4 to 10 percent of the ground area (Buechner 1942:HRR; Ellison 1946:S). Where gopher densities are particularly high, displaced soil may cover up to one-fourth of the surface area within 1 year (Turner 1973:HRR). Food availability often determines the foraging range of individual animals. Digging activity and soil disturbances may increase on poor range where a gopher will extend its burrow system in search of more vegetation (Scheffer 1931:B; Moore and Reid 1951:HRR).

Pocket gophers harvest and bury large quantities of vegetation during foraging activities and can greatly influence plant composition and density. On a range in Texas, Buechner (1942:HRR) found that gophers brought more than 5,600 lb/acre (6 300 kg/ha) per year to the surface and covered over 8 percent of the vegetation annually. A Colorado study revealed that gophers reduced the available herbage by as much as 20 percent or almost 80 lb/acre (90 kg/ha) (Turner 1969:HRR; Turner 1973:HRR). Andersen and MacMahon (1981:RGA) concluded that *T. talpoides* in Utah consumed 30 percent or more of the net annual primary production allocated to belowground plant parts. In Utah, Richens (1965:DC) found that areas under gopher control treatment produced two to three times more plant tissue than nearby uncontrolled areas.

Feeding activities and soil disturbance subject various plant species to different selective pressures (Buechner 1942:HRR). High gopher densities generally suppress perennial forbs and grass species even though annual weeds and grasses continue to thrive (Moore and Reid 1951:HRR; Turner 1969:HRR; Laycock and Richardson

1975:HRR). Some plants such as slender wheatgrass (*Agropyron trachycaulum*) and mountain brome (*Bromus carinatus*) may respond favorably to pocket gopher activity and benefit livestock (Turner 1973:HRR). Other potentially harmful plants such as orange sneezeweed (*Helenium hoopesii*), a species poisonous to sheep and unpalatable to cattle, may increase as a result of gopher activity (Turner 1969:HRR).

The degree of gopher influence on herbage composition depends on soil and vegetation characteristics and livestock grazing intensity over time (Moore and Reid 1951:HRR; Turner 1969:HRR). Buechner (1942:HRR) found gophers most abundant on overgrazed ranges and on heavily used areas where vegetation remained in early successional stages.

Gopher activity can aggravate impacts of grazing livestock and further contribute to range deterioration. Burrowing and mound building prevented the return of fescue (*Festuca idahoensis*) in Utah cattle enclosures (Tevis 1956:DTF). Moore and Reid (1951:HRR) found that gophers prevented perennial grasses from reestablishing on overgrazed ranges in Oregon. They also noted that overgrazing on poor range required gopher control for range improvement, but thought that control probably was unnecessary for meadows in fair condition.

Alternatively, in Kansas the plains pocket gopher destroyed undesirable weeds by feeding and digging (Downhower and Hall 1966:DT). Hall (1955:GR) discussed how gophers might actually improve conditions for grass return on overgrazed ranges. In the absence of livestock grazing, gophers destroyed large-rooted weeds and enabled grass reestablishment. Decreases in gopher abundance might result from the improvement of range conditions and the exclusion of livestock grazing. Similarly, on the subalpine grasslands in Utah, Ellison and Aldous (1952:HRR) found that grasses and sedges increased in the presence of gophers and the absence of cattle.

Gopher digging activities may affect development of rangeland soil (Grinnell 1923:S; Turner 1973:HRR). The rodents constantly mix earth during excavation activities. Richens (1966:B) estimated that they displaced 30,000 lb soil per acre (34 000 kg/ha) on mountain rangeland each year. Gophers may enhance range productivity by loosening and softening heavy clay soils previously compacted by livestock (Ellison and Aldous 1952:HRR; Ratliff and Westfall 1971:S). They may render ground more fertile through disturbance if minerals, interstitial air, and water become more available to plants (Grinnell 1923:S; Downhower and Hall 1966:DT). Tevis (1956:DTF) reported that gopher digging on overgrazed ranges in Utah left bare mineral soil exposed, creating an ideal seedbed for conifers. However, he noted later that gophers were destructive to seedlings trying to establish on the range.

The increased permeability and porosity of soil caused by this rodent's activity may favor water conservation (Turner 1973:HRR). Conversely, burrowing may cause accelerated soil erosion through the formation of erosion gullies (Tevis 1956:DTF). The soil piled on the surface weathers sooner and may contribute to increased sediment load in the watershed (Frank and others 1975:S). Free-flowing water channeled by castings can initiate erosion scar formation, and water flow through burrows can hasten soil breakdown (Day 1931:S). Marston and Julander (1961:HRF) found that pocket gophers reduced perennial plant cover in an aspen-cleared plot in Utah. They thought the remaining ground cover would not provide sufficient protection to the soil from overland flow and might enhance erosion.

Gopher influence depends on characteristics of individual areas and the intensity of land use. Ellison (1946:S) reported that gophers on the Wasatch Plateau in Utah helped to accelerate erosion, but overgrazing by cattle on the range caused the majority of the problems.

Forest Lands

On forest lands, intensified reforestation efforts throughout the West reveal that gophers can seriously hinder successful seedling regeneration (Moore 1940:DTF; Dingle 1956:DTF; Hermann and Thomas 1963:HRF; Barnes and others 1970:DC; Hooven 1971:DTF).

Gophers destroyed two-thirds of the trees on study plots in Oregon's 15,000-acre (6 100-ha) Cave Mountain burn within 3.5 years (Crouch 1971:DTF). Damage resulted in the loss of the $200,000 planting cost and an estimated loss of 450,000 bd.ft. ($9,000) (Canutt 1970:DTF). On the smaller, 170-acre (69-ha) Dugout Lake burn, pocket gopher depredation basically eliminated stocking (Barnes 1973:DTF). Damage control after replanting the area in 1969 included two $3,500 gopher-baiting programs. Costs reached $19,000 as of 1973 for both plantings and damage control.

Pocket gopher damage currently affects at least 300,000 acres (121 000 ha) of USDA Forest Service lands (Barnes 1978:DC), and rates as a major forest animal pest. Most damage is reported on ponderosa pine (*P. ponderosa*) plantations (Dingle 1956:DTF; Crouch 1969:DTF; Hooven 1971:DTF; Barnes 1973:DTF; Barnes 1974:HRF).

The response of populations resulting from forestation practices will vary between habitat types and with silvicultural practices. Clearcuts may support large populations, and damage often is acute in these areas (Williamson and Minore 1978:DTF; Minore 1978:DTF). Barnes (1974:HRF) found pocket gophers less abundant but widely distributed through shelterwood cut areas. Delayed reforestation after harvest poses the most serious problem through creation of open disturbed areas. These areas provide ideal gopher habitat, and as populations build with the establishment of profuse vegetation, the problems of reforestation increase (Barnes 1974:HRF; Capp 1976:DTF; U.S. Department of Agriculture 1979:DC). Pocket gopher problems will probably increase in all conifer stands, although future problems will intensify in true fir stands (Borrecco 1982, personal communication) and lodgepole pine (*P. contorta*) because of increased logging activity (U.S. Department of Agriculture 1979:DC). Some of the most serious impacts to reforestation take place when gophers, deer, elk, cattle, or beaver impact areas simultaneously (Evans and others 1981:DTF).

Identification and Description

Conifer damage by pocket gophers results from root pruning, stem clipping, girdling, partial removal of stems and crowns, or total removal of small seedlings (Barnes 1973:DTF) (fig. 7). Gophers can seriously affect conifer regeneration up to 10 years after planting (Dingle 1956:DTF). The most serious damage, however, occurs within the first 2 or 3 years, and damage to small seedlings often results in mortality (Crouch 1971:DTF; Hooven 1971:DTF). Crouch (1971:DTF) reported that total seedling removal caused 76 percent of the tree loss in the Cave Mountain, Oreg., burn study area.

Figure 7.—The root system of an established seedling is nearly destroyed by the pocket gopher.

Extensive gopher damage to conifer seedlings most commonly occurs in the absence of preferred vegetation (Burton and Black 1978:FF). Damage to trees occurs year-round but most frequently in winter. Scarcity of herbaceous vegetation forces gophers to feed above ground beneath the snowpack (Crouch 1969:DTF, 1979:DC; Canutt 1970:DTF; Barnes 1973:DTF; Buchner and Rorabaugh 1979:DTF). Barnes (1974:HRF) found that 90 percent of the gopher-caused tree damage on his study area occurred in winter with virtually all damaged trees dying. Allen and others (1978:DC) found gopher damage greatest during winter on the Targhee National Forest, with the majority attributed to crown clipping. Tree girdling occurred beneath the snowpack to a height of 3.3 to 3.9 ft (1 to 1.2 m). Hooven (1971:DTF) observed girdling damage in lodgepole pine to a height of over 7 ft (2.1 m). Extensive winter damage results in obvious white tree trunks showing after snowmelt (Barnes 1973:DTF).

Teeth marks on trees and shrubs characterize pocket gopher damage. Winter soil casts, mounds, or runways occasionally surround injured trees. Removal of a young seedling may result in a mound or plug or in no visible sign at all (Canutt 1970:DTF).

Porcupines (*Erethizon dorsatum*) or mountain beaver (*Aplodontia rufa*) were blamed for some pocket gopher damage in the past (Crouch 1969:DTF). Porcupines generally limit barking to the outer wood surface, while gophers often gnaw deeply into the wood of old seedlings and young saplings (Canutt 1970:DTF) (fig. 8). In addition, porcupines leave discarded fragments of outer bark at the base of the damaged tree while gophers do not.

Evidence of root pruning may not become apparent until the tree shows visible signs of stress. Trees may tilt and foliage may turn brown over time (Canutt 1970:DTF).

Tevis (1956:DTF) reported that burrowing gophers left the roots of red fir seedlings exposed with extensive damage resulting. However, Barnes (1973:DTF) and Turner (1973:HRR) thought that root exposure and damage resulting from burial by mounds and winter casts constituted lesser forms of injury.

CONTROL

The task of computing an economic analysis of pocket gopher damage and control remains difficult. Lack of data and detailed damage surveys creates a problem in estimating the extent of actual gopher impact on managed lands. Limited funding and a need to prioritize control areas complicate management decisions.

Presently, economic concern is primarily on gopher impacts to harvestable forest lands. Growing demands for wood products and subsequent inflation of timber values provide the basis for this concern.

Increased concern by land managers led to the formation in 1973 of the Northwest Forest Pocket Gopher Committee (NWFPGC) to study damage problems and promote solutions. In 1974, this group affiliated with the Oregon-Washington Silvicultural Council of the Western Forestry and Conservation Association. In 1975, the committee developed a questionnaire designed to determine the extent of gopher damage in the Pacific Northwest and the efforts to control it. Results of this survey showed that the majority of damage occurred on forest lands east of the Cascade Crest in Oregon and Washington. Almost 80 percent of those surveyed thought that damage over the coming 10 years (1975 to 1985) would remain constant or increase. The group indicated that control measures involved only 10 percent

A

B

Figure 8.—(A) The pocket gopher gnaws deeply into the wood and consumes everything, leaving no residue on the ground around the tree. (B) Porcupines chew off the bark but do not gnaw into the wood. They leave shreds of bark on the ground around the tree.

of the gopher-affected acreage; 80 percent of those administering control programs thought their efforts insufficient. Factors contributing to poor success included inadequate budget, personnel, equipment, and control techniques, and the inability to detect damage.

A recently formed USDA Forest Service "activity review team" looked at gopher-reforestation issues to find more workable solutions (U.S. Department of Agriculture 1979:DC). Under the team's influence, western Forest Service Regions 4 and 6 compiled available data on total area planted, seedling survival, area subjected to gopher control, and all associated costs for these programs. This type of comprehensive review in each region could serve as a starting point.

On forest lands control difficulties intensify when managers fail to anticipate damage while planning timber harvest (Barnes 1974:HRF; Buchner and Rorabaugh 1979:DTF). Early recognition of potential problem areas and prompt application of direct or indirect control could prevent or reduce losses (Barnes 1973:DTF; Capp 1976:DTF; Buchner and Rorabaugh 1979:DTF). Conifer losses in some areas may gradually increase enough to cause reforestation failures or restocking delays. Managers should monitor suspected problem areas and determine the need for damage control annually (Crouch 1979:DC). Cooperation among land managers, including wildlife biologists, will help prevent or decrease animal damage conflicts (Capp 1976:DTF; U.S. Department of Agriculture 1979:DC). Kinds of control vary with area size and situation. Successful control must exceed the naturally high annual gopher mortality rates (70–75 percent) (Hansen 1960:RGA). Capp (1976:DTF) recommends a population reduction of 90 percent. Managers must become familiar with the advantages and disadvantages of techniques. On rangelands, studies document both positive and negative influences of burrowing gophers, but the necessity for control efforts often remains unclear. Where they are integral components of range communities, the gophers' influence on habitat is difficult to evaluate apart from other interacting segments of the ecosystem. Personnel need to define the relationships between the amounts of forage consumed by gophers and the costs of control. In addition, factors that tend to naturally control or minimize the impact of damage need consideration. Gophers are less frequently a problem on well-managed rangelands. Control is more commonly recommended for improvement of deteriorated range than for maintenance of range in fair or good condition (Tietjen 1973:DC).

Alsager (1977:HRR) outlined a method for determining rodent impact to net vegetation production, and for analyzing costs and benefits of control. The technique requires intense labor effort but may warrant further evaluation.

Cost

The Pocket Gopher Reforestation Activity Review Team reported that the cost of contracting for rodent control doubled in the past few years (U.S. Department of Agriculture 1979:DC). Birch (1982, personal communication) concluded from a 1977 study that a 1.69:1 cost-benefit ratio existed on the Ashton Ranger District, Targhee National Forest, Idaho. Subsequent contract bidding competition reduced the cost of treatment. Present treatment costs range from $20 to $25 per acre ($50 to $62 per ha) for 2 years of treatment after planting, to $40 per acre ($100 per ha) for 7 years of protection. Birch (1978:DC) prepared guidelines for organizations wishing to initiate contract baiting control. Costs often increase because seedlings may remain vulnerable to gopher depradation up to 10 years, and many require treatment throughout this period. As reforestation efforts increase to meet expanding demands for wood products, gopher depradation and economic impacts can be expected to intensify (Capp 1976:DTF).

Methods

1. **Poison baits.**—Poison-coated baits constitute the most commonly used method of gopher population reduction. Baits used with good success include grains such as whole wheat, oat groats, milo, hulled barley, and cracked corn (Marsh and Cummings 1976:DC). In laboratory feeding tests *Thomomys* sp. accepted oat groats and soft milo maize more readily than other grain. Gophers preferred fresh carrots over other vegetables (Ward 1973:FF). Hungerford (1976:FF) found that gophers locate food by odor, and of the food odors tested, fresh carrot juice elicted the most obvious response.

Managers most commonly use strychnine alkaloid poison to coat baits (Capp 1976:DTF; Marsh and Cummings 1976:DC). The poison is fast acting and generally provides excellent control. Success of strychnine alkaloid as a poison depends on consumption of a lethal dose within a short time (Copeman 1957:DC). Animals ingesting sublethal doses may develop a bait aversion instead of dying (Marsh and Cummings 1976:DC). Reasons for consumption of sublethal quantities of poison include: preferences and availability of natural foods in comparison with baits, reduced toxicity of cached bait, and varying levels of bait tolerance by individuals (Barnes, personal communication). Age and associated behavior affect laboratory rodents' susceptibility to various baits (Salmon and Marsh 1979:DC). Although such studies have not been conducted on gophers, these findings may apply.

The amount of bait used varies with local conditions. A high-level strychnine bait (2.8 or 3 percent) used with the burrow builder consistently provides good control (85–95 percent or greater) under a variety of conditions and soil types. High-level strychnine baits are not recommended in hand-baiting because of the poison's hazardous nature (Marsh and Cummings 1976:DC).

Varying State and local laws govern the use of strychnine alkaloid or other toxicants for pocket gopher control. Program restrictions may limit the effectiveness of present poisoning methods (Barnes 1973:DTF; Capp 1976:DTF; Working Group of the Northwest Forest Pocket Gopher Committee 1976:DTF).

Rodenticide use and possible primary and secondary effects on nontarget species of wildlife generate substantial public concern. Possible baiting hazards to threatened or endangered species influence efforts to control damage. Studies generally indicate minimal danger to other animals from strychnine used in pocket gopher control. Fagerstone and others (1980:BE) found some evidence of nontarget strychnine mortality but no significant adverse effects on population levels. They observed little use of gopher burrows by other species.

Artificial burrow construction may result in exposure of small mammals to bait (Fagerstone and others 1980:BE). Hegdal and Gatz (1976:BE) found that bait applied with a burrow builder significantly decreased nontarget rodent populations on treated areas. Secondary strychnine poisoning might occur if predators consumed bait-killed pocket gophers or their food caches and ingested toxic doses of poison. Chances of this occurring are remote because poisoned gophers tend to die underground (Hegdal and Gatz 1976:BE; Barnes 1981, personal communications). Food caches generally contain greater concentrations of toxin than carcasses, but are less accessible because gophers often store food more than 12 inches (30 cm) below the ground surface. Hedgal and Gatz (1976:BE) concluded that proper strychnine baiting with the burrow builder did not constitute a hazard to seed-eating birds, raptors, and mammalian predators.

The development of increasingly safe and effective baits is becoming more complicated and expensive because of rigid regulations (Marsh and Cummings 1976:DC). In the future, it may be necessary to steer away from heavy reliance on poisons for control. Buchner and Rorabaugh (1979:DTF) suggest integrated pest management as an alternative.

2. **Hand baiting.**—Hand baiting remains as one of the oldest control methods in common use (Crouch 1933:DC; Crouch 1942:DC; Moore and Reid 1951:HRR; Colorado Cooperative Pocket Gopher Project 1960:DT). The procedure involves locating an occupied burrow system by observing mounds or plugs, finding a main runway by probing, placing toxic bait in the runway with a spoon or mechanical bait dispenser, and covering the opening.

Success depends primarily on the ability to accurately locate burrows and properly insert bait (Buchner and Rorabaugh 1979:DTF). Birch (1982, personal communication) reported that mechanical bait dispensers did not work on the Ashton Ranger District of Idaho because certain soils plugged the apparatus and personnel were unable to tell if bait was applied when the set was made. Crew morale and efficiency depend on weather, gopher activity, and the size of the treatment area. Crews of seven people working under contract may treat up to 90 acres (36 ha) per day depending on their previous experience and on the locale. Incentive pay programs may also serve to improve crew performance (Birch 1978:DC).

Costs of hand baiting relate to crew size and experience, gopher densities, topography, ground cover and debris, and travel distance (Canutt 1970:DC).

Barnes (1973:DTF) noted that baiting by hand or with a mechanical dispenser applies best to small areas or where isolated gopher populations exist. He also indicated that control efficiency dropped in areas greater than 5 acres (2 ha). Birch (1982, personal communication), however, indicated that such a drop in efficiency would be unlikely with contract baiting crews.

3. **Burrow builder.**—The burrow builder, first developed in California (Kepner and others 1962:DC) and Colorado (Ward and Hansen 1960:DC), provides one of the most efficient means for control on suitable sites (Barnes 1974:HRF; Marsh and Cummings 1976:DC). A tractor-drawn machine pulled across the ground constructs a burrow by means of a torpedo attachment and deposits bait simultaneously. The bait applicator can be used in established pastures, alfalfa and other forage crop fields, vineyards, orchards, or open fields (Marsh and Cummings 1976:DC). Some range and forest lands require the use of a sturdier version of the model (Canutt 1969:DC, 1970:DC; Barnes and others 1970:DC; Barnes 1974:HRF). On the Targhee National Forest, burrow builders constructed by Ghormley Mechanical Industries of Ashton, Idaho, and by Schneid-Miller Industries of Fort Collins, Colo., are currently in use. Birch (1978:DC), who described adjustments made to these machines and to their carriers, reported that a 1977 summer trial with a modified machine demonstrated acceptable burrow construction in rocky soils, brush, sod, slash piles, debris, and on steep slopes. The machine successfully constructed burrows in sod frozen to a depth of 1 to 2 inches (2 to 5 cm). Burrow builders, however, achieve highest success on reasonably firm, moist soils. Artificial burrows will collapse in overdry soils, and saturated soils tend to interfere with proper machine functioning (Marsh and Cummings 1976:DC).

4. **Habitat manipulation.**—Land use practices that alter habitat can strongly influence gopher populations. Range or forest management that disturbs soil and/or stimulates the production of herbaceous vegetation often improves habitat for pocket gophers. Early management planning assessment of potential gopher damage may enable effective, coordinated habitat manipulation as part of reforestation or other management goals (Volland 1973:HRF; Barnes 1974:HRF). Volland (1973:HRF) described the relationships between numerous community types and gopher densities in central Oregon, and suggested tree harvest methods and preventative management practices to minimize damage in different plant communities.

Modification of site preparation and logging practices in reforestation may discourage the establishment of favorable gopher habitat. In some cases, limiting site preparation to individual planting sites rather than disturbing entire areas will minimize soil disturbance. Barnes (1974:HRF) thought his method practical in brush fields, although problems with other animals such as rabbits and hares may increase. In some cases, however, minimal soil mixing may inhibit adequate natural restocking, or competition between pine, browse, and grass species may make it impractical (Buchner and Rorabaugh 1979:DTF). Packer (1971:DC) described other techniques of site preparation to minimize soil disturbance, including the clearing of tractor-cut strips and methods of terracing. The cutting of strips, however, may not reduce gopher damage problems, and in some cases may even increase them (Anderson 1982, personal communication).

Uncut buffer strips, 500 to 700 ft (152 to 213 m) wide, adjacent to logged areas, may delay or minimize gopher invasion from neighboring sites (Barnes 1974:HRF). Buffer strips of this size become impractical as acreage occupied by gophers increases and the value of wood products rises (Capp 1976:DTF). In addition, Crouch (1982, personal communication) observed pocket gophers traveling more than 500 ft (152 m) on logging roads between adjacent clearcuts. Thus, invasion may occur regardless of buffer strips.

Timber harvest should be designed for minimal canopy disturbance (Capp 1976:DTF). Barnes (1974:HRF) reviewed several studies indicating that the reduction in overstory canopy stimulated production of preferred gopher vegetation. He suggested that partial cuts should replace clearcutting whenever feasible. Shelterwood cuttings in lodgepole pine and mixed conifer habitat on the Deschutes National Forest, Oreg., showed promise for avoiding some of the regeneration problems experienced on wildfire and clearcut areas (Barnes 1978:DC). On the Dead Indian Plateau, Oreg., the best natural regeneration occurred when 60 percent of the overstory canopy remained after planting. Personnel estimated this optimal percentage given other variables affecting regeneration, but pocket gopher damage constituted a major concern. Buchner and Rorabaugh (1979:DTF), examining a number of harvest methods, indicated that properly employed selective cuts might result in excellent natural regeneration to the extent that gopher depredation would not cause a substantial impact.

Replanting should occur as soon as possible after harvest. Planting more and larger fast-growing stock can minimize seedling susceptibility to mortality from gophers. In addition, sites can be prepared for machine baiting by manipulating debris and planting trees to allow spaces large enough to accommodate a burrow builder (Capp 1976:DTF).

Herbicide reduces a habitat's carrying capacity for gophers by altering the plant community composition. On rangeland, treatment with 2,4-D provided dramatic reductions in forb species, and subsequent decreases in gopher populations followed (Keith and others 1959:DC; Hansen and Ward 1966:HRR; Tietjen 1973:DC; Hull 1971:DC). Extensive feeding trials revealed that direct ingestion of 2,4-D sprayed on grasses and forbs resulted in no apparent toxic effects to gophers (Tietjen and others 1967:HRR).

In forest environments, complete control of vegetation with atrazine, simazine, and 2,4-D reduced gopher activity to one-tenth of that on untreated areas. In addition, competition with conifer seedlings for soil moisture was reduced and seedling survival increased (Black and Hooven 1977:DC). Crouch and Hafenstein (1977:DC) found that aerial applications of atrazine improved survival of ponderosa pines that were subjected to competition from herbaceous vegetation and depredation by pocket gophers. Crouch (1979:DC) found in south-central Oregon that one or two fall applications of atrazine to 1-acre (0.4-ha) plots of ponderosa pine significantly increased seedling survival and growth after 10 growing seasons. His results strongly indicated that atrazine treatments over larger areas would further increase effectiveness.

Pocket gopher populations generally do not decline in response to vegetation alterations for at least 1 year after control treatments. Managers should delay forest regeneration attempts accordingly; otherwise, gophers are likely to increase feeding activity on planted conifers as other foods become unavailable (Black and Hooven 1974:HRF, 1977:DC; Burton and Black 1978:FF; Crouch 1979:DC).

Because control via vegetation alteration is short-lived, manipulation will probably be most valuable when used to improve the efficacy of direct control or to establish physical barriers to gopher dispersal. In USDA Forest Service Region 5, integrated control approaches combining habitat manipulation with baiting programs commonly occur. Baiting with increased stocking levels has also been used to resolve gopher damage problems. Combining methods of control may be expensive but necessary in many areas (Minore 1978:DTF). Because of growing concerns of potential human and environmental hazards, future use of herbicides and poison baits may be severely restricted.

5. **Kill trapping.**—Managers use kill trapping most extensively in small affected areas or where very low gopher populations occur. Trapping adequately substitutes for poisoning in terms of effectiveness, but the technique is more labor intensive and expensive (Crouch 1979:DC). Frank (1975:DC) did not consider kill trapping the most humane way of killing animals. Managers use trapping, in conjunction with other control methods, to remove any of the rodents missed in the initial control operation, to stop reinvasion at the onset, or as a research tool (Tietjen 1973:DC). Trapping incurs some nontarget mortality, but does not significantly affect other small mammal populations (Frank 1975:DC).

Of the variety of traps used, Tietjen (1973:DC) reported the Macabee type worked best for northern pocket gophers. In southern Alberta, Alsager (1977:HRR) evaluated a number of traps and achieved best success with the Guardian gopher trap. Frank (1975:DC) prepared a set of guidelines for conducting a trapping program.

Various authors discuss trapping techniques and related success (Dixon 1922:DC; Crouch 1933:DC; Storer 1938:DC). Because of characteristic behaviors of gophers, there is some controversy over whether to close openings above sets or to leave them open, exposed to light and air. Gamboa (1975:BE) tested the efficiency of both trapping methods and found no significant difference between them. He warned, however, that trapping efficiency may reflect species-specific behavioral responses.

6. **Wire caging and plastic seedling protectors.**—In the past, managers protected young trees from gopher damage by enclosing individual seedlings in wire cages. On the Dead Indian Plateau, Oreg., caged seedlings grew better in some instances than bare-root and container-grown seedlings. The cages provided protection from snow, litter fall, and foraging animals (Williamson and Minore 1978:DTF). However, managers did not consider caging practical because of expense. Industry subsequently developed plastic mesh seedling protectors such as "Vexar" to replace wire caging (Campbell and Evans 1975:DC) (fig. 9). Vexar effectively reduced gopher damage to conifer seedlings over unprotected seedlings (Anthony and others 1978:DC). In 1977, two 20-acre (8.1-ha) plots were planted with Vexar-protected seedlings on the Ashton Ranger District, Idaho. To date, both still show 96 percent tree survival and additional growth, as compared to 30 percent survival of nonprotected trees. In addition, 200 acres (81 ha) contract-planted in 1979 also remain protected from depredation. However, associated costs are three times higher than contract control by baiting (Birch 1982, personal communication). Although expensive, this procedure should be considered when there are environmental hazards associated with baiting or where a long-term commitment to rebaiting cannot be assured (Barnes and Anderson 1982, personal communication). Problems associated with this method, other than cost, may include: breakage; compression of the tubing by extreme cold, snow, and frost heaving; and deformity of terminal buds and roots protruding through mesh openings (Anthony and others 1978:DC).

Figure 9.—Seedling protected by a Vexar tube.

7. **Exclosures.**—Exclosures protected study plots from invading gophers with variable success (Horn and Fitch 1942:HRR; Ellison and Aldous 1952:HRR). Workers, however, place little value on exclosures for real operational control. Small-mesh wire, sheet metal, or concrete fencing may be effective in local situations. For best protection from overland and subterranean invasion, fencing should extend 2 ft (0.6 m) below ground surface and 1 ft (0.3 m) above ground depending on expected snow depth (Cummings 1962:DC). Cummings reported that fencing with wire mesh or concrete deterred burrowing in canals or ditches, although fencing involved high costs.

8. **Gas cartridges.**—The placement of gas cartridges in pocket gopher burrow systems provides one alternative to baiting. But the technique is costly and relatively ineffective because gophers have such long burrow systems (Rost 1978:DC). Methods previously discussed show greater promise for future use, although this method of control could be applied in campgrounds or situations where other toxicants or trapping techniques are undesirable (Borrecco 1982, personal communication).

Timing of Treatment

Successful damage control requires organizational commitment, persistence, and the timely coordination of all regeneration practices. On forest plantations, time-of-treatment decisions must take into account density, size, and distribution of existing tree stock, as well as pocket gopher abundance. The entire area occupied by gophers must receive treatment and, if necessary, periodic retreatment (Moore and Reid 1951:HRR; Richens 1965:DC; Allen and others 1978:DC). The administration of control treatments must occur at appropriate times to achieve maximum population reductions. Managers should concentrate efforts on achieving lowest gopher densities during the seasons of highest probable depredation. Allen and others (1978:DC) thought treatment should take place before the young dispersed or during the winter season. Buchner and Rorabaugh (1979:DTF) stated that for maximum success, toxic baits should be applied when animals are most active and preferably before parturition. Barnes (1974:HRF), however, recommended fall treatments because earlier treatments did not adequately protect areas from rapid reinvasion. Gophers exhibit strong tendencies to reinvade areas newly vacated after control (Barnes 1974:HRF). Spring baitings or less frequent applications may suffice on sites with low reinvasion potential or supporting low gopher populations (Barnes and others 1970:DC). Treatment extending 60 ft (18 m) into a plantation perimeter could minimize reinvasion after poisoning (Allen and others 1978:DC).

In areas of heavy infestation, Birch (1978:DC) recommended fall baiting with a mechanical burrow builder before planting, followed by hand baiting for two subsequent summers to allow adequate establishment of young plantations. However, managers must monitor sites annually thereafter and promptly re-treat sites showing reinvasion.

Miller (1948:B) found control on agricultural lands best after the first heavy rains of autumn. Lower vegetation exists, gophers accept baits more readily, and workers locate runways and mounds more easily during this time. Control effectiveness increases in the fall because it precedes the winter and spring breeding seasons. Summer and fall usually are poor times for control on nonirrigated lands because gophers become less active and vegetation may obscure mounds, making probing difficult.

Gopher population size dictates the number and kind of treatments necessary (Barnes 1974:HRF). Any technique depends on variables that may include: the physical restraints of the environment, especially soil and topography; lack of quality conifer seed; budget restraints; insufficient personnel to administer programs; equipment; and ecological or political consideration (Tietjen 1973:DC; Barnes 1974:HRF; U.S. Department of Agriculture 1979:DTF).

RESEARCH NEEDS

A strong need exists to develop new methods and refine existing techniques for management of pocket gophers. Recently in the Western United States, the Pocket Gopher-Reforestation Activity Review Team (U.S. Department of Agriculture 1979:DC) created procedures for assessing gopher damage, identifying related problems and issues, evaluating control efforts, and making recommendations to guide future research and control. To date, the team has reviewed management and reforestation activities in USDA Forest Service Regions 4 and 6 only, but considers the findings representative of all Western States. The group identified a number of areas and issues in need of attention. Many of these are included in this section.

Improved solutions to gopher damage prevention and control require more information than is presently available. In many areas, problems are evident, but detailed surveys documenting damage are lacking. Budget limitations make it necessary to prioritize research needs and to determine areas where control is most important. Relationships between gopher depredation and economic loss must be evaluated on different areas to analyze the long-term costs and benefits of control and to choose techniques most warranted.

Control Methodology

1. **Response to habitat manipulation.**—Indirect control via habitat manipulation has potential use, but further information is necessary to evaluate how gopher populations will respond to habitat changes resulting from herbicides, various silvicultural systems, and various site preparation techniques. On most areas, there is a shortage of information identifying the forest communities and situations where preventive management could be most effective (Barnes 1982, personal communication). Development of general criteria to foretell problem areas might be valuable for land managers who are faced with difficult decisions in land-use or harvest-planning stages. Clearly defined relationships between

gopher densities and specific habitat characteristics do not always exist (Volland 1973:HRF; Anderson 1976:HRF; Youmans 1979:HRF; Buchner and Rorabaugh 1979:DTF), but certain habitats can generally be correlated to high and low gopher populations. However, it is still necessary to evaluate each situation individually and maintain past and future studies for use as guides.

2. **Plastic seedling protectors.**—Further evaluation is needed on protective tubing such as Vexar. Although this method is promising, further improvements in preparation, transportation, and planting of enclosed seedlings are necessary to make the procedure more economically efficient (Anthony and others 1978:DC). Additional studies might determine whether this type of protective tube adversely affects seedling root development and tree growth.

3. **Poison baits.**—The development of new toxicants that might prove more effective, specific, or safer to people and nontarget wildlife is considered important. The best time for baiting treatments in different areas is still uncertain. The possibility of winter control and bait acceptance needs further study. Continued studies are needed of factors related to baiting mortality, including bait attractiveness, toxicity of poison, causes of varying rodent susceptibility, and bait duration. In 1978, Weyerhaeuser researchers looked at the possibility of enclosing baits in polyethylene bags (bagged bait) to extend duration, reduce baiting costs, and further combat reinvasion of existing burrow systems by dispersing gophers. At that time, results of their study seemed promising (Ray 1978, personal communication). Another suggestion involves further development of longer lasting toxic foam or grease for placement in artificial burrows. However, Marsh (1982, personal communication) indicated that past control efforts with existing toxic foams proved relatively ineffective on *T. bottae*. In the future, long-lived baits might meet with opposition from the Environmental Protection Agency.

4. **Hazards to nontarget species.**—Most studies do not indicate significant control-related hazards to nontarget species, but potential primary and secondary dangers of direct or indirect control practices are a major public concern. This is particularly true when treated areas occur in or near habitats of threatened or endangered species. Federal registration requirements for existing poisons and new toxicants are becoming increasingly restrictive. These same concerns are developing over herbicide use. Such uncertainties may limit future use of the baiting programs managers most commonly rely upon today. For this reason, further evaluation of control agents is necessary, and development of poison-free control measures is emphasized. In addition, opportunities to educate the public on these issues should not be overlooked.

5. **Feeding habits.**—Quantitative data on gopher feeding habits as they relate to reforestation will help predict problems and develop more effective control methods. Gopher population levels tolerable in conifer plantations should be assessed. Tree stocking levels able to withstand low to moderate gopher depredation need to determined. Radwin and others (1982:FF) compared essential oil content in ponderosa pine seedlings from nine different regions. Gophers exposed to seedlings showed different degrees of feeding preference. Further study may lead to the discovery or development of naturally gopher-resistant plant species and less vulnerable seedling stock. Such findings might also lead to development of some other gopher repellent or deterrent. However, the adaptable feeding preferences of gophers may limit the potential of this approach.

6. **Repellents.**—Potential for further development of repellents on forest lands exists. Information detailing subsequent effects to both the gophers and the trees themselves will be needed. In the past, repellents have provided protection for buried cables (Tigner and Landstrom 1968:DC), and Barnes (1973:DTF) cites a report of similar success with fruit trees.

7. **Grooming inhibitors.**—The use of special tacky substances or wetting agents placed in burrow systems or in the soil might inhibit animal grooming and condition gophers to avoid certain areas, abandon burrows, or become less able to survive. Such sticky substances are yet to be lab-tested, and adequate evaluation for control would require further behavioral research, including studies on food-handling and grooming behavior and the animal's response to these substances. Successful operational control is deemed unlikely.

8. **Reproductive inhibitors.**—The use of reproductive inhibitors has been considered, but the probability of success is judged low (U.S. Department of Agriculture 1979:DC). Some believe fossorial rodents communicate territoriality and reproductive status via specific chemical signals (pheromones) (Brown 1971:RGA). Employing these as repellents or to inhibit reproduction may be possible, but unlikely.

Integrated Management

The means to effective and efficient control most likely lies in a holistic approach. This entails integrating dynamics of gopher population structure and growth, economic analysis, land management options, and an understanding of forest ecology into an ecosystem-oriented analysis of the problems. On forest sites with serious gopher problems, successful regeneration often depends on the land manager's ability to integrate two or more control methods. In the future, emphasis on various control combinations and prevention of population buildups will increase. Managers should continue to familiarize themselves with pocket gopher problems and the ways to best use existing control techniques.

LITERATURE REVIEW

Category Key

General References (GR)

Adams, A. W. Wildlife surveys and investigations. Bismark, ND: North Dakota State Game and Fish Department; 1965. 17 p.

Allen, J. A. Notes on the mammals of Iowa. Boston Society of Natural History, Proceedings 13: 178-194; 1869.

Allen, J. A. Notes on the mammals of portions of Kansas, Colorado, Wyoming and Utah. Part I: On the mammals of middle and western Kansas. Essex Inst. Bull. 6(2): 43-52; 1874.

Allen, J. A. Notes on the mammals of portions of Kansas, Colorado, Wyoming, and Utah. Part IV: On the mammals of the Great Salt Lake Valley, Utah. Essex Inst. Bull. 6: 61-66; 1874.

Allen, J. A. List of mammals collected by Mr. Charles P. Rowley in the San Juan region of Colorado, New Mexico, and Utah, with descriptions of new species. Am. Mus. Nat. Hist. Bull. 5: 69-84; 1893.

Allen, J. A. On the mammals of Aransas County, Texas, with descriptions of new forms of *Lepus* and *Oryzomys*. Am. Mus. Nat. Hist. Bull. 6(6): 165-198; 1894.

Allen, J. A. List of mammals collected in the Black Hills region of South Dakota and in western Kansas by Mr. Walter W. Granger with field notes by the collector. Am. Mus. Nat. Hist. Bull. 7: 259-274; 1895.

Allen, J. A. List of mammals collected by Mr. Walter W. Granger in New Mexico, Utah, Wyoming and Nebraska, 1895-1896, with field notes by the collector. Am. Mus. Nat. Hist. Bull. 8: 241-258; 1896.

Allen, J. A. On mammals collected in Bexar County and vicinity, Texas, by Mr. H. P. Attwater, with field notes by the collector. Am. Mus. Nat. Hist. Bull. 8(5): 47-80; 1896.

Allen, J. A. Mammals from Beaver County, Utah, collected by the Museum expedition of 1904. Brooklyn Inst. Mus. Sci. Bull. 1: 117-122; 1905.

Allen, P. Kansas mammals. Kansas State Teachers College, Emporia, Inf. Stud. in Educ. Bull. 20(5): 1-62; 1940.

Ames, A. E. Mammalia of Minnesota. Minn. Acad. Sci. Bull. 1: 68-71; 1874.

Anderson, R. J.; Barnes, V. G.; Bruce, A. M. A bibliography of pocket gophers: Family Geomyidae. Weyerhaeuser For. Pap. No. 16. Centralia, WA: Weyerhaeuser Company, Forestry Research Center; 1976. 50 p.

Anthony, H. E. Field book of North American mammals. New York: G. P. Putnam and Sons; 1928. 674 p.

Bailey, B. Mammals of Sherburne County, Minnesota. J. Mammal. 10(2): 153-164; 1929.

Bailey, V. A biological survey of Texas. North American Fauna 25. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1905. 222 p.

Bailey, V. A biological survey of North Dakota. North American Fauna 49. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1927. 226 p.

Bailey, V. Mammals of New Mexico. North American Fauna 53. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1931. 412 p.

Bailey, V. The mammals and life zones of Oregon. North American Fauna 55. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1936. 416 p.

Baird, S. F. Characteristics of some new species of mammalia collected by the U.S. and Mexican Boundary Survey. Philadelphia Academy of Science, Proceedings 7: 331-333; 1855.

Baird, S. F. Mammals of North America. Pacific Railroad Survey, vol. 8, part I. Washington, DC: War Department; 1857. 757 p.

Baird, S. F. Report of exploration and surveys from the Mississippi River to the Pacific Ocean. Pacific Railroad Survey, vol. 8. Washington, DC: War Department; 1857. 394 p.

Baird, S. F. Report of mammals collected by the survey. Pacific Railroad Survey, Zoology Report, vol. 10, part I. Washington, DC: War Department; 1857: 6-9.

Baird, S. F. Mammals of the boundary. U.S. and Mexican Boundary Survey, Part II, Zoology. Washington, DC: U.S. Department of the Interior; 1859. 62 p.

Baird, S. F. Report on Gunnison and Beckwith's route. Pacific Railroad Survey, vol. 20, part 4, No. 1. Washington, DC: War Department; 1859. 8 p.

Baker, A. B. Mammals of western Kansas. In: Transactions, 1887 Kansas Academy of Science: 20th Annual Meeting; 1887 October 26-28; Topeka, KS. Topeka, KS: Kansas Academy of Science; 1889: 56-58.

Baker, R. H. Notes on mammals of Galveston and Mustang Islands. Texas. J. Mammal. 19(4): 505; 1938.

Bangs, O. The land mammals of peninsular Florida and coast region of Georgia. Boston Society of Natural History, Proceedings 28(7): 157-235; 1898.

Barnes, C. T. Mammals of Utah. University of Utah Bull. 12(15): 1-176; 1922.

Barnes, C. T. Utah mammals. University of Utah Bull. 17(12): 1-183; 1927.

Beed, W. E. A preliminary study of the animal ecology of the Niobra Game Reserve. Lincoln, NB: University of Nebraska Conservation Department; 1936 October. 33 p. Unnumbered bulletin.

Benson, S. B. A biological reconnaissance of Navajo Mountain, Utah. Univ. Calif. Publ. Zool. 40(14): 439-456; 1935.

Black, J. D. Mammals of northwestern Arkansas. J. Mammal. 17(1): 29-35; 1936.

Blair, W. F. Faunal relationships and geographic distribution of mammals in Oklahoma. Am. Midl. Nat. 22(1): 85-133; 1939.

Blair, W. F. A contribution to the ecology and faunal relationships of the mammals of the Davis Mountain Region, southwestern Texas. Misc. Publ. 46. Ann Arbor, MI: University of Michigan, Museum of Zoology; 1940. 39 p.

Borell, A. E.; Bryandt, M. D. Mammals of the Big Bend area of Texas. Univ. Calif. Publ. Zool. 48(1): 1-62; 1942.

Brandt, J. F. Beitrage zur nahern Kenntniss der Saugethiere Russlands. Ser 6 and 7. St. Petersburg, Russia: Mem. Acad. Imp. Sci.; 1855. 365 p.

Brants, A. Het geslacht der Muizen doo Linnaeus Opgesteld, volgens de tegenswoordige Toestand der Wetenscap in Familien, geslachten en Soorten Verdeeld door A. Brants. Berlyn: Academische Boekdrukkery; 1827. 190 p.

Brinnell, J. The biota of the San Bernardino Mountains: the mammals. Univ. Calif. Publ. Zool. 5(1): 134-160; 1908.

Brinnell, J. Native California rodents in relation to water supply. J. Mammal. 14: 293-298; 1933.

Brinnell, J. Review of the recent mammal fauna of California. Univ. Calif. Publ. Zool. 40(2): 71-234; 1933.

Brinnell, J.; Linsdale, J. M. Vertebrate animals of Points Lobos Reserve, 1934-1935. Publ. No. 481. Washington, DC: Carnegie Institute; 1936: 142-143.

Brinnell, J.; Storer, T. I. Animal life in the Yosemite. Berkeley: University of California Press; 1924. 752 p.

Brinnell, J.; Swarth, H. S. An account of the birds and mammals of the San Jacinto area of southern California, with remarks upon the behavior of geographical races of the margins of their habitat. Univ. Calif. Publ. Zool. 10: 197-417; 1913.

Durrant, S. D. Mammals of Utah. Univ. Kans., Mus. Nat. Hist., Publ. 6: 1-549; 1952.

Elliot, D. G. Synopsis of the mammals of North America and adjacent seas. Zool. Ser., Vol. 2. Chicago, IL: Field Columbian Museum; 1901. 471 p.

Elliot, D. G. A check list of the mammals of the North American continent, the West Indies and the neighboring seas. Zool. Ser., Vol. 6, Publ. 105. Chicago, IL: Field Columbian Museum; 1905. 761 p.

Elliot, D. G. A catalogue of the collection of the mammals in the Field Columbian Museum. Zool. Ser., Vol. 8, Publ. 115. Chicago, IL: Field Columbian Museum; 1907. 694 p.

Evermann, B. W.; Butler, A. W. Preliminary list of Indiana mammals. In: Proceedings, 1893 Indiana Academy of Science; 1893 December 27-28; Indianapolis, IN. Brookville, IN: Indiana Academy of Science; 1894: 124-139.

Fischer, J. B. Synopsis mammalium. Stuttgardia: Sumptibus J. G. Cottae; 1829. 752 p.

Giebel, C. G. A. Odontographie. Leipzig: A. Abel; 1885. 129 p.

Giebel, C. G. A. Beitratrage zum Osteologie den Nagethiere. Berlin: G. Bosselmann; 1857. 72 p.

Giebel, C. G. A. Die Saugethiere in Zoologischer, Anatomischer and Palaeontologischer Beziehung. Leipzig: A. Abel; 1859. 1108 p.

Gill, T. N. Arrangement of the families of mammals with analytical tables. Smithsonian Miscellaneous Collection, Publ. 230. Washington, DC: Smithsonian Institution; 1872; 11: 1-98.

Glass, B. P. Report on the mammals of the Black Mesa region, Oklahoma. In: Proceedings, 1949 Oklahoma Academy of Science: 38th Annual Meeting; 1949 December 2-3; Enid, OK. Norman, OK: Oklahoma Academy of Science; 1951; 30: 26-30.

Godman, J. D. American natural history: Part I-Mastology. Philadelphia: H. C. Carey and J. Lea; 1826-1829. Vol. 3.

Goldman, E. A. New mammals from Arizona, New Mexico and Colorado. Wash. Acad. Sci. J. 23(10): 463-473; 1933.

Goldman, E. A. Three new rodents from southern Utah. Biological Society of Washington, Proceedings 55: 75-78; 1942.

Hall, E. R. Critical comments on mammals from Utah, with descriptions of new forms from Utah, Nevada and Washington. Univ. Calif. Publ. Zool. 37(1): 11-13; 1931.

Hall, E. R. Mammals of Nevada. Berkeley: University of California Press; 1946. 710 p.

Hall, E. R. Handbook of mammals of Kansas. Misc. Publ. No. 7. Lawrence, KS: University of Kansas, Museum of Natural History; 1955. 303 p.

Hall, E. R.; Davis, W. B. Notes on Arizona rodents. Biological Society of Washington, Proceedings 47: 51-56; 1934.

Hall, E. R.; Kelson, K. R. The mammals of North America. New York: Ronald Press; 1959. Vol. 2.

Hall, E. R. The mammals of North America. 2d ed. New York: John Wiley & Sons; 1981. Vol. 2.

Harlan, R. Fauna Americana. Philadelphia: Finley; 1825. 318 p.

Harper, F. Mammal notes from Randolf County, Georgia. J. Mammal. 10(1): 84-85; 1929.

Hayward, C. L. A bibliography of Utah mammalogy; including references to names and type localities applied to Utah mammals. In: Proceedings, 1936 Utah Academy of Science, Arts, and Letters: 29th Annual Meeting; 1936 May 22-23; Salt Lake City, UT. Provo, UT: Utah Academy of Science, Arts, and Letters; 1936: 121-146.

Hayward, C. L. A bibliography of Utah mammalogy, including references to names and type localities. Great Basin Nat. 2(4): 125-136; 1941.
Hayward, C. L. Alpine biotic communities of the Uinta Mountains. Utah. Ecol. Monogr. 22(2): 93-120; 1952.
Henshaw, H. W.; Birdseye, C. The mammals of Bitterroot Valley, Montana, in relation to spotted fever. Circ. No. 82. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1911. 24 p.
Hibbard, C. W. A checklist of Kansas mammals. Kansas Academy of Science, Transactions 47(1): 61-88; 1944.
Hoffmeister, D. F. Observations on mammals in southeastern Arizona. Misc. Publ. No. 129. Chicago, IL: Chicago Academy of Science and Natural History; 1954. 1 p.
Howell, A. H. Notes on mammals of the middle Mississippi Valley, with description of a new woodrat. Biological Society of Washington, Proceedings 23: 23-33; 1910.
Ingles, L. G. Mammals of California. Stanford, CA: Stanford University Press; 1947. 258 p.
Jackson, H. H. T. A preliminary list of Wisconsin mammals. Wisc. Nat. Hist. Soc. Bull. 6(1-2): 1-33; 1908.
Jackson, H. H. T.; Warfel, H. E. Mammals of the regions adjacent to the salt plains in Oklahoma. Univ. Okla. Biol. Sur. Publ. 5(4): 65-72; 1933.
Johnson, C. E. Recollections of the mammals of northwestern Minnesota. J. Mammal. 11(4): 435-452; 1930.
Kennerly, C. B. R. Report upon the mammals of the route. Pacific Railroad Survey, 10 parts. Washington, DC: War Department; 1859; 6(2): 18.
Kennicott, R. The quadrupeds of Illinois, injurious and beneficial to the farmer. Agric. Rep. for 1857. Washington, DC: U.S. Patent Office; 1858: 52-110.
Knox, M. V. B. Kansas mammalia. In: Transactions, 1875 Kansas Academy of Science: 8th Annual Meeting; 1875 October 12-13; Topeka, KS. Lawrence, KS: Kansas Academy of Science; 1906: 19-22.
Kuhl, H. Beitrage zur Zoologie und vergleichenden Anatomie. Frankfurt-am-Main: Herman; 1820. 464 p.
Lantz, D. E. A list of Kansas mammals. In: Transactions, 1903 Kansas Academy of Science: 36th Annual Meeting; 1903 November 26-28; Manhattan, KS. Topeka, KS: Kansas Academy of Science; 1905: 171-178.
Lantz, D. E. Kansas mammals in their relation to agriculture. Bull 129. Manhattan, KS: Kansas Agricultural Experiment Station; 1905: 331-404.
Lantz, D. E. Additions and corrections to the list of Kansas mammals. In: Transactions, 1906 Kansas Academy of Science: 39th Annual Meeting; Topeka, KS. Topeka, KS: Kansas Academy of Science; 1907: 214-217.
Leraas, H. J. Notes on mammals from west-central Minnesota. J. Mammal. 23(3): 343-345; 1942.
Lesson, R. P. Manuel de mammalogie, ou histoire naturelle des mammiferes. Paris: Roret; 1827. 441 p.
Lichtenstein, K. H. H. Ueber aussere Backentaschen an Nagethieren. Abhandlungen der Koniglichen Akademie der Wissenschaften zu Berlin; 1822: 13-20.
Linsdale, J. Mammals of a small area along the Missouri River. J. Mammal. 9(2): 140-146; 1928.
Marshall, W. H. A survey of the mammals of the islands in Great Salt Lake, Utah. J. Mammal. 21(2): 144-159; 1940.
Merriam, C. H. Descriptions of twenty-six new species of North American mammals. North American Fauna 4. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1890. 60 p.
Miller, G. S., Jr.; Kellogg, R. List of North American recent mammals. U.S. Natl. Mus. Bull. 205. Washington, DC: Smithsonian Institution; 1955.
Mitchill, S. L. Undescribed little quadruped of Georgia. New York Medical Repository 5: 89; 1802.
Nelson, E. W. Smaller mammals of North America. Natl. Geogr. 33(5): 371-493; 1918.
Poole, A. J.; Schantz, V. S. Catalog of the type specimens of mammals in the United States National Museum, including the biological surveys collection. U.S. Natl. Mus. Bull. 178. Washington, DC: Smithsonian Institution; 1942. 705 p.
Rafinesque, C. S. Description of seven new genera of North American quadrupeds in Museum of Natural Sciences. Am. Mo. Mag. 2(1): 44-45; 1817.
Richardson, J. Fauna Boreali-Americana or the zoology of the northern parts of British America. London: J. Murray; 1892. Vol. I.
Richardson, J. Report on North American zoology. Brit. Assoc. Adv. Sci., Annu. Rep. 1836, 5: 121-124; 1837.
Richardson, J. The zoology of Captain Beechey's voyage. London: H. G. Bohn; 1839. 180 p.
Sanderson, G. C. Small-mammal population of a prairie grove. J. Mammal. 31(1): 17-25; 1950.
Say, T. Account of expedition from Pittsburgh to Rocky Mountains, performed in 1819 and 1820, by order of J. C. Calhoun, Secretary of War, under command of Stephen H. Long, from notes of Major Long, T. Say, and other gentlemen of the exploring party, by Edin James. (Long's Expedition to the Rocky Mountains). Philadelphia: H. C. Carey and J. Lea; 1823. Vol. I.
Schendel, R. R. Mammals of Payne County, Oklahoma. In: Proceedings, 1941 Oklahoma Academy of Science: 30th Annual Meeting; 1941 December 4-5; Edmond, OK. Norman, OK: Oklahoma Academy of Science; 1942: 75-76.
Schinz, H. R. Systematisches Verzeichniss aller bis jetzt bekannten Saugethiere: oder Synopsis mammalium nach dem Cuvier'schen System. Solothurn: Jent and Gassmann; 1844-1845. Vol. I.
Schmidt, F. J. W. Mammals of western Clark County, Wisconsin. J. Mammal. 12(2): 99-117; 1931.
Shaw, G. General zoology, or systematic natural history. London: G. Kearsley; 1801. Vols. I and II.
Sherman, H. B. Notes on some Florida mammals. J. Mammal. 10(3): 258-259; 1929.
Simpson, G. G. The principles of classification and a classification of mammals. Am. Mus. Natl. Hist. Bull. 85. Washington, DC: Smithsonian Institution; 1945. 350 p.
Stoner, R. D. The rodents of Iowa. Iowa Geol. Surv. Bull. 5: 1-172; 1918.

Storer, T. I.; Evans, F. C.; Palmer, F. G. Some rodent populations in the Sierra Nevada of California. Ecol. Monogr. 14: 165-192; 1944.
Sturber, T. The mammals of Minnesota. St. Paul, MN: Minnesota Department of Conservation, Game and Fish; 1932. 84 p.
Swanson, G.; Sturber, T.; Roberts, T. S. The mammals of Minnesota. Tech. Bull. 2. St. Paul, MN: Minnesota Department of Conservation; 1945. 108 p.
Vaughan, T. A. Mammals of the San Gabriel Mountains of California. Univ. Kans., Mus. Nat. Hist., Publ. 7(9): 513-582; 1954.
Warren, E. R. The mammals of Colorado, their habits and distribution. Norman: University of Oklahoma Press; 1943. 330 p.
Waterhouse, G. R. A natural history of the Mammalia. Vol. II, Rodentia. London: H. Balliere; 1848.
Wied-Neuwied, M. von. Uber einige Nager mit ausseren Backentaschen aus dem westlichen Nord-America. Acta. Acad. Caes. Leop. Carol. 19: 20; 1839.

Geologic and Historic References (GH)

Brown, B. The Conard fissure, a Pleistocene bone-deposit in northern Arkansas, with descriptions of two genera and twenty new species of mammals. Mem. Am. Mus. Nat. Hist. 9: 157-208; 1908.
British Museum of Natural History, Department of Zoology. Catalogue of the bones of mammalia in the collection of the British Museum. London: British Museum of Natural History; 1862. 296 p.
Cahalane, V. H. Mammals of the Chiricahua mountains, Cochise Co., Arizona. J. Mammal. 20: 418-440; 1939.
Camp, C. L. (and others). Bibliography of fossil vertebrates, 1928-1933. Special Papers 27 and 42. New York, NY: Geological Society of America; 1940.
Camp, C. L. (and others). Bibliography of fossil vertebrates, 1939-1943. Memoir 37. New York, NY: Geological Society of America; 1949. 371 p.
Carey, M. A biological survey of Colorado. North American Fauna 33. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1911. 256 p.
Childs, H. E., Jr.; Howard, W. E. The vertebrate fauna of San Joaquin Experiment Range. Misc. Paper No. 19. Berkeley, CA: California Forest and Range Experiment Station; 1955. 20 p.
Cockrum, E. L. Mammals of Kansas. Univ. Kans., Mus. Nat. Hist., Publ. 7(1): 1-303; 1952.
Corey, C. B. Mammals of Illinois and Wisconsin. Publ. 153, Zool. Ser. 11. Chicago, IL: Field Museum of Natural History; 1912. 505 p.
Coues, E. A critical review of the North American Rodentia. Philadelphia Academy of Natural Science, Proceedings 27: 272-327; 1875.
Dalquest, W. W. Mammals of Washington, vol. 2. Lawrence, KS: University of Kansas Museum of Natural History; 1948. 44 p.
Davis, W. B. The recent mammals of Idaho. Caldwell, ID: Caxton Printers; 1939. 400 p.
Davis, W. B. Mammals of the Guadalupe Mountains of western Texas. Occ. Pap. 7. Baton Rouge, LA: Louisiana State University Museum of Zoology; 1940: 69-84.
Davis, W. B.; Robertson, J. L. The mammals of Culberson County, Texas. J. Mammal. 25(3): 254-273; 1944.
Dellinger, S. C.; Black, J. D. Notes on Arkansas mammals. J. Mammal. 21(2): 187-191; 1940.
Dice, L. R. Notes on some mammals of Riley County, Kansas. J. Mammal. 4(2): 107-112; 1923.
Duck, L. G.; Fletcher, J. B. A survey of the game and furbearing animals of Oklahoma. P. R. Ser. 2. Oklahoma City, OK: Oklahoma State Game and Fish Commission; 1945. 144 p.
Duck, L. G.; Frye, J. C.; Leonard, A. B. Reconnaissance of Pleistocene deposits in north central Kansas. State Geol. Sur. Kans. Bull. 52(1): 1-28; 1944.
Duck, L. G.; Wilson, J. A. A new rodent from subsurface stratum in Bee County, Texas. J. Paleo. 24(5): 621-623; 1950.
Franzen, D. S. The pocket gopher, *Geomys quinni* (McGraw) in the Rexford fauna, Blancan age, of southwestern Kansas. Kansas Academy of Science, Transactions 50(1): 55-59; 1947.
Frey, R. W.; Voorhies, M. R.; Howard, J. D. Estuaries of the Georgia Coast USA sedimentology and biology. Part 8: Fossil and recent skeletal remains in Georgia estuaries. Senckenbergiana Marit. 7: 257-295; 1975.
Gawne, C. E. Rodents from the Zia sand Miocene of New Mexico USA. Am. Museum Novitates 2586. New York: American Museum of Natural History; 1975. 25 p.
Gazin, C. L. The late Cenozoic vertebrate faunas from the San Pedro Valley, Arizona. U.S. National Museum, Proceedings 92(3155): 475-518; 1942.
Gidley, J. W. Preliminary report of fossil vertebrates of the San Pedro Valley, Arizona and descriptions of new species of Rodentia and Lagomorpha. Prof. Pap. 131-E. Washington, DC: U.S. Department of the Interior, U.S. Geological Survey; 1922: 119-128.
Gidley, J. W.; Gazin, C. L. New mammalia in the Pleistocene fauna from Cumberland Cave. J. Mammal. 14(4): 343-357; 1933.
Gillette, D. D. Late quaternary mammals from the St. Marks River, Wakulla County, Florida USA. Fla. Sci. 39(2): 120-122; 1976.
Guilday, J. E. Saber-toothed cat *Smilodon floridanus* and associated fauna from a Tennessee USA cave, the 1st American Bank site. J. Tenn. Acad. Sci. 52(3): 84-94; 1977.
Hay, O. P. The Pleistocene of North America and its vertebrated animals from the states east of the Mississippi River and from the Canadian provinces east of longitude 95. Publ. 322. Washington, DC: Carnegie Institute of Washington; 1923. 499 p.
Hay, O. P. The Pleistocene of the middle region of North America and its vertebrated animals. Publ. 322A. Washington, DC: Carnegie Institute of Washington; 1924. 385 p.
Hay, O. P. The pleistocene of the western region of North America and its vertebrated animals. Publ. 322B. Washington, DC: Carnegie Institute of Washington; 1927. 346 p.

Hay, O. P. Second bibliography and catalogue of the fossil vertebrata of North America. Publ. 390. Washington, DC: Carnegie Institute of Washington; 1929. 1990 p.

Hibbard, C. W. An upper Pliocene fauna from Meade County, Kansas. In: Transactions, 1937 Kansas Academy of Science: 69th Annual Meeting; 1937 April 1-3; Manhattan, KS. Topeka, KS: Kansas Academy of Science; 1938: 239-265.

Hibbard, C. W. Notes on some vertebrates from the Pleistocene of Kansas. In: Transactions, 1937 Kansas Academy of Science: 69th Annual Meeting; 1937 April 1-3; Manhattan, KS. Topeka, KS: Kansas Academy of Science; 1937: 233-237.

Hibbard, C. W. The Borchers fauna, a new Pleistocene interglacial fauna from Meade County, Kansas. State Geol. Surv. Kans. Bull. 38(7): 197-220; 1941.

Hibbard, C. W. Mammals of the Rexroad fauna from the upper Pliocene of southwestern Kansas. In: Transactions, 1941 Kansas Academy of Science: 73rd Annual Meeting; 1941 April 3-5; Manhattan, KS. Lawrence, KS: Kansas Academy of Science; 1941: 265-313.

Hibbard, C. W. Palaeoecology and correlation of the Rexroad fauna from the upper Pliocene of southwestern Kansas, as indicated by the mammals. Univ. Kans. Sci. Bull. 1(6): 79-104; 1941.

Hibbard, C. W. Pleistocene vertebrate paleontology in North America. Geol. Soc. Am. Bull. 60: 1417-1428; 1949.

Hibbard, C. W.; Zakrzewski, R. J.; Eshelman, R. E.; Edmund, G.; Griggs, C. D.; Griggs, C. Mammals from the Kanopolis local fauna Pleistocene yarmouth of Ellsworth County, Kansas, USA. Contributions of the Museum of Paleontology, University of Michigan. 25(2): 11-43; 1978.

Howell, A. B. Surface wanderings of fossorial mammals. J. Mammal. 3: 19-22; 1922.

Korth, W. W. Geomyoid rodents from the Valentine formation of Knox County, Nebraska USA. Andrew Carnegie Mus. Nat. Hist. Bull. 48(16): 287-310; 1979.

Lawrence, B. Bones from the Governador area. Columbia Stud. Archeol. and Ethnol. 2(1): 73-78; 1944.

Li, C. K. A probable geomyid rodent from middle Miocene on Linchu Shatung, China. Vertebr. Palasiat. 12(1): 43-53; 1974.

Lindsay, E. H.; Van Devender, T. R. The California, USA, Wash, vertebrate fauna late Cenozoic of the San Pedro Valley, Arizona, USA. J. Ariz. Acad. Sci. 8: Supplement; 1973. 46 p.

Martin, L. D.; Bennett, D. K. The burrows of the Miocene beaver palaeocastor western Nebraska, USA. Palaeogeogr., Palaeoclimatol., Palaeoecol. 22(3): 173-194; 1977.

Matthew, W. D. The evolution of the mammals in the Eocene. Zoological Society of London, Proceedings; 1927: 947-985.

McGrew, P. O. An early Pleistocene (Clancan) fauna from Nebraska. Field Mus. Nat. Hist. Geol. Ser. 9(2): 31-66; 1944.

McNab, B. K. The metabolism of fossorial rodents: a study of convergence. Ecology. 47(5): 712-733; 1966.

Merriam, J. C. Tertiary mammal beds of Virgin Valley and Thousand Creek in northwestern Nevada: Part II, vertebrate faunas. Univ. Calif. Geol. Dep. Bull. 6(11): 199-304; 1911.

Merriam, J. C.; Sinclair, W. J. Tertiary faunas of the John Day region. Univ. Calif. Geol. Dep. Bull. 5(11): 171-205; 1907.

Munthe, J. *Gregorymys larsoni* new species Rodentia: Geomyidae from the Miocene of Colorado USA. Paleo Bios. 26. Berkeley, CA: University of California, Museum of Paleontology; 1977: 1-2.

Opdyke, N. D.; Lindsay, E. H.; Johnson, N. M.; Downs, T. The paleo magnetism and magnetic polarity stratigraphy of the mammal bearing section of Anza Borrego State Park, California. Quat. Res. 7(3): 316-329; 1977.

Parmalee, P. W.; Munson, P. J.; Guilday, J. E. The Pleistocene mammalian fauna of Harrodsburg crevice, Monroe County, Indiana, USA. Natl. Speleol. Soc. Bull. 40(2): 64-73; 1978.

Rensberger, J. M. Function in the cheek tooth evolution of some hyposodont geomyid rodents. J. Paleontol. 49(1): 10-22; 1975.

Rinker, G. C. *Cratogeomys castanops* from a recent terrace in southwestern Kansas. J. Mammal. 22(1): 88; 1941.

Romer, A. S. Vertebrate paleontology. 2nd ed. Chicago: University of Chicago Press; 1945. 687 p.

Scott, W. B. *Protoptychus hatcheri*, a new rodent from the Uinta Eocene. Philadelphia Academy of Natural Science, Proceedings 47: 269-286; 1895.

Simpson, G. G. Pleistocene mammals from a cave in Citrus County, Florida. Am. Mus. Novitates 328. New York: American Museum of Natural History; 1928. 16 p.

Stevens, M. S. Further study of the castolon local fauna arikareean early Miocene, Big Bend National Park, Texas, USA. Pearch-Sellards Series, Texas Memorial Museum, No. 28. Beaumont, TX: Lamar University; 1977. 69 p.

Stewart, J. D. Mammals of the trapshoot local fauna, late Pleistocene, of Rooks County, Kansas USA. In: Proceedings 1978 Nebraska Academy of Science and Affiliated Societies; 1978 April 14-15; Lincoln, NB. Lincoln, NB: Nebraska Academy of Science and Affiliated Societies; 1978: 45-46.

Storer, J. E. Mammals of the Hand Hills formation, southern Alberta, Canada. In: Churcher, C. S., ed. Essays on palaeontology in honor of Lorbshano Russel. Misc. Publ. Toronto, ON: Royal Ontario Museum of Life Science; 1976: 186-209. ISBN 0-88854-157-0.

Voorhies, M. R. A new genus and species of fossil kangaroo rat and its burrow. J. Mammal. 56: 160-176; 1975.

Waters, J. H. Second find of *Thomomys talpoides* from late Pleistocene in Kansas. J. Mammal. 37(4): 540-542; 1956.

Webb, S. D. A history of savanna vertebrates in the new world, Part I: North America. In: Johnston, R. F. C.; Frank, P. W.; Michener, C. D., eds. Annual review of ecology and systematics, vol. 8. Palo Alto, CA: Annual Reviews, Inc.; 1977: 355-380. ISBN 0-8243-1408-5.

White, J. A.; Downs, T. A new *Geomys* from the Vallecito Creek Pleistocene of California. Los Angeles County Mus. Contrib. Sci. 42: 1-34, 1961.

Wilson, R. W. A rodent fauna from later Cenozoic beds of southwestern Idaho. Publ. 440. Washington, DC: Carnegie Institute of Washington; 1933: 117-135.

Wilson, R. W. The Pleistocene mammalian fauna from the Carpinteria asphalt. Publ. 440. Washington, DC: Carnegie Institute of Washington; 1933: 59-76.

Wilson, R. W. A Pliocene rodent fauna from Smith's Valley, Nevada. Publ. 473. Washington, DC: Carnegie Institute of Washington; 1936: 15-24.

Wilson, R. W. Pliocene rodents of western North America. Publ. 487. Washington, DC: Carnegie Institute of Washington; 1937: 21-73.

Wood, A. E. Evolution and relationships of the Heteromyid rodents with new forms from the Tertiary of western North America. Carnegie Mus. Annu. 24: 73-262; 1935.

Wood, A. E. Geomyid rodents from the middle tertiary. Am. Mus. Novitates. No. 866. New York: American Museum of Natural History; 1936. 31 p.

Zittel, K. A. von. Textbook of palaeontology. Vol. 3: Mammalia. London: MacMillan; 1925. 316 p.

Distribution and Taxonomy (DT)

Allen, J. A. Descriptions of four new species of *Thomomys* with remarks on other species of the genus. Am. Mus. Natur. Hist. Bull. 5: 47-68; 1893.

Allred, D. M. Small mammals of the National Reactor Testing Station, Idaho, USA. Great Basin Nat. 33(4): 246-250; 1973.

Alston, E. R. On the classification of the order Glires. Zoological Society of London, Proceedings; 1876: 61-98.

Anderson, S. Taxonomy of gophers, especially *Thomomys* in Chihuahua, Mexico. Systematic Zool. 15(3): 189-198; 1966.

Bailey, V. The pocket gophers of the United States. Bull. No. 5. Washington, DC: U.S. Department of Agriculture, Division of Ornithology and Mammalogy; 1895. 47 p.

Bailey, V. Revision of the pocket gophers of the genus *Thomomys*. North American Fauna 39. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1915. 136 p.

Baker, R. H. The taxonomic status of *Geomys breviceps texensis* Merriam and *Geomys bursarius illanensis* Bailey. J. Mammal. 31(3): 348-349; 1950.

Baker, R. H. The pocket gophers (Genus *Thomomys*) of Coahuila, Mexico. Univ. Kans., Mus. Nat. Hist., Publ. 5(28): 499-514; 1953.

Baker, R. H.; Glass, B. P. The taxonomic status of the pocket gophers, *Geomys bursarius* and *Geomys breviceps*. Biological Society of Washington, Proceedings 64: 55-58; 1951.

Baker, R. H.; Williams, S. L. *Geomys tropicalis*. Mammal. Species 35: 1-4; 1974.

Beer, J. R. The pocket gopher in Minnesota. Minn. Sci. 23(4): 5; 1967.

Benson, S. B.; Tillotson, D. F. Descriptions of two species of pocket gopher (*Thomomys bottae*) from Sonora. Biological Society of Washington, Proceedings 52: 151-153; 1939.

Best, T. L. Ecological separation of three genera of pocket gophers (Geomyidae). Ecology. 54(6): 1311-1319; 1973.

Blossom, P. M. Description of a new race of pocket gopher (*Geomys lutescens hylacus*) from northwestern Nebraska. Occ. Pap. No. 368. Ann Arbor, MI: University of Michigan, Museum of Zoology; 1938. 1 p.

Boeer, W. J.; Schmidly, D. J. Terrestrial mammals of the riparian corridor in Big Bend National Park. In: Johnson, R. Roy; Jones, Dale A., tech. coords. Importance, preservation and management of riparian habitat: a symposium; 1977 July 9; Tucson, AZ. Gen. Tech. Rep. RM-43. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1977: 212-217.

Bond, S. I. An annotated list of the mammals of San Diego County, California USA. San Diego Society of Natural History, Transactions 18(4): 229-247; 1977.

Burt, W. H. A new pocket gopher of the genus *Thomomys* from Utah. Biological Society of Washington, Proceedings 44: 37-40; 1931.

Chamberlain, N. V. *Thomomys bottae aureiventris* Hall from Nevada. J. Mammal. 38(2): 267; 1957.

Chattin, J. E. The distribution of pocket gophers in southeastern Calif. San Diego Society of Natural History, Transactions 9(27): 265-284; 1941.

Cleveland, A. G. 1st South Texas USA records of *Pappogeomys castanops*. Tex. J. Sci. 29(3/4): 299; 1977.

Colorado Cooperative Pocket Gopher Project. Pocket gophers in Colorado. Bull. 508-S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1960. 26 p.

Coues, E. Synopsis of the Geomyidae. Philadelphia Academy of Natural Science, Proceedings 27: 130-138; 1875.

Dalquest, W. W.; Kilpatrick, W. Dynamics of pocket gopher distribution on the Edwards Plateau of Texas. Southwest Nat. 18(1): 1-9; 1973.

Dalquest, W. W.; Scheffer, V. B. Distribution and variation in pocket gophers, *Thomomys talpoides* in the state of Washington. Am. Nat. 78: 308-333, 423-450; 1944.

Davis, W. B. Critical notes on the pocket gophers of Texas. J. Mammal. 19(4): 488-490; 1938.

Davis, W. B. Distribution and variation of pocket gophers. (Genus *Geomys*) in the southwestern United States. Bull. No. 590. College Station, TX: Texas Agricultural Experiment Station; 1940. 38 p.

Davis, W. B. Substitute name for *Geomys personatus minor* Davis. J. Mammal. 24(4): 508; 1943.

Davis, W. B.; Buechner, H. K. Pocket gophers (*Thomomys*) of the Davis Mountains, Texas. J. Mammal. 27(3): 265-271; 1946.

Davis, W. H. Northern extension of range of pocket gophers east of the Mississippi. J. Mammal. 36(1): 142-143; 1955.

DeMott, D. L.; Lindsey, G. P. Pygmy shrew *Microsorex hoyi* in Gunnison County, Colorado USA. Southwest Nat. 20(3): 417-418; 1975.

Downhower, J. F.; Hall, E. R. The pocket gopher in Kansas. Misc. Publ. No. 44. Lawrence, KS: University of Kansas, Museum of Natural History; 1966. 32 p.

Drake, H.; Booth, E. S. Revisions of the ranges of the pocket gophers of southeastern Washington and northeastern Oregon and the description of a new subspecies *Thomomys talpoides whitmani*. College Place, WA: Walla Walla College, Department of Biological Science and Biology Station, Publ. 1(3): 44-58; 1952.

Durrant, S. D. Two new gophers from Utah. University of Utah Bull. 28(4): 1-6; 1937. (Biol. Ser. Vol. 3, No. 8).

Durrant, S. D. A new pocket gopher of the *Thomomys quadratus* group from the northern Great Basin region. University of Utah Bull. 29(6): 1-6; 1939. (Biol. Ser. Vol. 3, No. 10).

Durrant, S. D. Two new gophers (Mammalian Genus *Thomomys*) from western Utah. Biological Society of Washington, Proceedings 52: 159-162; 1939.

Durrant, S. D. The pocket gophers (Genus *Thomomys*) of Utah. Univ. Kans., Mus. Nat. Hist., Publ. 1: 1-82; 1946.

Feldhamer, G. A. Vegetative and edaphic factors affecting abundance and distribution of small mammals in southeast Oregon USA. Great Basin Nat. 39(3): 207-218; 1979.

Gabrielson, I. N. Notes on *Thomomys* in Oregon. J. Mammal. 4: 189-190; 1923.

Ghiselin, J. *Thomomys bottae* in Granite Springs Valley, Pershing County, Nevada. J. Mammal. 46(3): 525; 1965.

Glass, B. P. Ecological factors affecting distribution and speciation of pocket gophers in Oklahoma. Stillwater, OK: Oklahoma State University; 1952. Dissertation.

Goldman, E. A. New pocket gophers from Arizona and Utah. Wash. Acad. Sci. J. 21(17): 416-426; 1931.

Goldman, E. A. New pocket gophers of the genus *Thomomys*. Wash. Acad. Sci. J. 26(3): 111-120; 1936.

Goldman, E. A. New pocket gophers of the genus *Thomomys* from Arizona and Utah. Wash. Acad. Sci. J. 28(7): 333-343; 1938.

Goldman, E. A. The systematic status of certain pocket gophers with special reference to *Thomomys monticola*. Wash. Acad. Sci. J. 33(5): 146-147; 1943.

Goldman, E. A. The pocket gophers (Genus *Thomomys*) of Arizona. North American Fauna 59. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1947. 39 p.

Grinnell, J. Geography and evolution in the pocket gopher. Berkeley, CA: University of California Chronicle; 1926: 247-262.

Grinnell, J. The pocket gopher of the Honey Lake Valley. Univ. Calif. Publ. Zool. 30: 1-6; 1926.

Grinnell, J. A new pocket gopher from Lassen County, California. Biological Society of Washington, Proceedings 47: 193-198; 1934.

Grinnell, J.; Swarth, H. S. The pocket gopher of the boreal zone on San Jacinto Peak. California Academy of Science, Proceedings 4(6): 153-160; 1914.

Hall, E. R. New pocket gophers from Nevada. Univ. Calif. Publ. Zool. 38(4): 325-333; 1932.

Hall, E. R. Three new pocket gophers from New Mexico and Arizona. Biological Society of Washington, Proceedings 45: 95-98; 1932.

Hall, E. R. A new pocket gopher (Genus *Thomomys*) from eastern Colorado. Univ. Kans., Mus. Nat. Hist., Publ. 5: 81-85, 1951.

Hansen, R. M.; Vaughan, T. A.; Hervey, D. F.; (and others). Pocket gophers in Colorado. Bull. 508-S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1960. 26 p.

Hansen, R. M.; Reid, V. H. Distribution and adaptations of pocket gophers. In: Pocket gophers and Colorado mountain rangeland. Bull. 554-S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973: 1-19.

Harper, R. M. Notes on the distribution of the southeastern salamanders (*Geomys tuza* and allies). Science. 35: 115-119; 1912.

Harrison, J. A. Mammals of the wolf range local fauna pliocene of the San Pedro Valley, Arizona USA. Occ. Pap. 78. Lawrence, KS: University of Kansas, Museum of Natural History; 1978: 1-18.

Hooper, E. T. New pocket gophers from the vicinity of Mount Taylor, New Mexico. Occ. Pap. No. 422. Ann Arbor, MI: University of Michigan, Museum of Zoology; 1940. 13 p.

Hooper, E. T. A new race of pocket gopher of the species *Geomys lutescens* from Colorado. Occ. Pap. No. 420. Ann Arbor, MI: University of Michigan, Museum of Zoology; 1940. 3 p.

Hooper, E. T. Type localities of pocket gophers of the genus *Thomomys*. Misc. Publ. No. 58. Ann Arbor, MI: University of Michigan, Museum of Zoology; 1941. 26 p.

Hooper, E. T. Two genera of pocket gophers should be congeneric. J. Mammal. 27(4): 397-399; 1946.

Ingles, L. G. Family Geomyidae and the key to pocket gophers. In: Ingles, L. G. Mammals of the Pacific States. Stanford, CA: Stanford University Press; 1965: 201-211.

Ingles, L. G.; Biglione, N. J. The contiguity of the ranges of two subspecies of pocket gophers. Evolution 6(2): 204-207; 1952.

Johnson, M. L.; Benson, S. B. Relationship of the pocket gophers of the *Thomomys mazama talpoides* complex in the Pacific Northwest. Murrelet 41: 17-22; 1960.

Johnstone, W. B. A revision of the pocket gopher *Thomomys talpoides* in British Columbia. Can. Field-Nat. 68(4): 155-164; 1954.

Kelson, K. R. Two new subspecies of *Thomomys bottae* from New Mexico and Colorado. Univ. Kans., Mus. Nat. Hist., Publ. 5: 59-71; 1951.

Kennerly, T. E., Jr. Local differentiation in the pocket gopher *Geomys personatus* in southern Texas. Texas J. Sci. 6(3): 297; 1954.

Kennerly, T. E., Jr. Contact between the ranges of two allopatric species of pocket gophers. Evolution. 13: 247-263; 1959.

Kilby, J. D. The name salamander for the pocket gophers. J. Mammal. 16(4): 326-327; 1935.

Komarek, E. V.; Spencer, D. A. A new pocket gopher from Illinois and Indiana. J. Mammal. 12(4): 404-408; 1931.

LeConte, J. L. An attempt at a synopsis of the genus *Geomys rafinesque*. Philadelphia Academy of Natural Science, Proceedings 6: 157-163; 1852.

Lyon, M. W., Jr. Remarks on *Geomys bursarius illinoensis* Komarek and Spencer. J. Mammal. 13(1): 77-78; 1932.

Madsen, C. R. Florida pocket gopher (Salamander). Circ. 310. Gainesville, FL: Florida University Extension; 1967. 12 p.

Mares, M. A. Convergent evolution among desert rodents, a global perspective. Andrew Carnegie Museum of Natural History Bull. 16: 5-51; 1979.

Matson, J. O. The distribution of rodents in Owens Lake Region, Inyo County, California USA. Contributions in Science No. 276. Los Angeles, CA: Natural History Museum of Los Angeles County; 1976. 27 p.

McLaughlin, C. A. A taxonomic study of the pocket gophers, genus *Geomys* of the central United States. Urbana, IL: University of Illinois; 1958. 298 p. Thesis.

Mearns, E. A. The earliest systematic name of the tuoza, or Georgia pocket gopher. Biological Society of Washington, Proceedings 27: 102; 1914.

Merriam, C. H. Monographic revision of the pocket gophers, family Geomyidae (exclusive of the species of *Thomomys*). North American Fauna No. 8. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1895. 258 p.

Merriam, C. H. Descriptions of eight new pocket gophers of the genus *Thomomys* from Oregon, California, and Nevada. Biological Society of Washington, Proceedings 11: 213-216; 1897.

Merriam, C. H. Descriptions of twenty-three new pocket gophers of the genus *Thomomys*. Biological Society of Washington, Proceedings 14: 107-117; 1901.

Merriam, C. H. Monographic revision of the pocket gophers, family Geomyidae exclusive of the species of *Thomomys*. North American Fauna 8. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1906. 262 p.

Miller, R. S. Ecology and distribution of pocket gophers (Geomyidae) in Colorado. Ecology. 45(2): 256-272; 1964.

Mitchill, S. L. Detection of a mistake into which naturalists have been led, in relation to the *Mus bursarius* or pouched rat of Canada. Am. J. Sci. and Arts 4: 183-185; 1822.

Mohr, C. O. Distribution of the Illinois pocket gopher, *Geomys bursarius illinoensis*. J. Mammal. 16(2): 131-134; 1935.

Mohr, C. O. Distribution of the prairie mole and pocket gopher in Illinois. J. Mammal. 27(4): 390-392; 1946.

Moulton, M. P.; Choate, J. R.; Bissell, S. J. Sympatry of pocket gophers on Mesa De Maya, Colorado USA. Kansas Academy of Science, Transactions 82(3): 194-195; 1979.

Nelson, E. W.; Goldman, E. A. Revision of the pocket gophers of the genus *Cratogeomys*. Biological Society of Washington, Proceedings 47: 135-154; 1934.

Patton, J. L. An analysis of natural hybridization between the pocket gophers *Thomomys bottae* and *Thomomys umbrinus* in Arizona. J. Mammal. 54(3): 561-584; 1973.

Pittman, H. H. The prairie pocket gopher in Manitoba. Can. Field-Nat. 40(3): 60-62; 1926.

Quimby, D. *Thomomys* in Minnesota. J. Mammal. 23: 216-217; 1942.

Reichman, O. J.; Baker, R. J. Distribution and movements of two species of pocket gophers (Geomyidae) in an area of sympatry in the Davis Mountains, Texas. J. Mammal. 53: 21-33; 1972.

Rensberger, J. M. Sanctimum mammalia rodentia and the phyletic relationships of the large Arikareean geomyoids. J. Paleontol. 47(5): 835-853; 1973.

Russell, R. J. Evolution and classification of pocket gophers of the subfamily Geomyinae. Univ. Kans., Mus. Nat. Hist., Publ. 16(6): 473-579; 1968a.

Russell, R. J. Revision of pocket gophers of the genus *Pappogeomys*. Univ. Kans., Mus. Nat. Hist., Publ. 16(7): 581-776; 1968b.

Russell, R. J.; Baker, R. H. Geographic variation in the pocket gopher *Cratogeomys castanops* in Coahuila, Mexico. Univ. Kans., Mus. Nat. Hist., Publ. 7(12): 591-608; 1955.

Sands, J. L.; Findley, J. S. The relationships of two subspecies of pocket gophers in central New Mexico. J. Mammal. 40(30): 331-337; 1959.

Sherman, H. B. A new species of pocket gopher (*Geomys*) from eastern Georgia. J. Mammal. 21(3): 341-343; 1940.

Soper, J. D. The Mississippi Valley pocket gopher (*Geomys bursarius* Shaw) in Manitoba. Can. Field-Nat. 58(3): 71-72; 1944.

Storer, T. I.; Evans, F. C.; Palmer, F. G. Some rodent populations in the Sierra Nevada of California. Ecol. Monogr. 14: 165-192; 1944.

Taylor, W. P. A new pocket gopher from western Washington. Biological Society of Washington, Proceedings 32: 169-172; 1914.

Thornton, W. A.; Creel, G. C. Distribution of gophers Geomyidae in western Texas. Southwest Nat. 20(2): 272-275; 1975.

True, F. W. Description of *Geomys personatus* and *Dipodomys compactus*, two new species of rodents from Padre Island, Texas. U.S. National Museum, Proceedings 11: 159-160; 1888.

Vaughan, T. A. Two parapatric species of pocket gophers. Evolution. 21: 148-158; 1967.

Villa-Ramirez, B.; Hall, E. R. Subspeciation in pocket gophers of Kansas. Univ. Kans., Mus. Nat. Hist., Publ. 1(11): 217-236; 1947.

Walker, K. M. Distribution and life history of the black pocket gopher *Thomomys niger* (Merriam). Corvallis, OR: Oregon State University; 1949. M.S. thesis.

Walker, K. M. Distribution and taxonomy of the small pocket gophers of northwestern Oregon. Corvallis, OR: Oregon State University; 1955. 200 p. Dissertation.

Wight, H. M. Pocket gophers of Oregon. Oregon Countryman. 12(7): 18; 1920.

Wight, H. M. The Willamette Valley pocket gopher. Murrelet. 3(3): 6-8; 1922.

Williams, S. L.; Blake, R. J. *Geomys arenarius*. Mammal. Species. 36: 1-3; 1974.

Wood, A. E. Parallel radiation among the geomyoid rodents. J. Mammal. 18: 171-176; 1937.

Youngman, P. M. Geographic variation in the pocket gopher, *Thomomys bottae*, in Colorado. Univ. Kans., Mus. Nat. Hist., Publ. 9: 363-384; 1958.

Predators and Mortality (PM)

Ambrose, H. W. Effect of habitat familiarity and toe-clipping on rate of owl predation in *Microtus pennsylvanicus*. J. Mammal. 53(4): 909-912; 1972.

Arnold, L. W. The golden eagle and its economic status. Circ. 27. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1954. 35 p.

Bailey, T. M. Ecology of bobcats with special reference to social organization. Moscow: University of Idaho; 1972. 85 p. Dissertation.

Bent, A. C. Life histories of North American birds of prey, part I. Bull. No. 167. Washington, DC: U.S. National Museum, Smithsonian Institution; 1937. 409 p.

Bent, A. C. Life histories of North American birds of prey, part II. Bull. No. 170. Washington, DC: U.S. National Museum, Smithsonian Institution; 1938. 482 p.

Bird, R. D. The great horned owl in Manitoba. Can. Field-Nat. 43(4): 79-83; 1929.

Bond, R. M. Coyote food habits on the Lava Beds National Monument. J. Wildl. Manage. 3(3): 180-198; 1939.

Brown, L. H.; Watson, A. The golden eagle in relation to its food supply. Ibis. 106(1): 78-100; 1964.

Craig, T. H.; Trost, C. H. The biology and nesting density of breeding American kestrels and long-eared owls on the Big Lost River, southeastern Idaho USA. Wilson Bull. 91(1): 50-61; 1979.

Craighead, J. J.; Craighead, F. C., Jr. Hawks, owls, and wildlife. Harrisburg, PA: Stackpole; 1956. 443 p.

Dixon, J. Food predilections of predatory and furbearing mammals. J. Mammal. 6(1): 34-46; 1925.

Egoscue, H. J. Ecology and life history of the kit fox in Tooele County, Utah. Ecology. 43(3): 481-497; 1962.

English, P. F. Some observations on a pair of red-tailed hawks. Wilson Bull. 46(4): 228-235; 1934.

Errington, P. L. Food habits of southern Wisconsin raptors. Part III: hawks. Condor. 35: 19-29; 1933.

Errington, P. L. Of predation and life. Ames, IA: Iowa State University Press; 1967. 277 p.

Evans, F. C.; Emlen, J. T., Jr. Ecological notes on the prey selected by a barn owl. Condor. 49(1): 3-9; 1947.

Fassler, D. J. Terrestrial activity of the northern pocket gopher Geomyidae is indicated by owl predation. Southwest Nat. 19(4)L: 452-453; 1975.

Ferrel, C. M.; Leach, H. R.; Tillotson, D. F. Food habits of the coyote in California. Calif. Fish and Game 39(3): 301-341; 1953.

Fevold, H. R.; Craighead, J. J. Food requirements of the golden eagle. Auk. 75(3): 312-317; 1958.

Fichter, E.; Schildman, G.; Sather, J. H. Some feeding patterns of coyotes in Nebraska. Ecol. Monogr. 25(1): 1-37; 1955.

Fitch, H. S. Some observations on horned owl nests. Condor. 42: 73-75; 1940.

Fitch, H. S. Predation by owls in the Sierra foothills of California. Condor. 49: 137-151; 1947.

Fitch, H. S. A study of coyote relationships on cattle range. J. Wildl. Manage. 12(1): 73-78; 1948.

Fitch, H. S. Study of snake populations in central California. Am. Midl. Nat. 41(3): 513-579; 1949.

Fitch, H. S.; Swenson, F.; Tillotson, D. F. Behavior and food habits of the red-tailed hawk. Condor. 48: 205-237; 1946.

Fitch, H. S.; Twining, H. Feeding habits of the Pacific rattlesnake. Copeia. 2: 64-71; 1946.

Fitzner, R. E.; Berry, D.; Boyd, L. L.; Rieck, C. A. Nesting of ferruginous hawks (*Buteo ragalis*) in Washington 1974-1975. Condor. 79(2): 245-249; 1977.

Gashwiler, J. S.; Robinette, W. L.; Morris, O. W. Foods of bobcats in Utah and Nevada. J. Wildl. Manage. 24(2): 226-229; 1960.

Gloyd, H. K. Field studies of the diurnal raptors of eastern and central Kansas. Wilson Bull. 37(3): 133-149; 1925.

Grater, R. K. Coyote food habits near Boulder (Hoover) Dam. J. Wildl. Manage. 7(4): 422-423; 1943.

Hawthorne, D. M. Coyote food habits in Sagehen Creek Basin, Northeastern California. Calif. Fish and Game 58(1): 4-12; 1972.

Hisaw, F. L.; Gloyd, H. K. The bullsnake as a natural enemy of injurious rodents. J. Mammal. 7(3): 200-205; 1926.

Imler, R. H. Bullsnakes and their control on a Nebraska wildlife refuge. J. Wildl. Manage. 9(40): 265-273; 1945.

Jones, J. H.; Smith, N. S. Bobcat (*Lynx rufus*) density and prey selection in central Arizona, USA. J. Wildl. Manage. 43(3): 666-672; 1979.

Kalmbach, E. R.; Imler, R. H.; Arnold, L. W. The American eagles and their economic status. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1964. 88 p.

Knowlton, F. F. Aspects of coyote predation in south Texas with special reference to white-tailed deer. Lafayette, In: Purdue University; 1964. 208 p. Dissertation.

Korschgen, L. J. Food habits of the red fox in Missouri. J. Wildl. Manage. 23(2): 168-176; 1959.

Luttich, S.; Rusch, D. H.; Meslow, E. C.; Keith, L. B. Ecology of red-tailed hawk predation in Alberta. Ecology. 51(2): 190-203; 1970.

Marston, M. A. Winter relations of bobcats to white-tailed deer in Maine. J. Wildl. Manage. 6(4): 328-337; 1942.

Marti, C. D. Some comparisons of the feeding ecology of four owls in northcentral Colorado. Southwest. Nat. 14(2): 163-170; 1969.

Marti, C. D.; Braun, C. E. Use of tundra habitats by prairie falcons in Colorado, USA. Condor. 77: 213-214; 1975.

Maser, C.; Brodie, E. D., Jr. A study of owl pellet contents from Linn, Benton and Polk Counties, Oregon. Murrelet. 47(1): 9-14; 1966.

Maser, C.; Hammer, E. W.; Anderson, S. H. Food habits of the burrowing owl in central Oregon. Northwest Sci. 45(1): 19-26; 1971.

McAtee, W. L. Food habits of common hawks. Circ. No. 370. Washington, DC: U.S. Department of Agriculture; 1935. 36 p.

McGahan, J. Quantified estimates of predation by a golden eagle population. J. Wildl. Manage. 31(3): 496-501; 1967.

McGahan, J. Ecology of the golden eagle. Auk. 85(1): 1-12; 1968.
McLean, D. D. Predatory animal studies. Calif. Fish and Game 20(1): 30-36; 1934.
Mech, L. D. The wolf: the ecology and behavior of an endangered species. Garden City, NY: The Natural History Press; 1970. 384 p.
Meslow, E. C.; Keith, L. B. Summer food habits of red-tailed hawks near Rochester, Alberta. Can. Field-Nat. 80(2): 98-100; 1966.
Metzgar, L. H. An experimental comparison of screech owl predation on resident and transient white-footed mice (*Peromyscus leucopus*). J. Mammal. 48(3): 378-391; 1967.
Mollhagen, T. R.; Wiley, R. W.; Packard, R. L. Prey remains in golden eagle nests: Texas and New Mexico. J. Wildl. Manage. 36(3): 784-792; 1972.
Moore, J. C. Life history notes on the Florida weasel. Fla. Acad. Sci., Quar. J. 7(4): 247-263; 1945.
Morse, A. P. The way of a snake with a gopher. Copeia. 16(4): 71-72; 1927.
Murie, A. Ecology of the coyote. National Park Service Fauna Series 4. Washington, DC: U.S. Department of the Interior, National Park Service; 1940. 199 p.
Murie, A. Ecology of the coyotes in the Yellowstone. Fauna of the National Parks of the U.S. Bull. 4. Washington, DC: U.S. Department of the Interior, National Park Service; 1940. 206 p.
Murie, O. J. Food habits of the coyote in Jackson Hole, Wyoming. Circ. 362. Washington, DC: U.S. Department of Agriculture; 1935. 24 p.
Ogle, T. F. Predator-prey relationships between coyotes and white-tailed deer. Northwest Sci. 45(4): 213-218; 1971.
Orians, G.; Kuhlman, F. Red-tailed hawk and great horned owl populations in Wisconsin. Condor. 58: 371-385; 1956.
Ozoga, J. J.; Harger, E. J. Winter activities and feeding habits of northern Michigan coyotes. J. Wildl. Manage. 30(4): 809-818; 1966.
Pearson, O. P.; Pearson, A. K. Owl predation in Pennsylvania with notes on the small mammals of Delaware County. J. Mammal. 28: 137-147; 1947.
Pfeifer, R. W. Great blue herons (*Ardea herodias*) foraging for small mammals. Wilson Bull. 91(4): 630-631; 1979.
Reid, V. H. Population biology of the northern pocket gopher. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973: 21-41.
Ribic, C. A. Summer foods of coyotes at Rocky Flats, Colorado USA. Southwest Nat. 23(1): 152-153; 1978.
Rickart, E. A. An analysis of barn owl and great horned owl pellets from western Nebraska USA. Prairie Nat. 4(2): 35-38; 1972.
Robinson, W. B. Population trends of predators and fur animals in 1080 station areas. J. Mammal. 34: 221-227; 1953.
Robinson, W. B. Population changes of carnivores in some coyote-control areas. J. Mammal. 42(4): 510-515; 1961.
Scott, T. G. Some food co-actions of the northern plains red fox. Ecol. Monogr. 13(4): 427-479; 1943.
Seton, E. T. Lives of game animals, vol. V. Garden City, NY: Doubleday; 1929.
Smith, C. F.; Hopkins, C. L. Notes on the barn owls of the San Francisco Bay region. Condor. 39: 189-191; 1937.
Snead, E.; Hendrickson, G. O. Food habits of the badger in Iowa. J. Mammal. 23(4): 380-391; 1942.
Sparrowe, R. D. Prey-catching behavior in the sparrow hawk. J. Wildl. Manage. 36(2): 297-308: 1972.
Sperry, C. C. Food habits of the coyote. Wildl. Res. Bull. 4. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1941. 70 p.
Stendell, R. C.; Myers, P. White-tailed kite predation on a fluctuating vole population. Condor. 75(3): 359-360; 1973.
Tryon, C. A., Jr. The great grey owl as a predator on pocket gophers. Wilson Bull. 55(2): 130-131; 1943.
Wakeley, J. S. Activity periods, hunting methods, and efficiency of the ferruginous hawk. Raptor Res. 8(3/4): 67-72; 1974.
Weckwerth, R. P.; Hawley, V. D. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26(1): 55-74; 1962.
Williams, S. L. Effect of floods on *Thomomys bottae* in Texas USA. Southwest Nat. 21(2): 169-175; 1976.
Wood, J. E. Food habits of furbearers of the upland post oak region in Texas. J. Mammal. 35(3): 406-415; 1954.
Young, S. P. The bobcat of North America. Harrisburg, PA: Stackpole; 1958. 193 p.
Young, S. P.; Jackson, H. T. The clever coyote: part I and part II. Harrisburg, PA: Stackpole; 1951. 411 p.

Movements (M)

Adams, Glen D. Populations and spatial distribution of pocket gophers (*Geomys bursarius*). Ann Arbor, MI: University of Michigan; 1966. 136 p. Dissertation.
Hansen, R. M. Movements and survival of *Thomomys talpoides* in a mima-mound habitat. Ecology. 43(1): 151-154; 1962.
Ingles, L. G. Ground water and snow as factors affecting the seasonal distribution of pocket gophers, *Thomomys monticola*. J. Mammal. 30(4): 343-350; 1949.
Vaughan, T. A. Movements made by two species of pocket gophers. Am. Midl. Nat. 69(2): 367-372; 1963.

Fluctuations (F)

Aldous, C. M. Fluctuations in pocket gopher populations. J. Mammal. 38(2): 266-267; 1957.
Andersen, D. C.; MacMahon, J. A. Population dynamics and bioenergetics of a fossorial herbivore, *Thomomys talpoides* (Rodentia:Geomyidae), in a spruce-fir sere. Ecol. Monogr. 51: 179-202; 1981.
Blair, W. F. Some observed effects of stream-valley flooding on mammalian populations in eastern Oklahoma. J. Mammal. 29(2): 304-306; 1939.

Blair, W. F. Population dynamics of rodents and other small mammals. In: Demerec, M., ed. Advances in genetics, vol. 5. New York: Academic Press; 1953: 1-41.
Dingman, R. E. Variation in selected populations of pocket gophers (*Thomomys bottae*) of the Lower Colorado River. Tucson, AZ: University of Arizona; 1966. 134 p. Dissertation.
Hansen, R. M. Pocket gopher density in an enclosure of native habitat. J. Mammal. 46(3): 508-509; 1965.
Hansen, R. M.; Bear, G. D. Comparison of pocket gophers from alpine, sub-alpine and shrub-grassland habitats. J. Mammal. 45(4): 638-640; 1964.
Hansen, R. M.; Remmenga, E. E. Nearest neighbor concept applied to pocket gopher populations. Ecology. 42(4): 812-814; 1961.
Howard, W. E. A pocket gopher population crash. J. Mammal. 42(2): 258-260; 1961.
Mohr, C. O. Table of equivalent populations of North American small mammals. Am. Midl. Nat. 37(1): 223-249; 1947.
Proctor, J.; Whitten, K. A population of the valley pocket gophers (*Thomomys bottae*) on a serpentine soil. Am. Midl. Nat. 85(2): 517-521; 1971.
Reid, V. H. Response of small mammal populations to various intensities of livestock grazing in the southern Rocky Mountains Region. Denver, CO: Denver Wildlife Research Center; 1962. 36 p. Annual progress report (mimeo).
Reid, V. H. Small mammal populations in relation to grazing on Black Mesa. Denver, CO: Denver Wildlife Research Center, Wildlife Research Work Unit; 1966. 17 p. Annual progress report.
Reid, V. H. Small mammal populations in relation to grazing on Black Mesa. Denver, CO: Denver Wildlife Research Center, Wildlife Research Work Unit; 1967. 14 p. Annual progress report.
Thaeler, C. S., Jr. An analysis of three hybrid populations of pocket gophers. Evolution. 22(3): 543-555; 1968.
Wilks, B. J. Some aspects of the ecology and population dynamics of the pocket gopher (*Geomys bursarius*) in southern Texas. Texas J. Sci. 15(3): 241-283; 1963.

Natural History (NH)

Allen, M. C. Gophers and squirrels. Calif. Cultivator. 43: 66; 1914.
Blume, R. R.; Aga, A. Additional records of *Aphoidius* from pocket gopher burrows in Texas (Coleoptera:Scarabaeidae). The Coleopterists Bull. 33(1): 131-132; 1979.
Burnett, W. L. Pocket gophers. Circ. 10. Fort Collins, CO: Office of State Entomology; 1914. 8 p.
Criddle, S. The prairie pocket gopher, *Thomomys talpoides rufescens*. J. Mammal. 11(3): 265-280; 1930.
Frandsen, J. C.; Grundmann, A. W. The history of some subspecies of pocket gophers as told by their monoxenous nematodes. Utah Academy of Science, Arts, and Letters, Proceedings 37: 154-155; 1960.
Goldman, E. A. Remarks on pocket gophers with special reference to *Thomomys talpoides*. J. Mammal. 20(2): 231-244; 1939.
Hansen, R. M.; Vaughan, T. A. Plains pocket gopher studies. Progress Report 164. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1965. 2 p.
Hart, E. B. Karyology and evolution of the plains pocket gopher *Geomys bursarius*. Occ. Pap. No. 71. Lawrence, KS: University of Kansas, Museum of Natural History; 1978. 19 p.
Hegdal, P. L.; Ward, A. L.; Johnson, A. M.; Tietjen, H. P. Notes on the life history of the Mexican pocket gopher (*Cratogeomys castanops*). J. Mammal. 46(2): 334-335; 1965.
Howard, W. E. The pesky pocket gopher. Spreckles Sugar Beet Bull. 16(3): 21-22; 1952.
Howard, W. E.; Ingles, L. G. Outline for an ecological life history of pocket gophers and other fossorial mammals. Ecology. 32(3): 537-544; 1951.
Kennerly, T. E., Jr. Comparisons of morphology and life history of two species of pocket gophers. Texas J. Sci. 10(2): 133-146; 1958.
Lidicker, W. Z., Jr. Corrections and additions to our knowledge of the pocket gopher. Murrelet. 52(1): 12-13; 1971.
Long, C. A. Evolution of mammalian cheek pouches and a possibly discontinuous origin of a higher taxon Geomyidae. Am. Nat. 110(976): 1093-1097; 1976.
Newman, C. L. The pocket gopher (*Geomys breviceps*). Ark. Agric. Exp. Stn. Bull. 28: 108-112; 1894.
Pembleton, E. F.; Williams, S. L. *Geomys pinetis*. Mamm. Species. 86: 1-3; 1978.
Randall, W. A. Gophers. Calif. Cultivator. 44: 279; 1915.
Russell, R. J. A multiple catch of *Cratogeomys*. J. Mammal. 35(1): 121-122; 1954.
Sagal, B. E. Natural history of the pocket gopher, *Thomomys bottae*, of Alameda County, Calif. Berkeley: University of California; 1942. 92 p. Thesis.
Scheffer, T. H. The pocket gopher. Bull. 152. Lawrence, KS: Kansas Agriculture Experiment Station; 1908: 111-145.
Scheffer, T. H. The pocket gopher. Bull. 172. Lawrence, KS: Kansas Agriculture Experiment Station; 1910: 197-234.
Scheffer, T. H. Concerning the pocket gopher in mole range. Circ. 242. Pullman, WA: Washington Agricultural Experiment Station; 1954. 4 p.
Scott, W. F. Moles and gophers. Am. Iris Soc. Bull. 141: 13-16; 1956.
Shufeldt, R. W. The gophers and pouched rats. Forest and Stream. 31(14): 263-264; 1888.
Taylor, W. P. Outlines for study of mammalian ecology and life histories. Leaflet 304. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1948: 1-26.
Tryon, C. A., Jr. The biology of the pocket gopher (*Thomomys talpoides*) in Montana. Tech. Bull. 448. Bozeman, MT: Montana Agricultural Experiment Station; 1947. 30 p.

Tryon, C. A.; Cunningham, H. N. Characteristics of pocket gophers along an altitudinal transect. J. Mammal. 49(4): 699-705; 1968.
Walker, K. M. Distribution and life history of the black pocket gopher *Thomomys niger* (Merriam). Corvallis, OR: Oregon State University; 1949. Thesis.
Warren, E. R. Notes on pocket gophers. J. Mammal. 18(4): 473-477; 1937.
Washburn, F. L. Gophers and rabbits. Oreg. Agric. Exp. Stn. Bull. 5: 24-29; 1980.
Washburn, F. L. Gophers and moles. Oreg. Agric. Exp. Stn. Bull. 125: 14-24; 1893.
Washburn, F. L. Pocket gopher and "digger squirrel." Oreg. Agric. Exp. Stn. Bull. 38: 13-15; 1895.
Watson, J. R. "Salamanders" and "gophers." Bull. 609. Gainesville, FL: Florida Agriculture Experiment Station; 1945. 4 p.
Webster, C. L. The pocket or pouched gopher (*Geomys bursarius*). Am. Nat. 31: 114-120; 1897.
Wight, H. M. The life history and control of the pocket gopher in the Willamette Valley. Bull. 153. Corvallis, OR: Oregon Agriculture Experiment Station; 1918. 55 p.
Williams, S. L.; Genoways, H. H. Review of the desert pocket gopher *Geomys arenarius* Mammalia:Rodentia. Andrew Carnegie Mus. Nat. Hist. Bull. 47(23): 541-570; 1978.
Yocum, H. B. The pocket gopher. Circ. 43. Lawrence, KS: Kansas Agriculture Experiment Station; 1915. 4 p.

Physiology and Morphology (PHM)

Andersen, D. C.; MacMahon, J. A.; Wolfe, M. L. Herbivorous mammals along a montane sere; community structure and energetics. J. Mammal. 61: 500-519; 1980.
Akersten, W. A. Upper incisor grooves in the Geomyinae. J. Mammal. 54(2): 349-355; 1973.
Benson, S. B. Concealing coloration among some desert rodents of the southwestern United States. Univ. Calif. Publ. Zool. 40(1): 1-70; 1933.
Bongardt, H.; Richens, V. C.; Howard, W. E. Serum protein patterns in pocket gophers. J. Mammal. 49(3): 544-547; 1968.
Bradley, W. G. An albino pocket gopher. J. Mammal. 44(2): 261; 1963.
Bradley, W. G.; Miller, J. S.; Yousef, M. K. Thermo regulatory patterns in pocket gophers desert and mountain. Physiol. Zool. 47(3): 172-179; 1974.
Bradley, W. G.; Yousef, M. K. Thermo regulation in the Plains pocket gopher. J. Ariz. Acad. Sci. 9: Supplement; 1974. 18 p.
Bradley, W. G.; Yousef, M. K. Thermo regulatory responses in the Plains pocket gopher *Geomys bursarius*. Comp. Biochem. Physiol. A. Comp. Physiol. 52(1): 35-38; 1975.
Brown, J. C.; Williams, J. D. The rodent preputial gland. Mammal. Rev. 2(4): 105-147; 1972.
Burt, W. H. Bacula of North American mammals. Misc. Publ. 113. Ann Arbor, MI: University of Michigan, Museum of Zoology; 1960. 100 p.
Coues, E. The cranial and dental characters of Geomyidae. U.S. Geol. and Geogr. Surv. Terr. 2nd ser. Bull. 2: 81-90; 1875.
Dahlman, R. C.; Kucera, C. L. Root productivity and turnover in native prairie. Ecology. 46: 84-89; 1965.
Davis, W. B. Relation of size of pocket gophers to soil and altitude. J. Mammal. 19: 338-342; 1938.
Fehrenbacher, L. H.; Fleharty, E. D. Body composition, energy content and lipid cycles of 2 species of pocket gophers *Geomys bursarius* and *Pappogeomys castanops* in Kansas. Southwest Nat. 21(2): 185-198; 1976.
French, N. R.; Grant, W. E.; Grodzinski, W.; Swift, D. M. Small mammal energetics in grassland ecosystems. Ecol. Monogr. 46: 201-220; 1976.
Gettinger, R. D. Metabolism and thermo regulation of a fossorial rodent, the northern pocket gopher *Thomomys talpoides*. Physiol. Zool. 48(4): 311-322; 1975.
Getz, L. L. Color variation in pocket gophers *Thomomys*. J. Mammal. 38(4): 523-526; 1957.
Guthrie, D. A.; DeLong, N. Carotid arteries in the rodent genera *Pappogeomys, Geomys* and *Thomomys* family Geomyidae. South. Calif. Acad. Sci. Bull. 76(1): 63-66; 1977.
Hill, J. E. External characteristics of newborn pocket gophers. J. Mammal. 15: 244-245; 1934.
Hill, J. E. The cranial foramina in rodents. J. Mammal. 16(2): 121-128; 1935.
Hill, J. E. The retractor muscle of the pouch in the Geomyidae. Science. 81(2093): 160; 1935.
Hill, J. E. Morphology of the pocket gopher mammalian genus *Thomomys*. Univ. Calif. Publ. Zool. 42: 81-172; 1937.
Hisaw, F. L. The absorption of the pubic symphysis of the pocket gopher, *Geomys bursarius* (Shaw). Am. Nat. 58(654): 93-96; 1924.
Hisaw, F. L. The influence of the ovary on the resorption of the pubic bones of the pocket gopher *Geomys bursarius* (Shaw). J. Explor. Zool. 42: 411-433; 1925.
Hollinger, C. D. Anatomical adaptations in the thoracic limb of the California pocket gopher and other rodents. Univ. Calif. Publ. Zool. 13(12): 447-494; 1916.
Horst, G. R.; Langworthy, M. L.; Wadsworth, C. L. Micro villi in the renal pelvis and collecting ducts of the pocket gopher *Thomomys bottae*. Anat. Rec. 175(2): 346; 1973.
Howard, W. E. Growth rate of nails on adult pocket gophers. J. Mammal. 34(3): 394-396; 1953.
Howard, W. E.; Smith, M. E. Rate of extrusive growth of pocket gophers. J. Mammal. 33(4): 485-487; 1952.
Ingles, L. G. Pigmental variations in populations of pocket gophers. Evolution. 4: 353-357; 1950.
Johnson, D. R.; Groepper, K. L. Bioenergetics of north plains rodents. Am. Midl. Nat. 84: 537-548; 1970.
Kaup, L. Investigations on the muscular system of the hind extremity in bipedal rodents. Zool. Anz. 194(5-6): 416; 1975.
Kaup, L. Investigations on the bones of the hind extremity and the pelvis in bipedal rodents. Zool. Anz. 196(3-4): 241-254; 1976.

Kay, F. R. Two 3 di phospho glycerate blood oxygen dissociation and the biology of mammals. Comp. Biochem. Physiol. A. Comp. Physiol. 57(3): 309-316; 1977.

Kennerly, T. E., Jr. Comparisons of morphology and life history of two species of pocket gophers. Texas J. Sci. 10(2): 133-146; 1958.

King, B. F.; Tibbitts, F. D. Ultrastructural observations on cytophasmic lamellar inclusions in oocytes of the rodent *Thomomys townsendii*. Anat. Rec. 189(2): 263-272; 1977.

LaVoie, G. K.; Tietjen, H. P.; Fall, M. W. Albinism in *Thomomys talpoides* from Colorado. Great Basin Nat. 31(3): 181; 1971.

Lechner, A. J. Metabolic performance during hypoxia in native and acclimated pocket gophers. J. Appl. Physiol. Respir. Environ. Exercise Physiol. 43(6): 965-970; 1977.

Lechner, A. J. The scaling of maximal oxygen consumption and pulmonary dimensions in small mammals. Respir. Physiol. 34(1): 29-44; 1978.

Lechner, A. J. Electrophoretic characterization of the hemo globins in pocket gophers of the genus *Thomomys*. Comp. Biochem. Physiol. B. Comp. Biochem. 61(1): 73-76; 1978.

Levine, H. P.; Moody, P. A. Serological investigations of rodent relationships. Physiol. Zool. 12(4): 400-411; 1939.

Lidicker, W. Z., Jr. Regulation of numbers in small mammal populations—historical reflections and a synthesis. In: Snyder, D. P., ed. Populations of small mammals under natural selection. Pittsburgh: University of Pittsburgh; 1976: 122-141. (Snyder, D. P., ed. Special Publications Series, Pymatuning Laboratory of Ecology: v. 5).

Matthew, W. D. On the osteology and relationships of *Paramys* and the affinities of the Ischryomyidae. Am. Mus. Nat. Hist. Bull. 28: 43-72; 1910.

McCarley, W. H. Color mutations in a small partially isolated population of pocket gophers (*Ceomys breviceps*). J. Mammal. 32: 338-342; 1951.

McIntosh, W. C. On abnormal teeth in certain mammals, especially in the rabbit. In: Transactions, 1929 Royal Society Edinburgh: Eighth ordinary meeting; 1929 June 3; Edinburgh. Edinburgh: Royal Society of Edinburgh, Transactions. 56: 333-407; 1930.

Miller, M. A. Size characteristics of the Sacramento Valley pocket gopher *Thomomys bottae navus* Merriam. J. Mammal. 33(4): 442-456; 1952.

Miller, R. S. Rate of incisor growth in the mountain pocket gopher. J. Mammal. 39(3): 380-385; 1958.

Moore, T. D.; Spence, L. E.; Dugnolle, C. E. Identification of the dorsal guard hairs of some mammals of Wyoming. Bull. No. 14. Cheyenne, WY: Wyoming Fish and Game Department; 1974. 186 p.

Morejohn, G. V.; Howard, W. E. Molt in the pocket gopher, *Thomomys bottae*. J. Mammal. 37(2): 201-213; 1956.

Mossman, H. W.; Hisaw, F. L. The fetal membranes of the pocket gopher, illustrating an intermediate type of rodent membrane formation. Am. J. Anat. 66(3): 376-391; 1940.

Nevo, E. Adaptive convergence and divergence of subterranean mammals. In: Johnson, R. F.; Frank, P. W.; Michner, C. D., eds. Annual review of ecology and systematics, Vol. 10. Palo Alto, CA: Annual Reviews; 1979: 269-308. ISBN: 0-8243-1410-7.

Nielson, P. E. The fetal membranes of the kangaroo rat, *Dipodomys*, with a consideration of the phylogeny of the Geomyidae. Anat. Rec. 77(1): 103-127; 1940.

Orcutt, E. E. Studies on the muscles of the head, neck and pectoral appendages of *Geomys bursarius*. J. Mammal. 21(1): 37-52; 1940.

University of Pittsburgh. Radioecology of small vertebrate species under natural environments. Pittsburgh, PA: University of Pittsburgh; Progress Report 1960-1971. 83 p.

University of Pittsburgh. Radioecology of small vertebrate species under natural environments. Pittsburgh, PA: University of Pittsburgh; Progress Report, December 1, 1969-November 30, 1970. 47 p.

Ross, J. P. Seasonal variation of thermo regulation in the Florida pocket gopher *Geomys pinetis*. Comp. Biochem. Physiol. A. Comp. Physiol. 66(1): 119-126; 1980.

Rudd, R. L.; Mullen, D. A. Adrenal gland responses to experimental manipulations of captive pocket gophers (*Thomomys umbrinus*). J. Mammal. 44: 451-446; 1963.

Schimpf, D. J.; Henderson, J. A.; MacMahon, J. A. Some aspects of succession in the spruce-fir forest zone of northern Utah. Great Basin Nat. 40: 1-26; 1980.

Smith, C. F. Weights of pocket gophers. J. Mammal. 21: 220; 1940.

Storer, T. I.; Gregory, P. W. Color aberrations in the pocket gopher and their probable genetic explanation. J. Mammal. 15(4): 300-312; 1934.

Thomson, S. C. Studies of the anatomy of the extrahepatic biliary tract in Mammalia. Publ. No. 481, Zool. Series Vol. 22, No. 6. Chicago, IL: Field Museum of Natural History; 1940: 415-430.

Tryon, C. A.; Kondric, W. R.; Cunningham, H. N. Measurement of relative thyroid activity in free ranging rodents along an altitudinal transect. Nature. 218: 278-280; 1968.

Vaughan, T. A. Cranial asymmetry in the pocket gopher. J. Mammal. 42(3): 412-413; 1961.

Vaughan, T. A.; Hansen, R. M. Activity rhythm of the plains pocket gopher. J. Mammal. 42(4): 541-543; 1961.

Wade, O.; Gilbert, P. T. The abnormal growth of the molar teeth and the front claws of an adult pocket gopher, *Geomys bursarius* (Shaw). Am. Midl. Nat. 16(6): 960-961; 1935.

Webber, P. J.; May, D. E. The magnitude and distribution of below ground plant structures in the alpine tundra of Nivot Ridge, Colo. Arctic and Alpine Res. 9: 157-174; 1977.

Wahlert, J. H. Cranial foramina and relationships of the Eomyoidea Rodentia: geomorpha skill and upper teeth of *Kansasimys*. Am. Mus. Navitates No. 2645. New York: American Museum of National History; 1978. 16 p.

Woods, C. A. The hyoid laryngeal and pharyngeal regions of *Bathyergid* and other selected rodents. J. Morphol. 147(2): 229-250; 1975.

Yunker, V. M.; Alekseeva, G. V. Characteristics of hemopoiesis in hibernating gophers *Citellus erythrogenus*. J. Evol. Biochem. Physiol. 10(2): 171-173; 1974.

Reproduction, Growth, and Aging (RGA)

Aldous, S. E. Some breeding notes on rodents. J. Mammal. 16(2): 129-131; 1935.

Andersen, D. C. Observations on reproduction, growth, and behavior of the northern pocket gopher (*Thomomys talpoides*). J. Mammal. 59: 418-422; 1978.

Andersen, D. C. Population dynamics and bioenergetics of a fossorial rodent, the northern pocket gopher (*Thomomys talpoides*) in a spruce-fir ecosystem. Logan, UT: Utah State University; 1980. 147 p. Dissertation.

Andersen, D. C.; MacMahon, J. A. Population dynamics and bioenergetics of a fossorial herbivore, *Thomomys talpoides* (Rodentia:Geomyidae), in a spruce-fir sere. Ecol. Monogr. 51(2): 179-202; 1981.

Anthony, A. W. Notes on the young of the southern pocket gopher. J. Mammal. 4(2): 126-127; 1923.

Barrington, B. A., Jr. Description of birth and young of the pocket gopher *Geomys floridanus*. J. Mammal. 23(4): 428-430; 1942.

Bond, R. M. The breeding habits of *Thomomys bottae* in Orange County, Calif. J. Mammal. 27(2): 172-174; 1946.

Brown, L. N. Breeding biology of pocket gopher (*Geomys pinetis*) in southern Florida. Am. Midl. Nat. 85: 45-53; 1971.

Burt, W. H. On the breeding habits of pocket gophers. Murrelet. 14(2): 42; 1933.

Desy, E. A.; Druecker, J. D. The estrous cycle of the plains pocket gopher *Geomys bursarius* in the laboratory. J. Mammal. 60(1): 235-236; 1979.

Dixon, J. The breeding season of the pocket gopher in California. J. Mammal. 10(4): 327-328; 1929.

Ewel, K. C. Annual reproductive cycle of the male pocket gopher (*Geomys pinetis*). Gainesville, FL: University of Florida; 1970. 78 p. Dissertation.

Gunther, W. C. Studies on the male reproductive system of the California pocket gopher (*Thomomys bottae nauvus* Merriam). Am. Midl. Nat. 55(1): 1-40; 1956.

Gunther, W. C. Some dietary effects on the estrous cycle of the female California pocket gopher, *Thomomys bottae nauvus* (Merriam). In: Proceedings, 1956 Indiana Academy of Science; Fall Meeting; 1956 October 11-13; Bloomington, IN. Indianapolis, IN: Indiana Academy of Science, 1957: 331-336.

Hansen, R. M. Age and reproductive characteristics of mountain pocket gophers in Colorado. J. Mammal. 41(3): 323-335; 1960.

Hipply, D. J. An evaluation of the effect of mestranol on the reproductive systems of valley pocket gophers (*Thomomys bottae*) in central Arizona. Tucson, AZ: University of Arizona; 1969. 42 p. Thesis.

Horn, E. E. Some notes concerning the breeding habits of *Thomomys townsendi* observed near Vale, Malheur County, Oregon, during the spring 1921. J. Mammal. 4(1): 37-39; 1923.

Ingles, L. G. Field observations on the growth of young mountain pocket gophers. Murrelet. 30(2): 35-36; 1949.

Kennedy, J.; Brown, R.; Brown, C.; Bowman, K. The annual reproductive cycle of the plains pocket gopher *Geomys bursarius* in the panhandle of Nebraska, USA. In: Proceedings, 1976 Nebraska Academy of Sciences and Affiliated Societies: Abstracts of papers presented at the 86th Annual Meeting; 1976 April 23-24; Lincoln, NB. Lincoln, NB: Nebraska Academy of Sciences and Affiliated Societies; 1976: 64.

Lay, D. M. Observations on reproduction in a population of pocket gophers *Thomomys bottae* from Nevada. Southwest Nat. 23(3): 375-380; 1978.

Lee, T. G. A comparison between the implantation stages in *Dipodomys* and *Geomys*. Science. 27(702): 918; 1908.

Livezey, B. C.; Verts, B. J. Estimates of age and age structure in Mazama pocket gophers *Thomomys mazama*. Murrelet. 60(2): 38-41; 1979.

McCafferty, D.; Houfek, S. The effect of alpha chlorohydrin on the male reproductive system of *Geomys bursarius*. In: Proceedings, 1976 Nebraska Academy of Sciences and Affiliated Societies: Abstracts of papers presented at the 86th Annual Meeting; 1976 April 23-24; Lincoln, NB. Lincoln, NB: Nebraska Academy of Sciences and Affiliated Societies; 1976: 65.

Miller, M. A. Reproductive rates and cycles in the pocket gopher. J. Mammal. 27(4): 335-358; 1946.

Mossman, H. W. The thecal gland and its relation to the reproductive cycle: a study of the cyclic changes in the ovary of the pocket gopher *Geomys bursarius* (Shaw). Am. J. Anat. 61: 289-319; 1937.

Reid, V. H. Population biology of the northern pocket gopher. In: Turner, G. T. (and others), eds. Pocket gophers and Colorado mountain rangeland. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973. 90 p.

Reid, V. H. Population dynamics of northern pocket gophers on rangelands in western Colorado. Fort Collins, CO: U.S. Bureau of Sport Fisheries and Wildlife; 1981. 36 p. (Draft—to be published.)

Scheffer, T. H. Breeding habits of the mole and the gopher. Murrelet. 5(1): 3-4; 1924.

Scheffer, T. H. Breeding records of Pacific Coast pocket gophers. J. Mammal. 19(2): 220-224; 1938.

Schramm, P. Copulation and gestation in the pocket gopher. J. Mammal. 42(2): 167-170; 1961.

Smolen, M. J.; Genoways, H. H.; Baker, R. J. Demographic and reproductive parameters of the yellow-cheeked pocket gopher *Pappogeomys castonops*. J. Mammal. 61(2): 224-236; 1980.

Vaughan, T. A. Reproduction in the plains pocket gopher in Colorado. J. Mammal. 43(1): 1-13; 1962.

Vaughan, T. A. Reproduction and population densities in a montane small mammal fauna. In: Jones, J. K., Jr., ed. Contributions in mammalogy. Misc. Publ. 51. Lawrence, KS: University of Kansas, Museum of Natural History; 1969: 51-74.

Wight, H. M. Breeding habits and economic relations of The Dalles pocket gopher. J. Mammal. 11: 40-48; 1930.

Wing, E. S. Reproduction in the pocket gopher in north central Florida. J. Mammal. 41(1): 35-43; 1960.
Wirtz, J. H. Reproduction in the pocket gopher *Thomomys talpoides rostralis* Hall and Montague. J. Colo.-Wyo. Acad. Sci. 4(6): 62; 1954.
Wood, J. E. Reproductive pattern of the pocket gopher (*Geomys breviceps*). J. Mammal. 30: 36-44; 1949.

Parasites and Disease (PD)

Allred, D. M. Plague-important fleas and mammals in Utah and the western U.S. Great Basin Nat. 12(1-4): 67-75; 1951.
Cartwright, O. L. Concerning *Aphodius aegrotus* and *Aphodius geomysi*. Coleopt. Bull. 32(3): 258; 1978.
Chamberlain, R. W. Four new species of Collembola. Great Basin Nat. 4: 39-48; 1943.
Coffman, C. C.; McDaniel, B. The description of *Geomy lichus geomydis* new species and rates of infestations on 1 of its host *Geomys bursarius bursarius* in South Dakota, USA. Acarologia. 17(1): 183-194; 1975.
Ewing, H. E. The taxonomy of the mallophagan family Trichodectidae with special reference to the New World fauna. J. Parasitol. 22(3): 233-246; 1936.
Gordon, R. D. Studies on the genus *Aphodius* of the USA and Canada Coleoptera Scarabaeidae: Part 2, A new species from Georgia USA. Entomological Society of Washington, Proceedings 76(4): 455-459; 1974.
Hellenthal, R. A.; Price, R. D. Louse host associations of *Geomydoecus* Mallophaga: Trichodectidae with the yellow-faced pocket gopher *Pappogeomys castanops* Rodentia: Geomyidae. J. Med. Entomol. 13(3): 331-336; 1976.
Hopkins, G. H. E. The host-associations of the lice of mammals. Zoological Society of London, Proceedings 119: 387-604; 1949.
Hopkins, G. H. E.; Clay, T. A check list of the genera and species of Mallophaga. London: British Museum; 1952. 362 p.
Hubbard, C. A. Our western giant pocket gopher fleas. Pac. Univ. Bull. 4C: 1-8; 1943.
Hubbard, C. A. Fleas of western United States; their relation to the public health. Ames, IA: Iowa State College Press; 1947. 533 p.
Jellison, W. L. *Cuterebra thomomuris* sp. Nov., a warble from the pocket gopher, *Thomomys talpoides*. (Rodentia:Geomyidae). J. Parasitol. 35(5): 482-486; 1949.
Keegan, H. L. Six new mites of the superfamily Parasitoidea. American Microscopical Society, Transactions 65(1): 69-77; 1946.
Karitonova, N. N.; Leonov, Y. A. On the role of the red-cheeked suslik in the Omsk haemorrhagic fever (OHF) focus in northern Kulunda. Cairo, Egypt: Naval Medical Research Unit No. 3, Department of Medical Zoology; 1969. 3 p.
Mahunka, S. New data to the knowledge of *Pygmephorus* species, *Acari tarsonemida*, living on small mammals in America. Parasitol. Hung. 7: 197-200; 1974.
Mahunka, S. 3 new scutacarid species *Acari tarsonemida* from the nests of small mammals in the USA. Parasitol. Hung. 10: 129-134; 1977.
McCoy, G. W. The susceptibility of gophers, field mice and ground squirrels to plague infection. J. Infect. Dis. 6: 28; 1909.
McCoy, G. W. The susceptibility to plague of the weasel, the chipmunk and the pocket gopher. J. Infect. Dis. 8: 42-46; 1911.
Miller, R. S.; Ward, R. A. Ectoparasites of pocket gophers from Colorado. Am. Midl. Nat. 64(2): 382-391; 1960.
O'Farrell, T. P. Small mammals: their parasites and pathologic lesions, on the arid lands ecology reserve Benton County, Washington, USA. Am. Midl. Nat. 93(2): 377-387; 1975.
Price, R. D. Host records for *Gemydoecus* (Mallophaga:Trichodectidae) from the *Thomomys bottae umbrinus* complex (Rodentia:Geomyidae). J. Med. Entomol. 9: 537-544; 1972.
Price, R. D. Two new species of *Geomydoecus* from Costa Rican pocket gophers Mallophaga:Trichodectidae. Entomological Society of Washington, Proceeding 76(1): 41-44; 1974.
Price, R. D. The *Geomydoecus expansus* Mallophaga:Trichodectidae from the southeastern USA pocket gophers Rodentia:Geomyidae. Entomological Society of Washington, Proceedings 77(1): 61-65; 1975.
Price, R. D.; Hellenthal, R. A. A reconstruction of *Geomydoecus expansus*, Mallophaga:Trichodectidae from the yellow-faced pocket gopher Rodentia:Geomyidae. J. Kans. Entomol. Soc. 48(1): 33-42; 1975.
Price, R. D.; Hellenthal, R. A. A review of the *Geomydoecus taxanus* complex Mallophaga:Trichodectidae from *Geomys* and *Pappogeomys*:Rodentia:Geomyidae J. Med. Entomol. 12(4): 401-408; 1975.
Price, R. D.; Hellenthal, R. A. The *Geomydoecus* Mallophaga:Trichodectidae from the Hispid pocket gopher Rodentia:Geomyidae. J. Med. Entomol. 12(6): 695-700; 1976.
Price, R. D.; Hellenthal, R. A. A review of the *Geomydoecus tolucae* complex Mallophaga:Trichodectidae from *Thomomys* Rodentia:Geomyidae based on qualitative and quantitative characters. J. Med. Entomol. 16(4): 265-274; 1979.
Price, R. D.; Hellenthal, R. A. The *Geomydoecus neocopei* complex Mallophaga:Trichodectidae of the *Thomomys umbrinus* pocket gophers Rodentia:Geomyidae of Mexico. J. Kans. Entomol. Soc. 53(3): 567-580; 1980.
Price, R. D.; Hellenthal, R. A. The *Geomydoecus oregonus* complex Mallophaga:Trichodectidae of the western USA pocket gophers Rodentia:Geomyidea. Entomological Society of Washington, Proceedings 82(1): 25-38; 1980.
Price, R. D.; Timm, R. M. Description of male of *Geomydoecus scleritus* R. Mallophaga:Trichodectidae from the southeastern pocket gopher. J. Ga. Entomol. Soc. 14(2): 162-165; 1979.
Richens, V. B. Larvae of botfly in the northern pocket gopher. J. Mammal. 46(4): 689-690; 1965.
Rust, R. W. The acarinium of pocket gopher, *Thomomys bottae* (Rodentia:Geomyidae). J. Med. Entomol. 10: 169-175; 1973.

Rust, R. W. The population dynamics and host utilization of *Geomydoecus oregonus* a parasite of *Thomomys bottae*. Oecologia. 15(3): 287-304; 1974.

Skidmore, L. V. Note on a new species of Coccidia from the pocket gopher (*Geomys bursarius*) Shaw. J. Parasitol. 15(3): 183-184; 1929.

Smiley, R. L.; Whitaker, J. O., Jr. Mites of the genus *Pygmephorus acari* Pygnephoridae on small mammals in North America. Acta Zool. Acad. Sci. Hung. 25(3-4): 383-408; 1979.

Szabo, I. The past and the future tasks of Hungarian Siphonaptera research. Allattani Kozl. 63(1-4): 147-153; 1976.

Timm, R. M.; Price, R. D. The taxonomy of *Geomydoecus*:Mallophaga: Trichodectidae from the *Geomys bursarius* complex Rodentia:Geomyidae. J. Med. Entomol. 17(2): 126-145; 1980.

Timm, R. M.; Price, R. D. A new species *Geomydoecus dalgleishi* new species Mallophaga:Trichodectidae from the Texas pocket gopher *Geomys personatus* Rodentia:Geomyidae. J. Kansas. Entomol. Soc 52(2): 264-268; 1979.

Todd, K. S.; Lepp, D. L. Endoparasites of the northern pocket gopher from Wyoming. J. Wildl. Dis. 7(2): 100-104; 1971.

Tuszynski, R. C.; Whitaker, J. O. External parasites of pocket gophers, *Geomys bursarius* from Indiana. Am. Midl. Nat. 87(2): 545-548; 1972.

Ubelaker, J. E.; Downhower, J. F. Parasites recovered from *Geomys bursarius* in Douglas Co., Kansas. Kansas Academy of Science, Transactions 68(1): 206-208; 1965.

Ward, R. A. Host-parasite relations of the Mallophaga (biting lice) of pocket gophers. Entomol. Soc. Am. Bull. 3(3): 22; 1957.

Whitaker, J. O., Jr.; Goff, R. J. Mallophaga of wild mammals of Indiana, USA. Entomol. News. 90(1): 23-25; 1979.

Wilson, N.; Oliver, G. V., Jr. New records of chewing lice Mallophaga:Boopidae and Trichodectidae from native mammals in Texas, USA. Southwest Entomol. 4(2): 156-162; 1979.

Behavior (B)

Arkley, R. J. The mima mounds. Sci. Mon. 66(2): 175-176; 1948.

Arkley, R. J.; Brown, H. C. The origin of mima mound (hog wallow) microrelief in the far western states. Soil Sci. Soc. Am., Proc. 18: 195-199; 1954.

Axthelm, D.; Lee, D. Burrowing habits of the plains pocket gopher, *Geomys bursarius*. In: Proceedings, 1976 Nebraska Academy of Sciences and Affiliated Societies: Abstracts of papers presented at the 86th Annual Meeting; 1976 April 23-24; Lincoln, NB. Lincoln, NB: Nebraska Academy of Sciences and Affiliated Societies; 1976: 63.

Baker, A. E. M. Interspecific aggressive behavior of pocket gophers *Thomomys bottae* and *T. talpoides* (Geomyidae:Rodentia). Ecology. 55(3): 671-673; 1974.

Breckenridge, W. J. Actions of the pocket gopher (*Geomys bursarius*). J. Mammal. 10: 336-339; 1929.

Bryant, H. C. Nocturnal wanderings of the California pocket gopher. Univ. Calif. Publ. Zool. 12(2): 25-29; 1913.

Chapman, R. C.; Bennett, A. F. Physiological correlates of burrowing in rodents. Comp. Biochem. Physiol. A. Comp. Physiol. 51(3): 599-604; 1975.

Dalquest, W. W.; Scheffer, V. B. The origin of the mima mounds of western Washington. J. Geol. 50:68-84; 1942.

Dice, L. R. *Thomomys* the engineer - friend or foe? Am. For. 45(10): 512; 1939.

English, P. F. Some habits of the pocket gopher, *Geomys breviceps breviceps*. J. Mammal. 13: 126-132; 1932.

Gabrielson, I. N. *Thomomys* the engineer. Am. For. 44(10): 453-454, 478-479; 1938.

Hansen, R. M. Pocket gopher digging behavior in rocky soils. Progress Report 232. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1967. 2 p.

Hansen, R. M.; Miller, R. S. Observations on the plural occupancy of pocket gopher burrow systems. J. Mammal. 40(4): 577-584; 1959.

Hansen, R. M.; Morris, M. J. Movement of rocks by northern pocket gophers. J. Mammal. 49(3): 391-399; 1968.

Hickman, G. C.; Brown, L. N. Mound building behavior of the southeastern pocket gopher (*Geomys pinetis*). J. Mammal. 54(3): 786-790; 1973.

Hickman, G. C. The maternal behavior of a Mexican pocket gopher *Pappogeomys castanops*. Southwest Nat. 20(1): 142-144; 1975.

Hickman, G. C. Swimming behavior in representative species of the 3 genera of North American *Geomyid*. Southwest Nat. 21(4): 531-538; 1977.

Kanavau, J. L.; Havenhill, R. M. Compulsory regime and control of environment in animal behavior. Part 3. Light level preferences of small nocturnal mammals. Behavior. 59(304): 203-225; 1976.

Katz, S. J. Tool using behavior of the pocket gopher *Thomomys bottae*. Southwest Nat. 25(2): 270-271; 1980.

Kelly, A. O. The mima mounds. Sci. Mon. 66(2): 174-175; 1948.

Laycock, W. A. Seasonal periods of surface inactivity of the pocket gopher. J. Mammal. 38(1): 132-133; 1957.

Marshall, W. H. *Thomomys* as burrowers in the snow. J. Mammal. 22(2): 196-197; 1941.

Miller, M. A. Seasonal trends in burrowing of pocket gophers. J. Mammal. 29: 38-44; 1948.

Miller, R. S.; Bond, H. E. The summer burrowing activity of pocket gophers. J. Mammal. 41(4): 469-475; 1960.

Mohr, C. O.; Mohr, W. P. Abundance and digging rate of pocket gophers, *Geomys bursarius*. Ecology. 17(2): 325-327; 1936.

Parvin, J. B. On the habits of the gopher of Illinois (*Geomys bursarius*). 9th Annual Report. Washington, DC: Smithsonian Institution; 1854: 293-294.

Price, W. A. Pocket gophers as architects of mima (pimple) mounds of the western U.S. Texas J. Sci. 1: 1-17; 1949.

Richens, V. A. Notes on the digging activity of the northern pocket gopher. J. Mammal. 47(3): 531-533; 1966.
Scheffer, T. H. Habits and economic status of the pocket gophers. Tech. Bull. 224. Washington, DC: U.S. Department of Agriculture; 1931. 27 p.
Scheffer, T. H. Mound construction of the pocket gopher. Murrelet. 29: 9-10; 1948.
Scheffer, V. B. The mystery of the mima mounds. Sci. Mon. 65: 283-294; 1947.
Scheffer, V. B. Son exclusios del oeste de Norteamerica los micromoniticulos de tipo mima? Invest. Zool. Chil. 2(6): 89-94; 1954.
Scheffer, V. B. Do fossorial rodents originate mima type microrelief? Am. Midl. Nat. 59(2): 505-510; 1958.
Scheffer, V. B.; Kruckeberg, A. The mima mounds. BioScience. 16(11): 800-801; 1966.
Sharp, W. M. A pocket gopher (*Geomys lutescens*) travels backward. J. Mammal. 24(1): 99; 1943.
Stallings, J. H. The mima mounds. Sci. Mon. 66: 269-270; 1948.
Vaughan, T. A. Food handling and grooming behaviors in the plains pocket gopher. J. Mammal. 47(1): 132-133; 1966.
Vaughan, T. A. Resource allocation in some sympatric subalpine rodents. J. Mammal. 55(4): 764-795; 1974.
Vaughan, T. A.; Hansen, R. M. Experiments on interspecific competition between two species of pocket gophers. Am. Midl. Nat. 72(2): 444-452; 1964.
Virchow, D. Use of telemetry in the study of pocket gopher *Geomys bursarius* movements and activity patterns. In: Proceedings, 1977 Nebraska Academy of Sciences and Affiliated Societies: 87th annual meeting abstracts; 1977 April 15-16; Lincoln, NB. Lincoln, NB: Nebraska Academy of Sciences and Affiliated Societies; 1977: 23.
Vleck, D. The energy cost of burrowing by the pocket gopher *Thomomys bottae*. Physiol. Zool. 52(2): 122-136; 1979.
Watts, D. E. Burrowing habits of the plains pocket gopher in northcentral and northeastern Oklahoma during the fall and winter of 1969-1970. Stillwater: Oklahoma State University; 1970. 72 p. Dissertation.

Food and Feeding Habits (FF)

Aldous, C. M. Pocket gopher food caches in central Utah. J. Wild. Manage. 9(4): 327-328; 1945.
Aldous, C. M. The feeding habits of the pocket gopher *Thomomys talpoides moorei*, on the high mountain ranges of central Utah. J. Mammal. 32: 84-87; 1951.
Bleak, A. T. Disappearance of plant material under a winter snow cover. Ecology. 51(5): 915-917; 1970.
Burton, D. H.; Black, H. C. Feeding habits of Mazama pocket gopher in eastern Colorado. J. Mammal. 45(4): 588-597; 1978.
Cummins, E. B. Pocket gopher feeding preferences for ponderosa pine strains. Moscow, ID: University of Idaho; 1975. 51 p. Thesis.
Cunningham, H. N., Jr. An ecological study of the northern pocket gopher, *Thomomys talpoides* (Richardson) in relation to available food resources along an altitudinal transect. Pittsburgh, PA: University of Pittsburgh; 1966. 218 p. Dissertation.
Gunther, W. C. Some dietary effects on the estrous cycle of the female California pocket gopher *Thomomys bottae navus* (Merriam). In: Proceedings, 1956 Indiana Academy of Science: Fall meeting; 1956 October 11-13; Bloomington, IN. Indianapolis, IN: Indiana Academy of Science; 66: 331-336; 1957.
Howard, W. E. Relation between low temperature and available food to survival of small rodents. J. Mammal. 32(3): 300-312; 1951.
Hungerford, K. E. Food preferences and food location by pocket gophers in Idaho. In: Proceedings, 7th vertebrate pest conference; 1976 March 9-11; Monterey, CA. Sacramento, CA: Department of Food and Agriculture, Control and Erradication, Vertebrate Pest Conference 1976: 131-138.
Luce, D. G.; Case, R. M. Plains pocket gopher food habits in alfalfa fields. In: Proceedings, 1977 Nebraska Academy of Sciences and Affiliated Societies: 87th annual meeting abstracts; 1977 April 15-16; Lincoln, NB. Lincoln, NB: Nebraska Academy of Sciences and Affiliated Societies; 1977: 17.
Luce, D. G.; Case, R. M.; Stubbendieck, J. L. Plains pocket gopher food habits in western Nebraska USA rangeland. In: Proceedings, 1978 Nebraska Academy of Sciences and Affiliated Societies; 88th annual meeting abstracts; 1978 April 14-15; Lincoln, NB. Lincoln, NB: Nebraska Academy of Science and Affiliated Societies; 1978: 18-19.
Luce, D. G.; Case, R. M.; Stubbendieck, J. L. Food habits of the plains pocket gopher on western Nebraska Rangeland (impact on forage production). J. Range Manage. 33(2): 129-131; 1980.
Martin, A. C.; Zim, H. S.; Nelson, A. L. American wildlife and plants, a guide to wildlife food habits. New York: Dover Publishing; 1951. 500 p.
Myers, G. T. Food habits of the plains pocket gopher in the sandhills of eastern Colorado. Fort Collins, CO: Colorado State University; 1962. Thesis.
Myers, G. T.; Vaughan, T. A. Food habits of the plains pocket gopher in eastern Colorado. J. Mammal. 45(4): 588-597; 1964.
Radwan, M. A.; Crouch, G. L.; Harrington, C. A. Terpenes of ponderosa pine and feeding preferences by pocket gophers. J. Chem. Ecol. 8(1): 241-253; 1982.
Radwan, M. A.; Ellis, W. D.; Crouch, G. L. Chemical composition and deer browsing of red alder foliage. Res. Pap. PNW-246. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1978. 6 p.
Vaughan, T. A. Food handling and grooming behaviors in the plains pocket gopher. J. Mammal. 47(1): 132-133; 1966.
Vaughan, T. A. Food habits of the northern pocket gophers on shortgrass prairie. Am. Midl. Nat. 77(1): 176-189; 1967.
Wade, O. Food habits of a pocket gopher (*Geomys lutescens*). J. Mammal. 8(4): 310-311; 1927.
Ward, A. L. Mountain pocket gopher food habits in Colorado. J. Wildl. Manage. 24(1): 89-92; 1960.

Ward, A. L. Food habits and competition. In: Turner, G. T. (and others), eds. Pocket gophers and Colorado mountain rangeland. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973: 43-49.

Ward, A. L.; Keith, J. O. Feeding habits of pocket gophers on mountain grasslands, Black Mesa, Colorado. Ecology. 43(4): 744-749; 1962.

Wilks, B. J. 1962. Reingestion in geomyid rodents. J. Mammal. 43(2): 267; 1962.

Yorgason, I. J. 1960. An ecological study of the food habits of the pocket gopher *Thomomys talpoides rostralis*. Laramie, WY: University of Wyoming; 1960.

Genetics (G)

Avise, J. C.; Giblin-Davidson, C.; Laerm, J.; Patton, J. C.; Lansman, R. A. Mitochondrial DNA clones and matriarchal phylogeny within and among geographic populations of the pocket gopher *Geomys pinetis*. National Academy of Sciences USA, Proceedings 76(12): 6694-6698; 1979.

Baker, R. J.; Williams, S. L.; Patton, J. C. Chromosomal variation in the plains pocket gopher *Geomys bursarius major*. J. Mammal. 54(3): 765-769; 1973.

Berry, D. L.; Baker, R. J. Chromosomes of pocket gophers of the genus *Pappogeomys* subgenus *Cratogeomys*. J. Mammal. 53(2): 303-309; 1972.

Cross, J. C. Comparative study of the chromosomes of rodents. J. Morphol. Physiol. 52(2): 373-401; 1931.

Dowler, R. C.; Genoways, H. H. Variation in *Pappogeomys castanops* Geomyidae on the Llano Estacade of Texas and New Mexico. Southwest Nat. 24(4): 577-602; 1979.

Fry, K.; Salser, W. Nucleotide sequences of heavy strand alphs satellite DNA from kangaroo rat *Dipodomys ordii* and characterization of similar sequences in other rodents. Cell. 12(4): 1069-1084; 1977.

George, W. Conservatism in the karyotypes of 2 african molerats Rodentia:Bathyergidae. Z. Saugetierkunde. 44(5): 278-285; 1979.

Hart, E. B.; Patterson, R. R. Chromosomes of the yellow-faced pocket gopher *Pappogeomys castanops* in Kansas. Kansas Academy of Science, Transactions 77(4): 239-243; 1974.

Hinesley, L. L.; Thaeler, C. S., Jr. Karyotype and distribution of the southern pocket gopher *Thomomys umbrinus emotus*. J. Mammal. 58(2): 235-237; 1977.

Judd, S. R. *Thomomys agrestis* a study of speciation and intra populational chromosome variation in southern Colorado. N. Mex. Acad. Sci. Bull. 18(1): 39-40; 1978.

Kennerly, T. E., Jr. Gene flow pattern and swimming ability of the pocket gopher. Southwest. Nat. 8(2): 85-88; 1963.

Laguarda-Figueras, A.; Paulette, J.; Romero-Jarero, J.; Scaglia-de-Paulette, S. Chromosome analysis and meiotic behavior of *Pappogeomys merriami merriami*. Experientia (Basel). 29(7): 889-890; 1973.

Lansman, R. A.; Avise, J. C.; Shade, R. Restriction endo nucleases used to measure mitochondrial DNA sequence diversity in natural populations. J. Supramol. Struct. 9: Supplement 3; 1979. 143 p.

Mazrimas, J. A. Similarity of satellite DNA from 4 rodent families. Fed. Proc. 35(7): 1631; 1976.

Nevo, E. Test of selection and neutrality in natural population. Nature. 244(5418): 573-575; 1973.

Nevo, E.; Kim, Y. J.; Shaw, C. R.; Thaeler, C. S., Jr. Genetic variation, selection and speciation in *Thomomys talpoides* pocket gophers. Evolution. 28(1): 1-23; 1974.

Patton, J. L. An analysis of natural hybridization between the pocket gophers, *Thomomys bottae* and *Thomomys umbrinus*, in Arizona. J. Mammal. 54(3): 561-584; 1973.

Patton, J. L.; Dingman, R. E. Chromosome studies of pocket gophers, genus *Thomomys*. I. The specific status of *Thomomys umbrinus* Richardson in Arizona. J. Mammal. 49(1): 1-13; 1968.

Patton, J. L.; Yang, S. Y. Genetic variation in *Thomomys bottae* pocket gophers: macrogeographic patterns. Evolution. 31(4): 697-720; 1977.

Patton, J. L.; Feder, J. H. Genetic divergence between populations of the pocket gopher *Thomomys umbrinus*. Z. Saeugetierko 43(1): 17-30; 1978.

Patton, J. L.; Baker, R. J.; Genoways, H. H. Apparent chromosomal heterosis in a fossorial mammal. Am. Nat. 116(1): 143-146; 1980.

Patton, J. L.; Hafner, J. C.; Hafter, M. S.; Smith, M. F. Hybrid zones in *Thomomys bottae* pocket gophers genetic, phenetic and ecologic concordance patterns. Evolution. 33(3): 860-876; 1979.

Penney, D. F.; Zimmerman, E. G. Genic divergence and local population differentiation by random drift in the pocket gopher genus *Geomys*. Evolution. 30(30): 473-483; 1976.

Pierce, B. A.; Mitton, J. B. A relationship of genetic variation within and among populations: an extension of the Kluge kerfoot phenomenon. Syst. Zool. 28(1): 63-70; 1979.

Sarich, V. M. The utility of electrophoretic data in evaluating close phyletic relationships cercopithecoidea. Am. J. Phys. Anthropol. 49(1): 150; 1974.

Sarich, V. M. Rates sample sizes and the neutrality hypothesis for electrophoeresis in evolutionary studies. Nature (London) 265(5589): 24-28; 1977.

Sarich, V. M. Electrophoretic systematics at lower taxon levels. Am. J. Phys. Anthropol. 47(1): 158; 1977.

Selander, R. K.; Kaufman, D. W.; Baker, R. J.; Williams, S. L. Genetic and chromosomal differentiation in pocket gophers of the *Geomys bursarius* group. Evolution. 28: 557-564; 1975.

Thaeler, C. S., Jr. Four contacts between ranges of different chromosome forms of the *Thomomys talpoides* complex Rodentia:Geomyidae. Syst. Zool. 23(3): 343-354; 1974.

Thaeler, C. S., Jr. Chromosome polymorphism in *Thomomys talpoides agrestis* Rodentia:Geomyidae. Southwest Nat. 21(1): 105-116; 1976.

Vorontsov, N.; Sokolovskii, V. Genetics at the 1st International Theriological Congress. Sov. Genet. (Engl. Transl.) Genetika. 11(9): 1212-1215; 1975.

Williams, S. L.; Genoways, H. H. Karyotype of *Geomys pinetis* Mammalia:Geomyidae with a discussion of the chromosomal relationships within the genus. Experientia (Basel.) 31(10): 1141-1143; 1975.

Habitat Relationships—Forest Land (HRF)

Anderson, R. J. Relation of the northern pocket gopher to forest habitats in south central Oregon. Corvallis, OR: Oregon State University; 1976. 46 p. Thesis.

Barnes, V. G., Jr. Response of pocket gopher populations to silvicultural practices in central Oregon. In: Black, H. C., ed. Proceedings, symposium on wildlife and forest management in the Pacific Northwest; 1973 September 11-12; Corvallis, OR. Corvallis, OR: Oregon State University, School of Forestry; 1974: 167-175.

Barrett, J. S. Spacing and understory vegetation affect growth of ponderosa pine saplings. Res. Note PNW-27. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1965. 8 p.

Barrett, J. S. Ponderosa pine saplings respond to control of spacing and understory vegetation. Res. Pap. PNW-106. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1970. 16 p.

Barrett, J. S. Ponderosa pine growth and stand management. In: Precommercial thinning of coastal and intermountain forests on the Pacific Northwest: a short course held 1971 February 3-4; Pullman, WA. Pullman, WA: Washington State University; 1971: 5-9.

Barrett, J. W.; Youngberg, C. T. Effect of tree spacing and understory vegetation on water use in a pumice soil. Soil Sci. Soc. Am. Proc. 29: 472-475; 1965.

Black, H. C.; Hooven, E. H. Response of small mammal communities to habitat changes in western Oregon. In: Proceedings, symposium on wildlife and forest management in the Pacific Northwest; 1973 September 11-12; Corvallis, OR. Corvallis, OR: Oregon State University, School of Forestry; 1974: 177-186.

Buechner, H. K. Interrelationships between the pocket gopher and land use. J. Mammal. 23(3): 346-348; 1942.

Clary, W. P.; Ffolliott, P. F. Differences in herbage-timber relationships between thinned and unthinned ponderosa pine stands. Res. Note RM-74. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1966. 4 p.

Clary, W. P.; Ffolliott, P. F.; Jameson, D. A. Relationships of different forest floor layers to herbage production. Res. Note RM-123. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1968. 3 p.

Crouch, G. L. Atrazine improves survival and growth of ponderosa pine (*Pinus ponderosa*) threatened by vegetative competition and pocket gophers (Oregon). For. Sci. 25(1): 99-111; 1979.

Gordon, D. T. Growth response of eastside pine poles to removal of low vegetation. Res. Note PSW-209. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1962. 3 p.

Griffin, J. R. Oak regeneration in the upper Carmel Valley, California. Ecology. 52(5): 862-868; 1971.

Hermann, R. K.; Thomas, H. A. Observations on the occurrence of pocket gophers in southern Oregon pine plantations. J. For. 61(7): 527-529; 1963.

Jameson, D. A. The relationship of the overstory and herbaceous understory vegetation. J. Range Manage. 20(4): 247-249; 1967.

Layne, J. N. Ecology of small mammals in a flatwoods habitat in north central Florida USA with emphasis on the cotton rat *Sigmodon hispidus*. Am. Mus. Novitates No. 2544. New York: American Museum of Natural History; 1974. 48 p.

Lyon, J. L. Problems of habitat management for deer and elk in the northern forests. Res. Pap. INT-24. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1966. 15 p.

Marston, R. B.; Julander, O. Plant cover reductions by pocket gophers following experimental removal of aspen from a watershed area in Utah. J. For. 59(2): 100-102; 1961.

McConnell, B. R.; Smith, J. G. Understory response three years after thinning pine. J. Range Manage. 18(3): 129-132; 1965.

McConnell, B. R.; Smith, J. G. Response of understory vegetation in eastern Washington. J. Range Manage. 23(3): 208-212; 1970.

Minore, D. Shade benefits Douglas-fir in southwestern Oregon cutover area. Tree Planters' Notes. 22(1): 22-23; 1971.

Pase, C. P. Herbage production and composition under immature ponderosa pine stands in the Black Hills. J. Range Manage. 11(5): 238-243; 1958.

Patton, D. R. Deer and elk use of a ponderosa pine forest in Arizona before and after timber harvest. Res. Note RM-139. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1969. 7 p.

Pearson, G. A. Herbaceous vegetation a factor in natural regeneration of ponderosa pine in the Southwest. Ecol. Monogr. 12: 315-339; 1942.

Reynolds, H. G. Effect of logging on understory vegetation and deer use in ponderosa pine forest of Arizona. Res. Note RM-80. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1962. 7 p.

Reynolds, H. G. Use of natural openings in a ponderosa pine forest of Arizona by deer, elk and cattle. Res. Note RM-78. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1962. 4 p.

Reynolds, H. G. Slash cleanup in a ponderosa pine forest affects use by deer and cattle. Res. Note RM-64. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1966. 3 p.

Reynolds, H. G. Use of openings in spruce-fir forests of Arizona by elk, deer, and cattle. Res. Note RM-66. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1966. 4 p.

Reynolds, H. G. Improvement of deer habitat on southwestern forest lands. J. For. 67(11): 803-805; 1969.

Ronco, F. Lessons from artificial regeneration studies in a cutover beetle-killed spruce stand in western Colorado. Res. Note RM-90. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1967. 8 p.

Ronco, F. Shading and other factors affect survival of planted Engelmann spruce seedlings in central Rocky Mountains. Res. Note RM-163. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1970. 7 p.

Stein, W. I. Natural reproduction of Shasta red fir from a single good cone crop. Res. Note PNW-100. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1954. 5 p.

Stein, W. I. A successful direct seeding of sugar pine. Res. Note PNW-25. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1957. 19 p.

Volland, L. A. Relation of pocket gophers to plant communities in the pine region of central Oregon. In: Black, H. C., ed. Forest management in the Pacific Northwest. Corvallis, OR: Oregon State University; 1973: 149-166.

Wakeley, P. C. Planting the southern pines. Agric. Monogr. 18. Washington, DC: U.S. Department of Agriculture, Forest Service; 1954. 233 p.

Youmans, C. C. Characteristics of pocket gopher populations in relation to selected environmental factors in Pelican Valley, Yellowstone National Park. Bozeman: Montana State University; 1979. 79 p. Thesis.

Habitat Relationships—Rangeland and Agricultural Lands (HRR)

Alsager, D. E. Impact of pocket gophers (*Thomomys talpoides*) on the quantitative productivity of rangeland vegetation in southern Alberta: a damage assessment tool. In: Jackson, W. B.; March, R. E., eds. Test methods for vertebrate pest control and management materials: a symposium on test methods for vertebrate pest control and management materials; 1976 March 8; Monterey, CA. Philadelphia, PA: American Society for Testing and Materials; 1977: 47-57. ASTM STP 625.

Basile, J. V. Artificial revegetation studies on depleted big game winter ranges in Idaho: bitterbrush revegetation. Boise, ID: Idaho Fish and Game Department; 1956. 9 p.

Bond, R. M. Range rodents and plant succession. In: Transactions, 1945 North American Wildlife Conference (no meeting). Washington, DC: American Wildlife Institute; 1945: 229-234.

Branson, F. A.; Payne, G. F. Effects of sheep and gophers on meadows of the Bridger Mountains of Montana. J. Range Manage. 11(4): 165-169; 1958.

Buechner, H. K. Interrelationships between the pocket gopher and land use. J. Mammal. 23(3): 346-348; 1942.

Colorado Agriculture Experiment Station. Some relations of pocket gophers to rangelands on Grand Mesa, Colorado. Tech. Bull. 88. Fort Collins, CO: Colorado Agriculture Experiment Station; 1966. 20 p.

Cook, J. B. Pocket gophers spread Canada thistle. Calif. Dep. Agric. Bull. 28: 142-143; 1939.

Cummings, M. W. Grand Mesa pocket gopher study: a five year summary and progress report for 1946. Denver, CO: U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Denver Wildlife Research Center; 1946. Unpublished thesis.

Dearment, R. Habitat improvement evaluation: determination of plant survival in habitat plots. Oklahoma City, OK: Oklahoma Department of Wildlife Conservation; 1951. 15 p.

Dearment, R. Habitat improvement evaluation: determination of utilization of completed plots by bobwhite quail and other wildlife. Oklahoma City, OK: Oklahoma Department of Wildlife and Conservation; 1951. 12 p.

Dixon, J. Rodents and reclamation in the Imperial Valley. J. Mammal. 3(3): 136-146; 1922.

Ellison, L. Establishment of vegetation on depleted subalpine range as influenced by microenvironment. Ecol. Monogr. 19(2): 95-121; 1949.

Ellison, L. Subalpine vegetation of the Wasatch Plateau, Utah. Ecol. Monogr. 24(2): 89-184; 1954.

Ellison, L.; Aldous, C. M. Influence of pocket gophers on vegetation of subalpine grassland in central Utah. Ecology. 33(2): 177-186; 1952.

Fitch, H. S.; Bentley, J. R. Use of California annual-plant forage by range rodents. Ecology. 30: 306-321; 1949.

Garrison, G. A.; Moore, A. W. Relation of the Dallas pocket gopher to establishment and maintenance of range grass plantings. J. Range Manage. 9(4): 181-184; 1956.

Grant, W. E.; French, N. R.; Folse, L. J., Jr. Effects of pocket gopher *Thomomys talpoides* mounds on plant production in short grass prairie ecosystems. Southwest Nat. 25(2): 215-224; 1980.

Hansen, R. M.; Beck, R. F. Habitat of pocket gophers in Cochetopa Creek drainage, Colorado. Am. Midl. Nat. 79(1): 103-117; 1968.

Hansen, R. M.; Reid, V. H. Distribution and adaptations of pocket gophers. In: Turner, G. T. (and others), eds. Pocket gophers and Colorado mountain rangeland. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973: 1-19.

Hansen, R. M.; Ward, A. L. Some relations of pocket gophers to rangelands on Grand Mesa, Colorado. Tech. Bull. No. 88. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1966. 22 p.

Horn, E. E.; Fitch, H. S. Interrelations of rodents and other wildlife of the range. Calif. Agric. Exp. Stn. Bull. 663: 96-129; 1942.

Howard, W. E.; Childs, H. E. Ecology of pocket gophers with emphasis on *Thomomys bottae mewa*. Hilgardia. 29(7): 277-358; 1959.

Hutchinson, C. B.; Kotok, E. I. The San Joaquin experimental range. Bull. 663. Berkeley, CA: California Agricultural Experiment Station; 1942. 145 p.

Ingles, L. G. The ecology of the mountain pocket gopher (*Thomomys monticola*). Ecology. 33(1): 87-95; 1952.

Julander, O.; Chournos, N. Utah experiments reveal pocket gophers play ruinous role in range reseeding. Natl. Wool Grower. 49(7): 17; 1959.

Julander, O.; Low, J. B.; Morris, O. W. Influence of pocket gophers on seeded mountain range in Utah. J. Range Manage. 12(5): 219-224; 1959.

Julander, O.; Low, J. B.; Morris, O. W. Pocket gophers on seeded Utah mountain range. J. Range. Manage. 22(5): 325-329; 1969.

Kalmbach, E. R. Rodents, rabbits and grasslands. In: Grass: Yearbook of Agriculture for 1948. Washington, DC: U.S. Department of Agriculture; 1948: 248-256.

Kalmbach, E. R. Report of investigations of Grand Mesa gopher project: Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Laboratory; 1950. 3 p. Unpublished M.S. thesis.

Keck, W. M. Great Basin Station, 60 years of progress in range and watershed research. Res. Pap. INT-118. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1972. 35 p.

Larrison, E. J. Pocket gopher and ecological succession in the Wenas region of Washington. Murrelet. 23(2): 34-41; 1942.

Laycock, W. A. An ecological study of the pocket gopher *Thomomys talpoides tennellus* Goldman in the Jackson Hole region of Wyoming. J. Range Manage. 6(6): 461-462; 1953.

Laycock, W. A.; Richardson, B. Long-term effects of pocket gopher control on vegetation and soils of a subalpine grassland. J. Range Manage. 28(6): 458-462; 1975.

McGinnies, W. G. Annual report of the Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1947. 69 p.

Moore, A. W.; Reid, E. H. The Dalles pocket gopher and its influence on forage production of Oregon mountain meadows. Circ. 884. Washington, DC: U.S. Department of Agriculture; 1951. 36 p.

Phillips, P. The distribution of rodents in overgrazed and normal grasslands of central Oklahoma. Ecology. 17(4): 673-679; 1936.

Ratliff, R. D.; Westfall, S. E. Non-grazing and gophers lower bulk density and acidity in annual-plant soil. Rep. No. FSRN-PSW-254. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1971. 5 p.

Reid, V. H. Response of small mammal populations to various intensities of livestock grazing in the southern Rocky Mountains Region. Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center; 1962. 36 p. Annual progress report (mimeo).

Reid, V. H. Small mammal populations in relation to grazing on Black Mesa. Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center, Wildlife Research Work Unit; 1966. 17 p. Annual progress report.

Reid, V. H. Small mammal populations in relation to grazing on Black Mesa. Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center, Wildlife Research Work Unit; 1967. 14 p. Annual progress report.

Tester, J. R.; Marshall, W. H. A study of certain plant and animal interrelations on a native prairie in northwestern Minnesota. Occ. Pap. 8. Minneapolis-St. Paul, MN: University of Minnesota, Museum of Natural History; 1961. 51 p.

Tietjen, H. P.; Halvorson, C. H.; Hegdal, P. L.; Johnson, A. M. 2,4-D herbicide, vegetation and pocket gopher relationships: Black Mesa, Colorado. Ecology. 48(4): 634-643; 1967.

Turner, G. T. Responses of mountain grassland vegetation to gopher control, reduced grazing, and herbicide. J. Range Manage. 22(6): 377-383; 1969.

Turner, G. T. Effects of pocket gophers on the range. In: Turner, G. T. (and others), eds. Pocket gophers and Colorado mountain rangeland. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973. 90 p.

Turner, G. T.; Hansen, R. M.; Reid, V. H.; Tietjen, H. P.; Ward, A. L. Pocket gophers and Colorado mountain rangeland. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973. 90 p.

U.S. Department of Agriculture, Forest Service. Annual report of the Rocky Mountain Forest and Range Experiment Station. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1943.

U.S. Department of the Interior, Fish and Wildlife Service. Do gophers harm rangelands?: contributions to the report of the Division of Wildlife, January 1-December 31, 1967. Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Denver Wildlife Research Center; 1968: 41 p.

Ward, A. L.; Hegdal, P. L.; Hansen, R. M. Herbicide, vegetation and pocket gopher relationships on Grand Mesa, Colorado. Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center, Colorado Cooperative Pocket Gopher Project; 1963. 29 p. Annual progress report.

Wilks, B. J. Some aspects of the ecology and population dynamics of the pocket gophers (*Geomys bursarius*) in southern Texas. Texas J. Sci. 15(3): 241-283; 1963.

Williamson, H. G. Habitat improvement evaluation: adaptability of wildlife plants. Oklahoma City, OK: Oklahoma Department of Wildlife Conservation; 1954. 5 p.

Soils (S)

Albrecht, W. Soil fertility and wildlife—cause and effect. In: Transactions, 9th North American Wildlife Conference; 1944 April 24-26; Chicago, IL. Washington, DC: American Wildlife Institute; 9: 19-28; 1944.

Bond, R. M. Rodentless rodent erosion. Soil Conserv. 6(10): 269; 1941.

Branson, F. A.; Miller, R. F.; McQueen, I. S. Plant communities and soil moisture relationships near Denver, Colorado. Ecology. 46: 311-319; 1965.

Carson, C. C. The waterworks laboratory and civil defense. J. NEWWA. 66: 144; 1952.

Davis, W. B.; Ramsey, R. R.; Arendale, J. M., Jr. The distribution of pocket gophers (*Geomys breviceps*) in relation to soils. J. Mammal. 19(4): 412-418; 1938.

Day, A. M. Soil erosion is often caused by burrowing rodents. U.S. Department of Agriculture, Yearbook for 1931. Washington, DC: U.S. Department of Agriculture; 1931: 481-484.

Ellison, L. The pocket gopher in relation to soil erosion on mountain range. Ecology. 27(2): 101-114; 1946.

Frank, E. C.; Brown, H. E.; Thompson, J. R. Hydrology of Black Mesa watersheds, Western Colorado. Gen. Tech. Rep. RM-13. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; 1975. 11 p.

Grinnell, J. The burrowing rodents of California as agents in soil formation. J. Mammal. 4: 137-149; 1923.

Ratliff, R. D.; Westfall, S. E. Nongrazing and gophers lower bulk density and acidity in annual-plant soil. Res. Note PSW-254. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; 1971.

Taylor, W. P. Some animal relations to soils. Ecology. 16(2): 127-136; 1935.

Burrow Environment (BE)

Blume, R. R.; Aga, A. *Aphodius* from burrows of a pocket gopher in Brazos County, Texas Coleoptera:Scarabaeidae. Coleopt. Bull. 29(3): 161-162; 1975.

Blume, R. R.; Aga, A. Additional records of aphodius from pocket gopher burrows in Texas USA Coleoptera:Scarabaeidae. Coleopt. Bull. 33(1): 131-132; 1979.

Bond, H. E. Revegetation and disintegration of pocket gopher mounds: on Black Mesa, Colorado. Fort Collins, CO: Colorado State University; 1959. Thesis.

Cartwright, O. L. New *Aphodius* from Texas gopher burrows. Entomol. News. 55(5): 129-135; (6): 146-150; 1944.

Chamberlin, R. V. Two new Lithobiid Chilopods from burrows of the Florida pocket gopher. Entomol. News. 51(2): 48-50; 1940.

Fagerstone, K. A.; Barnes, V. G., Jr.; Anthony, R. M.; Evans, J. Hazards to small mammals associated with underground strychnine baiting for pocket gophers, *Thomomys* spp. In: Proceedings, 9th vertebrate pest conference; 1980 March 4-6; Fresno, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1980: 105-109.

Funderburg, J. B.; Lee, D. S. The amphibian and reptile fauna of pocket gopher (*Geomys*) mounds in central Florida. J. Herpetol. 1: 99-100; 1968.

Gamboa, G. J. Effects of light and air on the trapping response of the pocket gopher, *Thomomys bottae* (Geomyidae). Southwest Nat. 19(4): 444-446; 1975.

Hegdal, P. L.; Gatz, T. A. Hazards to wildlife associated with underground strychnine baiting for pocket gophers. In: Proceedings, 7th vertebrate pest conference; 1976 March 9-11; Monterey, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1976: 258-266.

Hickman, G. C. Burrow system structure of *Pappogeomys castanops* (Geomyidae) in Lubbock County, Texas USA. Am. Midl. Nat. 97(1): 50-58; 1977a.

Hickman, G. C. Geomyid interaction in burrow systems. Texas J. Sci. 29(3-4): 235-244; 1977b.

Hickman, G. C. Burrow system structure of the *Bathyergid cryptomys hottentotus* in Natal South Africa. Z. Saeugetierkd. 44(3): 153-162; 1979.

Hubbell, T. H. A blind cricket-locust (*Typhloceuthophilus floridanus* n. gen. et sp.) inhabitating *Geomys* burrows in peninsula Florida (Orthoptera, Gryllacrididae, Rhaphidorphorinae). Annu. Entomol. Soc. Am. 33(1): 10-32; 1940.

Hubbell, T. H.; Goff, C. C. Florida pocket gopher burrows and their arthropod inhabitats. Q. J. Fla. Acad. Sci. 4: 127-166; 1939.

Kennerly, T. E., Jr. Microenvironmental conditions of the pocket gopher burrow. Texas J. Sci. 16(4): 395-441; 1964.

Laycock, W. A. The initial pattern of revegetation of pocket gopher mounds. Ecology. 39(2): 346-351; 1958.

Lechner, A. J. Respiratory adaptations in burrowing pocket gophers from sea level and high altitude. J. Appl. Physiol. 41(2): 168-173; 1976.

Miller, M. A. Burrows of the Sacramento Valley pocket gopher in flood-irrigated alfalfa fields. Hilgardia. 26(8): 431-452; 1957.

Murray, D. F. Gravel mounds at rocky flats, Colorado. Mountain Geol. 4(3): 99-107; 1967.

Ross, B. A.; Tester, J. R.; Breckenridge, W. J. Ecology of mima-type mounds in northwestern Minnesota. Ecology. 49(1): 172-177; 1968.

Ross, E. S. New Histeridae (Coleoptera) from the burrows of the Florida pocket gopher. Annu. Entomol. Soc. Am. 33(1): 1-9; 1940.

Ross, E. S. *Onthophilus kirni* new species, and two other noteworthy Histeridae from burrows of a Texas pocket gopher. Entomol. News. 55(5): 115-118; 1944.

Scheffer, T. H. Excavation of a runway of the pocket gopher (*Geomys bursarius*). In: Transactions, 1940 Kansas Academy of Science: 72nd Annual Meeting; 1940 March 28-30; Wichita, KA. Topeka, KA: Kansas Academy of Science; 1940: 473-478.

Scheffer, T. H. Burrow associations of small mammals. Murrelet. 26: 24-26; 1945.

Smith, C. F. A burrow of the pocket gopher *Geomys bursarius* in eastern Kansas. Kansas Academy of Science, Transactions 51(3): 313-315; 1948.

Vaughan, T. A. Vertebrates inhabiting pocket gopher burrows in Colorado. J. Mammal. 42(2): 171-174; 1961.

Damage to Forest Land (DTF)

Anon. Multimillion dollar menu. Weyerhaeuser News. 41: 17-19; 1959 July.

Barnes, V. G., Jr. Pocket gophers and reforestation: a problem analysis. Special Sci. Rep.-Wildl. No. 155. Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center, Forest Animal Damage Unit; 1973. 18 p.

Barnes, V. G., Jr. Survival and growth of ponderosa pine seedlings injured by pocket gophers. Tree Planters Notes 29(2): 20-23; 1979.

Black, H. C.; Dimock, E. J.; Dodge, W. E.; Lawrence, W. H. Survey of animal damage on forest plantations in Oregon and Washington. In: Transactions, 34th North American wildlife and natural resources conference; 1969 March 3-5; Washington, DC. Washington, DC: Wildlife Management Institute; 1969: 34: 388-408.

Buchner, R.; Rorabaugh, J. The mountain pocket gopher (*Thomomys monticola*) and some implications for timber management. Placerville, CA: U.S. Department of Agriculture, Forest Service, Eldorado National Forest; 1979. 36 p.

Canutt, P. R. Brief case history of several different reforestation situations in region six. Portland, OR: U.S. Department of Agriculture, Forest Service, Regional Forester's Office; 1967. 21 p.

Canutt, P. R. Relative damage by small mammals to reforestation in Washington and Oregon. In: Black, H. C., ed. Proceedings, symposium on wildlife and reforestation in the Pacific Northwest; 1968; Corvallis, OR. Corvallis, OR: Oregon State University, School of Forestry; 1969: 55-59.

Canutt, P. R. Pocket gopher problems and control practices on National Forest lands in the Pacific Northwest Region. In: Proceedings, 4th vertebrate pest conference; 1970 March 3-5; West Sacramento, CA. Davis, CA: University of California, Department of Agricultural Zoology, Vertebrate Pest Commission; 1970: 120-125.

Capp, J. C. Increasing pocket gopher problems in reforestation. In: Proceedings, 7th vertebrate pest conference; 1976 March 9-11; Monterey, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1976: 221-228.

Crouch, G. L. Animal damage to conifers on national forests in the Pacific Northwest region. Res. Bull. PNW-28. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1969. 13 p.

Crouch, G. L. Susceptibility of ponderosa, jeffrey and lodgepole pines to pocket gophers. Northwest Sci. 45(4): 252-256; 1971.

Davidson, E. D.; Barbour, M. G. Germination establishment and demography of coastal bush lupine *Lupinus arboreus* at Bodega Head, California, USA. Ecology. 58(3): 592-600; 1977.

Dingle, R. W. Pocket gophers as a cause of mortality in eastern Washington pine plantations. J. For. 54(12): 832-835; 1956.

Evans, J.; (and others). Survey of forest-animal damage in southwestern Oregon. Olympia, WA: U.S. Department of the Interior, Fish and Wildlife Service; 1981. 31 p. Job completion report, forest animal research project.

Hermann, R. K. Survival of planted ponderosa pine in southern Oregon. Res. Pap. 2. Corvallis, OR: Oregon State University, Forest Research Lab; 1965. 32 p.

Hooven, E. F. Pocket gopher damage on ponderosa pine plantations in southwestern Oregon. J. Wildl. Manage. 35(2): 346-353; 1971.

Ingles, L. G. The ecology of the mountain pocket gopher *Thomomys monticola*. Ecology. 33(1): 87-95; 1952.

Kuck, L. E. The effects of the northern pocket gopher on reforestation: activity and movement. Moscow, ID: University of Idaho; 1969. 49 p. Thesis.

Lantz, D. E. Pocket gophers as enemies of trees. In: Yearbook for 1909. Washington, DC: U.S. Department of Agriculture; 1909: 209-218.

Lawrence, W. H.; Kverno, N. B.; Hartwell, H. D. Guide to wildlife feeding injuries on conifers in the Pacific Northwest. Portland, OR: Western Forestry and Conservation Association; 1961. 44 p.

Miles, W. R. Hazard of growing Christmas trees. Conserv. Volunteer. 25(144): 10-15; 1961.

Miles, W. R.; Krefting, K. W.; Hansen, H. L. Pocket gopher damage in red and scotch pine Christmas tree plantations in central Minnesota. Minn. For. Note No. 110. St. Paul, MN: University of Minnesota, School of Forestry; 1961. 2 p.

Minore, D. The Dead Indian Plateau: A historical summary of forestry observations and research in a severe southwestern Oregon environment. Gen. Tech. Rep. PNW-72. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1978. 23 p.

Moore, A. W. Wild animal damage to seed and seedlings on cutover Douglas-fir lands of Oregon and Washington. Tech. Bull. 706. Washington, DC: U.S. Department of Agriculture; 1940. 28 p.

Moore, A. W. The pocket gopher in relation to yellow pine reproduction. J. Mammal. 24(2): 271-272; 1943.

Oregon Department of Forestry. Lowly gopher adds reforestation woes. The Forest Log. 31: 2; 1961.

Tevis, L., Jr. Pocket gophers and seedlings of red fir. Ecology. 37(2): 379-381; 1956.

Tietjen, H. P. Control of pocket gophers. In: Turner, G. T. (and others), eds. Pocket gophers and Colorado mountain rangeland. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973: 73-82.

Tietjen, H. P. 2,4-D vegetation and pocket gophers. In: Turner, G.T. (and others), eds. Pocket gophers and Colorado mountain rangeland. Bull. 554S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973: 63-71.

U.S. Department of Agriculture. Activity review report, pocket gopher-reforestation activity review: West. Reg. 4 and 6. Washington, DC: U.S. Department of Agriculture; 1979. 26 p.
U.S. Department of Agriculture, Forest Service. Control of pocket gopher in Texas. Washington, DC: U.S. Department of Agriculture, Forest Service; 1972. 15 p. Draft environmental impact statement.
Wight, H. M. Breeding habits and economic relations of The Dalles pocket gopher. J. Mammal. 11: 40-48; 1930.
Williamson, D. M.; Minore, D. Survival and growth of planted conifers on the Dead Indian Plateau east of Ashland, Oregon. Res. Pap. PNW-242. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1978. 15 p.
Working Group of the Northwest Pocket Gopher Committee. Survey of pocket gopher research in the western United States 1975. Portland, OR: Western Forestry and Conservation Association, Oregon-Washington Silvicultural Council, Northwest Pocket Gopher Committee; 1975. 5 p.
Working Group of the Northwest Forest Pocket Gopher Committee. Survey of pocket gopher damage to conifers in the Pacific Northwest, 1975. Portland, OR: Western Forestry and Conservation Association, Oregon-Washington Silvicultural Association, Northwest Pocket Gopher Committee; 1976. 7 p.

Damage to Rangeland, Agricultural Land, and Gardens (DTR)

Joki, W. M. Gophers or gardens? Org. Gard. 10(1): 19-22; 1946.
Jones, M. A. The pocket gopher, night raider, works alone. Better Homes and Gardens. 11: 22, 38-39; 1932 September.
Lantz, D. E. Rodent pests of the farm. Farmer's Bull. 932. Washington, DC: U.S. Department of Agriculture; 1918. 23 p.
Moore, P.; Skou, S.; Naer, E. The gopher menace. Calif. Citrog. 41: 273-275; 1956.
Moore, P. W. Underground problems brought to light. Calif. Citrog. 40: 251-252; 1955.
Morris, P. A. Circumstantial evidence. Better Homes and Gardens. 16(1): 104-107; 1937.
Scheffer, T. H. Concerning the pocket gopher and destructive habits. Better Fruit. 10(10): 7-8; 1916.
Scheffer, T. H. Habits and economic status of the pocket gophers. Tech. Bull. 224. Washington, DC: U.S. Department of Agriculture; 1931. 27 p.
Scheffer, T. H.; Garlough, F. E. Rodents and moles as pests in bulb plantings. Circ. 381. Washington, DC: U.S. Department of Agriculture; 1936. 16 p.
Silver, J. Rodent enemies of fruit and shade trees. J. Mammal. 5(3): 165-173; 1924.
Sparks, H. Money down the hole. Calif. Citrog. 38(6): 20-22; 1952.
Steinburg, H. M. The western gardeners' public enemy No. 1. Am. Homes. 21: 97; 1939 March.
Stiles, C. F. Don't let gophers ruin your alfalfa. Farmer - Stockman 60(1): 52; 1947.
Wight, H. M. Breeding habits and economic relations of The Dalles pocket gopher. J. Mammal. 11: 40-48; 1930.
Wisor, D. R. Your underground enemy. Calif. Citrog. 30: 319; 1945.

Damage to Buried Materials (DBM)

Connolly, R. A.; Landstrom, R. E. Gopher damage to buried cable materials. Mater. Res. Stand. 9(12): 13-18; 1969.
Howard, W. E. Tests of pocket gophers gnawing electric cables. J. Wildl. Manage. 17(3): 296-300; 1953.

Damage Control (DC)

Anon. Directions for destroying pocket gophers. Bi-175. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1919.
Anon. Killing gophers. Calif. Cultivator. 61: 390; 1923.
Anon. Killing gophers. Calif. Cultivator. 68: 539; 1927.
Anon. Stop the mound builders: use poison baits to control pocket gophers. Wallace's Farmer 55: 1004; 1930.
Anon. Gas chambers for gophers. Reclam. Era. 38(2): 27; 1952.
Agular, Dias A. Control de la Tuza (*Geomys* sp.). Fitolfilo. 12(24): 5-15; 1959.
Allen, A. W.; Johnson, S. J.; Keller, B. L. Success of pocket gopher control in reducing tree mortality. St. Anthony, ID: U.S. Department of Agriculture, Forest Service, Targhee National Forest; 1978. 22 p.
Altman, R. W. Controlling pocket gophers. Extension Facts No. 9001. Stillwater, OK: Oklahoma State University; 1966. 1 p.
Anthony, R. M.; Barnes, V. G., Jr. Evaluation of vexar tubes and increased stocking rates to alleviate reforestation losses by pocket gophers. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1980. 5 p. Annual progress report, forest ADC research project.
Anthony, R. M.; Barnes, V. G., Jr.; Evans, J. Vexar plastic netting to reduce pocket gopher depredation of conifer seedlings. In: Proceedings, 8th vertebrate pest conference; 1978 March 7-9; Sacramento, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1978: 138-144.
Atzert, S. P. A review of sodium monofluroacetate (compound 1080); its properties, toxicology and use in predator and rodent control. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service, Report by the Bureau of Sport Fisheries and Wildlife; 1971. 36 p.
Bare, Os. S.; Sooter, C. A. Pocket gopher control. Agric. Ext. Econ. 1544. Lincoln, NB: Nebraska Agricultural Extension Service; 1946. 47 p.
Barnes, V. R-6 silviculture workshop: pocket gopher damage control-state of the art. Colville, WA: U.S. Department of Agriculture, Forest Service, Colville National Forest; 1978. 2 p.

Barnes, V. G., Jr.; Fagerstone, K. A.; Anthony, R. M.; Evans, J. Effects of strychnine baiting in forest plantations on pocket gophers and other small mammals. Denver, CO: U.S. Department of the Interior, Fish and Wildlife Service, Denver Wildlife Research Center. 1980. 25 p. Job completion report, Forest ADC. Unpublished.

Barnes, V. G.; Martin, P.; Tietjen, H. P. Pocket gopher control on Oregon ponderosa pine plantations. J. For. 68(7): 433-435; 1970.

Baumgartner, D. M. Suppliers of pest repellents and traps. Pullman, WA: Washington State University; Cooperative Extension Service, College of Agriculture; 1972. Extension mimeo E.M. 3538.

Becker, E. M. Gopher control by the poisoning method. Calif. Citrog. 28: 182-183; 1943.

Becker, E. M. Vigil and vigor vanish vexatious varmit! Calif. Citrog. 31: 494; 1946.

Bell, W. B. 1925. Destroying pocket gophers. U.S. Golf Assoc. Bull. Green Sec. 5: 36-38; 1925 February.

Bell, W. B.; Piper, S. F. Extermination of ground squirrels, gophers and prairie dogs in N. Dakota. Circ. 4. Fargo, ND: North Dakota Agricultural Experiment Station, Agricultural College; 1915. 11 p.

Besemer, S. T. Mechanical gopher control on golf courses. Calif. Turfgrass Cult. 14(2): 16; 1964.

Birch, L. E. Guidelines for effective contract control of the Rocky Mountain pocket gopher. St. Anthony, ID: U.S. Department of Agriculture, Forest Service, Targhee National Forest, Ashton Ranger District; 1978. 46 p.

Black, H. C.; Hooven, E. F. Effects of herbicide-induced habitat changes on pocket gophers in southwestern Oregon. In: Proceedings, 29th Annual California Weed Conference. Sacramento, CA: California Weed Conference; 29: 119-127; 1977.

Blonk, H. Gassing the gopher: gas-work takes the guesswork out of killing gophers on (irrigation) canal banks. Reclam. Era. 37: 194-196; 1951.

Borrecco, J. E. Controlling damage by forest rodents and lagomorphs through habitat manipulation. In: Proceedings, 7th vertebrate pest conference; 1976 March 9-11; Monterey, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1976: 203-210.

Bristol, W. M. Getting gophers and squirrels. Pacific Rural Press. 87: 12; 1914.

Brock, E. M. Toxicological feeding trials to evaluate the hazard of secondary poisoning to gopher snakes *Pituophis catenifer*. Copeia. 2: 244-245; 1965.

Burnett, W. L. Pocket gophers with suggestions for control. Circ. 23. Fort Collins, CO: Office of the State Entomologist; 1917. 8 p.

Campbell, D. L.; Evans, J. "Vexar" seedling protectors to reduce wildlife damage to Douglas-fir. Leafl. 508. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1975. 11 p.

Canutt, P. R. New developments in gopher control. In: Proceedings, 1968 Western Reforestation Coordination Committee: annual meeting; 1968 December 3; San Francisco, CA. Portland, OR: Western Forestry and Conservation Association; 1968: 24-27.

Canutt, P. R. Development and operation of the forestland and burrow builder. In: Black, H. C., ed. Proceedings, symposium on wildlife and reforestation in the Pacific Northwest; 1968; Corvallis, OR. Corvallis, OR: Oregon State University, School of Forestry; 1969: 77-79.

Canutt, P. R. Pocket gopher problems and control practices on National Forest lands in the Pacific Northwest Region. In: Proceedings, 4th vertebrate pest conference; 1970 March 3-5; West Sacramento, CA. Davis, CA: University of California, Department of Agricultural Zoology, Vertebrate Pest Commission; 1970: 120-125.

Caroline, M. The pocket gopher burrow builder. Texas Agric. Prog. 6(4): 6-7; 1960.

Christensen, R. D. Environmental rodent control: summary report. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region, Range Improv. Notes. 17(3): 3; 1972.

Conrad, P. W.; McLaughlin, J. M. Can pocket gophers be controlled by anhydrous ammonia (NH^3) on mountain rangelands? U.S. Department of Agriculture, Forest Service, Intermountain Region, Range Improv. Notes. 16(4): 1-4; 1971.

Cook, J. B. Protecting young trees from gophers. Calif. Citrog. 39: 72, 89-90; 1954.

Copeman, Vander R. Poisoning by strychnine. J. For. Med. 4(4): 180-185; 1957.

Crabtree, D. G. Review of current vertebrate pesticides. In: Proceedings, 1st vertebrate pest control conference; 1962 February 6-7; Sacramento, CA. Elizabeth, NJ: National Pest Control Association; 1962: 326-362.

Crouch, G. L. Atrazine improves survival and growth of ponderosa pine threatened by vegetative competition and pocket gophers. For. Sci. 25(2): 99-111; 1979.

Crouch, G. L.; Frank, L. R. Poisoning and trapping pocket gophers to protect conifers in northeastern Oregon: forest pest control, rodent control. Res. Pap. PNW-261. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1979. 8 p.

Crouch, G. L.; Hafenstein, E. Atrazine promotes ponderosa pine regeneration. Res. Pap. PNW-309. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1977: 1-7.

Crouch, W. E. Pocket gopher control. Farmer's Bull. No. 1709. Washington, DC: U.S. Department of Agriculture; 1933. 21 p.

Crouch, W. E. Pocket gopher control. Conservation Bulletin No. 23. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1942. 20 p.

Cummings, M. W. Control of pocket gophers. In: Proceedings, 1st vertebrate pest control conference; 1962 February 6-7; Sacramento, CA. Elizabeth, NJ: National Pest Control Association; 1962: 113-125.

Dixon, J. Control of the pocket gopher in California. Bull. No. 281. Berkeley, CA: California Agricultural Experiment Station; 1917. 13 p.

Dixon, J. Control of the pocket gophers in California. Bull. No. 340. Berkeley, CA: California Agricultural Experiment Station; 1922: 337-350.

Dixon, J. Control of pocket gophers and moles in California. Circ. 29. Berkeley, CA: California Agriculture Experiment Station; 1929. 16 p.

Dixon, J. Methods for controlling pocket gophers and moles in California (excerpts). Calif. Citrog. 17: 331; 1932.

Driscoll, R. S. Repellents reduce deer browsing on ponderosa pine seedlings. Res. Note PNW-5. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1963. 8 p.

Eadie, W. R. Animal control in field, farm and forest. New York: MacMillan; 1945. 257 p.

Ellis, G. R. Plastic mesh tubes constrict black walnut root development after two years. Tree Planters Notes. 23(3): 27-28; 1972.

Evans, J.; Hegdall, P. L.; Griffith, R. E., Jr. Methods of controlling jack rabbits. In: Proceedings, 4th vertebrate pest conference; 1970 March 3-5; West Sacramento, CA. Davis, CA: University of California, Department of Agricultural Zoology, Vertebrate Pest Commission; 1970: 109-116.

Fagerstone, K. A.; Barnes, V. G., Jr.; Anthony, R. M.; Evans, J. Hazards to small mammals associated with underground strychnine baiting for pocket gophers *Thomomys* spp. In: Proceedings, 9th vertebrate pest conference; 1980 March 4-6; Fresno, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1980: 105-109.

Frank, L. Gopher control analysis report, fiscal year 1973. Bend, OR: U.S. Department of Agriculture, Forest Service, Deschutes National Forest; 1975: 11 p. Report 2650, Control December 15, 1972. 11 p.

Gabrielson, I. N. Controlling rodent and other small animal pests in Oregon. Ext. Bull. 335. Corvallis, OR: Oregon Agricultural College; 1921. 19 p.

Gabrielson, I. N. Controlling rodents and other small animal pests in Oregon. Ext. Bull. 629. Corvallis, OR: Oregon State College; 1944. 24 p. (Revised, Hansen, G. H., ed. 1957. 31 p.)

Gamboa, G. J. Effects of light and air on the trapping response of the pocket gopher *Thomomys bottae* Geomyidae. Southwest Nat. 19(4): 444-446; 1975.

Garlough, F. E. Research studies in the control of destructive mammals. Leaflet 91. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1937. 12 p.

Garlough, F. E.; Ward, J. C. Possibilities of secondary poisoning of birds and mammals. Science. 75: 335-337; 1932.

Golovanova, E.; Egorava, L. A prospective pesticide in the control of gophers. Zasheh. Rast. ot Ured. i Boleznei. 1: 21; 1965. In Russian.

Haigh, S. Poison gophers and rats. Pacific Rural Press. 90: 65; 1915.

Handley, M. H. County programs for vertebrate pest control in California (ground squirrel, pocket gopher, and meadow mouse). In: Proceedings, 8th vertebrate pest conference; 1978 March 7-9; Sacramento, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1978: 60-62.

Hansen, R. M. New dispenser aids gopher control. Pamphlet 1-S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1956. 8 p.

Hanson, W. O.; Smith, J. G. Significance of forage quality as a tool in wildlife management. In: Range and wildlife habitat evaluation - a research symposium. Misc. Publ. No. 1147. Washington, DC: U.S. Department of Agriculture; 1970: 25-31.

Hayne, D. W. Zinc phosphide: its toxicity to pheasants and effect of weathering upon its toxicity to mice. East Lansing, MI: Michigan Agriculture Experiment Station, Quarterly Bull. 33: 412-425; 1951.

Hegdal, P. L.; Gatz, T. A. Hazards to wildlife associated with underground strychnine baiting for pocket gophers. In: Proceedings, 7th vertebrate pest conference; 1976 March 9-11; Monterey, CA. Sacramento, CA: Department of Food and Agriculture, Control and Eradication, Vertebrate Pest Conference; 1976: 258-260.

Hickling, W. C.; Colberg, W. J. Pocket gopher control with the mechanical burrowing machine. Ext. Circ. A-368. Fargo, ND: North Dakota Agricultural College; 1962. 6 p.

Hines, T.; Dimmick, R. W. The acceptance by bobwhite quail of rodent baits dyed and treated with zinc phosphide. In: Proceedings, 1970 Southeastern Association of Game and Fish Commissioners: 24th annual conference; 1970 September 27-30; Atlanta, GA. Nashville, TN: Wildlife Resources Agency, Ellington Agricultural Center; 1970: 201-205.

Hoffer, M. C.; Passof, P. C.; Krohn, R. Field evaluation of DRC-714 for deermouse control in a redwood habitat. J. For. 67(3): 158-159; 1969.

Hood, G. A. Zinc phosphide—a new look at an old rodenticide for field rodents. In: Marsh, R. E., ed. Proceedings, 5th vertebrate pest conference; 1972 March 7-9; Fresno, CA. Davis, CA: University of California, Department of Animal Physiology, Vertebrate Pest Conference; 1972: 85-92.

Hornbeck, R. Hand gopher control. In: Proceedings, 1st reforestation workshop; 1968 March 6-8; Portland, OR. Portland, OR: U.S. Department of Agriculture, Forest Service, Region 6; 1968: 235-245.

Howard, W. E. Rodent control on California ranges. J. Range Manage. 6(6): 423-434; 1953.

Hull, A. C., Jr. Effect of spraying with 2,4-D upon abundance of pocket gophers in Franklin Basin, Idaho. J. Range Manage. 24: 230-232; 1971.

Ivan, O. A.; Levin, L. V.; Skalinov, S. V. Gliftor in the control of gophers. Zashch. Rast. ot Ured. i Bolzenei. 12: 10-11; 1964. In Russian.

Janda, J.; Bosseova, M. The toxic effect of zinc phosphide baits on partridges and pheasants. J. Wildl. Manage. 34(1): 220-223; 1970.

Johnson, D. R. Effects of range treatment with 2,4-D on food habits of rodents. Ecology. 45(2): 241-249; 1964.

Johnson, D. R.; Hansen, R. M. Effects of range treatment with 2,4-D on rodent populations. J. Wildl. Manage. 33(1): 125-132; 1969.

Johnson, W. V. Rabbit control. In: Proceedings, 2nd vertebrate pest conference; 1964 March 4-5; Anaheim, CA. Davis, CA: University of California, Department of Animal Physiology; 1964: 90-96.

Kalmbach, E. R. "Ten eighty" a war produced rodenticide. Science. 102: 232-233; 1945.

Kalmbach, E. R.; Welch, J. F. Color of rodent baits and their value in safeguarding birds. J. Wildl. Manage. 10(4): 353-360; 1946.

Keith, J. O.; Hansen, R. M.; Ward, A. L. Effect of 2,4-D on abundance and foods of pocket gophers. J. Wildl. Manage. 23(2): 137-145; 1959.

Kepner, R. A.; Howard, W. E. Mechanical gopher-bait applicator for pastures and open fields. Calif. Agric. 14(3): 7-14; 1960.

Kepner, R. A.; Howard, W. E.; Cummings, M. W.; Brock, E. M. Construction and use of U. C. mechanical gopher-bait applicator. Davis, CA: University of California, Agriculture Extension Service; 1961. 8 p.

Kepner, R. A.; Howard, W. E.; Cummings, M. W.; Brock, E. M. U. C. mechanical gopher-bait applicator. Davis, CA.: University of California, Agriculture Extension Service; 1962.

Kepner, R. A.; Howard, W. E.; Cummings, M. W. Mechanical application of gopher bait. American Society of Agricultural Engineers, Transactions 8(3): 335-337; 1965.

Kimbal, J.; Poulson, T. A.; Savage, W. F. An observation of environmental rodent control. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region; Range Improvement Notes. 15(2); 1970.

Klinger, G.; Hafenstein, E. L. Machine gopher control on the Winema National Forest. In: Proceedings, 1st forest reforestation workshop; 1968 March 6-8; Portland, OR. Portland, OR: U.S. Department of Agriculture, Forest Service, Region 6; 1968: 29-34.

Lantz, D. E. Destroying gophers and prairie dogs. Kansas State Board of Agriculture; Q. Rep. 21(81): 325-331; 1902.

Lantz, D. E. Directions for destroying pocket gophers. Circ. No. 52, rev. ed. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1908: 1-4.

Lawrence, W. H. Wildlife damage control problems on Pacific Northwest tree farms. In: Transactions, 23rd North American Wildlife Conference; 1958 March 3-5; St. Louis, MO. Washington, DC: Wildlife Management Institute; 1958: 146-151.

Lynch, G. M. The effect of strychnine control on nest predators of dabbling ducks. J. Wildl. Manage. 36(2): 436-440; 1972.

Marsh, R. E.; Plesse, L. F. Semipermanent anticoagulant baits. California Department of Agriculture, The Bulletin. 49(3): 195-197; 1960.

Marsh, R. E.; Cummings, M. W. Pocket gopher control with mechanical bait applicator. Pub. AXT-261. Berkeley, CA: University of California, Agricultural Extension Service; 1968. 8 p.

Marsh, R. E.; Cummings, M. W. Pocket gopher control with mechanical bait applicator. Leaflet 2699. Berkeley, CA: Cooperative Extension, U.S. Department of Agriculture and University of California; 1976. 7 p.

Martin, W. E. Toxicants commonly used in the animal damage control programs of the Division of Wildlife Services. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1971. 26 p.

McKeever, S. Compound 1080 and forest regeneration: characteristics of the poison in relation to bait shyness, poison shyness, toxicity to rodents and phytotoxicity to conifer seed. Sacramento, CA: California Department of Conservation, Division of Forest Reproduction; 1964. 18 p.

Mickel, C. E. Poisoning pocket gophers. St. Paul, MN: University of Minnesota, Agricultural Experiment Station; 1923. 4 p.

Mickel, G. Pocket gopher in Colorado. Fort Collins, CO: Colorado Agriculture College; 1957. 6 p.

Miller, M. A. Eradication of pocket gophers; comparative field tests demonstrate best poison, baits and dosages for practical gopher control. Calif. Agric. 4(12): 8-10; 1950.

Miller, M. A. Experimental studies on poisoning pocket gophers. Hilgardia. 22(4): 131-166; 1953.

Miller, M. A. Poison gas tests on gophers. Calif. Agric. 8(10): 7-14; 1954.

Miller, M. A.; Howard, W. E. Size of bait for pocket gopher control. J. Wildl. Manage. 15(1): 62-68; 1951.

Miller, M. A.; Hansen, R. S. New developments in pocket gopher control. Cattle Guard. 2: 32-33; 1956.

Moore, A. W.; Ward, J. C. The effect of altitude on the action of drugs. I. Strychnine. J. Am. Pharm. Assoc. 24(6): 460-464; 1935.

Morgan, D. N., ed. How Morrison gets gophers. Pacific Rural Press. 108: 482; 1924.

Murton, R. K. The use of biological methods in the control of vertebrate pests. In: Jones, P.; Solomon, M. E., eds. Biology in pest disease control: proceedings, 13th symposium of the British Ecological Society; 1972 January 4-7; Oxford. Oxford: Blackwell Scientific Publications; 1974: 211-233. 398 p.

Neff, J. B. Poison for gophers. Calif. Cultivator. 26: 149; 1906.

de Ong, E. R. Gopher control. Calif. Cultivator. 54: 5; 1920.

Packer, P. E. Site preparation in relation to environmental quality. In: Maintaining productivity of forest soils: Annual meeting of western reforestation coordinating committee; 1971 November 30-December 1; Portland, OR. Portland, OR: Western Forestry and Conservation Association; 1971: 23-27.

Palotas, G. New method for gopher control (Gas cartridge) (in Hungarian). Magyar Mezogazdasag. 23(8): 14-15; 1968.

Parten, H. L. Controlling pocket gophers. Agric. Ext. Folder 75. St. Paul, MN: University of Minnesota, Agricultural Extension; 1939. 6 p.

Parten, H. L.; Issac, R. Controlling pocket gophers. Agric. Ext. Folder 75. St. Paul, MN: University of Minnesota, Agricultural Extension; 1951. 8 p.

Pehrson, J. E. Growers war with gophers. Calif. Citrog. 49(11): 434; 1964.

Pehrson, J. E. Bait machines go for gophers. Western Fruit Grower. 19(7): 19; 1965.

Radosevich, S. R.; Howard, W. E.; Marsh, R. E. Preliminary report on: effects of vegetative manipulation and animal damage control in the regeneration of conifer seedlings: U.S. Department of Agriculture, Forest Service-University of California-Davis contract supplement -41. Davis, CA: University of California, Department of Botany; 1981. 12 p.

Ray, V. Response of pocket gophers (*Thomomys mazama*) to baiting with strychnine oats plus attractant in polyethylene bags. Tech. Rep. Pocket Gopher 042-4102/78/84. Centralia, WA: Weyerhaeuser Company, Western Forestry Research Center; 1978. 5 p.

Richens, V. B. An evaluation of control on the Wasatch pocket gopher. J. Wildl. Manage. 29(3): 413-425; 1965.

Richens, V. B. An evaluation of control on the pocket gopher (*Thomomys talpoides*) on the Cache National Forest. Logan, UT: Utah State University; 1967a. Dissertation.

Richens, V. B. Gophacide, latest findings from studies of this new rodenticide. Pest Control. 35(9): 28, 30, 50; 1976b.

Richens, V. B. The status and use of gophacide. In: Proceedings, 3rd vertebrate pest conference; 1968 March 7-9; San Francisco, CA. Davis, CA: University of California, Department of Agricultural Zoology, vertebrate pest conference; 1968: 118-125.

Robison, W. H. Acute toxicity of sodium monofluoroacetate to cattle. J. Wildl. Manage. 34(3): 647-648; 1970.

Rosedale, D. O. New device aids in gopher control. Western Fruit Grower. 15(7): 29; 1961.

Rosedale, D. O.; Cummings, M. W. Mechanical bait applicator controls gophers in citrus. Calif. Agric. 16(9): 14; 1962.

Rost, G. R. Effectiveness of gas cartridges for pocket gopher control. Boise, ID: U.S. Department of the Interior, Fish and Wildlife Service, Animal Damage Control; 1978. 6 p.

Rudd, R. L.; Genelly, R. E. Pesticides: their use and toxicity in relation to wildlife. Game Bull. No. 7. Sacramento, CA: California Department of Fish and Game; 1956. 209 p.

Salmon, T. P.; Marsh, R. E. Age as a factor in rodent susceptibility to rodenticides. In: Beck, J. R., ed. Vertebrate pest control and management materials: proceedings, 2nd symposium on test methods for vertebrate pest control and management materials; 1978 March 10; Monterey, CA. Philadelphia, PA: American Society for Testing and Materials; 1979: 84-100. ASTM STP 680.

Sanders, G. E. Gopher control by means of calcium cyanide. Agric. Gaz. Can. 8: 628-629; 1921.

Sargent, A. B.; Peterson, B. R. Pocket gopher control in Minnesota with the mechanical burrow builder. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Branch of Predator and Rodent Control; 1963. 18 p.

Saskatchewan; Chief Game Guardian. The effect of gopher poison on prairie chickens. BI-1028. Washington, DC: U.S. Department of Agriculture, Bureau of Biological Survey; 1918: 20-21.

Schroeder, M. H. Gophacide, a candidate for control of Ord's kangaroo rat. J. Wildl. Manage. 31(2): 339-341; 1967.

Skinner, W. W. Extermination of pocket gophers and ants. Ariz. Agric. Exp. Stn. Bull. 45: 227-230; 1902.

Slawson, H. H. Baits vs. gas for gophers. Pest Control. 22(12): 16; 1954.

Spencer, D. A. Chemical controls as a management measure. J. For. 60(1): 28-30; 1962.

Storer, T. I. Control of injurious rodents in California. Circ. 79. Berkeley, CA: California Agricultural Extension Service; 1938. 62 p.

Storer, T. I. Field rodent control by destruction of burrows. J. Wildl. Manage. 9(2): 156-157; 1945.

Storer, T. I. Control of field rodents in California. Circ. 138. Berkeley, CA: California Agricultural Extension Service; 1947. 51 p.

Storer, T. I. Controlling field rodents in California. Circ. 434. Berkeley, CA: California Agricultural Extension Service; 1953. 47 p. (Revised 1958. 50 p.)

Storer, T. I. Controlling pocket gophers and moles in gardens. Leaflet 135. Berkeley, CA: University of California, Agricultural Extension; 1961.

Storer, T. I.; Mann, M. P. Bibliography of rodent control. Rep. 182. Washington, DC: National Research Council, Insect Control Commission; 1946. 324 p.

Storer, T. I.; Mann, M. P. Bibliography of rodent control (first supplement) and bibliography of ANTU. Rep. 1. Washington, DC: U.S. Public Health Service, National Institute of Health; 1948. 76 p.

Tasker, J. B. Pocket gopher control in forest plantations. J. For. 49(2): 130-131; 1950.

Texas Agricultural College. Thumbs down on pocket gophers with poisoned grain. Ext. Leaflet 192. College Station, TX: Texas Agricultural College; 1954. 1 p.

Tietjen, H. P. 2,4-D, vegetation, and pocket gophers. In: Turner, G. T. (and others), eds. Pocket gophers and Colorado mountain rangeland. Bull. 544S. Fort Collins, CO: Colorado State University, Agriculture Experiment Station; 1973: 63-72.

Tigner, J. R.; Landstrom, R. E. Chemical protection methods progress. Electron. Packag. Prod. 8(4): 120-134; 1968.

Tissot, A. N. Control of the pocket gopher or "salamander". Circ. S-87. Gainesville, FL: Florida Agricultural Experiment Station; 1955. 10 p.

Tucker, R. K.; Crabtree, D. G. Handbook of toxicity of pesticides to wildlife. Resour. Publ. No. 84. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1970. 131 p.

U.S. Department of Agriculture. Activity review report, pocket gopher-reforestation activity review: West. Reg. 4 and 6. Washington, DC: U.S. Department of Agriculture; 1979. 26 p.

U.S. Department of Agriculture, Forest Service. Animal damage control handbook. FSH 1609.22 R6. Portland, OR: U.S. Department of Agriculture, Forest Service, Region 6; 1968. 226 p.

U.S. Department of the Interior, Fish and Wildlife Service. Pocket gopher control. Wildl. Leaflet 340. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1952. 6 p.

U.S. Department of the Interior, Fish and Wildlife Service. Pocket gophers and their control in Oregon. Forest Series, Animal Damage Control Leaflets. Portland, OR: U.S. Department of the Interior, Fish and Wildlife Service, Division of Wildlife Service; 1952. 2 p.

Van Gorder, C. L. Champion gopher catchers. Co. Agent & Vo-Ag Teacher. 16(5): 20-29; 1960.

Villa-Ramirez, B. Las Tuzas (control of pocket gophers as field pests). Tierra Mexico. 8: 546-549; 1953.

Ward, A. L.; Hansen, R. M. The burrow-builder and its use for control of pocket gophers. Spec. Sci. Rep., Wildl. No. 47. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service; 1960. 7 p.

Ward, A. L.; Hansen, R. M. Pocket gopher control with the burrow-builder in forest nurseries and plantations. J. For. 60(1): 42-44; 1962.

Ward, A. L.; Hegdal, P. L.; Richens, V. B.; Tietjen, H. P. Gophacide, a new pocket gopher control agent. J. Wildl. Manage. 31(2): 332-338; 1967.

Washburn, F. L.; Mickel, C. E. Effectiveness of calcium cyanide in poisoning the pocket gopher, *Geomys bursarius* (Shaw). Tech. Bull. 27. St. Paul, MN: Minnesota Agricultural Experiment Station; 1925. 14 p.

Washington State University. Pocket gopher control. Exten. Mimeo E. M. 3799. Pullman, WA: Washington State University; 1973. 17 p.

Washington State University. Pocket gopher control. Exten. Mimeo E. M. 1365. Pullman, WA: Washington State University; 1952. 10 p.

Webster, M. H. Controlling damage by deer, rabbits, porcupine and gophers in orchards. In: Proceedings, 1954 Washington State Horticultural Association: 50th annual meeting; 1954 December 6-8; Yakima, WA. Pullman, WA: Washington State Horticultural Association; 1954: 28-31.

Welch, J. F. A review of chemical repellents for rodents. J. Agric. Food Chem. 2(3): 142-149; 1954.

Wick, W. Q.; Landforce, A. S. Mole and gopher control. Ext. Bull. 804. Corvallis, OR: Oregon State University; 1965. 16 p.

Wight, H. M. The life history and control of the pocket gopher in the Willamette Valley. Bull. 153. Corvallis, OR: Oregon Agriculture Experiment Station; 1918. 55 p.

Williston, H. L. Control of animal damage to young plantations in the south. J. For. 72(2): 78-81; 1974.

Wolleb, E. Fumigating squirrels and gophers. Pacific Rural Press. 21: 180; 1881.

Worswick, J. D. Gopher control important. Calif. Cultivator. 92: 244-245; 1947.

Population Estimation (PE)

Artmann, J. W. Telemetric study of the pocket gopher, *Geomys bursarius*. St. Paul, MN: University of Minnesota; 1967. 81 p. Thesis.

Beck, R. F.; Hansen, R. M. Estimating plains pocket gopher abundance on adjacent soil types by a visual technique. J. Range Manage. 19(4): 224-225; 1966.

Driscoll, R. S.; Watson, T. C. Aerial photography for pocket gopher populations. In: Proceedings, 1974 symposium on remote sensing and photo interpretation; 1974 October; Banff, AL. Ottawa, ON: Canadian Institute of Surveying; 1974: 481-492.

Ingles, L. G.; Clothier, R.; Crawford, L. A. Methods of estimating pocket gopher populations. J. Wildl. Manage. 13(3): 311-312; 1949.

Julander, O.; Ferguson, R. B.; Dealy, J. E. Measure of animal range use by signs. Misc. Publ. 940. Washington, DC: U.S. Department of Agriculture; 1963. 172 p.

Mohr, C. O.; Stumpf, W. A. Comparison of methods for calculating areas of animal activity. J. Wildl. Manage. 30(2): 293-304; 1966.

Reid, V. H.; Hansen, R. M.; Ward, A. L. Counting mounds and earth plugs to census mountain pocket gophers. J. Wildl. Manage. 39(2): 327-334; 1966.

Capture, Housing, and Handling (CHH)

Baker, R. J.; Williams, S. L. A live trap for pocket gophers. J. Wildl. Manage. 36(4): 1320-1322; 1972.

Handley, G. H. Housing of the pocket gopher in captivity. J. Mammal. 25: 407-408; 1944.

Howard, W. E. A live trap for pocket gophers. J. Mammal. 33(1): 61-65; 1952.

Ingles, L. G. An improved live trap for pocket gophers. Murrelet. 30(3): 55-56; 1949.

Johnson, C. E. Notes on a pocket gopher in captivity. J. Mammal. 7(1): 35-37; 1926.

Keith, J. O. An efficient and economical pocket gopher enclosure. J. Range Manage. 14(6): 332-334; 1961.

Sargent, A. B. A live trap for pocket gophers. J. Mammal. 47(4): 729-731; 1966.

Scheffer, T. H. Hints on live trapping. J. Mammal. 15(3): 197-202; 1934.

Sherman, H. B. A box trap for the capture of live *Geomys*. J. Mammal. 22(2): 182-184; 1941.

Sherman, H. B.; Barrington, B. A. A pocket gopher cage. J. Mammal. 22: 91-93; 1941.

U.S. GOVERNMENT PRINTING OFFICE: 1983—676-032/1033 REGION NO. 8

Teipner, Cynthia Lea; Garton, Edward O.; Nelson, Lewis, Jr. Pocket gophers in forest ecosystems. Gen. Tech. Rep. INT-154. Ogden, Ut: U.S. Department of Agriculture. Forest Service, Intermountain Forest and range Experiment Station; 1983. 53 p.

A state-of-the-knowledge report on available information on gopher biology, ecology, damage, and control. Habits and related problems are reviewed for gopher species throughout the United States, but attention is focused on pocket gophers in northwestern forest enviroments. A bibliography containing over 1,000 literature citations is included.

KEYWORDS: pocket gopher, forest plantation protection, plastic seedling protectors, poison bait, burrow builder, tree damage

The Intermountain Station, headquartered in Ogden, Utah, is one of eight regional experiment stations charged with providing scientific knowledge to help resource managers meet human needs and protect forest and range ecosystems.

The Intermountain Station includes the States of Montana, Idaho, Utah, Nevada, and western Wyoming. About 231 million acres, or 85 percent, of the land area in the Station territory are classified as forest and rangeland. These lands include grasslands, deserts, shrublands, alpine areas, and well-stocked forests. They supply fiber for forest industries; minerals for energy and industrial development; and water for domestic and industrial consumption. They also provide recreation opportunities for millions of visitors each year.

Field programs and research work units of the Station are maintained in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)

FOREST SERVICE
U S
DEPARTMENT OF AGRICULTURE