Gary W. Witmer, USDA/APHIS Denver Wildlife Research Center, Washington State University, Pullman, Washington 99164-6410

and

Rodney D. Sayler and **Michael J. Pipas**, Dept. of Natural Resource Sciences, Washington State University, Pullman, Washington 99164-6410

Biology and Habitat Use of the Mazama Pocket Gopher (*Thomomys mazama*) in the Puget Sound Area, Washington

Abstract

The ecology and distribution of the Mazama pocket gopher is poorly understood and several subspecies are being considered for state and federal protection. We studied Mazama pocket gophers near Olympia, Washington from February-April 1992 and in April 1995 to describe their biology and habitat use as part of a larger assessment of experimental population control methods. Males were significantly larger than females in mass and standard body measurements. Gophers from two sites, Lacey and Olympia, Washington, had similar physical measurements, although gophers near Lacey weighed more and had longer tail and hind foot lengths, while gophers near Olympia had longer ear lengths. Olympia males had longer baculum lengths. The capture of pregnant and lactating females and dual occupancy of some burrows by males and females indicated that breeding activities were underway during this period. There was a nearly 1:1 sex ratio of males to females. Densities were lower (10/ha) near Lacey in an orchard with mowed grass and forb understory and past population control than for an unexploited population at the Olympia site (60/ha), containing a Christmas tree plantation with an understory of orchard grass and the invasive, introduced Scotch broom. Food caches occurred about 53 cm in depth and held about 200-250 g of root cuttings (2,500 g maximum), indicating that gophers in the area fed heavily on thistle and Scotch broom. Pocket gophers reinvaded 22 of 25 (88%) burrow systems within 10 weeks after removal trapping. The conflicting goals of population control to reduce agricultural damage versus protection of rare or threatened pocket gopher subspecies requires better information on taxonomy, distribution, and population status of subspecies. Limited home range sizes (108 m^2 for males; 97 m^2 for females), dependence upon common herbaceous and woody foods, and rapid reinvasion rates suggest that rare subspecies may be readily managed if taxonomic and population issues are clarified.

Introduction

Three genera of pocket gophers (*Geomys, Pappogeomys, Thomomys*) occur in North America (Hall 1981). These fossorial mammals are uniquely adapted to a life of extensive underground burrowing with the exploitation of a wide array of above and below ground vegetation for food (Chase et al. 1982, Nevo 1979). They may play important ecological roles in soil aeration, mixing, and drainage, and in the distribution and succession of plant species and communities (Chase et al. 1982). Additionally, gophers are preyed upon by numerous avian and mammalian predators, and their burrows (active and abandoned) are used by other animal species (Chase et al. 1982). Ecological equivalents to pocket gophers occur on most continents (Nevo 1979).

The taxonomic classification of pocket gophers in North America is in a state of flux and more than 300 species and subspecies have been described (Hall 1981). This may relate to the fact that populations of pocket gophers have significant genetic plasticity and are easily isolated by any of several factors: rocky, poorly drained, or excessively compacted soils; extensive forest cover with little understory vegetation; or land use practices such as extensive and regular plowing (Hall 1981). Little is known about the fossorial western pocket gopher (*Thomomys mazama*) of western Washington and Oregon despite their economic importance and uncertain population and taxonomic status (Witmer 1992). The original work of Dalquest and Scheffer (1944) still serves as the basic source of information on the species. Several of the six subspecies occurring in the Puget Sound area are being considered for federal or state protection (Washington Department of Fish and Wildlife 1994). At the same time, pocket gophers are generally considered a major pest in many agriculture and reforestation areas and are the object of extensive control efforts (Case 1983, Chase et al. 1982, Teipner et al. 1983). Consequently, it is important to learn more about the biology, habitat use, distribution, and taxonomy of this species so that appropriate management decisions can be made. We collected data on the biology and habitat use of Mazama pocket gophers during field trials of experimental methods of population control in the Lacey, Washington (1992) and Olympia, Washington (1995) areas.

Study Area and Methods

Field data were collected at the Washington Department of Natural Resources' Meridian Seed Orchard, near Lacey (1992) and at the Olympia airport (1995), Thurston County, Washington. The sites are about 15 km apart. The Orchard is located in T17N, R1W, Section 1. The airport is located at T17N, R2W, Section 14. The sites are in the Puget Sound Area of the Western Hemlock (*Tsuga heterophylla*) vegetation zone (Franklin and Dyrness 1973). The most common tree species in the area is Douglas-fir (*Pseudotsuga menziesii*). The areas are at about 50 m above mean sea level and receive about 90 cm of precipitation annually. Soils are Tumwater gravelly-sandy loams and derive from glacial drift and outwash. The Lacey study was conducted on an 3.3 ha mowed field that had been forested until about 1985. Tree stumps were removed and the area was converted to agricultural use. After an oat crop was produced on the site for two seasons, the field has been fallow and mowed once per year. The Olympia study was conducted on 0.6 ha of Christmas tree plantation with an understory dominated by orchard grass (*Dactylis glomerata*) and Scotch broom (*Cytisus scoparius*). Because of the mild climate, well-drained soils, abundant herbaceous vegetation, and lack of tree cover canopy cover, both sites can be considered to represent good quality pocket gopher habitat and are probably typical of many non-forested areas in the Puget Sound area.

During late February 1992, pocket gophers were live-trapped, anesthetized with methoxyflurane, and 6 g radiocollars and leg bands attached. Animals were allowed to recover and then released back into their burrow opening. Twenty-five animals were radiocollared at the Lacey site. Each animal was located daily and monitored briefly for movement/activity. The final radiotelemetry data were collected in early April 1992. Consequently, data presented here on densities, home ranges, and burrow, nest, and food cache depths represent the late winter/early spring period. This is a period when only adults and subadults (not juveniles) are present. Animals recovered dead during the course of an experimental toxic bait study were recovered and necropsied. In addition to mass at the time of capture, information was obtained from necropsies on standard body measurements, sex, and reproductive status. Animals still alive at the end of experimental field trials or with nonfunctional radiotransmitters were recovered by live-trapping, euthanized, and necropsied. During a four day period in April 1995, pocket gophers were live-trapped or kill-trapped at plots at the Olympia site. Information on mass, standard body measurements, sex ratio, and density were recorded. T-test analyses were performed to test for differences between sexes and between study sites and evaluated at the a=0.05 significance level.

Results and Discussion

Twenty-five pocket gophers were captured, radiocollared, and monitored over the course of about 40 days of field trials at the Lacey site. Because of the timing of these field trials, all animals were 1+ years old (i.e., adults and subadults); some were probably about to enter their first breeding cycle. Information on mass and standard body measurements are presented for nine females and ten males (Table 1). Data on six animals were not obtained because the animals had radiocollars chewed off and were never recovered (N=2) or succumbed to predation (N=4). Data are also presented for 21 females and 17 males from the Olympia site (Table 1). Males were significantly heavier and larger than females, but there was overlap in the range of masses and measurements (Table 1).

Despite the fact that the two sites are only about 15 km apart, we found significant differences in some masses and body measurements between the two populations of females and of males. The Lacey gophers had been captured about a month earlier in the year than the Olympia gophers, but this does not entirely account for the heavier body masses from the Lacey site. Five of the Lacey gophers captured and weighed in late February were also captured and weighed in early April (the latter being the time period of capture of the Olympia gophers). These Lacey gophers had declined somewhat in weight, but not significantly (t-test = 1.2, 8 df, p = 0.267). Lacey females were

TABLE 1. Average weights and standard body measurements (SD) for male and female pocket gophers, *Thomomys mazama*, collected near Lacey and Olympia, WA, during 1992, and 1995, respectively.[a]

Sex & Study Site	Weight (g)	Total Length (mm)	Tail Length (mm)	Hind Foot Length (mm)	Ear Length (mm)	Baculum Length (mm)	Max. Testis Length (mm)
A. Females:							
Lacey (N=9)	126.7* (14.1)	211.1 (7.8)	60.1* (5.0)	28.0 (1.6)	7.0* (0.0)	—	—
Olympia (N=21)	104.1* (14.9)	205.2 (6.2)	54.2* (4.8)	27.0 (1.0)	7.5* (0.6)	—	—
	p=0.001	p=0.066	p=0.010	p=0.108	p=0.022		
B. Males:							
Lacey (N=10)	146.7 (16.9)	221.8 (8.4)	62.2* (4.3)	30.2* (2.1)	7.7* (2.2)	24.3* (2.2)	12.4 (1.5)
Olympia (N=17)	134.6 (10.4) p=0.061	223.2 (7.0) p=0.667	57.2* (4.7) p=0.011	28.5* (0.7) p=0.033	8.4* (0.5) p=0.017	26.6* (1.9) p=0.015	13.4 (0.8) p=0.072
C. Sites Combined:							
All Females (N=30)	111.0* (17.9)	207.0* (7.1)	56.1* (5.5)	27.3* (1.3)	7.4* (0.6)	—	—
All Males (N=27)	139.1* (14.2) p=0.000	222.7* (7.4) p=0.000	59.1* (5.1) p=0.036	29.1* (1.6) p=0.000	8.1* (0.6) p=0.000	25.7 (2.3)	13.0 (1.2)
D. Sexes Combined:							
Lacey (N=19)	137.2* (18.4)	216.7 (9.6)	61.2* (4.6)	29.2* (2.2)	7.4* (0.6)	—	—
Olympia (N=38)	117.8* (20.1)	213.3 (11.1)	55.6* (4.9)	27.7* (1.1)	7.9* (0.7)	—	—
	p=0.000	p=0.250	p=0.000	p=0.010	p=0.008		

[a]Paired values in columns marked with asterisks are significantly different (P<0.05).

significantly heavier, somewhat longer in total length, and had significantly longer tails and shorter ears (Table 1). They had similar hind foot lengths. Lacey males were somewhat heavier, had similar total lengths, had significantly longer tails and hind feet, but significantly shorter ears (Table 1). Baculum lengths were significantly longer in Olympia males, but testes lengths were similar. This pattern was also observed when the sexes at each site were combined: Lacey gophers were significantly heavier, somewhat longer, had significantly longer tails and hind feet, but significantly shorter ears (Table 1). This result is interesting because the two sites are presumably within the range of the same subspecies, T. m. tumuli. Smith and Patton (1980) noted that genetic variation and a lack of breeding barriers between isolated gopher populations can occur because of occasional influx of dispersing individuals, whereas gopher morphology may vary substantially between nearby populations because of a more direct response to environmental conditions (e.g., soil type, weather regime, available forage). Hence, they suggest less taxonomic splitting of isolated gopher populations into distinct species and subspecies. The masses and measurements we report are in about the middle of the range published by Ingles (1965) and Hall (1981) for T. mazama. We note, however, the difficulty of identifying subspecies based on external measurements and weight of specimens in the hand: most of the six subspecies' measurements and weights given by Dalquest and Scheffer (1944) fall within ±1 standard deviation (SD) unit of our masses and measurements and all fall within ±2 SD. Considerably more research may be required to resolve taxonomic issues of isolated gopher populations in the Puget Sound area.

The sex ratio of males and females at the Lacey site was not different from a ratio of 1:1 (9 females, 10 males). Five of 23 field estimations of sex of live animals, based on palpation of baculum and pubic gap, proved to be in error (22%) when estimates were later compared with necropsy results. We caution researchers not to rely too heavily on results of sexing live animals in the field. McCravy and Rose (1992) provided similar warnings to researchers regarding the determination of reproductive status of live, in-hand, small mammals. The sex ratio of gophers at the Olympia site was somewhat skewed towards females (21 females, 17 males), but suggests a nearly 1:1 ratio.

Baculum length averaged 25.7 mm (SD = 2.3; range = 20-30; n = 27) and fell within the range reported by Ingles (1965) and Hall (1981) for T. mazama. The measurement is useful to distinguish *T. mazama* from all other species of Thomomys, but is not generally used to distinguish subspecies of *T. mazama*. Despite overlap in the ranges of baculum lengths, we found a significant difference in lengths between the two sites, suggesting that this measurement may be useful in distinguishing populations of *T. mazama* in the Puget Sound area. Testes, with the exception of one individual, were both developed with one usually 1-2 mm larger (in the long axis) than the other. The average maximum length of the larger testis was 13.0 mm (SD = 1.2; range = 10-15; n = 27) and was similar between sites.

One of the 9 necropsied females at the Lacey site was pregnant, bearing 7 fetuses (2 large, 5 small). Three other females were post-partum with turgid uteri and swollen teats. Five placental scars were observed in one of these uteri, 2 in another; none could be discerned in the third. Litter sizes reported in the literature average about 5, but range from 2-8 (Chase et al. 1982, Ingles 1965). Five of the 9 (56%) females necropsied from the Lacey site were not pregnant or post-partum, but the study was conducted relatively early in the breeding season. A higher incidence of pregnant or post-partum individuals may have been observed 1 or 2 months later (Verts and Carraway 1991). At the Olympia site, 19 of 21 females (90.5%) were not pregnant at the time of capture. Two females (9.5%) were pregnant, each carrying 4 fetuses.

The gopher population at the Lacey site occupied a field that had been densely forested about 6 years before the study. Prior to tree harvest, the forested area probably supported few gophers because gophers require the forbs and grasses of an early successional stage for food. Additionally, gopher population reduction activities after forest removal occurred on several occasions in recent years. Information on Mazama pocket gopher distribution in the Puget Sound area is primarily based on Dalquest and Scheffer (1944). At that time, disjunct populations occupied nonforested areas, primarily glacial-outwash prairies. Very few locational records of western pocket gophers are in the Priority Habitats and Species database (Washington Department of Fish and Wildlife, unpubl. data, 1995). We speculate that the current distribution of pocket gophers may differ with populations being more widespread because of extensive deforestation in the south Puget Sound area. For example, aerial photographs of Thurston County, WA, which was historically largely forested, show large areas that have been deforested for urban development, agriculture, right-of-ways, and other development (Pringle 1990). Updated distribution maps are needed before informed management decisions can be made on the need for protection and the threat of new developments on specific subspecies.

The population at the Lacey site occupied a 3.3 ha field which contained at least 32 individual burrow systems; a few systems with little surface activity may have been overlooked. Consequently, we estimate a minimum subadult/adult density of 10 gophers per ha. Later in the year, after production of young, the density could become much greater (perhaps 5 times larger) until dispersal occurred. During March, while live-trapping animals to recover radiocollars, we caught 2 adults in each of several burrow systems, indicating the mating season was underway, as has been noted by others (Marsh and Steele 1992; Teipner et al. 1983). Gopher densities at the Olympia site were 6 times higher (60 per ha), perhaps because of more favorable habitat or because gopher populations there had not been previously reduced by the use of toxicants or kill traps as on several occasions in recent years at the Lacey site. At least five of these burrow systems were occupied by an adult male and female.

Home ranges for males (108 m2; SD = 37.9; range = 73-143; n = 4) were somewhat larger than for females (97 m2; SD = 57.1; range = 47-151; n = 4) at the Lacey site. These home ranges are somewhat smaller than figures reported in the literature for the species and subspecies of Thomomys (Chase et al. 1982; Teipner et al. 1983). Because we only monitored animals at this study site between February-April, 1992, it is possible that annual home ranges for pocket gophers would be somewhat larger. Marsh and Steele (1992) noted, however, that home ranges for pocket gophers are relatively uniform throughout the year. It is also possible that the field, with its dense herbaceous plant cover mowed only once per year in the late summer or fall, provided for the food requirements of individual pocket gophers in a relatively small area. Home ranges are generally smaller in better quality habitat (Chase et al. 1982; Marsh and Steele 1992). Some radiocollared pocket gophers were recovered dead in their nests because part of the Lacey study was a test of an experimental rodenticide. These nests were at an average depth of 88.5 cm (SD = 25.9; range 48-150; n = 12). The chambers were roughly ovoid in shape, about 25 cm in diameter and 15 cm in height, and consisted of dry grass often with a few pieces of plastic and root cuttings. The nests were notably clean as excretory wastes were deposited in nearby fecal chambers.

We occasionally encountered food caches while excavating pocket gopher nests or burrows. Gophers typically clip and cache fleshy and succulent roots and stems (Marsh and Steele 1992). Five caches at the Lacey site averaged a depth of 52.8 cm (SD = 15.0; range = 36-72). These chambers were about 30-60 cm from the nest, were about 23 cm in diameter and about 18 cm in height. They were usually full of a single type of root cuttings with segments 2.5-5 mm in diameter and about 3 cm long. The most common plant species were thistle (*Cirsium* spp.) and Scotch broom (*Cytisus scoparius*). Most caches contained about 200-250 g of cuttings, but one cache had about 2,500 g of cuttings. One food cache at the Olympia site was encountered; it contained root cuttings of Scotch broom and weighed 782 g.

While many burrows were located in the top 25 cm of soil at the Lacey site where foraging in the high density root zone occurs, some were much deeper. Based on the recovery of 5 radiocollared gophers from burrows, deep burrows averaged 141 cm in depth (SD = 21.9; range = 119-150). Deep burrows may provide important refugia during inclement weather and may help drain the burrow system during periods of heavy or prolonged rainfall (Teipner et al. 1983).

During the course of the Lacey study, 4 of 25 (16%) radiocollared gophers were taken by predators. The most common predator was believed to be red-tailed hawks (*Buteo jamaicensis*). Because an experimental rodenticide was being used, however, we cannot be sure that this rate reflects a natural rate. Mortality rates may be very high in late summer/fall when juveniles are dispersing (Marsh and Steele 1992).

We rechecked the 25 burrow systems at the Lacey site 10 weeks after all 25 radiocollared adults and several presumptive mates had been removed. Twenty-two of 25 (88%) systems were reoccupied, based on the open hole occupancy method (Barnes et al. 1970). Consequently, there appears to be a high reinvasion rate of burrow systems as noted by others (Marsh and Steele 1992; Teipner et al. 1983). Because of the large investment of energy in making a burrow system, burrows are believed to be a valuable resource sought out by dispersing gophers (Reichman and Smith 1990).

It is apparent that more research is needed to determine the distribution and status of subspecies of western pocket gophers in the Puget Sound area. It is also apparent that pocket gopher populations can vary in numerous morphological characteristics despite relatively close (15 km) proximity. Better documentation of these differences may help managers and interested parties more readily identify endangered from non-endangered subspecies of pocket gophers. Management of rare or threatened pocket gopher subspecies should be possible by providing adequate burrowing and foraging habitat, if subspecies can be more readily identified and monitored in the future.

Acknowledgements

We thank the Washington Department of Natural Resources, especially manager Joanne Kaye, for providing the use of the Meridian Seed Orchard as a study site. We also thank Olympia airport operations supervisor, John Berntsen, for allowing the opportunity to study pocket gophers there. We also thank Jim Farley, John Farley, and Ted Otto for assistance with field work.

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Received 23 July 1995
Accepted for publication 19 December 1995