

The Plains Pocket Gopher
(Geomys bursarius)
in Manitoba - An assessment
of its biology, habitat requirements,
and management options.

by

©Michael Oberpichler

A Practicum Submitted in
Partial Fulfillment of the
Requirements for the Degree
Master of Natural Resources Management

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A practicum submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of Master of Natural Resources Management.

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ABSTRACT

The plains pocket gopher (Geomys bursarius) was designated as "Vulnerable" by the Committee on the Status of Endangered Wildlife in Canada in 1988. Since limited data about the Canadian population existed, there was a need to identify basic ecological parameters in order to improve management decision-making.

This study investigated the status of the plains pocket gopher in southern Manitoba. G. bursarius prefers sandy, loamy soil and resides in alfalfa/hay and pasture areas most often. Their distribution is 5 - 6 km further north, and about 6.4 km further east than reported previously. Males in the sample significantly outweigh females and many more females were caught than males. The ectoparasitic flea Foxella ignota appeared in small numbers on 20% of the gophers captured. The breeding season starts as early as April 10 and continues through to June 21. Females produce an average of 3.46 young/pregnancy.

No control programs exist in Manitoba on a provincial, municipal, or local basis. A survey of selected U.S. states within the known range of G. bursarius showed a similar result. Literature on control methods is available from some areas with plains pocket gopher populations.

Land use data in the study area were obtained in the field in 1987 and 1988 and from Statistics Canada for census years 1981 and 1986. These data indicate that land use patterns are stable or improving for pocket gophers. Private and crown land comparisons show that private lands contain more gophers and better gopher habitat. Prime areas of habitat are identified and their potential as sanctuaries assessed.

Recommendations are made regarding future management of the plains pocket gopher in Manitoba. Additional studies of gopher ecology should be mounted as well as ongoing monitoring of distribution and demographics. The Canadian population of G. bursarius does not require immediate active preservation, but if monitoring demonstrates a need, the establishment of a sanctuary (which may include other vulnerable/endangered species) should be considered. The most suitable form of sanctuary, among those currently available in Manitoba, would be a Tall Grass Prairie Reserve currently being discussed by the World Wildlife Fund, the Manitoba Naturalists Society, Wildlife Habitat Canada, Manitoba Habitat Heritage Corporation, and Manitoba Department of Natural Resources.

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Chapter I
INTRODUCTION

1.1 PREAMBLE

The plains pocket gopher (Geomys bursarius Shaw) is a fossorial rodent that occurs in extreme south-central Manitoba (Wrigley and Dubois 1973). This is the only area in Canada where this species is found. Due to limited range and low population in Canada, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has designated the species as Rare¹ (Shoesmith 1984). In 1988, COSEWIC revised the Rare category and renamed it Vulnerable (M. Shoesmith, pers. commun.).

The Canadian portion represents the northernmost part of the gopher's range and questions have been asked as to why preserving this small population is important when the bulk of their distribution occurs in the United States. The plains pocket gopher is a component of one of the most endangered ecosystems in Canada - the prairie (World Wildlife Fund 1988). The prairie ecosystem in Canada,

¹ Rare/Vulnerable - "any indigenous species of fauna or flora that, because of its biological characteristics, or because it occurs at the fringe of its range, or for some other reason, exists in low numbers or in very restricted areas in Canada but is not a threatened species" (Cook and Muir 1984).

comprised of the tall, mixed, and short-grass prairie and aspen parkland, is endangered because of man's influence upon the land. Agriculture has had the most significant impact on habitat and therefore the number of animal species that are able to inhabit this ecosystem. Society must ensure that at least a portion of the prairie is preserved in Manitoba, otherwise further degradation will result in a monoculture environment and a loss of genetic diversity.

This rationale has been propounded by many, including van Zyll de Jong and Nero (1971), Smith (1980), and Odum (1983). A healthy ecosystem is one in which there is a diversity of organisms. Species are being lost at an ever increasing rate because of man's impingement on wildlife habitat. Society should not be responsible for the disappearance of another species in our country. No matter how small its distribution, the Canadian plains pocket gopher is as important as any other species in providing an ecological and aesthetic as well as a scientific value (van Zyll de Jong and Nero 1971). G. bursarius would make excellent subjects for the study of limiting factors of temperature, water, soil, permafrost, and interspecific competition (Smith 1980, Odum 1983). Any one or combination of these factors can result in range, density, number, and phenotypic variations in the Canadian population, possibly making them distinctly different from populations more centrally located in the range (Smith 1980, Odum 1983).

1.2 PROBLEM STATEMENT

Data on the Canadian population of the plains pocket gopher are limited. The occurrence of the species was initially recorded by Bailey (1926), with further work done by Soper (1944). The species was not studied again until Wrigley and Dubois (1973) mapped the gopher's range. Limited work has been done in Manitoba since that time on any aspect of pocket gopher ecology.

It is not known what effect agriculture and human control methods are having on gopher habitat or population numbers. Without assessing current trends and potential factors that may be threatening the species, management plans for the plains pocket gopher cannot be formulated.

Since the plains pocket gopher is listed as a "Vulnerable" species of Canada, a study of its life history and ecological parameters is needed. Basic data are required to determine if the species needs protection. In addition, the need for acquiring habitat in Agro-Manitoba that may be used as a sanctuary for the gophers must be addressed.

1.3 OBJECTIVES

The purpose of this study was to gather data concerning general ecological parameters of the plains pocket gopher in Manitoba and to identify, if necessary, habitat areas that may meet the requirements for a potential sanctuary. Thus, the objectives were to:

1. determine ecological factors influencing plains pocket gophers in Manitoba,
2. determine the distribution of the species in Manitoba,
3. investigate control methods proposed or in place at the provincial, municipal, and local levels in Manitoba and in the United States,
4. analyze land use changes and document optimal habitat locations in the study area,
5. assess the need and feasibility of acquiring suitable habitat for gophers in terms of:
 - i) ecological requirements, and
 - ii) legal and administrative requirements, and
6. recommend management alternatives for the plains pocket gopher in Manitoba.

Chapter II

BACKGROUND

2.1 INTRODUCTION

The plains pocket gopher recently has been given the status of "Vulnerable" by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This species has not been studied extensively in Canada and data are lacking about population distribution, general ecology, and management. This study is in response to that need.

2.2 DESCRIPTION

The plains pocket gopher is so named because of its fur-lined cheek pouches or pockets used for carrying food (Fig. 1). These pouches may be turned inside out in order to release the food. The animal is built powerfully in the forequarters, since a great deal of time is spent excavating the burrow system (Banfield 1974, Jones et al. 1983). The head is fairly small and flattened. The forepaws have claws up to 3 cm in length. Plains pocket gophers also have small external ears, small eyes, and lips that close behind the incisors to prevent soil from entering the mouth when digging occurs (Banfield 1974, Jones et al. 1983).

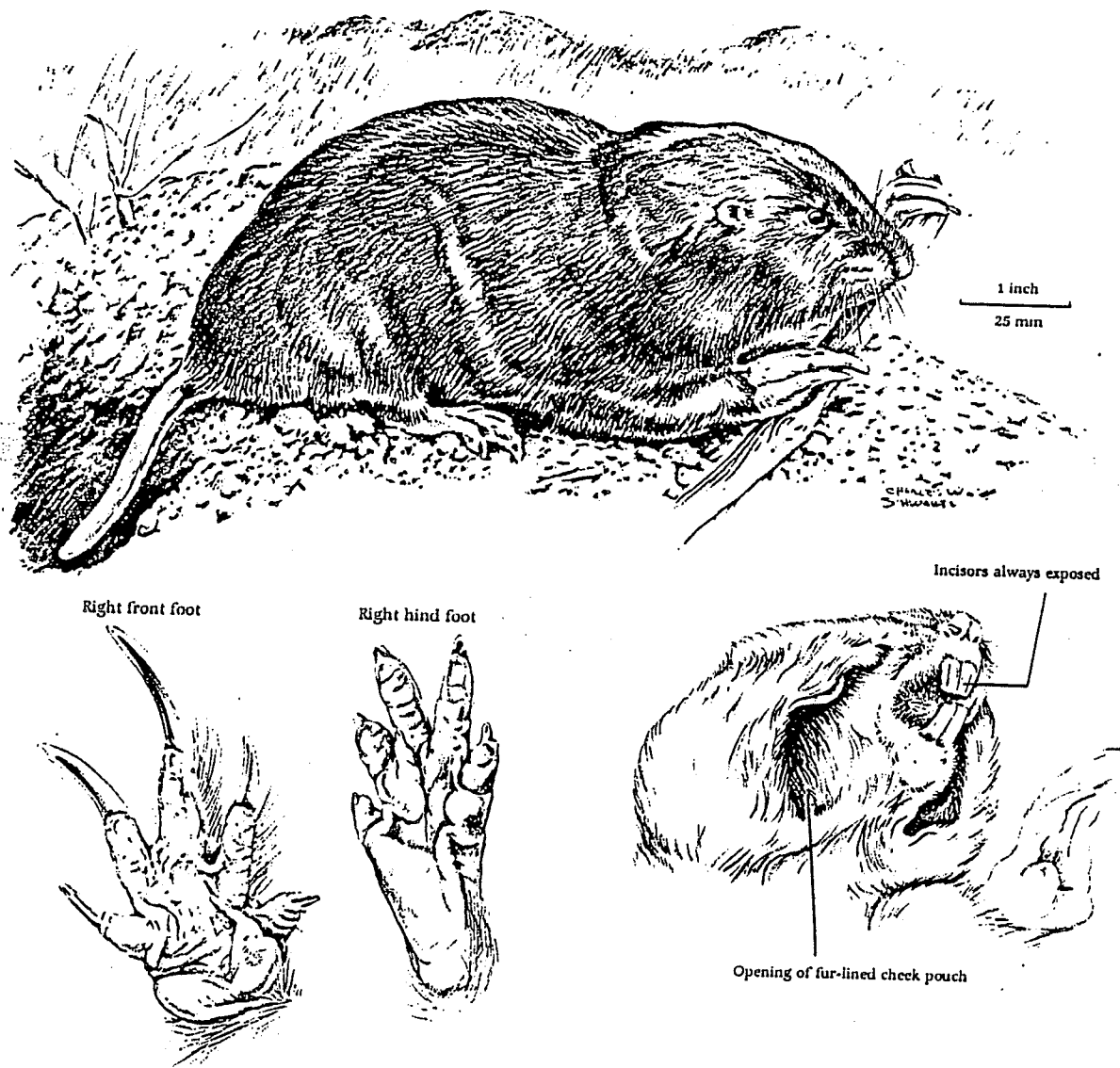


Figure 1: The plains pocket gopher (top), the fur-lined cheek pouches and grooved incisors (right), and feet (left) (Schwartz and Schwartz 1981).

Their tail is short and sparsely haired, and serves a sensory function when the gopher has to move backwards in the tunnel. Vibrissae (whiskers) on their face are sensitive to touch and also assist the gopher in moving around in a dark environment (Jones et al. 1983).

Plains pocket gophers have two grooves on each upper incisor, thus distinguishing them from other species of gophers (Fig. 1). The total length usually varies from 17.8 to 35.6 cm and males are generally longer and heavier than females (Case 1983). The short fine fur is typically light brown for most Manitoba specimens, although black and even spotted individuals have been caught in the United States (Vaughan 1962).

2.3 RANGE

2.3.1 North American Distribution

The plains pocket gopher range occurs in the north from extreme southern Manitoba to the eastern portions of North and South Dakota and western Wisconsin; west through Wyoming, Colorado, and New Mexico; east through Iowa and Illinois to northwestern Indiana; and as far south as Texas, Louisiana, Arkansas, and Missouri (Hall 1981) (Fig. 2).

In contrast to its extensive distribution in the United States, the plains pocket gopher in Canada is limited to a

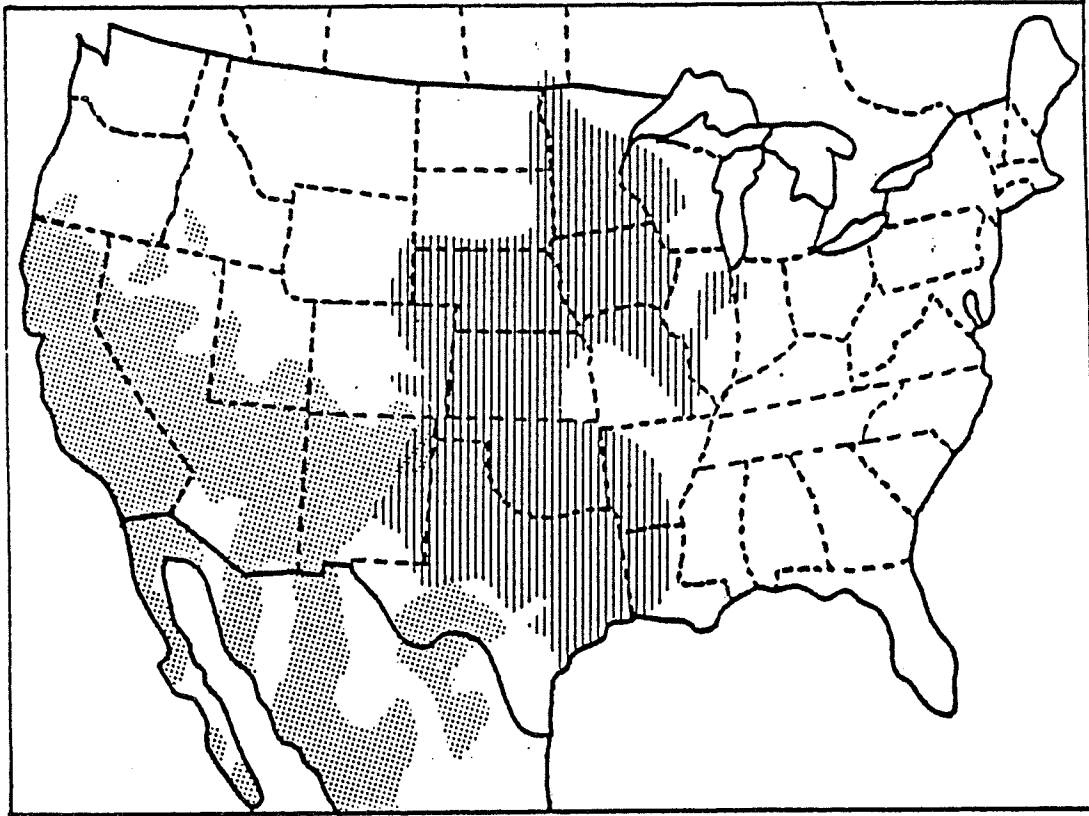


Figure 2: Plains pocket gopher range in North America (vertically shaded region, Hall 1981).

small (500 km²) portion of southern Manitoba (Fig. 3). The species was first reported in Manitoba by Bailey (1926). Soper (1944) captured 10 specimens on May 15, 1943. He believed, on the basis of mounds only, that the gopher occurred from just east of the Red River near Emerson to 32 km east of Emerson and to a maximum distance of 5 km north of the Canada - United States border. Soper (1961) maintained this distribution although he had only captured the species 18.4 km east of Emerson. The distribution was more accurately mapped by Wrigley and Dubois (1973). They showed that the pocket gopher was found 21 km north of the Canada - United States border and that the species' most westerly extension was 10 km east of Emerson, not at Emerson as Soper had assumed (Fig. 4).

Distribution on a broad scale may be explained in biogeographical terms. The Pleistocene Epoch (started 2-3 million years ago and ended 10,000 years ago) brought fluctuations of cool and warm climatic conditions that resulted in mass extinction (or constriction to a southern range) of many mammal species (Vaughan 1978, Wrigley and Lammers 1984). Manitoba was completely covered by glaciers during the last Ice Age. As the glaciers began to retreat because of warming trends from 8000 to 4000 years before present, many species migrated northward (Vaughan 1978). In fact, mammal species such as the cotton rat (Sigmodon

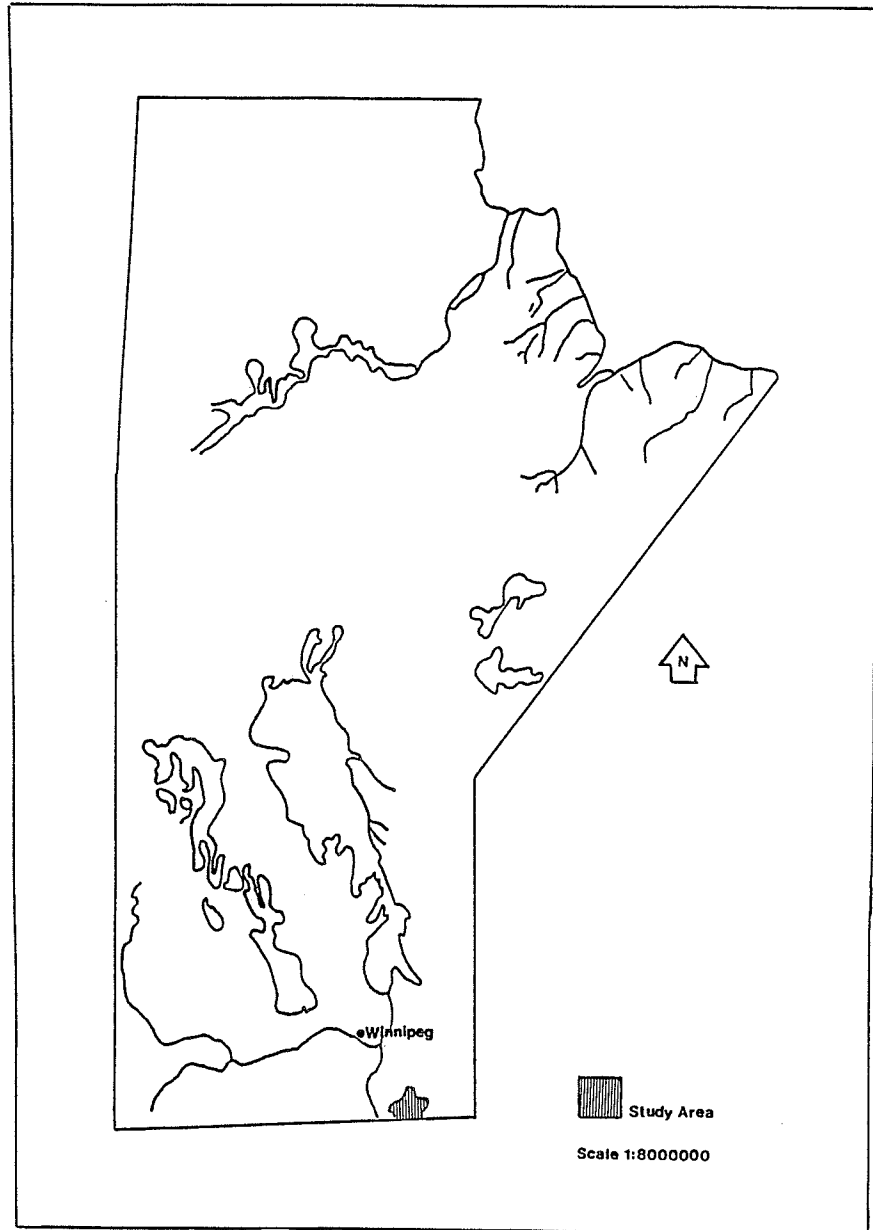


Figure 3: Range of plains pocket gopher in Manitoba - 1972 (after Wrigley and Dubois 1973).

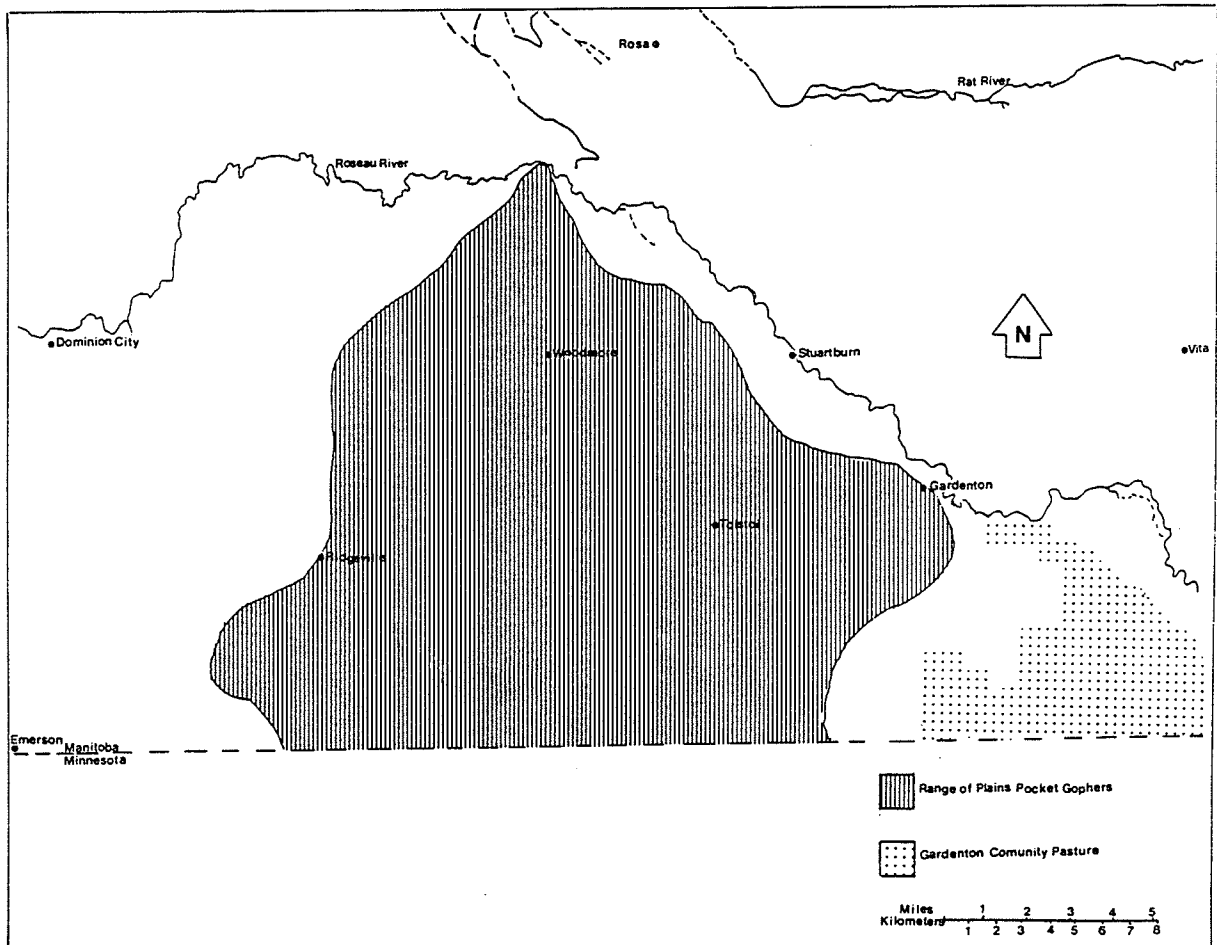


Figure 4: Study area in southern Manitoba (after Wrigley and Dubois 1973).

hispidus), opossum (Didelphis virginiana), and the raccoon (Procyon lotor) are still moving north (Vaughan 1978). In Manitoba, most mammal species are thought to have re-entered the province after the Ice Age, including the plains pocket gopher (Wrigley and Lammers 1984). The gopher's distribution in Manitoba is geographically and ecologically directed (occurring on high ground, in a preferred soil type). At present there is no paleontological evidence to suggest that the plains pocket gopher ever existed in Manitoba before the Ice Age (J. Dubois, pers. commun.).

2.3.2 Habits

The plains pocket gopher is usually described as solitary, intolerant, and pugnacious. It tolerates others of its kind only during the breeding season (Banfield 1974).

G. bursarius goes through periods of feeding, digging, and rest every day. Between or during these activities, a gopher will check its burrow system for intruders (Banfield 1974). It is not known at what intervals pocket gophers actually sleep during the day or night.

Burrow excavation activity varies from peaks in early spring (to re-excavate the burrow system) and fall (to gather food for storage) to much reduced activity in the summer (Axthelm and Lee 1976). The burrow system may be

quite extensive (up to 150 m in length) and complex in its pathways (Schwartz and Schwartz 1981). Burrow depth varies from 15-80 cm depending on soil type, soil moisture, and vegetation on the surface. Burrow diameter is approximately 8-10 cm. Nest, food storage or defecation chambers may be between 1-3 m from the surface, depending on soil type, moisture, and the freezing line (Banfield 1974, Schwartz and Schwartz 1981, and Jones et al. 1983).

The digging habit has several, usually unnoticed benefits to the surrounding soil. It deepens the soil profile and improves drainage while reducing runoff and erosion (Schwartz and Schwartz 1981, Jones et al. 1983). In addition, the soil is aerated, weeds are removed by their feeding, and humus is built up (Jones et al. 1983). Along with the bison (Bison bison) and the prairie dogs (Cynomys spp.), the pocket gopher has contributed significantly to the formation of the prairie soil (Forsyth 1985).

In hilly regions pocket gophers may cause erosion. Conflicts with humans occur when they eat large amounts of vegetables in gardens and create unsightly mounds (Willis 1981). The Manitoba Department of Agriculture demonstrated their concern about pocket gophers in the leaflet entitled "Pest Facts" (Plews 1984). Gophers cause losses in cultivated areas, especially in alfalfa fields, where they consume large amounts of vegetation and hinder crop harvest. Adequate control is difficult and expensive because of the

gopher's solitary, underground nature. Trapping and poisoning are suggested methods of control (Plews 1984).

When dispersing from the natal burrow, gophers may be forced to swim. G. bursarius has been determined to be an average swimmer (compared to the valley pocket gopher (Thomomys bottae) and the Mexican pocket gopher (Pappogeomys castanops)) covering a distance of 30 cm per second (Hickman 1977a). Males were found to be no better swimmers than females and the average time a G. bursarius could swim was 2 min, 13 sec (before sinking)(Hickman 1977a).

2.3.3 Interaction

2.3.3.1 Intraspecific

Most of the year gophers lead a solitary existence, defend their territory vigorously, and aggressively attack their own kind (Vaughan 1962, Case 1983, Sudman et al. 1986). During the winter and near the mating season, however, the above non-social behaviours change; Vaughan (1962) mentioned instances where two or more males and females were actually huddled in a nest together.

Not much time is spent out of the burrow, except to pile excavated soil, and mobility between burrow systems is restricted to the mating season (Banfield 1974, Jones et al. 1983).

2.3.3.2 Interspecific

Many species of animals have been found within the burrow, several of which seem to cohabit with the pocket gopher. Various amphibians, including the tiger salamander (Ambystoma tigrinum) and toads (Bufo speciosus), (B. valliceps), (Scaphiopus couchi), and (S. holbrooki) have been found in moist burrows with gophers (Hickman 1977b). It was suggested that the gopher could recognize that some of these amphibians had poisonous or bad-tasting skin. Thus, they were not attacked but instead tolerated in the burrow (Hickman 1977b).

Reptiles such as the hognose snake (Heterodon platyrhinus) were also allowed to exist in the burrow, although the snake's tough skin may affect the ability of the pocket gopher to ward off this intruder (Hickman 1977b).

Various mammals such as deer mice (Peromyscus spp.), pocket mice (Perognathus spp.), grasshopper mice (Onychomys spp.), and ground squirrels (Spermophilus spp.) are often found dead in pocket gopher burrows, and do not appear to be tolerated (Hickman 1977b). One dead meadow jumping mouse (Zapus hudsonius) was found in a burrow during this study as well as one live tiger salamander (A. tigrinum).

2.3.4 Mortality Factors

Pocket gophers are part of the diet of predatory mammals, snakes, and birds (Forsyth 1985). Thirty-five per cent of the long-tailed weasel's (Mustela frenata) diet consists of gophers, according to one Manitoba study (L. Gamble, pers. commun.). The actual number of gophers taken, however, is questionable, since the long-tailed weasel has been given the status of "Threatened" by COSEWIC (Cook and Muir 1984). The badger (Taxidea taxus) would normally be considered a significant predator of the Manitoba population as well, but their numbers have been quite reduced for several years (J. Dubois, pers. commun.). In fact, they were listed by COSEWIC as a "Species of Concern" in 1988. Predators in the United States include the gopher snake (Pituophis melanoleucus), barn owl (Tyto alba), and great horned owl (Bubo virginianus), however, only the latter is prevalent in Manitoba (Hickman 1977b, Goyer 1981, Rickart 1972, respectively).

Chapter III

METHODS

3.1 LITERATURE REVIEW

A literature review was done on the plains pocket gopher, with most information obtained from other areas of its range for comparative purposes. This included a computer search, a manual search of pocket gopher literature, and information obtained through contacting various agencies including Manitoba Agriculture, Manitoba Museum of Man and Nature, Department of Natural Resources, Statistics Canada, and Agricultural Departments of several of the United States.

3.2 FIELD STUDIES - ECOLOGY

3.2.1 Soil

The type of soil preferred by pocket gophers is critical to its distribution (Moulton et al. 1983). With Wrigley and Dubois (1973) as a basis, the expected Manitoba distribution was plotted on a soil map (Ehrlich et al. 1953). Locations of gophers trapped or mounds observed in the study area were also then plotted and the particular soil type noted. A Chi-square test was used to determine preference of any particular soil type or soil sub-type.

3.2.2 Vegetation

Vegetation requirements of G. bursarius were identified in the literature to the level of plant communities. To gather information in Manitoba, selected trap site habitat characteristics were recorded in the field. A checklist of the physical location of the burrows, exact map location, surrounding cultivation practice, and a description of vegetation types in the immediate burrow area, was completed for every trap site (see Appendix A). Vegetation preference of Manitoba plains pocket gophers was qualitatively recorded at each trap site and placed into one of the following six categories: cereal, fallow, alfalfa/hay, broadleaf, wild, and pasture. Broadleaf refers to any annual floral species that is a member of the dicots not including trees or bushes. Wild means any bushy and/or treed areas with intermittent grass that has not been cultivated in recent years. These qualitative statements were categorized and analyzed for vegetative preferences using Chi-square.

3.3 BIOLOGY

3.3.1 General

Data concerning pocket gopher biology were gathered by trapping. Live traps were used as much as possible. Individuals caught and released may form the basis for additional studies concerning movement in the future. Live traps were constructed following Hart (1973). Macabee traps

were also used, since these were considered to yield the highest trapping success (J. Dubois, pers. commun.). The trap success for both trap types was assessed according to gophers caught per trap night (see Appendix B).

Gophers were trapped from two main areas; near the edge of known distribution and in areas of concentration. Selection of suitable sites was based on abundance of mounds and cooperation of private landowners.

Collected individuals were weighed using a laboratory balance accurate to one tenth of a gram; measured in mm as to total, tail, hind foot, and ear to notch lengths; classified as adult male, adult female, or juvenile; and prepared as museum specimens. The difference between adults and juveniles is quite apparent, as juveniles are generally smaller and have short, gray fur. The weights of adult males and females were compared statistically using Chi-square.

Live-trapped gophers were weighed with a hand scale accurate to the nearest gram. The gopher was tattooed on its hind toes using a hypodermic 20 gauge needle and green veterinarian's ink. The right hind foot was used for numbers 1 through 5 and, the left for 6 to 10. For example, the 11th gopher caught had two tattooed dots on its 1st digit of its right hind toe. Numbers such as 12 and 21 were differentiated by tattooing spots on their tails. This method was used instead of the usual toe clipping because it

is a less stressful and damaging procedure, especially to fossorial rodents (Canadian Council on Animal Care 1984). Sex was determined and males checked for scrotal testes and females for lactation. Handling time was less than five minutes. Gopher behaviour during handling was qualitatively recorded.

3.3.2 Sex Ratio

The sex ratios for collected and live-trapped individuals were compared and discussed. Any deviations from the mean were analyzed using a Chi-square test if the sample size allowed, or the Student's t-test for samples less than 30.

3.3.3 Reproduction

Collected females were examined for number of embryos, placental scars, estrous or non-estrous reproductive condition, or non-breeding condition. Embryo and placental scar counts were averaged and compared to findings in the literature. Sampling started in April to determine the reproductive season more accurately. Conception dates were estimated by using the known gestation period (Vaughan 1962).

Testes measurements and scrotal condition were recorded for male gophers. Actual sperm presence was not determined.

3.3.4 Ectoparasites

Traps were generally checked twice daily - mid-morning and evening. Live traps were checked more often. Collected gophers were packed in plastic freezer bags immediately upon excavation to ensure retention of ectoparasites such as lice and fleas. Live-trapped gophers were also checked by combing the fur. All ectoparasites were examined by Dr. T. Galloway, Professor of Entomology, University of Manitoba. Dr. Galloway determined the species, sex, and frequency of each parasite on every gopher. These data were related to the location of capture.

3.4 DISTRIBUTION

The plains pocket gopher's present distribution was determined by systematically trapping individuals around the periphery of the range, using the map by Wrigley and Dubois (1973) as a guide. A broad band around the known distribution was surveyed. Trapping was done only in those areas where the range, soil, vegetation, and the burrow diameter indicated that this species was likely present. Results were plotted on a map of the study area.

3.5 PERSONAL INTERVIEWS - QUESTIONNAIRES

Control of pocket gophers was examined at four levels: U.S., provincial, municipal, and local. Grassland specialists at Agriculture Manitoba were surveyed as to what types of control plans or actions were in place. For the municipal level, appointments were made with Agricultural Representatives having jurisdiction in the study area. Finally, a questionnaire concerning pocket gophers was sent or given to selected farmers (see Appendix C). The questionnaire asked questions on such topics as: machine damage from mounds, reduction of crops, number of gophers killed annually, and additional comments.

The Department of Agriculture of each American state within the range of the plains pocket gopher was contacted to find out the types of controls in place or contemplated to reduce pocket gopher damage (see Appendix D).

3.6 LAND USE AND LOCATION OF OPTIMAL HABITATS

Manitoba Agriculture was contacted for information on land use within the study area. This was followed up with phone calls to Statistics Canada, Crown Lands Office, and the Provincial Forestry Branch for information on land use in southern Manitoba. Both crown and private lands were investigated, with particular attention paid to changing land use patterns. In addition, habitat assessment sheets

were used in 1987 and in 1988 to determine any change in land use in the one year period. Prime habitat areas were determined by ground survey in 1987 and 1988. Checklists helped delineate suitable habitat and its location was plotted on a map of the study area.

3.7 FEASIBILITY OF LAND ACQUISITION

3.7.1 Ecological Requirements

A number of optimal areas of habitat in the study area were determined from ground studies. Any area with a dense population of plains pocket gophers was recorded. Other ecological requirements of soil and vegetation were assessed and matched, from the literature and the present study, to the best areas in terms of these needs on a map of the area.

3.7.2 Legal and Administrative Requirements

The Canada Land Survey described the agricultural use of the study area. The legal status of the plains pocket gopher was found from the literature and personal communication. There are a number of agencies that are involved in acquiring habitat for rare (vulnerable) or endangered flora and fauna. Each organization's role was outlined and the potential to obtain an area of land, for some type of sanctuary, was discussed using information provided by Manitoba Department of Natural Resources and Museum of Man and Nature personnel. Actual monetary value of the land was found from Manitoba Agriculture.

Chapter IV
RESULTS AND DISCUSSION

4.1 ECOLOGY

4.1.1 Soil

Studies on the plains pocket gopher in the United States have shown that they prefer soils that have a sand content of at least 40% (Downhower and Hall 1966), ranging at times as high as 64 - 92% (Moulton et al. 1983). Clay and silt each usually make up only 18% of the preferred soil type (Moulton et al. 1983) and are never higher than 30% (Downhower and Hall 1966); exceptions include the silt loam in Nebraska (Heaney and Timm 1985) and soils high in clay in Iowa (M. Shoesmith, pers. commun.). Other factors such as organic matter, phosphorous content, or particle size, however, do not appear to be as important (Hirsch et al. 1984). When comparing the range in Manitoba to a soil map (Ehrlich et al. 1953), plains pocket gophers inhabit, almost exclusively, sandy loam areas. Plains pocket gophers in Manitoba seem to avoid those soils which have a high silt and/or clay content; perhaps because these are not sufficiently aerated to allow proper gas exchange with the outside environment (Moulton et al. 1983). Compaction may also be a factor that would discourage pocket gophers from

these soils, since burrowing would be more difficult. The moisture content may affect aeration and thus habitability of some soil types (Moulton et al. 1983).

Of the capture sites, 81 of 91 (89%) were in a sandy loam soil type (see Table 1). Since there are different sub-types of sandy loam, a Chi-square test was done to see if the gophers preferred a specific sub-type, such as fine-textured sand or deeply mantled gravel. Although the test showed that there was a preference for certain sandy loams, it was not an accurate test because it was difficult to transfer precisely locations recorded in the field onto a 1:250,000 soil map. In addition, a significant number of captures (20 of 91) were on the border between two soil types so that allocating a particular capture to a specific soil type was difficult.

The ten captures made on the periphery of the sandy loam soils (ie. in other soil types), may possibly be due to population pressures from the center of their range in Manitoba.

4.1.2 Vegetation

The plains pocket gopher actively seeks out forb species (Reichman and Smith 1985). Thus, it has been suggested that this vegetative type is a critical habitat determinant. Forbs are a major food source and in some instances make up

TABLE 1

Plains pocket gopher capture sites in different soil types,
Manitoba, 1987-88.

Soil type	Area covered in study area (km ²)	# of gophers trapped
Pelan-deep	42.04	14
Poppleton	34.44	12
Springbank	26.91	24
Pelan-shallow	23.45	4
Kittson-deep	21.05	9
Kittson-shallow	8.43	4
Caliento	6.02	7
Tolstoi	5.80	2
Leary	4.23	1
Garson Complex	3.76	1
Steinbach	2.66	2
Agassiz	1.91	1
Birds Hill	0.22	0
Red R.-Emerson*	5.90	5
Red R.-Clay*	5.18	2
Aluvium*	3.59	2
Marquette*	3.51	1
Riverdale*	2.84	0
Osborne Clay*	1.32	0
Semple*	1.04	0
Bog*	0.16	0
Total	204.46	91

* not sandy loam soil sub-type.

more than 98% of a gopher's diet in the form of roots, stems, and leaves (Luce and Case 1977). In addition, most mounds are seen in alfalfa fields and pasture land since these areas are infrequently cultivated and contain many perennial forb species (Foster and Stubbendieck 1980, Luce et al. 1981, Hirsch et al. 1984, Reichman and Smith 1985).

It has also been found, however, that the plains pocket gopher can subsist on a less optimal diet (Luce and Case 1978). Stomach contents of gophers caught near Chadron, Nebraska, revealed that 20 species of grasses and forbs were eaten. Five species alone, including Blue grama (Bouteloua gracilis), made up 70% of the vegetation (and thus food source of the gophers) (Luce and Case 1978).

The Chi-square test was used to determine if habitat type was randomly distributed among trapping sites (Table 2).

TABLE 2

Plains pocket gopher occurrence in specific habitat types of 98 trap sites in Manitoba, 1987-88.

Habitat type	% of occurrences
cereal	20
fallow	1
alfalfa/hay	34
broadleaf	2
wild	12
pasture	31

The test indicated that vegetational types with high variations from the expected included cereal, alfalfa/hay, wild, and pasture ($\chi^2=242.74$, $df=5$, $p<0.005$) and thus were the preferred type. Fallow and broadleaf areas had the lowest deviations from the expected and in the opposite direction (ie. less than expected value) suggesting that these areas were significantly avoided.

The avoidance of fallow and broadleaf areas is entirely consistent with the literature. Gophers are deterred by annual cultivation so that the frequency of occurrence in this area is expected to be low. Fallow areas obviously do not supply enough food for pocket gophers so that the frequency here is expected to be low as well.

The suggestion by the data that alfalfa/hay and pasture land is preferred is substantiated by Foster and Stubbendieck (1980), Luce et al. (1981), Hirsch et al. (1984), and Reichman and Smith (1985).

4.2 BIOLOGY

4.2.1 General

A total of 54 individuals were collected, using the Macabee gopher trap on April 22 and from 11 - 26 June 1987. Another 18 gophers were trapped on April 14, 1988. The average and extreme external measurements of all individuals are shown in Table 3.

TABLE 3

Morphological data from plains pocket gophers collected in
1987-88.

	Sex								
	Adult males n=16 12-87,4-88			Adult females n=48 34-87,14-88			Juveniles n=8 8-87,0-88		
length (mm)	max	min	avg.	max	min	avg.	max	min	avg.
total	303	260	287.58	279	240	255.73	209	179	196.4
tail	98	74	88.34	85	65	77.68	70	58	63.1
foot	40	35	37.75	37	33	35.80	32	29	30.5
ear	9	7	7.91	8	6	6.94	6	6	6.0
wt.(g)	442.9	206.1	349.01	314.4	186.5	241.45	116.1	77.6	103.8

Although adult males are usually said to be longer than adult females (Banfield 1974, Jones et al. 1983), there was no significant difference between the sexes in this sample. In terms of weight, males significantly outweighed females.

These dimensions and weights warrant further discussion. First, they do not follow the usual results that males are longer and weigh more than females (Banfield 1974, Schwartz and Schwartz 1981, Jones et al. 1983). This may be accounted for by the small sample size in this study. Secondly, these gophers were the heaviest and longest ever taken from the Manitoba population (based on collected gophers in the Manitoba Museum of Man and Nature collection, Soper 1943, Soper 1961). This may be due to an increase in the overall sample size.

A female and her young captured in the same burrow system indicate that the young stay with their mother at least until weaning. Unfortunately, the two became disassociated when mixed with several other adult and juvenile specimens collected during a farm demonstration session. Analysis of the age of the juvenile would have been possible through a growth vs. weight graph, as in Sudman et al. (1986).

A number of plains pocket gophers (25) were live-trapped, marked, weighed, sexed, and released (Table 4), to document occurrence and behaviour.

TABLE 4

Summary of live-trapped and released plains pocket gophers
in Manitoba, 1987.

	Sex								
	adult males n=8			adult females n=16			juvenile n=1		
	max	min	avg.	max	min	avg.	max	min	avg.
wt.(g)	320	190	285.0	235	120	181.6	85	85	85.0

One distinction occurred between the live-trapped and collected specimens. Both males and females caught in Macabees were larger, on average, than their live-trapped counterparts. This may be sampling bias caused by the size or diameter of the live trap. Similar bias towards smaller live-trapped individuals was shown in Hickman (1977a) and Hickman (1977b), but was not commented upon in those reports.

4.2.2 Sex Ratio

In total (ie. live-trapped, collected, and museum collection gophers) there were 38 male, 124 female, and 11 juvenile (8 females, 3 males) specimens taken from the Manitoba population. Of 162 adults, 124 were female (77%), indicating a skewed sex ratio ($\chi^2=47.87$, $df=1$, $p<0.005$). An additional 8 of 11 juveniles (73%) were female. Further

study may find the reason for this extreme imbalance. One can only suggest that perhaps there is a bias for capturing female gophers in the spring and summer, and that this alone is the cause for the unevenness. Females need more nourishment for the demands of reproduction so that more tunnels are excavated. Seeking fresh mounds, we trap these gophers, thus creating a sampling bias. However, a number of specimens have been collected at different times of the year from April to October with similar results.

Higher male mortality due to fighting and to exposure to predators and accidents while actively seeking out females during the mating season may also account for the uneven ratio (see Vaughan 1962, Hurly 1987). Vaughan (1962) found that 57% of his specimens were female and that male captures outnumbered female captures only in May. He also noted that many more males than females had head injuries such as limb lacerations, deep cuts on the head, and minor cuts on the body; all presumably caused by fighting. Thus, he concluded, that more males would die since more were injured. Such injuries were found on four individuals (2 female, 2 male) in the present study.

4.2.3 Reproduction

Most female plains pocket gophers come into estrous and become pregnant in March or April according to information obtained from Colorado, Nebraska, and Kansas populations

(Vaughan 1962, Kennedy et al. 1976, Desy and Druecker 1979, Sudman et al. 1986). Vaughan (1962) caught pregnant females in August meaning that the mating season could last until late July.

The gestation period is 18 to 21 days in length with the female producing one litter (in the north only) of three to five young (Vaughan 1962). More precisely, Vaughan (1962) noted an average of 3.43 young or placental scars per female for Colorado plains pocket gophers and Kennedy et al. (1976) recorded 3.6 young or placental scars per female for a Nebraska population.

Placental scars or actual embryos in adult females almost always occurred in 3's and 4's in the present study, with the average being 3.46 young per female.

New data concerning the reproductive season of the plains pocket gopher in Manitoba have also been found. The earliest pregnant specimen was caught on April 22 and was carrying four 25 mm embryos. The projected conception date was April 10, using Vaughan's (1962) maximum gestation period of 21 days.² Births and/or pregnancies have been recorded in March and early April in Colorado, Nebraska, and Kansas populations (Vaughan 1962, Kennedy et al. 1976, Desy and Druecker 1979, Sudman et al. 1986). The latest pregnant

² Sudman et al. (1986) found that one female plains pocket gopher kept in the laboratory gave birth to one young 51 days after capture, indicating a gestation period of at least 51 days. This finding, however, has not been verified by other researchers.

female caught was on June 26, revealing three embryos averaging 6 mm in length. The projected conception date was June 21. Vaughan (1962) caught pregnant females in August so that further sampling may extend the known reproductive season both later and earlier for the Canadian population. Canadian plains pocket gophers have not been sampled between July 27 - October 8 or between October 20 - April 14.

Males with scrotal testes were first caught on April 22. This was the earliest ever recorded for the Manitoba population. The last scrotal male was captured on June 23. Sperm production usually starts in January and lasts until May for Nebraska specimens (Kennedy et al. 1976), but it has been shown in a Colorado population that the testes need not be scrotal for the animal to be in breeding condition (Vaughan 1962). Only 4 males of 20 were scrotal in the present study, which would seem to support this point. Specimens were not examined for sperm production in the present study.

4.2.4 Ectoparasites

G. bursarius has been found to harbour the lice of the genus Geomydoecus with subspecies of lice equivalent to gopher subspecies. Spicka (1981), for example, noted that only Geomys bursarius illinoensis will have the flea Geomydoecus illinoensis.

Many collected specimens had individuals of subspecies of Geomydoecus spp. left on their bodies even after they were preserved frozen in plastic bags. The exact subspecies was not determined as there were too many variables in characteristics to identify (Dr. T. Galloway, pers. commun.).

Dr. Galloway also determined that plains pocket gophers in this study harboured the flea Foxella ignota. This ectoparasite is considered to be a true pocket gopher flea as it predominates on both G. bursarius and the northern pocket gopher (Thomomys talpoides) (Holland 1986). F. ignota infestation was not great (1 to 3 fleas per individual with only 20% of the sample being affected) and that most individuals occurred on the periphery of the range (8 of 10). Only peripheral Geomys had the flea Opisocrotis bruneri, usually found on ground squirrels, suggesting that these gophers encountered more ground squirrel burrows than centrally located individuals.

4.3 DISTRIBUTION

Live-trapped and collected gophers around the periphery of the gopher's suspected range led to the map seen in Fig. 5. The present study found G. bursarius across the Roseau River to the north, to a maximum of 6 km, and east about 6.4 km from the range found by Wrigley and Dubois (1973). This apparent range increase, however, is not very extensive,

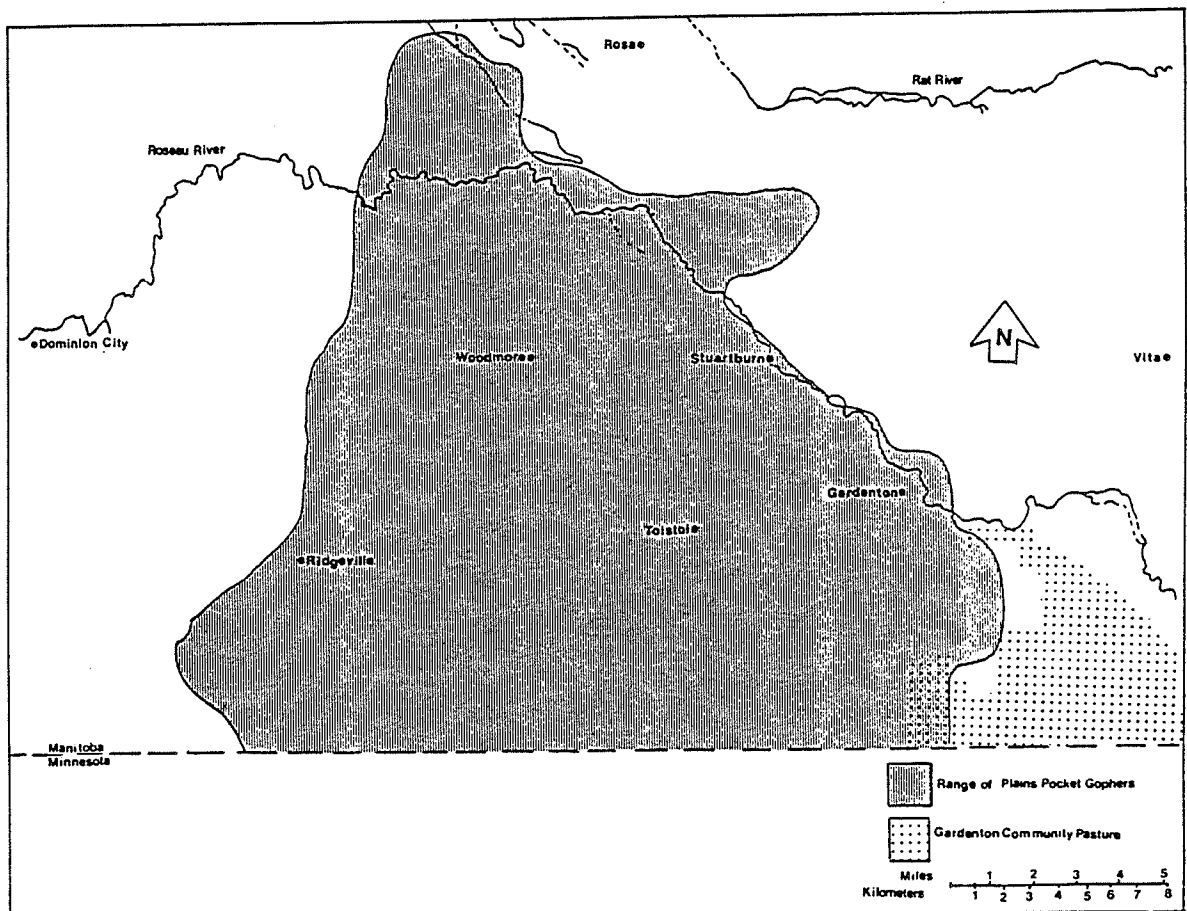


Figure 5: Range of the plains pocket gopher in Manitoba - 1988.

representing 5 to 6 km in 15 years. As observed by museum personnel, during the 1970's the northern pocket gopher extended its range further north and west by a few kilometers every year in Manitoba.

Why does the plains pocket gopher have this range now? The answer may in part be due to the interaction between the two species. The plains pocket gopher population in Canada is entirely surrounded by the northern species (Wrigley and Dubois 1973). G. bursarius is more aggressive, as was demonstrated by live trap captures of both species. A plains pocket gopher would make hissing noises and attempt to bite the wire of the cage. It would also put on a threat display, gaping its mouth and prominently displaying its long claws, during capture. Upon placing an individual back in its burrow, the animal would continue with burrowing activities rather than trying to flee. T. talpoides was much more docile in the trap, and upon being placed in the burrow, would make a speedy effort to scramble for the safety of its home. Dispersing young G. bursarius are of somewhat smaller size and weight than adult T. talpoides. Thus, while an adult would have no trouble, a young plains pocket gopher may or may not be successful in displacing an adult northern pocket gopher from its burrow (see also Hickman 1977b). The Roseau River may have hindered the species' expansion northward for several years, since G. bursarius are only average swimmers (Hickman 1977a) and could have transversed

this river only during drier conditions. Sudman et al. (1987) found the Platte River to be an effective barrier between subspecies of G. bursarius in Nebraska.

Along much of its length in southern Manitoba the Roseau River is also the boundary between preferred and non-preferred soil types, so that when river crossings occurred, an unsuitable soil type was likely to have been encountered. Soil type seemed to be a limiting factor in the Manitoba population in the present study. Other extrinsic factors such as temperature, freezing line level, and humans can cause seasonal fluctuations especially among small populations at the range limit of a species (Smith 1980, Odum 1983).

4.4 CONTROL - GENERAL

4.4.1 Introduction

Many different types of control methods for pocket gophers exist (Miller 1969, Kolach 1973, Banfield 1974, Barnes 1974, Schwartz and Schwartz 1981, Willis 1981, Case 1983, Hanson 1984, Andelt and Case 1985, Godfrey 1987). Some methods are of little use while others are commonly used because of their effectiveness.

4.4.2 Poison

Poisoning pocket gophers is probably the most advertised, experimented, cost effective and documented control (Ward and Hansen 1960, Sargeant and Peterson 1963, Kolach 1973, Barnes 1974).

Ward and Hansen (1960) studied one of the first burrowbuilders for its effectiveness. The burrowbuilder is a mechanical device attached to a conventional tractor that purposely creates artificial pocket gopher burrows with a torpedo shaped tool. Included immediately behind the tool is an automatic bait dispensing system that deposits poisoned grain every few meters into the burrows created. At the back of the burrowbuilder are two closely aligned wheels that pack the disturbed earth (Fig. 6). The burrowbuilder torpedo is set at a depth that will maximize the number of natural burrow systems that are bisected. Pocket gophers will find the bait as they inspect the newly formed burrow system (Ward and Hansen 1960).

The bait used may vary from milo and barley (Sargeant and Peterson 1963, Barnes 1974, Willis 1981) to tap root forb species such as carrots and turnips (Miller 1969). Cracked corn and beans have not received as high a rating in the study by Willis (1981).

The burrowbuilder is the recommended method over a large area and was priced initially at about \$450/unit by Ward

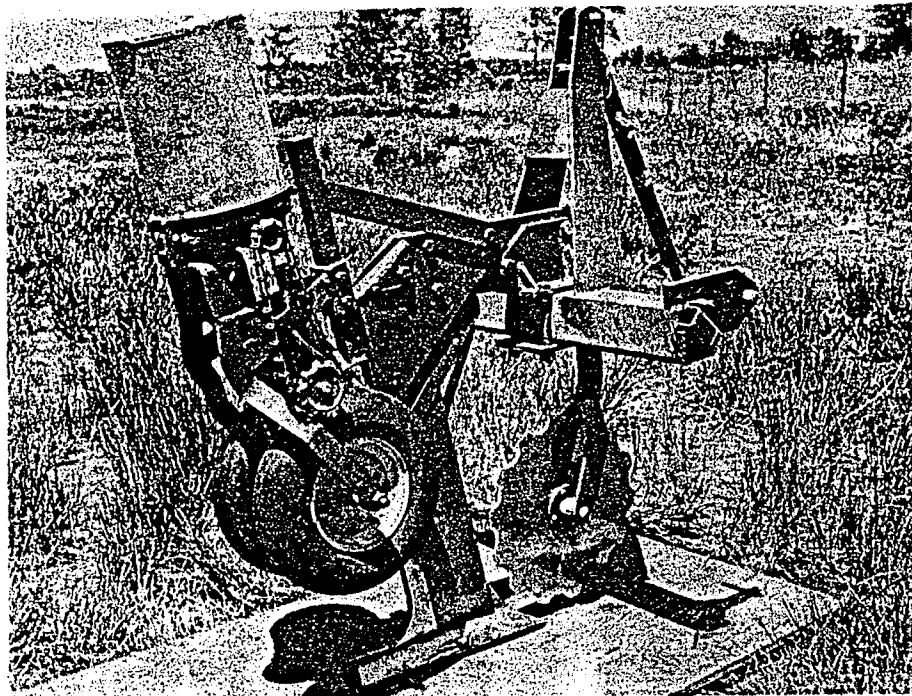


Figure 6: The mechanical burrowbuilder (Ward and Hansen 1960).

and Hansen (1960) and Miller (1969). Today, the cost in Manitoba is closer to \$900/unit (C. Grier, pers. commun.). Besides the ever increasing cost, there are other drawbacks to the burrowbuilder. Moist soil is required so that the artificial burrows keep their shape and improper handling of the equipment and material (wrong depth setting, not enough weight on the builder, and wrong bait dispensing and poison concentrations) can result in little or no control (Willis 1981).

In areas of low infestation and smaller area, the pogo stick applicator is recommended (Case 1983, Hanson 1984, Andelt and Case 1985). The poisoned bait is either distributed directly into the burrow system by the poking action of the applicator or may be spooned into the hole created by the stick (Case 1983, Hanson 1984, Andelt and Case 1985).

Recently Godfrey (1987) has shown that a greater control rate can be obtained with the use of a new, longer lasting, paraffin coated bait that controls the initial resident gopher as well as any subsequent immigrants to the area.

4.4.3 Trapping

Trapping pocket gophers is more labour intensive and expensive so that this method should be confined to a small area (Case 1983, Andelt and Case 1985). The most popular

types of commercially available traps seem to be the Macabee and Death Clutch varieties (Willis 1981, Case 1983). These are set by excavating the burrow system at a particular spot between two adjacent mounds. After setting, the burrow should only be sealed enough so as to keep out sunlight. The draft that is created by the loose soil will attract the gopher to the area for repairs (Willis 1981, Case 1983). Trapping success may be just as high as poison control, but requires more effort as stated before (Case 1983).

4.4.4 Other Methods

Other methods of control have been attempted with limited or no success. A study by Keith et al. (1959) showed that 2,4-D sprayed on open grassland would reduce the gopher population by as much as 87% because 85 - 99% of their food was eliminated. This method is not used today because of 2,4-D's toxicity.

Fumigants of various types are generally ineffective, because soil porosity leads to leakage which causes gophers to sense the fumigant well before the concentration becomes lethal (Willis 1981, Case 1983). Miller (1969) did estimate that a 50 - 60% control rate may be possible with the fumigant methyl bromide, but did concede that bait poisoning was more effective.

Exclusion of gophers has helped in some instances (Willis 1981, Case 1983, Andelt and Case 1985). This control may include grain buffer zones around an alfalfa field, underground fencing, weed control so as not to attract gophers, crop rotation, and planting different alfalfa varieties to fan out the root system (Willis 1981, Case 1983, Andelt and Case 1985). These methods, however, present greater expense, inconvenience, or loss of crop volume and are therefore not used under most circumstances (Andelt and Case 1985).

Flooding a burrow system is sometimes mentioned, but has neither been applied nor thoroughly tested experimentally. The method has also never been proven to actually kill gophers, but may just deter them for a period of time.

Shooting is not recommended since pocket gophers seldomly venture out of their burrow system (Case 1983, Andelt and Case 1985).

4.4.5 Manitoba - Provincial

There is not any formal control program at the provincial level at this time, but a general pocket gopher program, for both Geomys and Thomomys, has been suggested recently (Bonney 1985). Bonney (1985) estimated that pocket gophers in Manitoba (including T. talpoides) cause \$11 - \$13 million loss to forage producers annually. They may cause:

1) yield loss due to mounds; 2) mounds themselves smothering alfalfa crops; 3) reduced stand longevity and 4) machine breakdown because of mounds. Bonnefoy (1985) suggested an overall organization to coordinate community action groups. The organization would investigate improving alfalfa longevity, reducing forage losses, and providing information to forage producers about pocket gophers. The organization could also investigate such activities as a literature review on pocket gophers, poison bait effectiveness, trapping feasibility, analysis of natural controls, demonstrating poison application and field-leveling techniques, and finally, evaluating cost-benefit ratios of the various methods of control and providing this information to forage producers. Once the initial analysis is complete, local community action groups should be formed to actually control pocket gophers. Only the decided control method, as determined by the group's members, should be used for best results. The number of hectares that need to be treated, funds, and the actual application are duties of this local group. The results of their efforts should be evaluated and relayed back to the members of the organization.

This control plan was first proposed in 1985, but has not been approved for funding to date (D. Campbell, pers. commun.). The main species of concern is T. talpoides which covers much of southern Manitoba and is quite plentiful

(MMMN records), but the plains pocket gopher is of equal concern where locally abundant.

4.4.6 Manitoba - Municipal

At the municipal level, less research action compared to the provincial level has been taken. None of the Manitoba Agriculture representatives that were contacted knew of any formal groups who were actively controlling pocket gophers. At a trapping and information session near Woodmore, Manitoba, it was possible to inform farmers of pocket gopher ecology and of the differences between the species. The Agricultural representatives showed two poison bait applicators of the pogo stick and artificial burrowbuilder. Although only twelve farmers attended (it was haying time), many agreed that the meeting was useful.

One farmer indicated that in Minnesota, local officials are currently paying a bounty of \$1.00 per pair of pocket gopher front feet. One burrowbuilder is currently in use in the range of G. bursarius in Manitoba.

A recent development (April 14th, 1988) at the Agricultural Representative's office in Vita has resulted in hundreds of Macabee traps being ordered. Upon hearing of the success of trapping in this study, the Vita office responded to the needs of farmers and used some P.F.R.A. funds to subsidize the farmer's cost of the traps at \$1.00 per trap (W. Happychuk, pers. commun.).

4.4.7 Manitoba - Local

The summary of the questionnaire given out to individual farmers asking them to assess the pocket gopher population and damage on their property is shown in Table 5. Most farmers (14/19) said that pocket gophers had always been on their land and that they used some type of control method, mostly trapping (17), but some poisoning (8) and cultivating (7). Over half (10) also claimed that they killed between 11 - 50 gophers per year, but nine farmers believe that they have just as many gophers every year. Many farmers believed that pocket gophers caused loss in terms of alfalfa/hay consumption (7), cutter-bar raising to clear mounds (18), and machine damage by mounds (13). In general, the respondents feel that pocket gophers are a nuisance. They would like the species totally eliminated from all property, including crown-owned land, ditches, and unused portions of their property.

Recently, anhydrous ammonia (a plant fertilizer used in a concentrated gaseous form) was placed into a few plains pocket gopher burrow systems to observe the effect. Vegetation immediately above the burrows died, and pocket gopher activity stopped (no fresh mounds were seen). However, it was unknown whether the pocket gopher had been killed or had simply moved to another locality (G. Bonnefoy, pers. commun.). If a concentration lethal to pocket gophers and not to plants above the burrows is found, this technique

TABLE 5

Farmer opinion questionnaire summary for plains pocket gophers in Manitoba, 1987.

n=19					
	% response				
Gophers on land	always 74	last 10 yrs 16	last 5 yrs 5	this yr 5	
Control of gophers	trap 90	poison 42	shoot 5	cultivate 37	anhydrous 11 none 5
Gophers killed/yr	1-10 21	11-50 53	more than 50 21	none 5	
Changes in gopher #	increase 37		decrease 16		same 47
Type of damage	eat crop 37	damage machine 95	reduce harvest 68		

may become very popular in the near future, as it is readily available to farmers. However, W. Happychuk (pers. commun.) believes that the method does not kill gophers, is too time consuming, costly, and labour intensive. One pogo stick, however, is available for loan to farmers at the Vita, Manitoba Agricultural office.

4.4.8 Control - United States

A letter was sent to 17 states that have a known distribution of G. bursarius, asking the Agriculture department about their control methods and programs in place or considered. All letters that contained additional addresses were followed up, but only three states, Arkansas, Colorado, and Minnesota, sent back a second response. The responses of 13 states have been summarized in Table 6.

Most states do not have any formal control program, despite damage (a number of commonly used control methods were mentioned in their letters). Six states sent Case's (1983) study, indicating that it is an appropriate reference guide.

Although a bounty apparently exists in at least one county in Minnesota (H. Hill, pers. commun.), this fact was never mentioned by the state Department of Agriculture officials. Other counties in plains pocket gopher range may have similar bounties, unknown to state officials (M. Shoesmith, pers. commun.). Generally, however, it seems that the number of farmers affected by gophers does not warrant a state-wide or even localized sponsorship of trap or burrowbuilder costs.

TABLE 6

Gopher control in the United States.

State	Control
North Dakota	no program; provide information only -sent Case's study and reference to Missouri mammals
Minnesota	no program; give advice to farmers through pamphlets -referred to Case's pamphlet and gave a reference
Wisconsin	no program; small distribution, no control strategies of any kind
South Dakota	education program; information/demonstration sessions -sent Case's pamphlet and a control reference
Wyoming	no program; advise farmers on burrowbuilder, Macabee trapping, but discourage buffer zone and alternate alfalfa techniques
Iowa	no program; no control or advice, no university research projects
Illinois	no program; not one complaint in 8 years would advise farmers to use poison bait if problem
Indiana	no program; population in decline, no control wanted -gave reference to write to
Colorado	no program; tell farmers to use burrowbuilder or trapping - gave reference to write - received more
Kansas	no program; pamphlet given to farmers/landowners -burrowbuilder, trapping recommended, gave reference
Missouri	no program; no complaint in last 3 years -sent reference of Missouri mammals
Arkansas	no program; used all types, sent Case's study -reference sent on strychnine poisoning and trapping methods although had no problem in 25 years
Louisiana	no program; admits problem in pasture and coniferous tree farms where locally abundant -advice is burrowbuilder, sent Case's study

Surprisingly, no response was obtained from states with large distributions of pocket gophers including Nebraska, Oklahoma, and Texas. Although follow-up letters were sent in late June 1988, no response was received.

4.5 LAND USE

4.5.1 Private land

Data from Statistics Canada on land use in both municipal regions are summarized in Table 7. Data were used from 1981 and 1986 for comparison purposes. On the whole, the types and area of grain grown has varied little (probably because of prices) between the two surveys. Exceptions include a major drop in barley, corn, rye and buckwheat production. Oilseed production has risen in terms of canola and flax. Peas were grown at a high rate in 1986 throughout both L.G.D. of Stuartburn and the R.M. of Franklin.

An important man-made habitat for plains pocket gophers is an alfalfa or hay field (Table 2), and this category (tame hay) has increased (albeit marginally in Franklin) in both areas.

The total improved area (land altered by man) in Stuartburn has increased significantly since 1981, especially in the amount of pasture land ($\chi^2=117.3$, $df=1$, $p<0.005$). Since pasture is preferred habitat for the plains pocket gopher, this result is beneficial. The amount of unimproved area in Stuartburn has increased as well, and

TABLE 7

Land Use in L.G.D. of Stuartburn and the R.M. of Franklin.

Land use type	Stuartburn (ha)		Franklin (ha)	
	1981	1986	1981	1986
Total land		112000		95000
Tot. arable area	50331	55112	79705	74111
Improved area - total	18378	20011	62367	57162
- under crops	13586	13899	55940	51951
- summer fallow	1074	1525	2198	2230
- pasture	2662	3513	2857	2343
- other	1057	1073	1372	636
Unimproved area - total	31952	35101	17338	16949
- pasture	NA	25799	NA	13290
- woodland	3808	2785	1545	1455
- other	28144	6516	15793	2203
Total wheat	319	708	19781	20089
Oats - grain	1770	1618	2435	2205
Oats - fodder	437	658	266	418
Barley - grain	800	289	8306	5502
Mixed grain	334	478	625	692
Corn - grain	74	0	1663	62
Rye - grain	190	29	513	91
Buckwheat	2337	601	2579	652
Corn for silage	227	198	657	454
Canola - Rapeseed	78	123	1703	2605
Flaxseed	59	304	3423	9528
Soybeans	0	0	126	0
Sunflowers	0	0	3029	0
Potatoes	0	0	2	0
Mustard	0	0	146	0
Peas	0	0	887	1099
Tame Hay	6704	8741	6131	6159
Dryfield beans	0	0	38	653
Sugar beets	0	0	420	345
Canary seed	0	0	NA	753
Total berries	0	0	3.4	14
Number of farms	263	231	314	274
Farm size - avg.	97-161	97-161	97-161	97-161

much was converted to pasture by 1986. The reason for the increase in land area in Stuartburn is that more land was made available by improved drainage, where the original flow of the Roseau River has been diverted by the Gardenton Floodway.

In Franklin, the total improved area has dropped significantly, including the amount of pasture ($\chi^2=50.81$, $df=1$, $p<0.005$). Unimproved area decreased as well. Pasture land was not censused in 1981 or 1986.

A ground survey was done each summer to determine if land use changed from one crop year to the next. The 98 trap sites from 1987 which had their land use recorded were again studied in 1988. The results concur with Statistics Canada data in that the types of crops grown were not significantly different from the previous year ($\chi^2 =.0813$, $df=1$, $p>0.05$). Relatively little gopher habitat loss was observed, and an increase was seen (in pasture areas) according to Statistics Canada 1981 and 1986 census years.

4.5.2 Crown land areas

There were five crown land parcels in or near the study region (Fig. 7).

Crown land area 1 was 64 ha (1/4 section) that is covered by aspen (Populus spp.) and willow (Salix spp.) with only small sections of clearings that consist of intermittent,

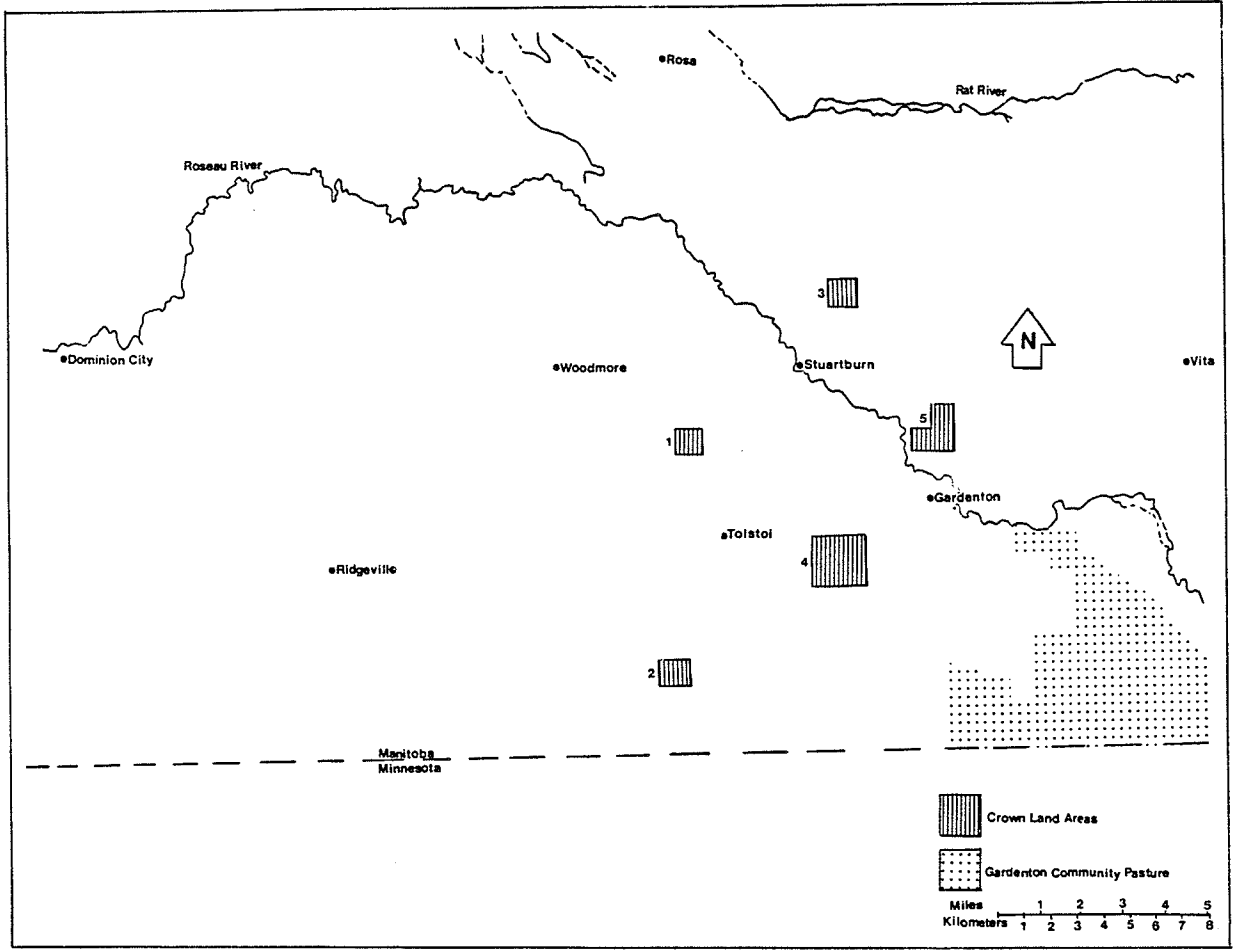


Figure 7: Study area showing crown land areas.

clumped grass clearings. There is an old fence line around the area and about 20 cows were seen grazing in an open area in the southeast corner. According to W. Happychuk (pers. commun.), however, the piece is no longer crown, but belongs to a Mr. Badger, who lives near the area.

Crown land area 2 is also 64 ha that has an older fence line (mostly falling over) than the previous parcel described. The land is thickly covered by aspen and willow trees as well as many bush species. The area is so grown in that on the periphery, no clearings were observed. This area is leased to a Mr. Reimer, but use is unknown.

Area 3 is 64 ha that contains the dump for Stuartburn. The remainder of it is sparsely covered with aspen, with some bush and intermittent grass species.

Area 4 is 256 ha (1 section). The southwest 64 ha (1/4 section) is rented and used as pasture. The other portions are not rented at the moment (W. Happychuk, pers. commun.). The parcel was moist, with areas of willow growth. Other parts are elevated and able to support some prairie species (J. Joyce, pers. commun.). This parcel does not seem to be optimal gopher habitat, and only one set of mounds was seen near the highway at the north side of the section.

Area 5 is included in this discussion even though it appears slightly out of the plains pocket gopher's present distribution. The whole section is crown land except for

the north west 64 ha. The land contained many aspen, oak (Quercus spp.), willow, and intermittent grasses. No mounds were found, although many clearings were present. The area was burned the previous fall (J. Joyce, pers. commun.). The region was poor in terms of prairie species.

Existing crown land areas are less than optimal habitats for pocket gophers at present. Their soil is sandy loam, as the gophers prefer, but conditions such as high moisture (evidenced by the lush willow growth in most areas) likely affect compaction, aeration, burrowing capability, and vegetational growth. These factors adversely affect plains pocket gopher habitat requirements.

4.5.3 Optimal Habitat

Fig. 5 shows optimal habitat for plains pocket gophers in Manitoba. The entire range contains the proper soil type and general vegetation type. Some less optimal areas exist in river or creek basins, swamps or other areas. Overall, however, this is the best habitat in Manitoba for the plains pocket gopher.

There are some specific areas (areas A - E) in the mapped region that are of particular interest (Fig. 8). These regions are private lands that have been unaltered for a period of time so that they support a significant number of gophers. Most of these areas contain a high density of plains pocket gophers/ha.

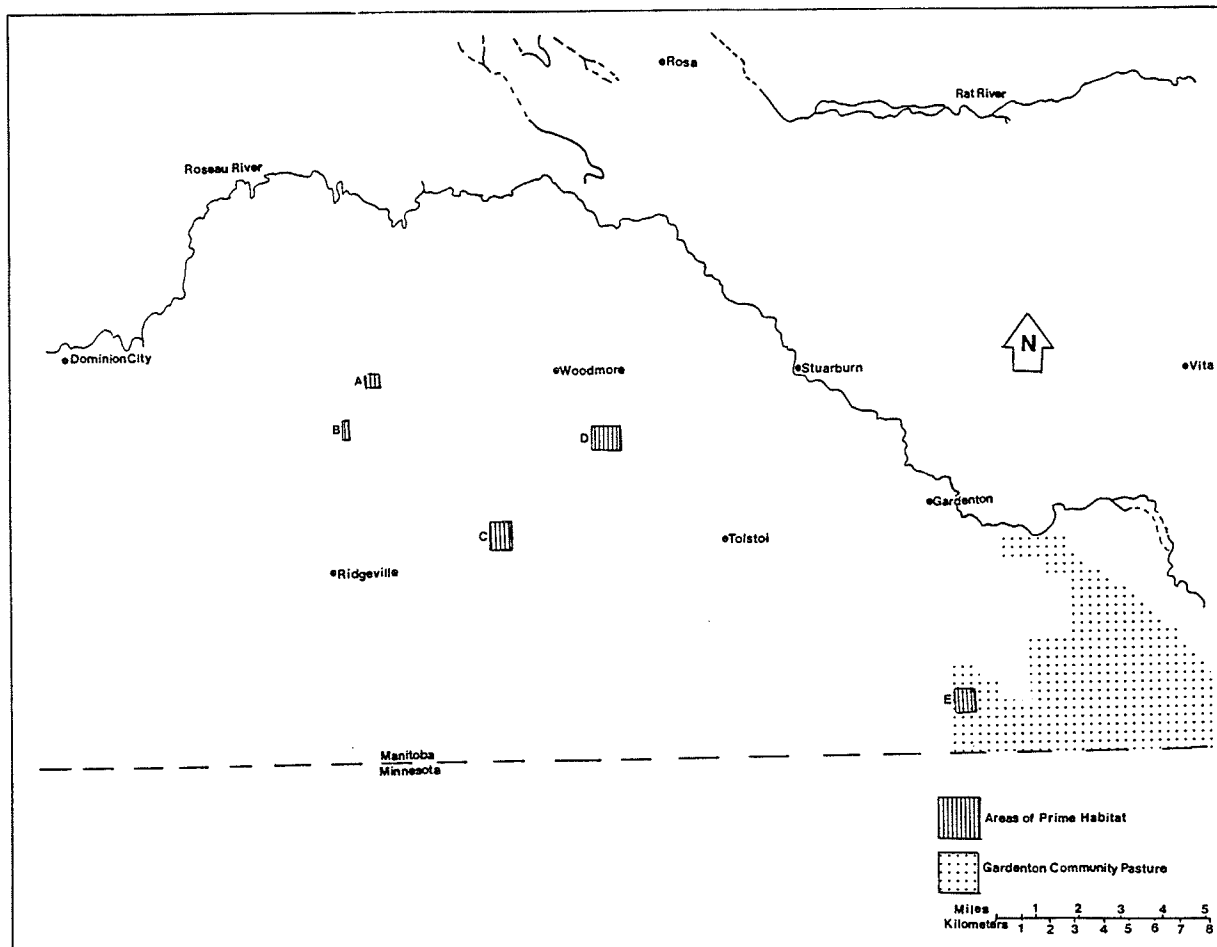


Figure 8: Map showing locations of prime habitat for plains pocket gophers in Manitoba.

Area A is a parcel of land covering approximately 20 ha which is owned by a Mr. Craig. The land was seeded with alfalfa approximately 15 years ago, but has not undergone any major change except for periodic cutting and yearly fertilization. Over time, the alfalfa has been substantially reduced and now many wild grass species predominate.

Area B belongs to a Mr. D. Seward. The piece is slender, approximately 5 ha in area, and contains alfalfa and grass. It appeared in 1987 to have been at least 5 years since the field was last seeded because of the way the grass species were taking over.

A Mr. R. Klapka had an 8-year, 30 ha alfalfa field at area C in 1987. He indicated in 1987 that it was to be ploughed under because of the unevenness that had resulted from gopher activity. When the same area was checked in 1988, the land had been ploughed and left fallow.

Area D belongs to a Mr. M. Grier and was heavily populated by the plains pocket gopher in 1987. The fields covered about 40 ha and were in prime alfalfa production state. By spring 1988, the gopher population had been reduced substantially by trapping and using a burrowbuilder, with help from the Vita agricultural office.

H. Hill operates the Gardenton Community Pasture which supports a large plains pocket gopher population approximately 1 km north of the Canada - U.S. border at area

E. No plans for cultivating the community pasture in the near future exist (Mrs. H. Hill, pers. commun.).

The above areas have been identified as having had a high density of plains pocket gophers/ha. Many other private lands and roadside ditches were observed to contain gophers, but not to the same extent. Since most gophers in Manitoba occur on private land, they are subject to landowner desires.

4.6 FEASIBILITY OF LAND ACQUISITION

4.6.1 Ecological Requirements

Most areas mentioned previously that are within the distribution map boundary represent feasible locations for plains pocket gopher sanctuaries. The ecological requirements of soil and vegetation are met, generally speaking. Most areas are optimal now, but it is unknown if they will remain optimal in the future. Most lands have the correct basic ecological characteristics (hay and wild grass species, soil type), but land use determines the presence or absence of pocket gophers. (leaving the area to nature - no cultivation). If land is used for pasture, alfalfa, or tame hay then this is favourable for the plains pocket gopher, but if the land is used for annual crops, then these areas are less optimal (Table 7).

4.6.2 Legal and Administrative Requirements

In the last survey done, the plains pocket gopher was not covered under any federal or state regulation in the United States (Case 1983). The species is covered by the Non-game Program and generally mentioned in the Wildlife Act in Manitoba, but may be specifically designated in the proposed Manitoba Endangered Species Act (M. Shoesmith, pers. commun.).

There are several administrative ways to proceed if habitat is to be set aside for the plains pocket gopher in Manitoba. First, an interested agency specializing in habitat acquisition may be found, such as the World Wildlife Fund (WWF). This internationally known group supports the acquisition of, and at times obtains, specific habitats for critically important areas of interest on the direction of biologists, conservation groups, and farmers and ranchers (Mattson and Suggett 1988). Presently, the organization is involved with the Prairie Conservation Action Plan (PCAP) of their Wild West Program. This plan outlines numerous goals aimed at quantifying, conserving, preserving, and protecting fauna and flora of the prairie as well as encouraging the public to participate in these activities (World Wildlife Fund 1988).

Rare and endangered species and habitats receive special attention from the Nature Conservancy of Canada (NCC), and

this agency has acquired 800 ha in southwestern Manitoba for this purpose. Another organization is Wildlife Habitat Canada (WHC), which has committed \$2 million for habitat purchase and enhancement in Manitoba. Their primary objective is to involve landowners in conservation. The Manitoba Wildlife Federation (MWF) has been acquiring habitat through land lease arrangements, land donations, or co-operator programs since 1944, and has to date secured over 8000 ha of wildlife habitat in Manitoba. Preserving critical species and habitat is also of concern to the Manitoba Habitat Heritage Corporation (MHHC). The Manitoba Naturalists Society (MNS) created the Habitat Conservation Fund in 1984 and has since concentrated on preserving wildlife habitat, especially the tall grass prairie. Many of these organizations have worked together in the past to form co-operative solutions to various floral and/or faunal concerns (Mattson and Suggett 1988).

The Manitoba Department of Natural Resources (MDNR) is responsible for managing the province's forestry, fisheries, wildlife, and crown land resources (Mattson and Suggett 1988). The Department can establish several different types of ecological reserves depending on the needs involved. Wildlife Management Areas (WMA) are obtained in regions where they are critical to a species and at times may be enhanced. Provincial parks serve a habitat securing function as well as providing outdoor recreation. The founding of

the Ecologically Significant Areas (ESA) Program in 1973 resulted in preserving unique habitat for rare or endangered species. Land gifts are accepted by the Manitoba Habitat Bequeathment Program for the same purpose. Municipal members choose local residents to head Conservation District Authorities to establish co-operation programs with farmers to preserve habitat (Mattson and Suggett 1988).

For organizations to purchase land, since private lands have been designated as prime habitat locations for the plains pocket gopher, landowners will need to be approached. Land in the Rural Municipality of Franklin had an average value of \$922.50/ha in 1987. In the Governmental District of Stuartburn the land value was lower at \$487.50/ha in 1987. These numbers may change from year to year as was indicated by land value statistics from 1985 and 1986 (Manitoba Farm Lands Ownership Board 1988). Each site, however, will have its own merits, changing the actual land values.

Land may be obtained and managed in the following ways:

1. the province may purchase/expropriate and designate land as a park, WMA, or ESA; and manage it,
2. a private agency/individual may purchase the same land and manage it to suit its own purpose, or

3. a cooperative effort of government and private agency/individual acquire the land and then:

i) the government may retain title and designate the area as a park, WMA, or ESA, or

ii) the agency/individual retains the title and uses the land according to the purpose/mandate of that particular organization.

The above is a brief overview of the agencies and ecological reserves available in Manitoba. The optimal choice would:

1. involve multi-agency participation including MNS, WWF, MHHC, WHC, and MDNR, and
2. establish a reserve for the plains pocket gopher in Manitoba.

The cited agencies have contributed a great deal to habitat and species preservation in the past and are all actively involved at this time in ensuring that further prairie ecosystem degradation does not occur. Both WWF and MNS have tried to educate the public with their recent Prairie Conservation Action Plan and pamphlet, respectively. There has been some discussion among the mentioned agencies to set aside a Tall Grass Prairie Reserve. The plains pocket gopher historically occurred in the tall grass prairie ecosystem and an effort could be made to place the reserve in or near

the gopher's present range. Thus, a reserve of this type will be multi-functional ensuring that at least some of the original native prairie species will be preserved.

Unfortunately, most farmers interviewed in the present study feel that the plains pocket gopher is a nuisance. Thus, it may be difficult to obtain a piece of land for purpose of sanctuary, since a high pocket gopher population may anger nearby farmers who see the mammal as a pest and a threat to their crops. This attitude may be overcome through public education using leaflets, pamphlets, open houses and information sessions in the area.

Chapter V

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The plains pocket gopher is found in Canada only on about 500 km² in southern Manitoba. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has designated the species as "Vulnerable", on the basis of their distribution and numbers. This study was done in response to a need to acquire more data on the species in Manitoba. The following conclusions result:

Objective 1

1. As predicted by the literature, the plains pocket gopher prefers sandy, loamy soils in Manitoba.
2. Vegetation analysis showed that plains pocket gophers preferred cereal, alfalfa/hay, wild and pasture land uses. Fallow and broadleaf areas are avoided.
3. From the measurement of 72 plains pocket gophers collected in June 1987 and April 1988, males are not longer than females, but males are heavier than females. Both sexes on average outweighed previous samples taken from the Manitoba population.

4. A total of 25 live-trapped individuals were found to be lighter than collected gophers.
5. A significantly greater number of captures were female than male.
6. The earliest pregnant female was caught on April 22 and the latest on June 26, an increase in the known reproductive season for Manitoba. The breeding period in the Canadian population is estimated to occur between April 10 and June 21.
7. Concurrent with the literature, Canadian pocket gopher females give birth to an average of 3.46 young per pregnancy.
8. The ectoparasitic flea, Foxella ignota was found in small quantities on 20% of the gophers. The ground squirrel flea, Opisocrotis bruneri, was found on gophers at the periphery of the range.

Objective 2

9. The plains pocket gopher has a range which is a maximum of 6 km north and 6.4 km east of the Roseau River from that known previously. Suitable soil exists only on a front 12.9 km across, with the Roseau River, the northern pocket gopher, and humans all acting as hindrances to further expansion.

Objective 3

10. Control methods examined in the literature include poisoning, trapping, and other less successful

methods, with the most cost effective being poisoning. Overall, trapping was reported to be too labour intensive for larger areas of infestation.

11. At the provincial level, a pocket gopher control program was proposed but has not yet been funded.
12. At the municipal level, hundreds of Macabee traps were sold to area farmers at a subsidized cost.
13. Manitoba farmers use traps as their main control method. They control gophers because of damages caused to crops and equipment.
14. The United States has no formal control programs in place or projected in the states of North Dakota, Minnesota, Wisconsin, South Dakota, Wyoming, Iowa, Illinois, Indiana, Colorado, Kansas, Missouri, Arkansas, and Louisiana.

Objective 4

15. Land use, in terms of plains pocket gopher habitat in the study area, is consistent from one year to the next.
16. Crown land parcels in the study area are not good habitat because they contain a predominance of tree species over forbs and grasses.
17. Some private land areas were found to have dense plains pocket gopher populations and are identified as optimal gopher habitats that could be considered as possible sanctuary sites.

Objective 5

18. Most of the gopher's existing range is good habitat where the soil and vegetation requirements are met. On the periphery, however, soil conditions are sometimes not appropriate.
19. The acquisition of land could be arranged by a number of agencies (working together) including the WWF, MNS, WHC, MHHC, and MDNR in the forms of an ecological reserve. Suitable land must be bought, perhaps in an area where not all landowners are positive towards the plains pocket gopher.

As far as could be determined by the preceding conclusions, there is no cause for immediate concern for the plains pocket gopher, although the following recommendations are made in the hope that they are carried out to ensure the species' existence in Manitoba.

5.2 RECOMMENDATIONS

1. An effort should be made to increase public awareness of the plains pocket gopher's status in Manitoba. Educational pamphlets, bulletins, newsletters, and perhaps open houses and information sessions are needed to highlight the species. There should be emphasis on the importance of the gopher and the ecosystem in which it resides.

2. New ecological data have been compiled for the plains pocket gopher in Manitoba, but more research should be done in the following areas:

- soil sub-type preference,
- population, and
- reproductive season.

Live traps should be used as much as possible to gather these data.

Further research should be done on the agricultural losses directly attributable to the plains pocket gophers in Manitoba.

Monitoring should be done in the following areas:

- effect of increased local trapping on the population,
- distribution changes stemming from habitat or population pressures, and
- changes in land use that may affect the above.

3. If monitoring shows a decrease in habitat and a reduction in number of plains pocket gophers, the establishment of an ecological reserve should be considered. A multi-agency involvement such as WWF, MNS, WHC, MHHC, and the MDNR is recommended as the most feasible. A Tall Grass Prairie reserve, if sited within the plains pocket gopher range, would make an excellent refuge for the species. Plains

pocket gopher acceptance may be improved locally if the species is included in such a multi-purpose project, so that positive aspects outweigh the perceived negatives of the pocket gopher. The optimal habitats sited in this study should be used as a guideline for such a reserve.

4. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) should keep the species listed as "Vulnerable" for the time being as the future of the plains pocket gopher remains uncertain.

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Happychuk, W., Agricultural Representative, Manitoba
Agriculture, Vita.

Hill, H., Coordinator of Gardenton Community Pasture, 5 km
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Hill, Mrs. H., Housewife, 5 km south of Gardenton.

Joyce, J., Tall Grass Prairie Project, Manitoba Department
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Department of Natural Resources, Winnipeg.

Appendix A

SAMPLE OF HABITAT CHECKLIST

Geomys bursarius

Gopher Id# _____ Weight _____ Weather _____

Date _____ Sex _____ Temp. _____

Time _____ Marks _____

Other _____

1. Physical location of mounds _____ roadside embankment
_____ ditch bottom
_____ field side embankment
_____ field edge
_____ in field

Map location _____

- Cultivation practise _____ fallow
_____ cultivated
_____ cereal
_____ alfalfa/hay
_____ pasture
_____ wild

2. Soil type of mound _____

3. Mound itself was _____ active
_____ abandoned
_____ not sure

4. Vegetation _____ domesticated
_____ wild

5. Burrow # _____

6. Landowner _____

Appendix B
TRAP SUCCESS

Year caught	Type of trap	Number of trap nights	Total number of captures	Percent efficiency	Weighted efficiency
1987	Macabee	147	60*	40.82 (A)	39.73
	Live	73	29**	39.73	
1988	Macabee	29	18	62.07 (B)	44.32(A,B)

* includes miscellaneous captures:

Thomomys talpoides, (northern pocket gopher) = 13

Citellus tridecemlineatus,

(thirteen-lined ground squirrel) = 1

** includes 25 marked and released, and two dead in trap plains pocket gophers. Two live captures were northern pocket gophers.

Appendix C

SAMPLE OF LETTER AND QUESTIONNAIRE GIVEN TO
MANITOBA FARMERS

190 Rupert Ave.
Winnipeg, Manitoba
R3B 0N2
Tel.:(204) 956-2830

Dear Sir/Madam:

This letter is in regard to the plains pocket gopher (Geomys bursarius) which may, or may not, be on your property. The plains pocket gopher exists in all of Canada only in the most southern region of Manitoba and is considered a rare mammal species.

Recently, the World Wildlife Fund through their Wild West Program, has given the Manitoba Museum of Man and Nature a grant to study this rare species. In addition to the literature research and field work, we would appreciate your participation in our study by filling out the enclosed questionnaire, and sending it back in the stamped and addressed envelope also enclosed. It will only take a minute of your time and the information you give us in terms of your knowledge and opinion will be of value to the management of this species in Manitoba. Thank you for your time.

Sincerely,

Jack Dubois
Associate Curator, Mammals

Michael Oberpichler
Research Assistant, Mammals

encl.

MO/emb

June 1987

Name _____
Address _____
Phone _____

(Please check the appropriate answers)

1. Have pocket gophers ever been on your property?
 always
 last 10 years
 last 5 years
 last year
 this year
 never

2. If yes, what type(s) of control do you use to keep the population in check?
 none
 trapping
 poisoning
 shooting
 cultivating

3. How many gophers do you kill per year?
 0
 1-10
 11-50
 over 50

4. What do you feel is happening to the gopher population on your farm? Is it
 increasing
 decreasing
 about the same
 don't know

5. Do you believe that gophers do significant damage on your farm by
 consuming crops
 their mounds damaging your machines (eg. swather)
 reducing harvest (have to raise cutter bar to clear mounds)

6. Additional comments: _____

Appendix D

SAMPLE OF LETTER SENT TO STATES

Michael Oberpichler
Natural Resources Institute
177 Dysart Rd.
University of Manitoba
Winnipeg, Manitoba, Canada
R3T 2N2
May-June 1988

Department of Agriculture
P.O. Box 94947
301 Centennial Mall S.
Lincoln, NE 68509

Dear Sir / Madam,

I am a Masters student at the Natural Resources Institute, University of Manitoba, Canada. My thesis is on the ecology and management of the plains pocket gopher, Geomys bursarius, in Manitoba; with some emphasis on control. Since this species has a known distribution in your state, I would like some information on control management strategies used by your department. Any information you can send me on control programs in place or studies concerning ecologically sound (buffer zones, other exclusion and/or alternate alfalfa seed planting) or labour intensive (poison, fumigation, and/or trapping) management of this species in your state, would be greatly appreciated. Thank you for your time.

Sincerely,

Michael Oberpichler
2nd year NRI student