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*"NORTHERN POCKET GOPHER (THOMOMYS TALPOIDES)
CONTROL IN AGRO-MANITOBA."*

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.

By

Ms. Yvette Deniset

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1994

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ABSTRACT

The northern pocket gopher (*Thomomys talpoides*) has been an agricultural pest since the late 1800's. In Manitoba, it is estimated that the annual loss to farmers, due to the gopher, in forage crops alone is approximately \$15 million. Therefore, this study was designed to develop a management plan to alleviate this loss.

The study took place from 1991 to 1993 on private land near St. Claude, Manitoba. A census count was undertaken on each study plot three times per year each season, weather permitting. After this, removal trapping or rodenticide application was tested to determine their effectiveness in pocket gopher control. Live trapping was also undertaken for two of the three years. The latter was done only after the first (spring) and last (fall) counts of the season. Since pocket gophers rarely come above ground, pocket gopher sign was used as an index to determine efficacy of treatments.

Rodenticide application appeared to be an effective method of control. Pocket gopher numbers were reduced greatly after the first application in spring, but often rebounded quite drastically. Trapping efforts did not reduce the resident pocket gopher population and each count throughout the season showed an increase in their numbers. Live trapping did not provide any new information on dispersal since the capture success rate was extremely low.

Rodenticide application appears to be the only viable method of control at this time. However, research is being done throughout the United States and Canada in an attempt to provide alternatives. Trapping is viable only on small acreage areas (less than 10 acres) or in home gardens. More research should

also be done to determine the cost-effectiveness of rodenticide treatment for farmers and to further develop a reliable census method.

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CHAPTER 1

1.0 Introduction

1.1 Background

A member of the Geomyidae family (Order Rodentia), northern pocket gophers (*Thomomys talpoides*) (Figure 1) are fossorial herbivores relying on below ground plant parts for much of their sustenance (Anderson and MacMahon 1981). Their existence is almost completely subterranean, and they are rarely seen above ground. In Canada, the northern pocket gopher ranges from the edge of the Canadian Shield in Manitoba, north to the edge of the agricultural frontier (Figure 2), through Saskatchewan and Alberta to parts of southern British Columbia (Hall 1981) (Figure 3).

Pocket gophers first appeared in the late Oligocene/early Miocene epochs during the Tertiary period of the Cenozoic era, approximately 30 to 25 million years ago (Vaughan 1978; Romer 1936). Although they are not restricted to semiarid habitats today, many of their most characteristic specializations probably evolved in response to the soil conditions and floral assemblages of the semiarid and plains environments that developed during this time period (Romer 1936).

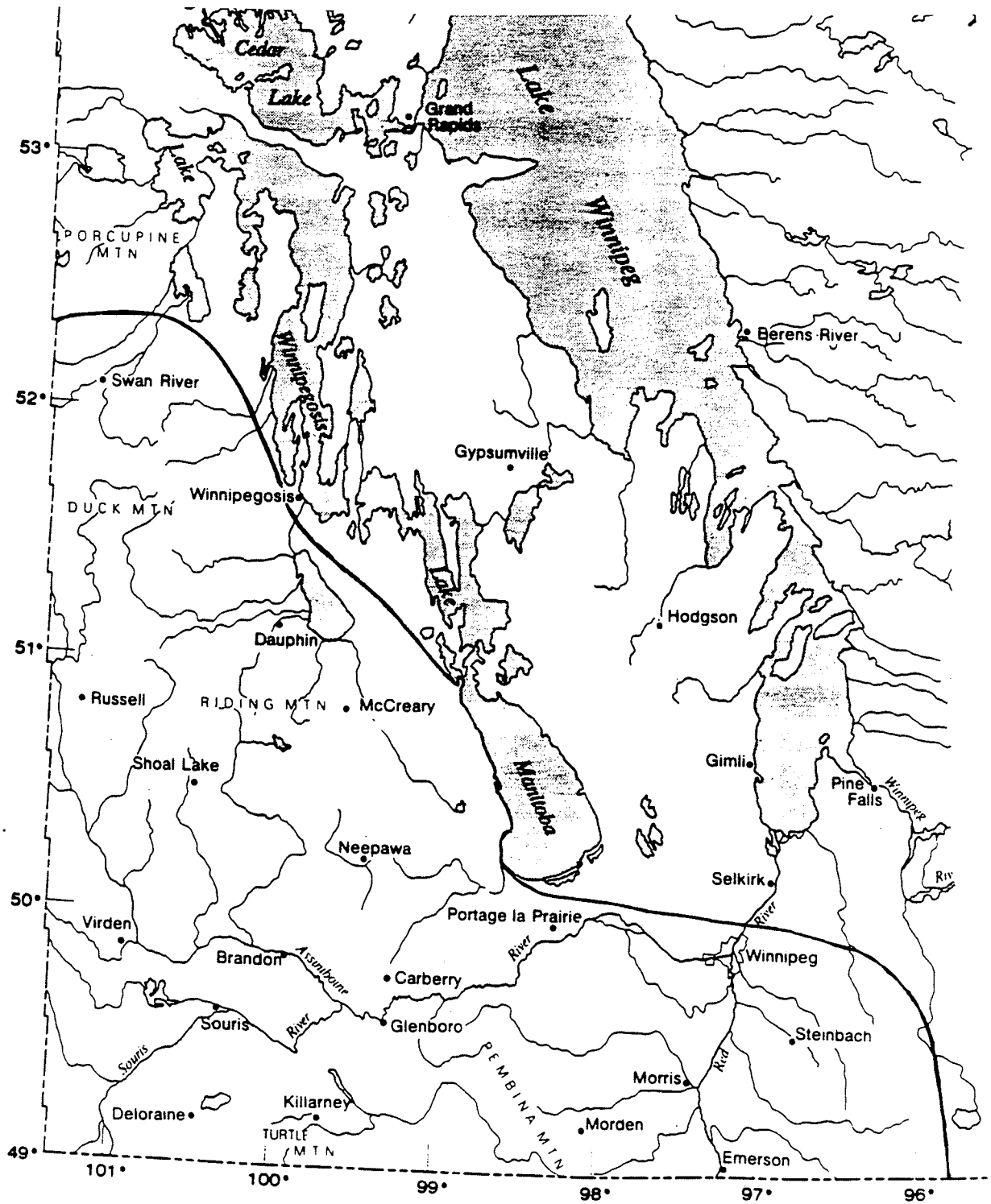
The burrow systems of the gopher are extensive (Figures 4 and 5) and are usually marked on the surface by a series of mounds of earth. These burrow systems provide retreats for pocket gophers but also tiger salamanders (*Ambystoma tigrinum*) and occasionally, in abandoned burrows, burrowing owls (*Speotyto cunicularia*) (Vaughan 1978). Burrows provide channels allowing

FIGURE 1: The Northern Pocket Gopher (*Thomomys talpoides*)



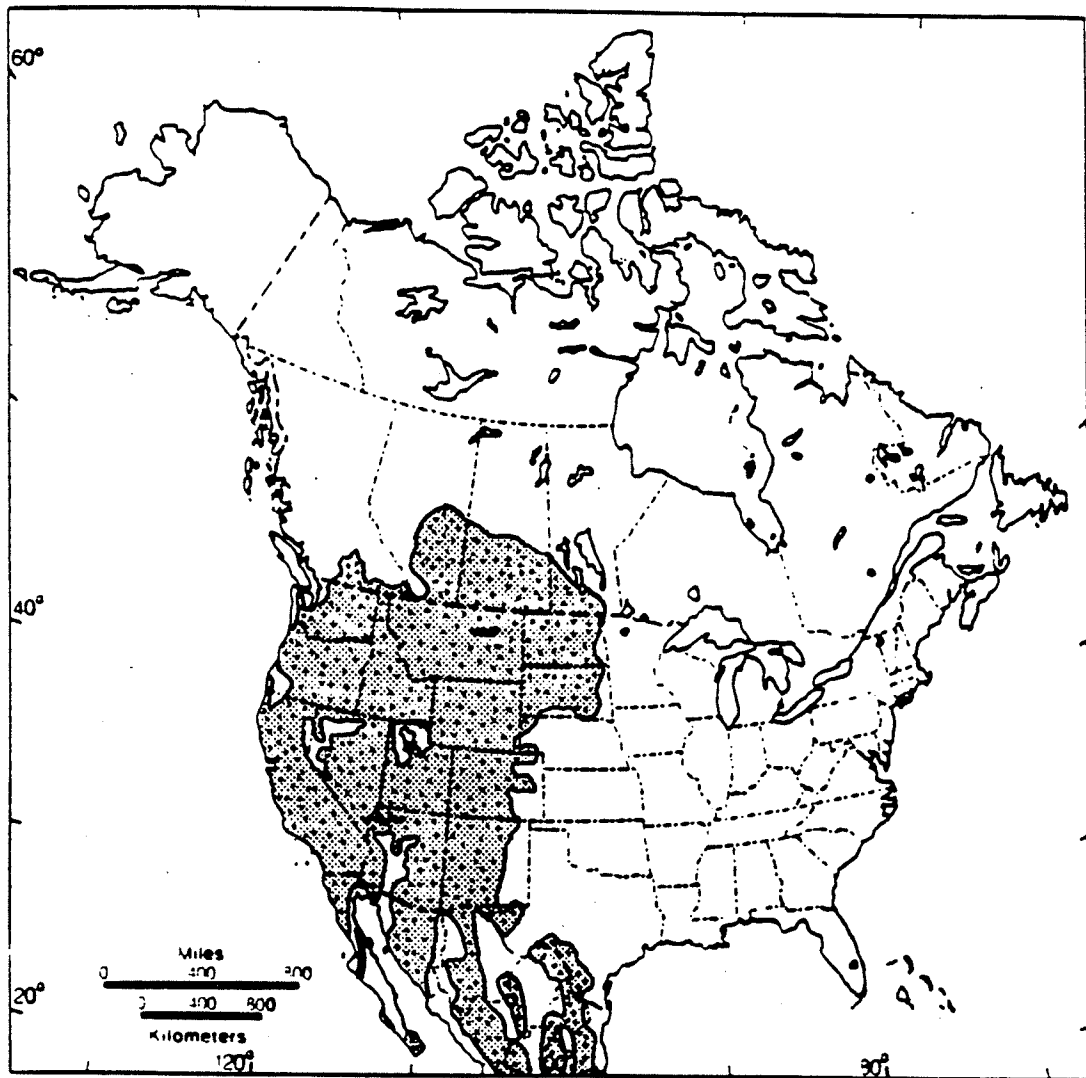
Source: Manitoba Museum of Man and Nature

FIGURE 2: The Range of the Northern Pocket Gopher (*Thomomys talpoides*) in Manitoba



Source: Questionnaire Results

FIGURE 3: The North American Range of the Northern Pocket Gopher (*Thomomys talpoides*)



Source: Chase et al., 1982

FIGURE 4: Northern Pocket Gopher Burrow System



FIGURE 5: Northern Pocket Gopher Burrow System



fairly deep penetration of water during periods of snowmelt in mountainous regions and in some areas they apparently reduce soil erosion (Vaughan 1978). The mounds of soil created by the pocket gopher are a more productive food source and they create an excellent opportunity for seed germination.

Mounds (Figure 6) are not conical (like moles) because the excavated earth is brought to the surface through an inclined lateral tunnel rather than a vertical shaft (Hall 1981). Sometimes, only a soil plug (Figure 7) indicates the end of a tunnel (Case 1983). The rate of mound building is variable. Estimates include an average of one to three per day, up to 70 mounds per month (Case 1983). This activity brings a large amount of soil to the surface, variously estimated at 2.25 tons per gopher each year up to 46.75 tons per acre for a population of 50 pocket gophers (Case 1983; Bonnefoy 1985).

Concentrations of burrow systems often occur, but each is exclusive to one pocket gopher (Vaughan 1978). Only during breeding season and the raising of young is a burrow system occupied by more than one gopher. While they are colonial, they are never social and will defend their own burrow against any interlopers (Vaughan 1978; Tunberg 1984).

Pocket gophers benefit plant production by increasing water infiltration, decreasing soil compaction by their tunneling, adding fertility to the soil by their feces and buried vegetation and by reducing plant density (Case 1983). Mielke (1977) who concluded that the role of fossorial rodents, such as geomyids, were a dynamic force in determining the biochemical attributes of the North American prairie lands and that the burrowing activities of such fossorial rodents may provide an explanation for the genesis of these prairie soil. He



FIGURE 6: Northern Pocket Gopher Mounds

FIGURE 7: Northern Pocket Gopher Mound with a Plug



stated that the bison (*Bison bison*) grazed and trampled the dense prairie vegetation, accelerating forb growth, on which the gophers thrive. The gopher, in turn, worked the soil, thus increasing soil fertility and stimulating vegetative growth, increasing food for the bison.

Ellison and Aldous (1952) reported that where *Thomomys talpoides* were present in Utah, the common dandelion (*Taxaxacum officinale*) markedly decrease and rhizomatous species, grasses, sedges and forbs increased. As Turner et al. (1973) noted, pocket gophers often "grow their own food" by causing soil conditions that tend to favour continual growth of the plants they commonly eat.

1.2 Natural History

Pocket gophers are so named because they have fur-lined cheek pouches outside of the mouth, one on each side of the face (Case 1983). These pockets, which are capable of being turned inside out, are used for carrying food.

There are 33 species of pocket gophers represented by five genera (Hall 1981) in the western hemisphere. In Manitoba, there are two species, *Thomomys* and *Geomys* (Wrigley and Dubois 1973). The subject of this study was the northern pocket gopher (*Thomomys talpoides*). *Thomomys* have smooth-faced incisors and small forefeet with small claws (Case 1983). In the Central United States, the northern pocket gopher is typically from 217 mm to 372 mm in length. The average weight for adult males is 104.4 g and 94.4 g for adult females (Chase et al. 1982).

The northern pocket gopher is a widespread species in the grasslands of southern Manitoba (Wrigley and Dubois 1973). Often mistakenly referred to as "moles", pocket gophers most seriously affect alfalfa fields, pastures and hayland, but also affect other crops such as peas, lentils, horticultural crops and other field crops (Bonney 1985).

Food consists mainly of the underground parts of plants, especially the succulent portion (Hall 1981). Therefore, alfalfa fields are extremely attractive to the pocket gopher (Tietjen 1983; Bonney 1985). Approximately 1.2 million acres of forage land in Manitoba are affected by pocket gophers (Bonney 1985). Populations of gophers are generally concentrated on light textured, friable soil (Bonney 1985; Reid and Hansen 1973), with good herbage production. Soil with good drainage, poor water holding capacity and high porosity are highly preferable to soil grading to clays (Davis et al. 1939; Davis 1940; Miller 1964; Reid and Hansen 1973). Gopher populations are high in alfalfa fields where soil conditions are optimal and a highly preferred food is abundant (Miller 1964). Pocket gophers eat mostly the roots of the alfalfa but there is evidence suggesting that they will eat the whole plant (Case et al. 1982; Vaughan 1978). We have observed both root and above-ground alfalfa parts in captured gopher cheek pouches. Pocket gophers are forb dependent (Tietjen 1973).

Natural selection has adapted pocket gophers for a subterranean existence (Hill 1937; Holliger 1916) in burrow systems. Digging is accomplished with the strong front claws and the large incisor teeth (Reid and Hansen 1973; Hall 1981). The pocket gopher skids the loosened earth along the floor of the burrow in front of its chest with the palms of its forefeet, pushing the soil to the

surface (Hall and Kelson 1959; Hall 1981). Soil, rocks and other items are "kicked" away from the digging area with their hind feet (Case 1983).

Pocket gophers do not hibernate and are therefore active throughout the year (Reid and Hansen 1973; Case 1983). Tunneling above the ground through the snow, a process that creates soil casts (see Figure 8), allows the pocket gopher the chance to forage above ground without fear of predation (Reid and Hansen 1973; Case 1983).

1.3 The Problem

The Manitoba Department of Agriculture, estimates that losses to Manitoba farmers, caused by the northern pocket gopher in forage crops is \$15 million annually (Bonney 1985). Nietfeld and Roy (1990) determined the minimum annual economic loss in haylands of Alberta to be \$14 million. The most heavily affected regions of Manitoba are alfalfa and tame hay fields in agricultural areas. The northern pocket gopher is responsible for three problems in these field types:

- 1) reducing harvest,
- 2) damaging machinery, and
- 3) crop consumption

Harvest reduction is caused when the pocket gophers have been established on a field for only a few years. Case (1983) states that the plains pocket gopher (*Geomys bursarius*) may reduce yields of grasslands and alfalfa fields in Nebraska by 21 to 49%. Luce et al. (1981) documented that the plains pocket gopher decreased yields of dryland alfalfa by 43 to 46% in south eastern Nebraska. Alfalfa plant density also decreased but other plant species

FIGURE 8: Northern Pocket Gopher Casts



Source: Manitoba Museum of Man and Nature

increased when pocket gophers were present. This offset the loss of yield somewhat but total forage yields were still between 37 and 38% less when gophers were present. The mounds (Figures 4, 5, 6 and 7) of the burrow systems cover the alfalfa foliage thereby suffocating it. As well, the life of the hay stand is reduced due to the cumulative effects of all of these pocket gopher activities. Farmers attempt to avoid the mounds by raising the swathing knife. Farming machinery is also damaged by the mounds of soil created by the pocket gophers' excavating. Swathing knives are dulled at an accelerated rate and machines become plugged, resulting in increased maintenance and repair costs for the farmers. Problems are also created for livestock since old burrow systems often cave in when walked upon. As well, a recent survey of Manitoba and Saskatchewan farmers reported that 22% of the respondents worked up their alfalfa stands due to damage by gophers (Mupondwa et al. 1993). This is an expensive process in terms of both time and money.

The problem is compounded since forage crops are considered a viable cash crop, along with oilseeds and grains, which can enhance and stabilize farm incomes (Forage Strategy for Manitoba 1987). Good quality hay is a readily saleable commodity with net farm returns comparing favourably with returns from other crops. As well, soil prone to wind and water erosion, flooding and excess moisture would benefit from the use of forage crops. Forages benefit the soil by increasing organic matter, reducing salinity and improving internal drainage. Also, forages generally provide better economic returns on marginal land (Forage Strategy for Manitoba 1987). Therefore, because of the northern pocket gopher, potential farm cash income is reduced.

The problems stated above are all contributors to the total economic loss. The

purpose of this study was to recommend management options to keep gopher populations at a reasonable number. There is great concern among the farming community about the negative effects of the northern pocket gopher. Farmers of the St. Claude, Manitoba area, (the study area, Figure 9), government officials and others have displayed considerable interest in the development of a management strategy. The result was this three year cooperative study being undertaken.

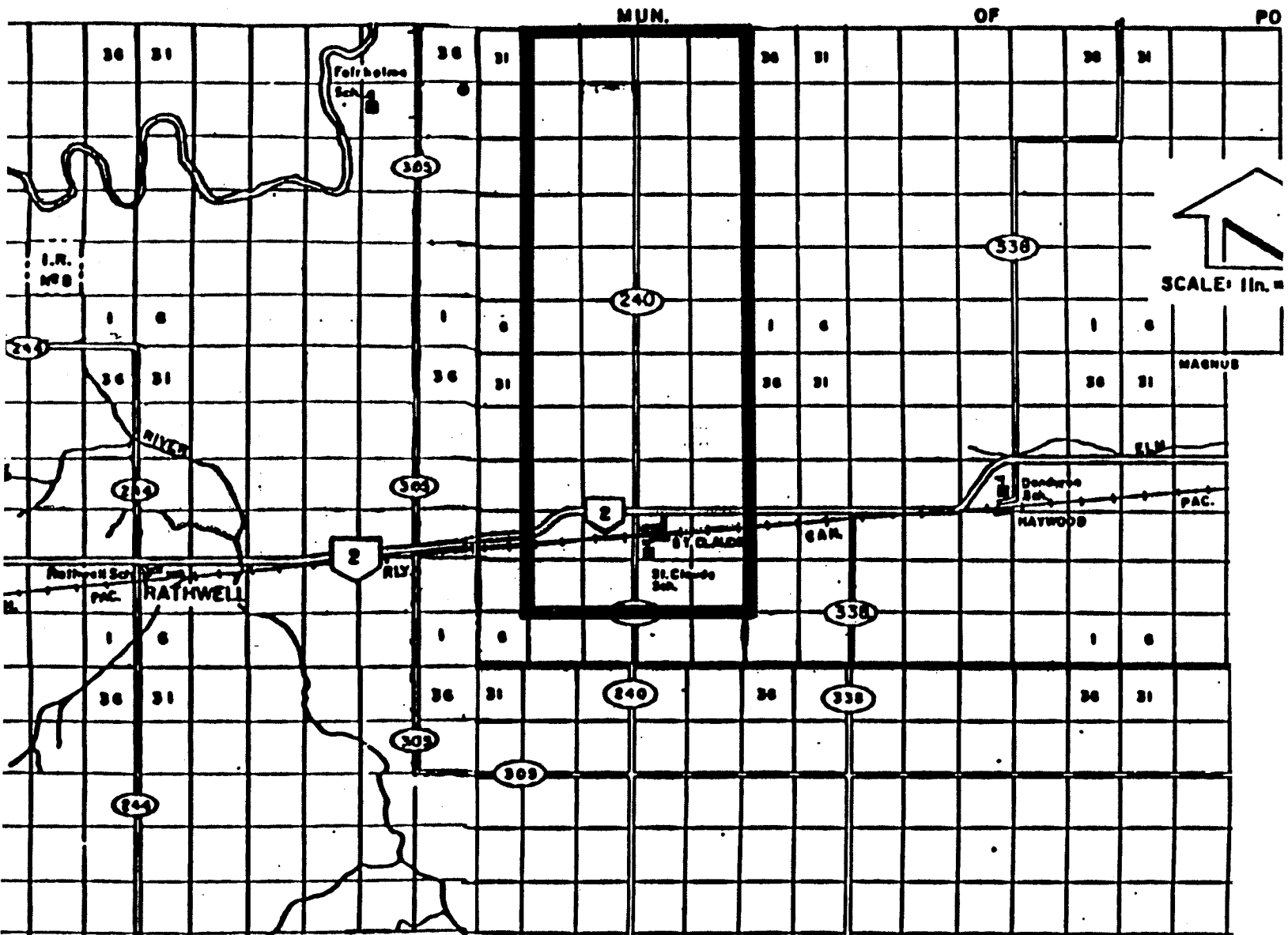
1.4 Objectives

The purpose of this study was to gather data on the effectiveness of several types of rodenticides and on the biology of the northern pocket gopher in order to recommend management alternatives.

Specific objectives of the research were:

- 1) to recommend management alternatives for the control of the northern pocket gopher in agricultural areas of Manitoba,
- 2) to determine the relative effectiveness of various traps and rodenticides,
- 3) to determine what Manitoba farmers know about pocket gophers and to examine the historical impact of the pocket gopher in agricultural areas and their effect on local tillage and other agricultural practices,
- 4) to obtain more specimens of *Thomomys talpoides* to provide more basic natural history data, particularly reproductive information, and data on seasonal foraging patterns and on the timing and dispersal of weaned young.

FIGURE 9: The Study Area, St. Claude, Manitoba



Source: Manitoba Department of Agriculture

1.5 Constraints

During the study period, certain constraints became apparent which may have had an effect on the end results. For example, replicates were undertaken on previously treated plots and not on new plots for every treatment (both trapping and rodenticide). This implies that a previously experimented population of pocket gophers may have developed 'bait-shyness', thereby reducing the effectiveness of a rodenticide.

The lack of a reliable, universally-accepted census method did not allow for an accurate population count and therefore, an index had to be used. A review of the literature shows that there is no precise methodology for determining actual pocket gopher populations. Skalski (1991) states that animal sign (eg: tracks, excavation and scats) provide an indirect method for inferring animal density. For some difficult species, such as the pocket gopher, an index appears to be all that is available. Because of this, it was not possible to determine if the population decreased or increased. This also had an effect on the ability to statistically test the results for significance. The large variability in this study would not allow for any statistical analysis on the census data collected. Due to the number of plots, it was not possible to conduct statistical testing which would determine the significance of a specific treatment. Therefore, it was not possible to determine if the changes in counts over the study period were significant.

Timing and non-uniformity of bait application resulted in additional variability to the data to be analyzed. Adjustments made to the burrow builder throughout the study period allowed for inconsistencies in application rates. Applications

occurred at various times throughout the field seasons, sometimes taking several weeks to complete.

There was no standardization of any crop/vegetation parameters of each plot as to, for example, age and composition of the stand, seed stock/variety, soil type and moisture. Each of these variables could affect the results of the study by causing different responses to the various rodenticides.

Inconsistent weather led to staggered cutting, flooding and other factors which in turn led to missing data in some study plots. Census counts and trapping could not be undertaken in uncut or flooded fields. This resulted in unreliable data in some areas of the study.

CHAPTER 2

2.0 Literature Review

2.1 Historical Overview

It is obvious, when reviewing the literature, that the pocket gopher has been considered a problem by farmers for many decades. Studies have been undertaken since the early 1900's. For example, according to Tietjen et al. (1973), studies on the effects of pocket gophers on ground cover, vegetation and soil were carried out by Grinnel in 1923, Criddle in 1930, Taylor in 1935 and Larrison in 1942.

Management and control have been major issues especially in Colorado (Tietjen 1973) and Nebraska (Case 1983). In Manitoba, a study by Oberpichler (1989) focused on the problems and management option of the plains pocket gopher (*Geomys bursarius*). The plains pocket gopher was designated as "Vulnerable" by the Committee on the Status of Endangered Wildlife in Canada in 1988 (Oberpichler 1989). The northern pocket gopher (*Thomomys talpoides*) has a much greater range through the province (Figure 2), and populations are quite high in some areas (Bonney 1985). During the summers of the 1970's, the Manitoba government applied rodenticides on many acres of forage. However, no study of this calibre has been undertaken on the control of this gopher in Manitoba.

Damage by gophers includes destruction of underground utility cables and irrigation pipe, direct consumption, smothering of forage by earthen mounds and change in species composition on rangelands by providing seedbeds

(mounds) for invading annual plants (Case 1983). In forage crops, machinery damage is evident as are cutting losses which occur from lifting the cutter bar to avoid mounds (Bonney 1985). Forage stand longevity and yield losses are other concerns along with forage quality losses and spoilage of forage from soil contamination (Bonney 1985).

In California, gophers reduced potential herbage by 24%, or 813 pounds per acre on the average, over an eight year period (Fitch and Bentley 1949). As plants mature and become less palatable, gophers feed more on roots and bulbs (Ward 1960). According to Turner (1973), in agricultural areas, gophers also reduce ground cover and may sometimes be the primary cause for exposure of bare soil. The agricultural problems experienced across North America appear to be quite similar and have been occurring for some time.

2.2 Control Methods

There are four basic methods of controlling pocket gophers: herbicides, baiting with toxicants, trapping and exclosures (Tietjen 1973). Additional methods of control used on other mammals will be discussed.

2.2.1 Herbicides

Studies by members of the Colorado Cooperative Pocket Gopher Project and others since 1956, have progressed to the point where there is now a sound understanding of the interrelationships between rangeland, herbicide treatments, vegetative response, pocket gopher food habits and populations (Keith et al. 1959; Hansen and Ward 1966; Tietjen et al. 1967; Hull 1971).

The herbicide used in these studies was 2,4-D (2,4-dichlorophenoxyacetic acid). Results showed that the spraying had an indirect limiting effect on the pocket gopher populations by significantly reducing forb production, composition and ground cover. This was the primary reason for the population decline (Tietjen 1973) as forbs make up 94% of their yearly diet in alfalfa fields (Ward 1973). Of this 94%, alfalfa leaves and stems account for 23% and roots for 71% (Ward 1973).

2.2.2 Baiting with Toxicants

Baiting with toxicants has the broadest application (Tietjen 1973). There are three requirements which should be satisfied by a control agent (Tietjen 1973):

- 1) effectiveness against the target species;
- 2) relative safety to man and non-target species, and,
- 3) economy of manufacture and use.

The development of baits for northern pocket gophers has undergone an evolutionary process. One of the initial concepts was that the best accepted baits were those related to the pocket gopher's natural food habits (Tietjen 1973). As Tietjen noted (1973), previous studies by Lantz (1909), Burnett (1917), Scheffer and Garlough (1936), Crouch (1942), Miller and Howard (1951), Moore and Reid (1951), Storer (1953), Miller (1953) and Dingle (1956) all investigated the use of wet baits such as sweet potato, alfalfa leaves and roots, prunes and carrots. Wet baits are generally better accepted than cereal grains, but their use presents problems in bait formulation, storage and application (Tietjen 1973). However, studies by Ward et al. (1967) showed that oat groats treated with **Gophacide** (DRC-714) are effective in controlling

northern pocket gophers. Due to these problems, studies undertaken today are focused on single-dose, target specific rodenticides and not wet baits.

A study by Lewis and O'Brien (1990), suggest that strychnine-laced alfalfa is the most effective method of toxicant control, especially in late spring and summer. Another study by Evans et al. (1990), also suggests that strychnine baits are effective in controlling northern pocket gophers. The problem with the strychnine baits, however, is that they fail to meet the second requirement stated by Tietjen (1973) above.

However, with the increased research being undertaken in chemical control methods new baits that have recently been developed that better meet the requirements have been tested quite extensively. For example, Tunberg et al. (1984) state that single-dose, anticoagulant toxicants (eg. **Maki** and **Contrac**) made into bait blocks with a suitable grain and paraffin have the potential to kill the initial gopher and new invading gophers, offering long-term control with fewer treatments. According to Marsh and Plesse (1960) the paraffin is used to moisture-proof the baits so that they will remain acceptable longer, will hold ample bait for multiple feeding and will be easier to handle. Godfrey (1987) also believes that the use of persistent baits that remain toxic and acceptable to the gophers for an extended period are essential to achieve long-term control. Stimman and Clark (1981) state that anticoagulant poisons offer a good degree of safety for non-target species.

Another recently developed type of rodenticide is Cholecalciferol (**Quintox**) which causes a fatal build up of calcium in the blood stream (Marsh and Tunberg 1986). It was found to have a low probability of secondary poisoning,

that is, it is target specific, since the gopher will stop feeding about the time plasma calcium levels become uncontrollably high, thus consumption of bait far in excess of a lethal dose is probably rare. This prevents bait-shyness, since death occurs quickly. This conserves bait and prevents rodents from consuming excessive overdoses (Bell Laboratories, Inc. 1989), the major problem with anticoagulants, (Tunberg et al. 1984; Godfrey 1987; Gossen and Gadd 1990), and allows for some leftover bait for invading gophers.

All rodenticides are usually applied with mechanical burrow builders, however, baiting by hand is also common (Godfrey 1987). The burrow builders allow for larger areas to be treated faster, but their use may be restricted by soil conditions, topography and obstructions (Godfrey 1987). Godfrey also states that artificial burrows may expedite reinvasion by gophers and they might also expand the infested area. Tickes et al. (1982) state that the condition of the artificial burrow constructed is a factor that should be emphasized, with a smooth, solid burrow constructed at the right depth and spacing to intercept the maximum number of existing systems. As Crouch (1986) points out, baiting can be successful but its effects are not permanent or even long-lasting in most areas. Success seldom results in the mortality of all gophers, often leaving enough animals to repopulate in a year or two, and therefore baiting must be repeated periodically.

2.2.3 Trapping

Trapping is recommended for controlling pocket gophers only on relatively small areas or where the population is low (Tietjen 1973; Lewis and O'Brien 1986; Godfrey 1987). The technique, while slower and more expensive than

chemical treatment, is equally dependable. However, the best use for trapping may be for removing the few animals remaining after rodenticide or herbicide applications or as a research tool (Tietjen 1973).

2.2.4 Exclosures

Exclosures consist of fencing, shelterbelts or any other material which could be used to keep pocket gophers out of fields. Tietjen (1973) recommends that, although exclosures can be effective, they should only be considered as a research tool. According to a study by Salmon et al. (1990), exclosures may be the only technique which ensures the complete exclusion of gophers from experimental and ornamental plots. Godfrey (1987) also states that in limited areas where intensive maintenance is possible, exclusion may be feasible. A barrier of at least 60 cm deep and 90 cm high with a mesh size of 1.27 cm is necessary (Salmon et al. 1990). Godfrey goes on to state that crop rotation may be of some benefit by creating periodic unfavourable conditions but is a method of limited applicability (Case 1983; Tickes et al 1983; Godfrey 1987). A band of cereal grain grown as a perimeter to an alfalfa field may be effective as a barrier if the enclosed field is cleared of all gophers (Godfrey 1987). Flood irrigation may also be effective in some areas but this too has limited applicability (Case 1983).

According to Tietjen (1973), many studies have used exclosures to determine the effects of pocket gophers and other rodents on rangelands (such as Horn and Fitch 1942; Fitch and Bentley 1949; Moore and Reid 1951; Ellison and Aldous 1952; Branson and Payne 1958; Keith 1961). These authors all came to the same conclusion: exclosures apparently were successful in eliminating

most pocket gopher movement into study areas. However, supplemental baiting or trapping in a buffer zone around the enclosure is usually necessary to prevent pocket gophers from eventually invading the enclosures, especially during the winter by tunneling through the snow pack.

2.2.5 Additional Control Methods

A study by Dolbeer et al. (1991) evaluated the efficacy of fumigation in controlling woodchucks in Ohio. Two similar studies were undertaken with ground squirrels, with one demonstrating an efficacy level of 84% using a combination of carbon monoxide, sodium nitrate and nitrogen (Matschke and Fagerstone 1984). However, fumigants are not effective in sandy or dry soils where gas may readily dissipate (Case 1983). With pocket gopher populations, it is seldom effective in giving more than short-term relief and in all but low density populations, the time and cost of using this control method is prohibitive (Case 1983; Godfrey 1987). However, as Plesse (1984) points out, fumigation leaves no hazardous residues, has no secondary effect on cats or dogs or other predators should a carcass be recovered and eaten and one to seven gophers (i.e., an adult female with a litter) can be eliminated by a single treatment.

Moline and Demarais (1987) studied the efficacy of aluminum phosphide on black-tailed prairie dogs and yellow-face pocket gophers in Texas. They discovered that the fumigant was more effective on the prairie dog than the gopher and believe that this was due in part to soil porosity and moisture.

Sullivan et al. (1989, 1990) have been studying the response of pocket

gophers to the application of predator odours as repellents and of synthetic semiochemicals of stoat (*Mustela erminea*). A significance avoidance response to certain treated areas was noted, but the authors believe that more investigation is needed.

The use of creeping-rooted varieties of alfalfa versus tap-rooted varieties, natural control methods, such as the presence of predators, habitat alteration and various cultural methods (Case 1983, 1989) are other possible pocket gopher control methods. Bounties have been used in Manitoba as well as in the United States. However, on species such as the coyote they have not really proven to be very effective management tools, since they are costly and inefficient (Young and Jackson 1951; Bekoff 1978).

CHAPTER 3

3.0 Methodology.

3.1 Introduction

In order to meet the aforementioned objectives, the study utilized various methods of data collection. Objective 1 was achieved by evaluating all of the results obtained from the other objectives, through trapping, the questionnaire and the literature review.

For Objective 2, a census count method was needed in order to determine the pocket gopher population in the study plots. However, an index of the population was used. Rodenticides were applied at two times of the year, spring and fall.

The literature review and the questionnaire were undertaken to meet Objective 3.

Objective 4 was met by removal and live trapping.

3.2 Data Collection

Two primary methods were used to obtain data. The first, paired trials, were set up to measure the effect of removal trapping and the effect of four rodenticides applied at two different seasons. Sixteen fields were chosen from those volunteered by local farmers for rodenticide application and two other fields were chosen for the removal trapping. Live trapping was also undertaken

for the 1991 and 1992 field seasons on two fields. Four trap types were used for the removal trapping, two trap types were used for the live trapping and four rodenticides were selected. Census counts were done three times per field season to determine the efficacy of treatments.

The rodenticides were selected by George Bonnefoy, Forage Specialist, Province of Manitoba Department of Agriculture. Trap selection was made by Jack Dubois based on availability and on the success of those used in previous studies.

The census count method, modified after Reid et al. (1966), was also selected by Jack Dubois since it appeared to be successful in determining actual gopher populations.

The second primary method, a questionnaire designed by the author, was sent out in May of 1992 (see Appendix A for a copy of the questionnaire).

The biological and reproductive data were compiled by Melanie Dubois who also aided in the field work. Specimens were prepared by standard museum methods.

Rodenticide application was undertaken by George Bonnefoy, Jana Watt (summer student with the Manitoba Department of Agriculture) and the author using a few different burrow-building machines modified with a variety of seed dispensers (Tietjen 1973; Hunter 1980; Tickes et al. 1982; Godfrey 1987).

3.2.1 Census Method

In order to measure the effects of the control methods used, regular censuses of all experimental fields were necessary. Three census counts were done each field season, the first prior to resumption of growth and the subsequent counts after each cut of alfalfa, weather permitting. Initially, 50 metre by 50 metre plots were marked and raked to flatten any and all mounds and/or plugs and left for 48 hours. In returning to the plots, each was divided into 10 metre strips, for ease of counting fresh sign (mounds and plugs). The methodology was modified from Reid et al. (1966).

Plot areas were randomly selected in each study field and set up using a compass and a steel measuring tape. Chaining pins, marked with orange flagging tape, indicated each corner of the plot. Plot size was increased from 50 metres by 50 metres to 71 metres by 71 metres in all alfalfa fields of 20 acres and more after the initial count in 1991. This was to provide a stronger index of pocket gopher population changes over the study period. Results have been adjusted to account for this change in plot sizes in the accompanying charts and graphs.

To provide a more accurate count, the majority of the census plots were increased to 71 metres by 71 metres after the first count in 1991. Those that were left at 50 metres by 50 metres were the smaller acreage fields.

3.2.2 Mechanical and Chemical Control

For the mechanical and chemical control segment of the project, initially four

removal trap types, two live trap types and three varieties of rodenticides were used.

The removal traps were:

Macabee

Victor Easy Set

Topnik's Wooden Box

The Black Hole

One of the live traps used was made at the museum and modeled after a trap designed by Baker et al. (1972). The second live trap had been used in a previous pocket gopher study and was modified after Hart (1973).

The rodenticides were:

Maki

Quintox

Gophacide

Contrac was added for the second and third field seasons.

(See Appendix B for the chemical composition and manufacturer information).

Trapping was done after the spring census count and after each cut of alfalfa. The rodenticides were applied either after the first census count of the season or in the fall, after the last census count. These treatments were repeated throughout the project at approximately the same time, in the same field, with some aberrations due to weather and logistics.

To set a trap, it is necessary to find the main runway or tunnel of the gopher's

burrow system. A hole is then dug to access the tunnel, the trap set and placed in the tunnel. Then, the hole must be covered, without hindering the trigger mechanism of the trap, allowing only a small amount of air to enter the burrow system. It is thought that when the gopher senses the draft of air and finds the source, an attempt is made to repair the burrow system. In so doing, soil is pushed in front of the gopher which then triggers the trap and catches the gopher. Traps were secured to a bamboo stake, which also acted as a marker.

Live trapping was undertaken in the 1991 and 1992 season but not in 1993. The purpose of this was to look at population structure and dynamics of the pocket gophers. Traps were set the same way as for removal, however, these are larger, requiring a longer setting and checking time and they have to be checked more often. Upon trapping, the gophers were then weighed, sexed, tattooed, providing identification for subsequent trapping. Tattooing is the accepted method of marking burrowing rodents because, according to The American Society of Mammalogists, is the least harmful to the animal.

An **Elston Burrow Builder** was used in the 1991 season and most of the 1992 season to apply the rodenticides. For the second part of the 1992 season and the 1993 season a modified **Bob Kentch - The Gofer** was used. The machine was pulled behind a tractor, at varying speeds dependent on the product, creating an artificial burrow and dispensing the rodenticide. Rodenticides were dispensed within the limitations of machine calibration, at the manufacturers' recommended rates (Table 1), in rows, at a distance of 6 metres apart.

The artificial burrow builder was pulled behind a tractor at varying speeds,

depending on the product. The rodenticides were dispensed, within the limitations of calibration. The artificial burrows are intended to attract the pocket gophers, which upon using them, find the poison and ingest it.

TABLE 1: Manufacturers' Recommended Application Rates (Lbs./Acre)

RODENTICIDE	APPLICATION RATE (LBS./ACRE)	MANUFACTURER'S RECOMMENDED RATE (LBS./ACRE)
Maki	3.95	4.00
Quintox	3.00	3.00
Gophacide	1.33	1.50
Contrac	3.00	3.00

Rodenticide treatments were done in the spring (mid-May) or the fall (late August/early September) with an application of each variety occurring in two fields each time. This was to test whether the gophers were more susceptible to different rodenticides at different times of the year. In 1993, **Gophacide** was applied, using the **Gofer Getter Junior** hand-bait applicator, along ditches, road sides and bluffs, which are areas of potential reinfestation. Hence, a buffer zone was created around the experimental plots. Table 2 shows the plots, landowners, acreages of the treated fields and treatments which were undertaken.

TABLE 2: Plots, Landowners, Acreages and Treatments of the Study

PLOT	LANDOWNER	ACREAGE	TREATMENT
A1	N. Bruneau	10	Removal by trapping
A2	LeFloch Bros.	30	Removal by trapping
B1	D. Bruneau	10	Live trapping
B2	J. Cewick	10	Live trapping
C1	Ray-Bert Farms	22	Maki - spring
C2	A. Philippot	22	Maki - spring
D1	LeFloch Bros.	30	Maki - fall
D2	C. Bruneau	22	Maki - fall
E1	Ray-Bert Farms	22	Quintox - spring
E2	A. Philippot	22	Quintox - spring
F1	G. DeRocquigny	22	Quintox - fall
F2	L. Rey	20	Quintox - fall
G1	G. Goulet	22	Gophacide - spring
G2	C. Bruneau	20	Gophacide - spring
H1	L. Rey	22	Gophacide - fall
H2	G. DeRocquigny	20	Gophacide - fall
I1	R. Bruneau	20.6	Confrac - spring
I2	Lacroix Farms	20	Confrac - spring
J1	L. Rey	22	Confrac - fall
J2	LeFloch Bros.	20	Confrac - fall
K1	R. Bruneau	20	Gophacide - spring
K2	N. Bruneau	20	Gophacide - spring
L1	R. Bruneau	20	Maki - fall

3.2.3 Biological and Cultural Control

To obtain information on biological and cultural control, a questionnaire was sent out to Forage Council members. It was prepared in early May, 1991 and was sent out to all 204 Manitoba Forage Council members in May, 1992. The

purpose of this was to determine how the landowners of the province perceived the pocket gopher problem, how long they have been a problem, if predators were present on their property and did they help control the numbers, what type of alfalfa they were planting, to provide farmers with an opportunity to offer suggestions for pocket gopher control and any other comments or concerns they might have.

3.3 Analytical Methods

All pocket gopher specimens were dissected to provide reproductive and other biological information. The number of embryos present in a pregnant female and their size provided an estimate of the average number of young per litter. Breeding information was also thereby derived. A representative sample of specimens became part of the Manitoba Museum of Man and Nature's collections.

Census count results were used to indicate if a decrease or an increase in the study plot had occurred. This was then used to indicate the control methods' effectiveness.

3.4 Statistical Tests

The change in number of pocket gopher sign in each plot was calculated on a plus/minus basis to determine if the increase or decrease in number of pocket gopher sign was significant (Table 3). Due to the extreme variability in the study, caused by too many plots with not enough replicates, it was not possible to conduct statistical testing (Dr. Carl Schwarz, Department of Statistics,

University of Manitoba, pers. comm.). The number of pocket gopher sign in each plot did enable the development of an index which was used to determine the effectiveness of the various treatments undertaken.

TABLE 3: Census Counts and the Changes (+/-) Between Each Count

PLOT	May-91	Jun-91	Chg (+/-)	Aug-91	Chg (+/-)	May-92	Chg (+/-)	Jul-92	Chg (+/-)	Sep-92	Chg (+/-)	May-93	Chg (+/-)	J/A-93	Chg (+/-)
A1	13	25	12	35	10	7	-22	65	58	43	-22	11	-21	35	24
A2	2	9	7			20		103	83	112	9	48	-64	179	131
B1	1	0	-1	11	11	10	-1	28	18	25	-3	3	-22	64	61
B2	1	9	8	14	5	13	-1	17	4						
C1	6	2	-4	21	19	56	35	28	-28	58	30	34	-24	32	-2
C2	12	0	-12	6	6	6	0	7	1	21	14	12	-9	3	-9
E1	12	0	-12	36	36	24	-12	34	10	85	51	25	-60	50	25
E2	0	0	0	15	15	10	-5	10	0	8	-2	9	1	6	-3
G1	2	24	22	55	31	43	-12	75	32	107	32	22	-85		
G2	22	88	66	65	-23	84	-19	163	79						
I1						20		47	27	72	25	35	-37	91	56
I2						6		14	8			22		50	28
K1												25		20	-5
K2												55		98	43
D1				60		47	-13	122	75	301	79	5	-296		
D2				38		6	-32	36	30	76	40	5	-71	48	43
F1								9		3	-6	9	6	6	-3
F2				28		10	-18	30	20	83	53	35	-48	106	71
H1								15		22	7	5	-17	39	34
H2				71		30	-41	81	51	94	13	19	-75	29	10
J1				26				7				19		77	58
J2								4		41	37	20	-21	24	4
L1												26		47	21

CHAPTER 4

4.0 Results and Discussion

4.1 The Questionnaire

Of the 204 questionnaires sent out to Manitoba Forage Council members (Appendix A), 118 were returned. Among other things, the respondents gave a new indication as to how the pocket gopher population in Manitoba has spread, by indicating their geographical position in the province, as well as to how serious landowners perceive the problem to be.

Only sixteen replied that pocket gophers were not a problem and these were from the Interlake region, an area where there are no pocket gophers. Of the 102 that replied that gophers were a problem, seventy-five felt that they have always been a problem.

Figure 10 illustrated how the respondents felt about the change in the pocket gopher population. Eleven felt that the population had decreased, 36 felt it had remained unchanged and 49 felt that their numbers had increased .

Figure 11 showed that the most common methods of control used by farmers are trapping (43) and cultivating (42). Only 22 replied that they had tried poisoning and 5 reported other control methods such as rotating fields and fumigation. Forty-three replied that they used no control.

Forty-four of the respondents replied that they had purchased traps and of these, 12 replied that they had contracted children to trap and 3 contracted

FIGURE 10: QUESTIONNAIRE RESULTS ON LANDOWNERS' OPINIONS OF POCKET GOPHER POPULATION LEVELS

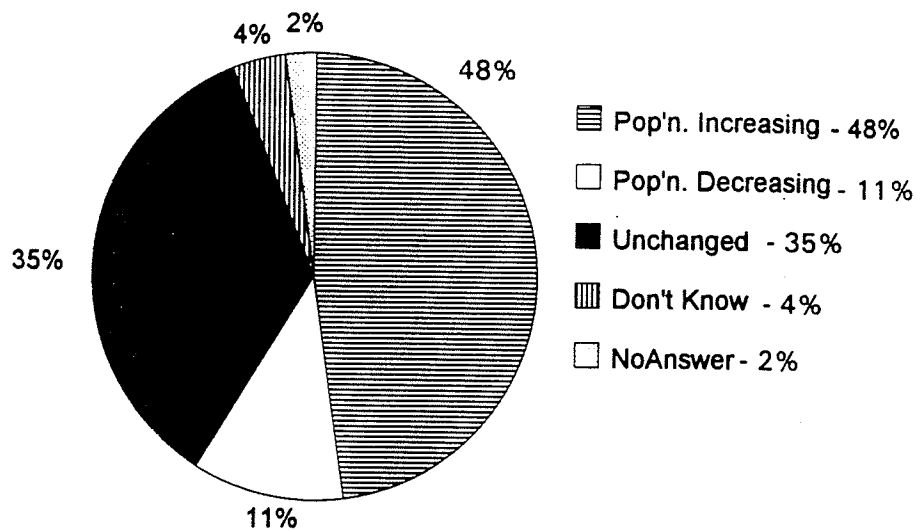
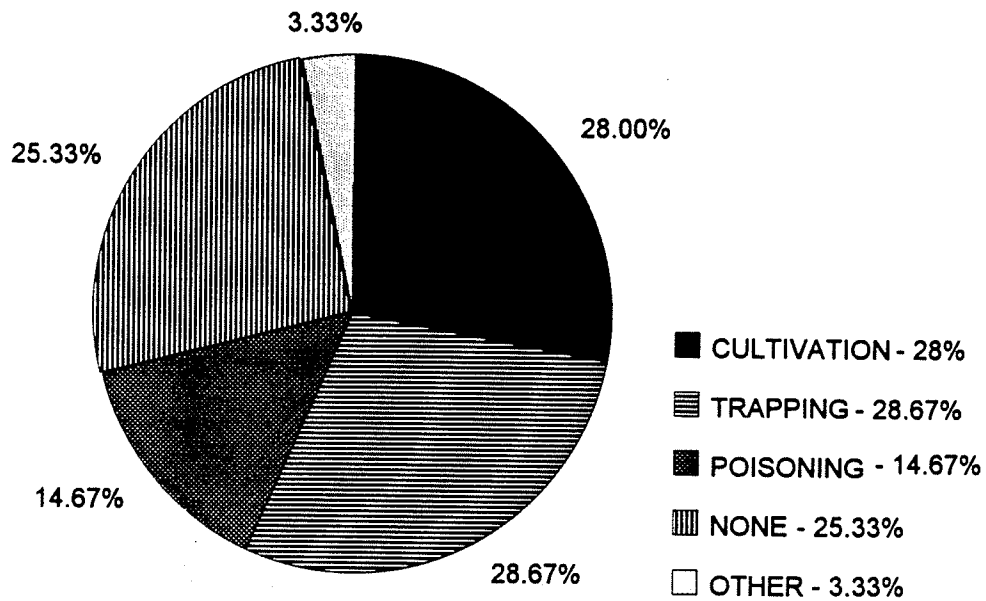


FIGURE 11: QUESTIONNAIRE RESULTS ON CONTROL METHODS USED BY LANDOWNERS



adults. Nine replied that they had either bought a burrow builder or rented one. Eight replied that they had used a hand bait applicator.

Fifty replied 'yes' to trying creeping-rooted varieties of alfalfa and of those, 6 replied that they had noticed a difference in susceptibility to pocket gopher damage as opposed to tap-rooted varieties. Thirty said no difference was noticed and 2 replied that they did not know since they had just seeded the alfalfa.

Only nine stated that shelterbelts deter the spread of pocket gophers while eighty-five said that they do not. The species of trees listed as the most effective were ash, poplar and caragana.

Suggestions offered for pocket gopher control ranged from spearmint gum to disease to poisoning to shooting.

Figure 12 illustrated that the field type most affected was alfalfa (57 replies) and alfalfa/tame hay (19 replies).

Figure 13 showed that thirty percent of respondents believed that the pocket gopher problem is very serious. Only 6% replied that it is not serious at all.

Figure 14 showed that respondents feel that most of the damage done by pocket gophers was to machinery (44%), then to harvest reduction (29%) and then to crop consumption (18%).

All but one replied that they had at least one of the natural predators of the

FIGURE 12: QUESTIONNAIRE RESULTS ON LANDOWNERS' OPINIONS ON FIELD TYPES MOST AFFECTED BY POCKET GOPHERS

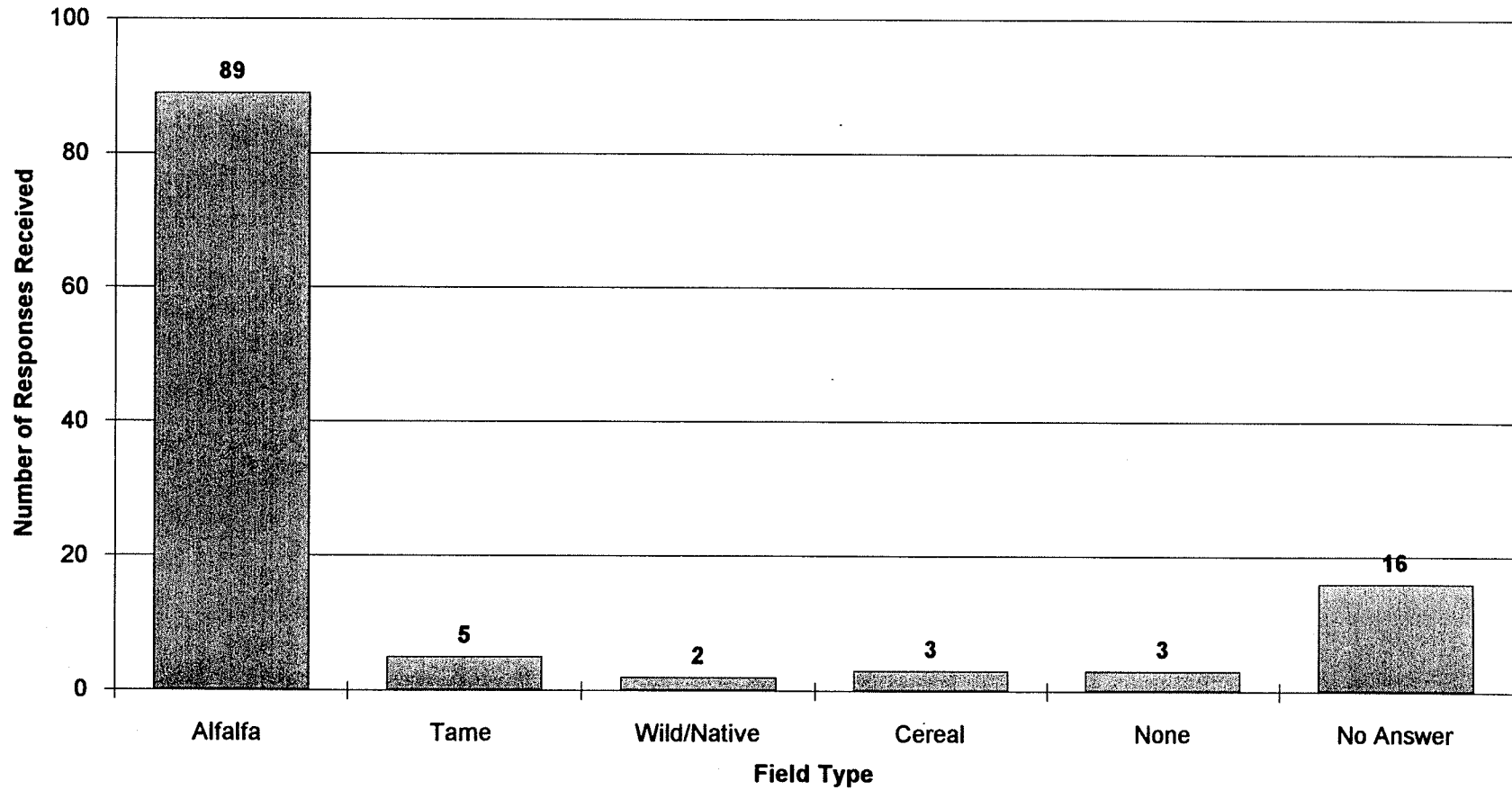


FIGURE 13: QUESTIONNAIRE RESULTS ON LANDOWNERS' OPINIONS ON THE SERIOUSNESS OF THE POCKET GOPHER PROBLEM

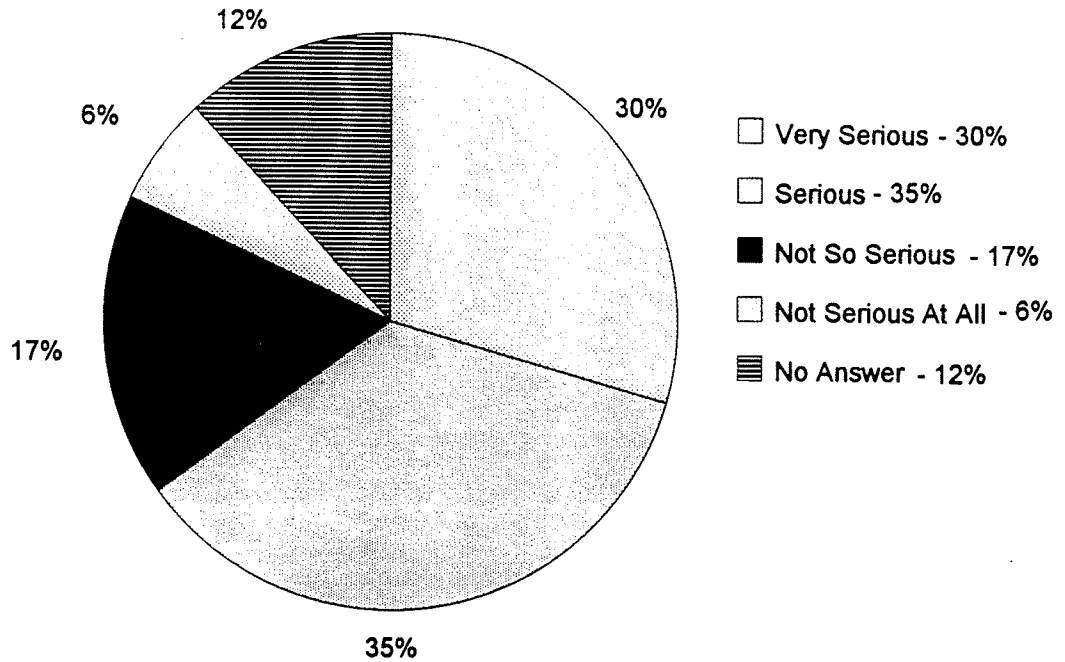
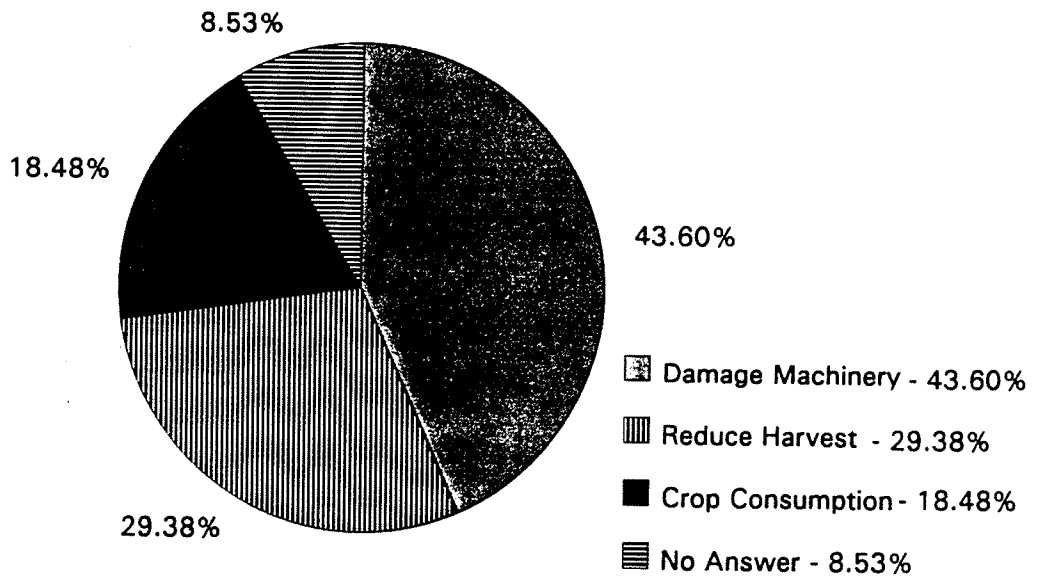


FIGURE 14: QUESTIONNAIRE RESULTS ON LANDOWNERS' OPINIONS ON THE MOST DAMAGE DONE BY POCKET GOPHERS TO:



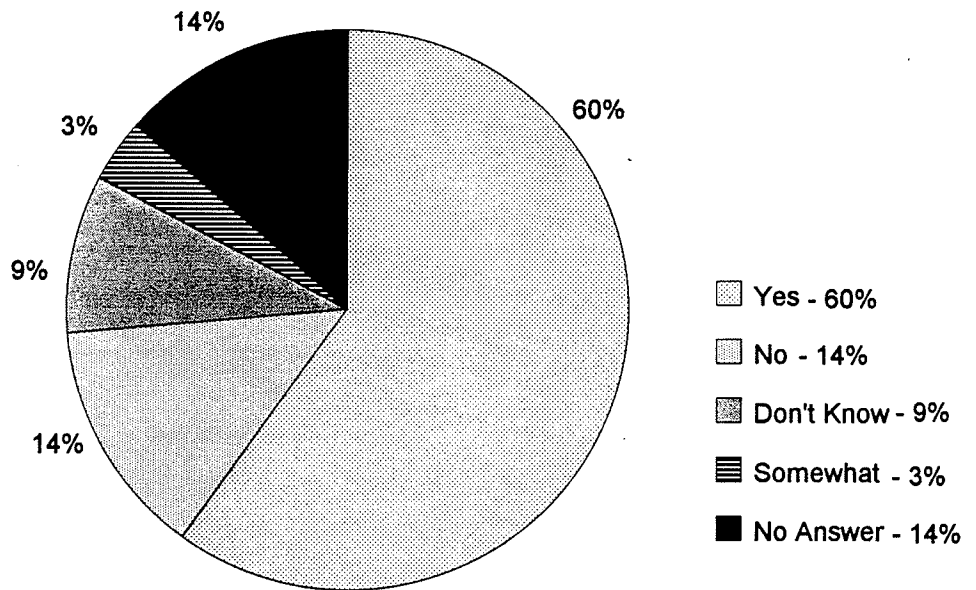
pocket gopher on their property. Numbers here varied, because of the size of the selection, but thirty-one responded to having all of those listed present (coyotes, badger, hawks, fox, owls and weasels). Foxes were the most frequently listed predator (97 replies), followed by hawks (92 replies), coyotes (91 replies), owls (78 replies), badgers (64 replies) and weasels (52 replies). Figure 15 illustrated that the majority of respondents believed that predators do alleviate the pocket gopher numbers somewhat but that a better method of control is needed.

4.2 The Census Method

The census method used by Reid et al. (1966) needed to be modified if it were to be applied to this study. Since their study was not exactly duplicated, the formula they used could not be used here and was of dubious validity (Dr. Carl Schwarz pers. comm.). Hence, the number of pocket gopher sign in each census plot represents an index of the gopher population, rather than an exact count. That is, we assume that changes in number of pocket gopher sign from count to count represents a change in the overall population, as the counts were done in a uniform manner.

Three new fields were selected in the spring of 1993 to replace the previous spring **Gophacide** (G1, G2) treatment fields and one of the fall **Maki** (D1) treatment fields. The same procedures were carried out to set up the plots. One of the live trapping fields (B2) was trapped out in 1992 prior to being cultivated and not replaced. The other live trapping field (B1) was also converted to removal trapping because of the poor return of information for the effort in the live trapping. After the initial capture, those tattooed were rarely

FIGURE 15: QUESTIONNAIRE RESULTS ON LANDOWNERS' OPINIONS ON PREDATORS' EFFECT ON POCKET GOPHERS



recaptured. Because of this it was not possible to determine much beyond the continual rise in numbers.

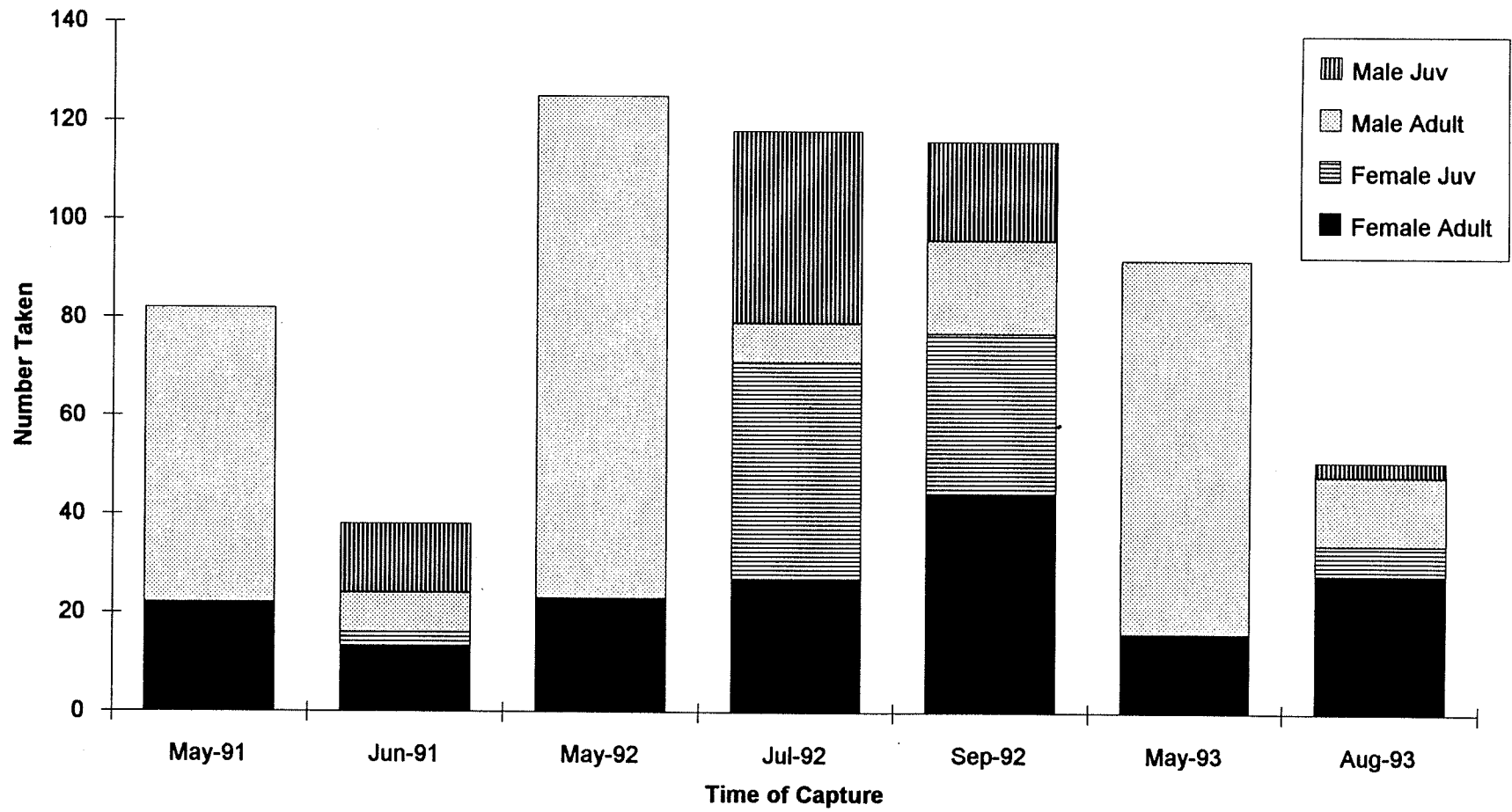
4.3 Mechanical and Chemical

This part of the study covered the trapping and rodenticide treatments. Four trap types and four rodenticides were evaluated. The results of each treatment are discussed in the following sections.

4.3.1 Trapping

For the three years spent in the field, trapping results have followed a similar pattern year to year (Figure 16). The majority of pocket gophers captured in the spring are males, in the summer, females and some juveniles, and in the fall, mostly juveniles and some females but fewer males. During the spring, (from May into early June), males are actively seeking receptive females for breeding. Females are foraging early in the summer (late June and early July) to feed young and, depending on the time of weaning, juveniles have begun to forage for themselves. Some may have already left the female's burrow system and established themselves in their own burrow system. The increase in the number of juveniles present in the fall (late August and early September) is a sign of the dispersal of weaned young. Females rarely tolerate their young after weaning, however, some juvenile females may be allowed to remain longer than juvenile males (Chase et al. 1982). Our results suggest that either a juvenile female or a juvenile male may be allowed to remain in the mother's burrow system. In this study, we recorded 25 "double catches" including adult/juvenile (15), adult/adult (7) and juvenile/juvenile (3) and one triple catch

FIGURE 16: POCKET GOPHER CAPTURES: 1991, 1992 AND 1993



(one adult and two juveniles).

The most successful trap was the **Macabee** followed by the **Victor Easy Set**. The total number of pocket gophers captured was 622. Table 4 shows the efficiency ratings of each trap, their cost and source.

TABLE 4: Trap Types, Prices, Efficiencies and Sources

TRAP TYPE	PRICE	EFFICIENCY	SOURCE
Black Hole	\$12.00	42.8%	Northstar Seed Ltd. Box 714 Neepawa, MB. SWAT Exterminators 65 St. Anne's Wpg., MB.
Wooden Box	\$7.49	46.8%	Topnik's Ent. Ltd. Box 1449 Steinbach, MB.
Easy Set (pair)	\$3.75	35.9%	EKCO Canada Ltd. Niagra Falls, ON.
Macabee (pair)	N/A	51.5%	Not available locally
Overall Average		44.25%	

The **Macabee** and **Easy Set** traps were set in pairs, with one trap facing each way in each tunnel in the burrow system. This, in conjunction with their small size, could explain their higher success rate.

In 1991, the time taken to set traps, collect, bag and tag gophers was recorded for each field session in 1991. On average, it took 35 minutes per gopher,

showing just how labour intensive trapping is. Locating tunnels is the most difficult task since it is impossible to know if that particular tunnel is still in use or if it has been plugged off further into the burrow system. The presence of pocket gopher sign does not necessarily mean that the gopher is still present. Trapping time was not recorded in 1992 or 1993.

For the 1993 field season, the trapping methodology was altered somewhat. Traps were left in the ground for at least three trap nights (1 trap in the ground for one night = one trap night) to verify the removal of all burrow occupants. To speed up the checking of the traps, the **Black Hole** and the **Wooden Box** traps were preferentially used. These traps are larger than the other two and are never totally concealed when set. Therefore, one can observe without excavating if the trigger mechanism has been activated, saving time when checking traps.

Live trapping is an even more difficult endeavour since a much larger hole must be dug in order for the trap to fit. Concealment of the trap and checking time are also longer. Here, the overall efficiency was approximately 20%. Pocket gophers caught were weighed, sexed, tattooed and released. The intent was to re-trap these gophers in each field session of each field season. However, the re-capture rate was extremely low, approximately 2%, with only a few gophers being re-trapped. In 1993, live trapping was completely halted and removal trapping undertaken on the B plots.

4.3.2 Rodenticide Treatments

At the beginning of the study, only three varieties of rodenticides were used:

Gophacide, **Maki** and **Quintox**. The fourth rodenticide, **Contrac**, was first applied as a fall treatment in 1991 and the first spring treatment was in 1992. Of these, **Gophacide**, a strychnine-based poison, and **Quintox**, a calcium-building poison which causes heart attack, are registered with the Federal Government for pocket gopher control. **Maki** and **Contrac** are both second-generation, single dose anti-coagulants, as yet unregistered for use in Canada. Rodenticides were applied at two times of the year, spring and fall.

The same fields were used for the rodenticide treatments until the 1993 field season. Due to the withdrawal of fields by landowners, three new fields were established, two for the spring **Gophacide** treatments and one for a fall **Maki** treatment.

Varying conditions, such as soil moisture, season, palatability and solubility of bait, can hamper the application and the effectiveness of the rodenticides (Case 1983; Godfrey 1987; Vossen and Gadd 1990). For example, **Gophacide** is water soluble while **Maki** is not. This implies that, in moist conditions, the bait could be washed through the soil and not have time to be ingested by the local pocket gopher population before dissipation.

The results of the study show that spring and fall **Maki** initially have a drastic effect on pocket gopher numbers (Figures 17 and 18). However, all local populations displayed a significant ability to rebound in numbers very soon after treatment.

While spring **Gophacide** treatments did not appear to have any effect on pocket gopher populations, the fall treatments show otherwise (Figures 19 and

FIGURE 17: SPRING MAKI (C1, C2) CENSUS COUNTS: 1991, 1992 AND 1993

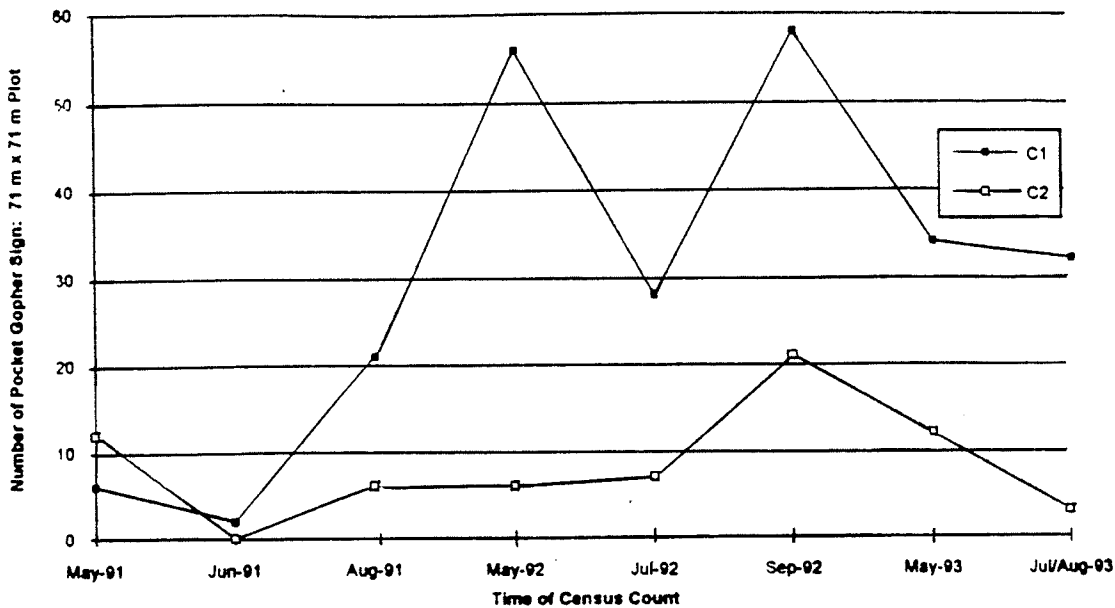


FIGURE 18: FALL MAKI (D1, D2, L1) CENSUS COUNTS: 1991, 1992 AND 1993

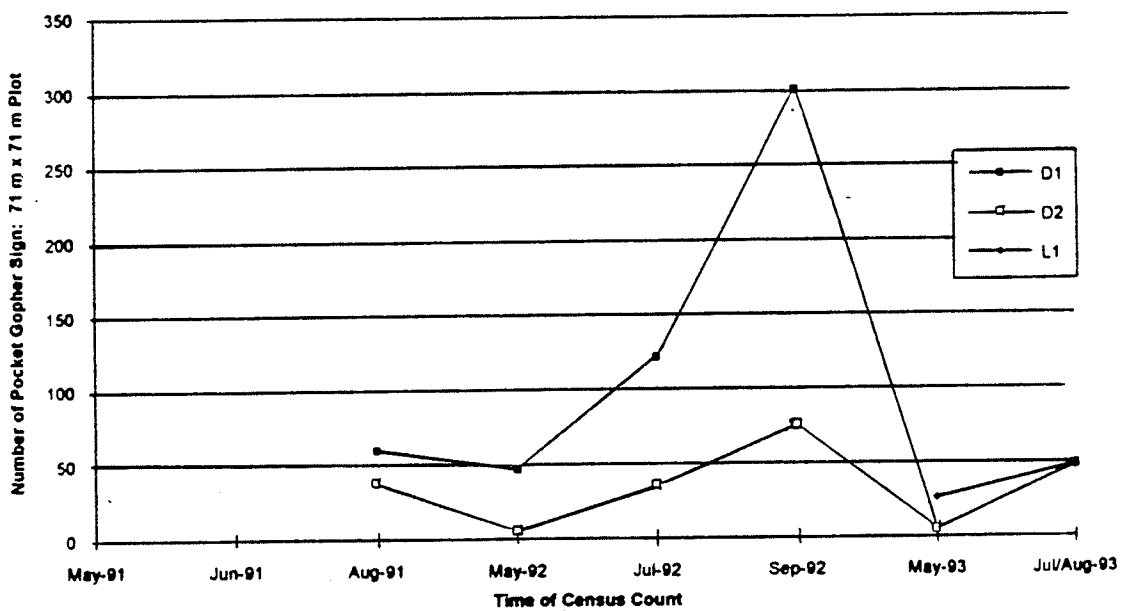


FIGURE 19: SPRING GOPHACIDE (G1, G2, K1, K2) CENSUS COUNTS: 1991, 1992 AND 1993

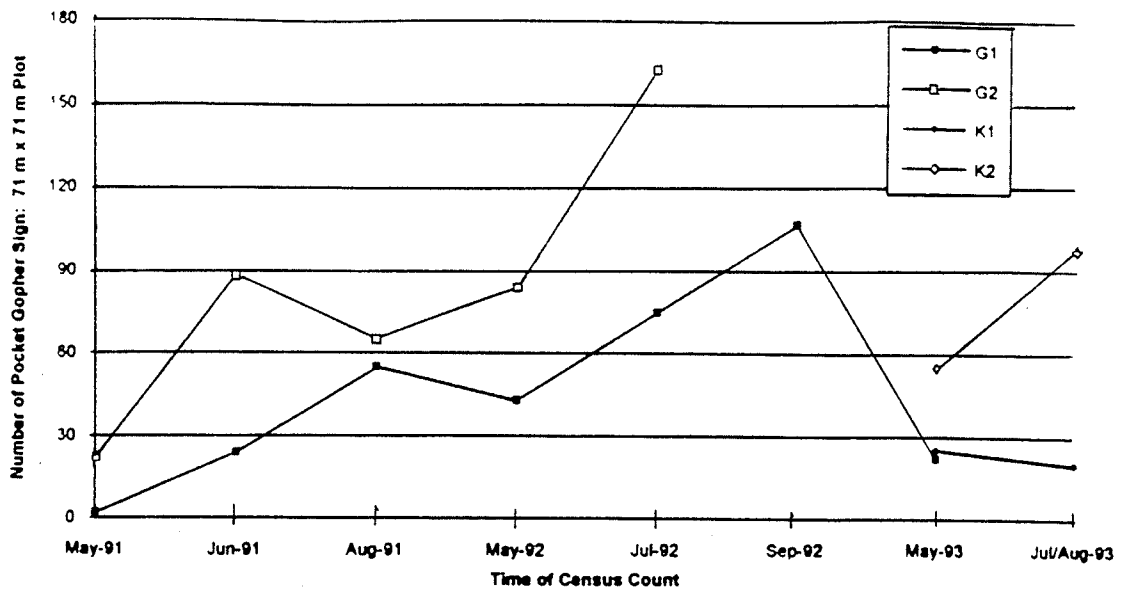
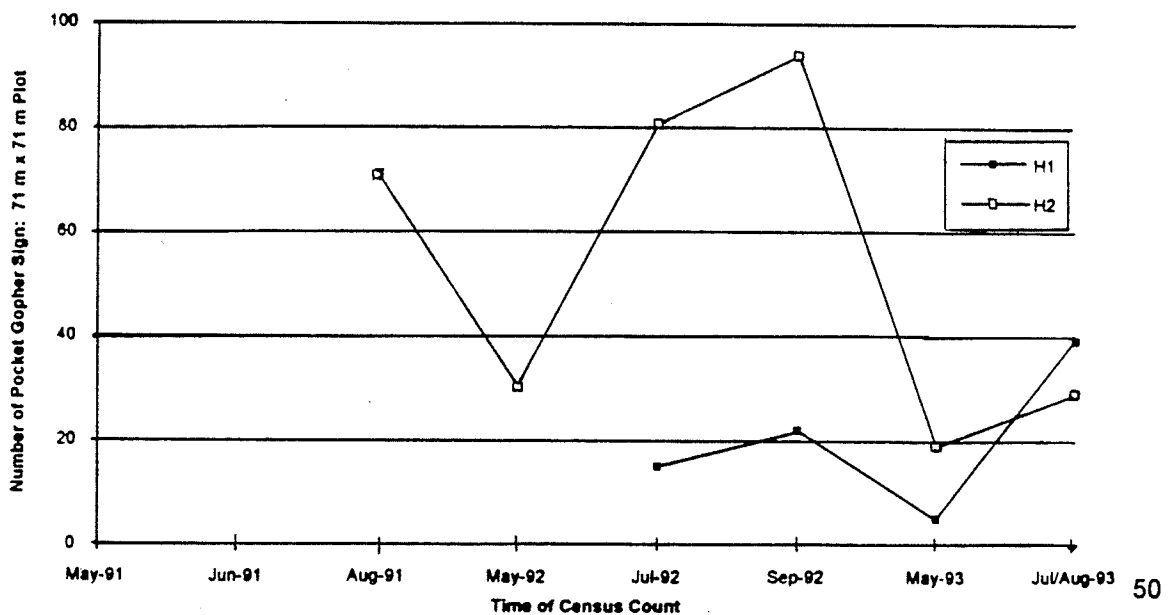


FIGURE 20: FALL GOPHACIDE (H1, H2) CENSUS COUNTS: 1991, 1992 AND 1993



20).

Spring **Contrac** treatments have not been very effective (Figure 21). Number of pocket gopher sign increased in both fields in 1992. However, the fall **Contrac** fields did show a slight reduction in pocket gopher sign (Figure 22). Spring **Contrac** treatments did not appear to have reduced the number of pocket gopher sign (Figure 21). However, insufficient data does not allow for a full evaluation of the rodenticide.

Spring **Quintox** appeared to have been effective but pocket gopher numbers tended to increase during post-treatment times (Figure 23). However, numbers never increased dramatically throughout the study as they did in other treatments. Fall **Quintox** also showed a reduction in number of pocket gopher sign but, again, numbers rebounded post-treatment, particularly in F2 (Figure 24).

Gaps in the data for the rodenticides are due to inclement weather conditions which affected the schedule by which the farmers cut the alfalfa. As well, there were difficulties in locating some fields.

Three artificial burrow builders were evaluated in this study: the **Elston Burrow Builder**, **Bob Kentch - The Gofer** and **The Western Alfalfa Machine**. The latter machine did not make suitable tunnels and was therefore discarded. **The Gofer** has proven to be the better of the machines tried. The machine did not easily plug up and it tended to stay in the ground which reduced the chance for poison to be dispensed above ground. Much custom. work had to be done to fit a bait dispenser that worked for all baits.

FIGURE 21: SPRING CONTRAC (I1, I2) CENSUS COUNTS: 1991, 1992 AND 1993

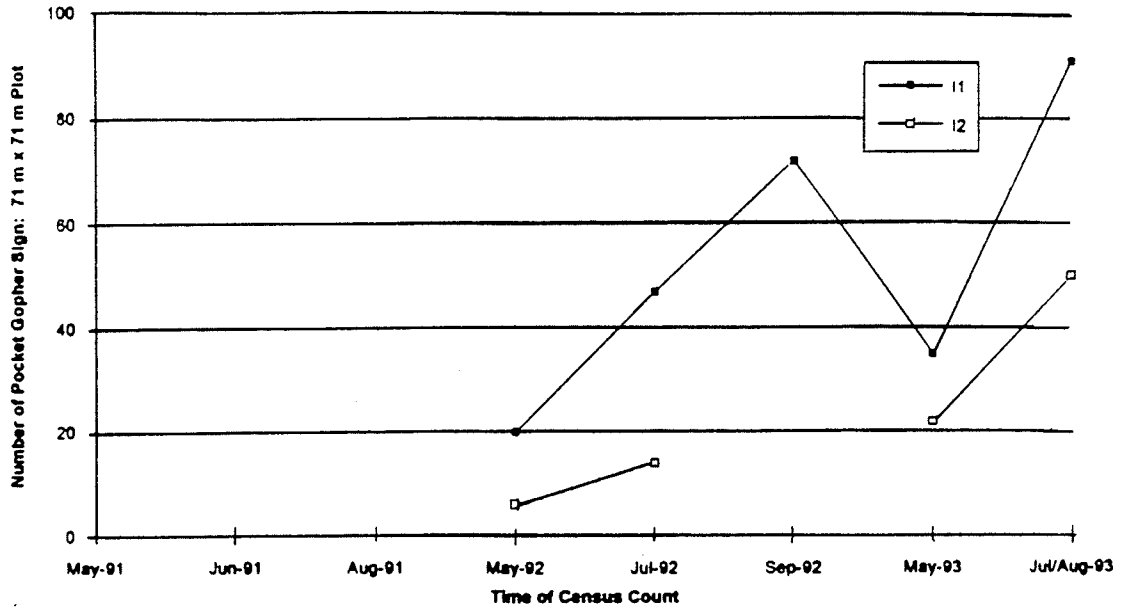


FIGURE 22: FALL CONTRAC (J1, J2) CENSUS COUNTS: 1991, 1992 AND 1993

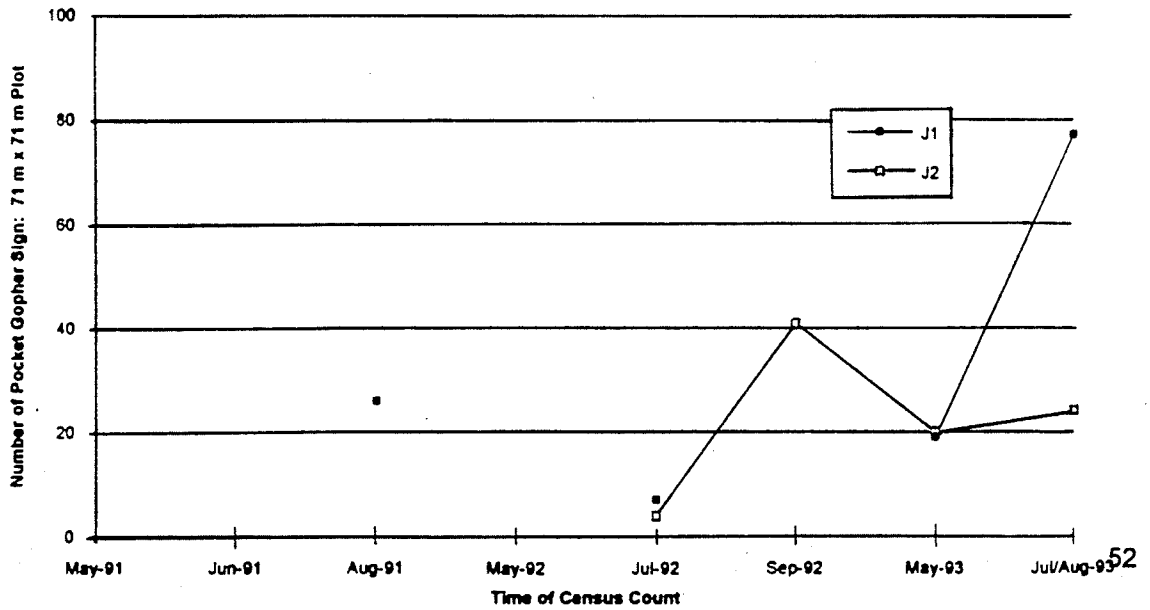


FIGURE 23: SPRING QUINTOX (E1, E2) CENSUS COUNTS: 1991, 1992 AND 1993

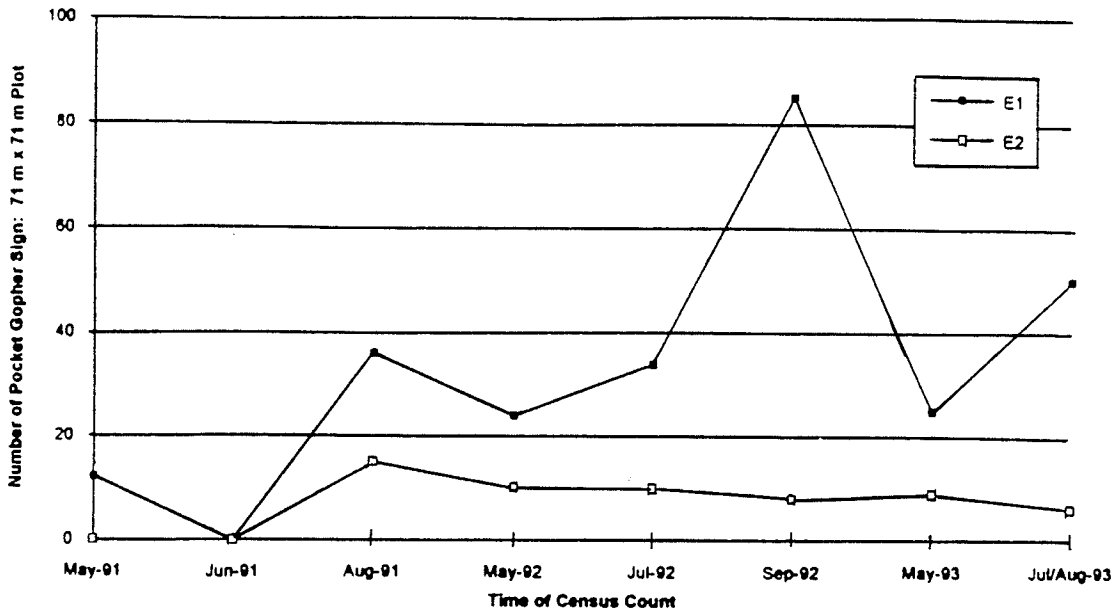
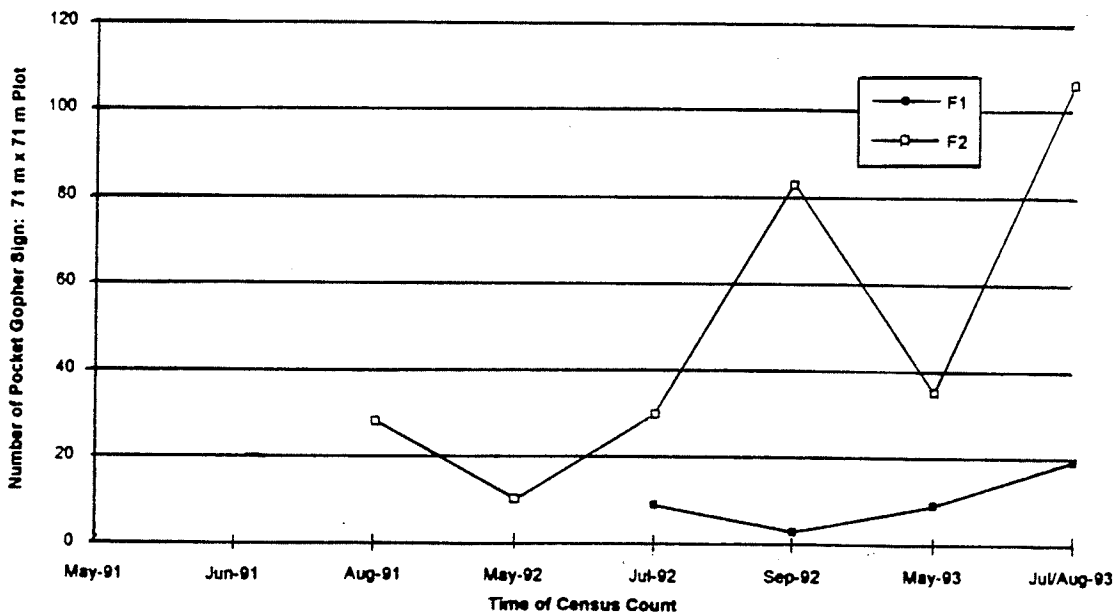


FIGURE 24: FALL QUINTOX (F1, F2) CENSUS COUNTS: 1991, 1992 AND 1993



Care should be undertaken to ensure proper bait application and handling procedures are undertaken and that there is minimal potential for negative effects on non-target species.

4.4 Biological and Cultural Results

4.4.1 Biological Results

The average number of young per litter is 4.8, as determined by counting the number of embryos or placental scars. This varies with species, female size, food availability and altitude of habitat (Chase et al. 1982). Hansen (1960) found that the litter size of *Thomomys talpoides* ranged from 3.2 to 6.4. These differences were attributed to locality rather than yearly fluctuations. Tryon (1947) found that the average number of young per litter in the Bridger Mountains, Montana, was 4.4 and, that in no case was there evidence of more than one litter per year.

Removal trapping has given an indication of when females become pregnant. The earliest pregnancy found in this study was 16 May and the latest 28 June. From the measurement of embryos, it was possible to determine the conception date. Turner's (1973) estimation of the gestation period is 21 days, and, according to Hill (1934), *Thomomys* measure 36 mm at birth. Therefore, it is calculated that the pocket gopher embryos grow at a rate of 1.9 mm per day. A pregnant female caught on 16 May had 5 embryos measuring 34 mm each in length so conception was approximately 29 April. Estimated date of birth was 18 May. A pregnant female captured on 28 June had 5 embryos which measured 6 mm each. Conception date was then 25 June. Estimated date of

birth was 10 July. Therefore, for this study, the breeding season ranged from mid April to the end of June with young born from May to June. This coincides with Reid (1973) who found that pregnancy occurred between March 1 and June 15 and births from late March to late July.

Wight (1930) and Howard and Childs (1959) state that the weaning of young occurs approximately 40 days after birth. From this study, we can determine that the dispersal of weaned young occurs from the end of June to the end of August. Young gophers have been captured as early as 28 June (1991) and as late as 4 September (1992). Tryon (1947) found that young disperse from their mother's burrow systems from mid-July to 31 August.

Adults were captured throughout the field seasons, with their numbers dropping off after the breeding season (Figure 16). Mean gopher length and weight for each sex are summarized in Table 5.

TABLE 5: Sexes, Mean Total Length (mm) and Mean Total Weight (gm) of Pocket Gophers Captured During the Study

SEX	MEAN TOTAL LENGTH (MM)	MEAN TOTAL WEIGHT (GM)
Adult Female	229.9	156.6
Juvenile Female	211.9	116.2
Adult Male	243.4	202.3
Juvenile Male	212.2	116.4

4.4.2 Cultural Results

Observations made in the field have shown that the cultivation methods among farmers do not vary dramatically. Questionnaire results show that some farmers are trying creeping-rooted varieties of alfalfa over the tap-rooted. Fifty respondents replied that they had just seeded the creeping-rooted variety and six of these said that they had noticed a decline in pocket gopher numbers in those fields. However, the alfalfa had recently been seeded and most had not yet noticed a difference.

4.4.2.1 Predators

Prior to agriculture, natural predators controlled pocket gophers. However, over the years, numbers of various predators, such as the long-tailed weasel, have declined drastically. It was listed as "threatened" in Manitoba in 1982 by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) (Manitoba Environment 1993). There were a large number of red-tailed hawks in the study area and some badger activity, but not enough to keep the large gopher populations down to an acceptable level.

Observations were made in the field as to the presence of predators, such as the badger, fox and coyote. The number of hawks and owls observed during the study period was noted as was the presence or absence of other natural predators of the pocket gopher. Conversations with the farmers who participated in the project also provided insight into the situation. These included owls, coyotes and fox as well as badgers, weasels and hawks. Some stated that most of these mammal's numbers had increased quite significantly

over the past few years. They attributed this to the increased awareness of many farmers. However, declining trapper effort due to reduced rates of return on pelts may have been as significant or had a greater influence on increased predator populations.

CHAPTER 5

5.0 Conclusions and Recommendations

5.1 Conclusions

Objective 1:

Controlling pocket gophers continues to be heavily studied since no sure-fire method has been found, and newer and better poisons are being developed. The results of this study show that more research is needed to develop a census method for pocket gophers. It was difficult to determine whether or not the rodenticides had the desired effect on pocket gopher numbers, since there is not a reliable census count method. As well, more research is needed to determine the most efficient control method. However, when comparing the removal trapping and live trapping census counts (Figures 25 - 27) with the rodenticide counts (Figures 17 - 24), it appears that the rodenticides were effective.

Objective 2:

Trapping is an inefficient control method because it is so labour intensive. However, on smaller fields, it can be useful in keeping pocket gopher numbers down. Impalement-type traps (the **Macabee** and the **Easy Set**) were the most effective of the traps tested (Table 4). This is at least partly due to the fact that two were set in each burrow system (in two-way tunnels). The **Black Hole** and the **Wooden Box** appeared to be to easier to plug with soil, but take less time to check. Therefore, it can be concluded that both trap types take alot of time and energy to set, check and reset, which is not conducive to large affected areas (10 acres +) or to those who do not have the time to spend in the fields.

FIGURE 25: REMOVAL PLOT A1 CENSUS COUNTS: 1991, 1992 AND 1993

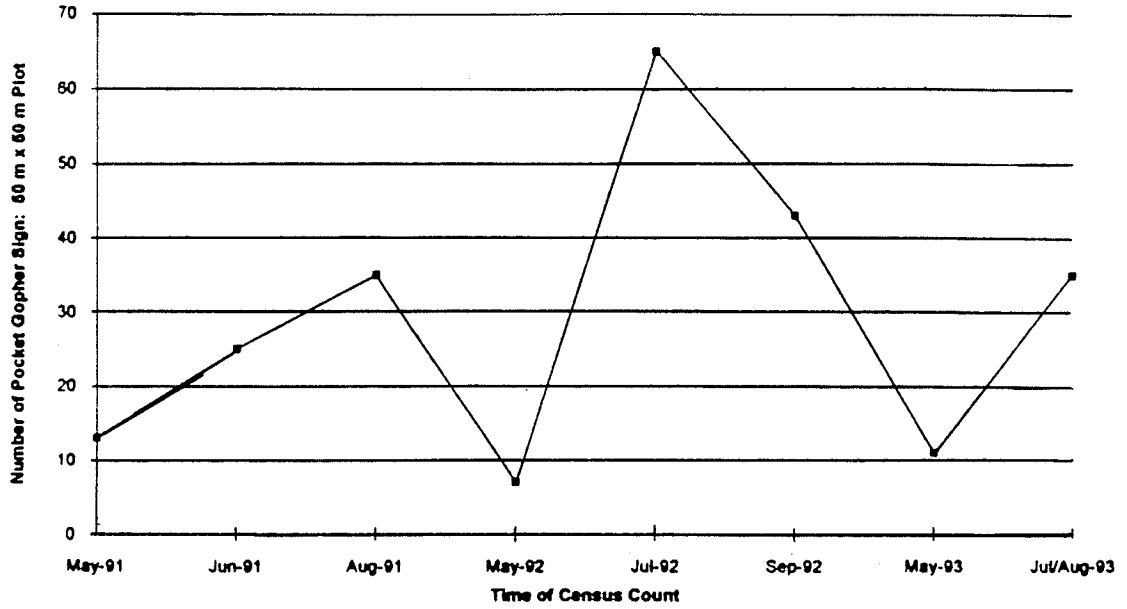


FIGURE 26: REMOVAL PLOT A2 CENSUS COUNTS: 1991, 1992 AND 1993

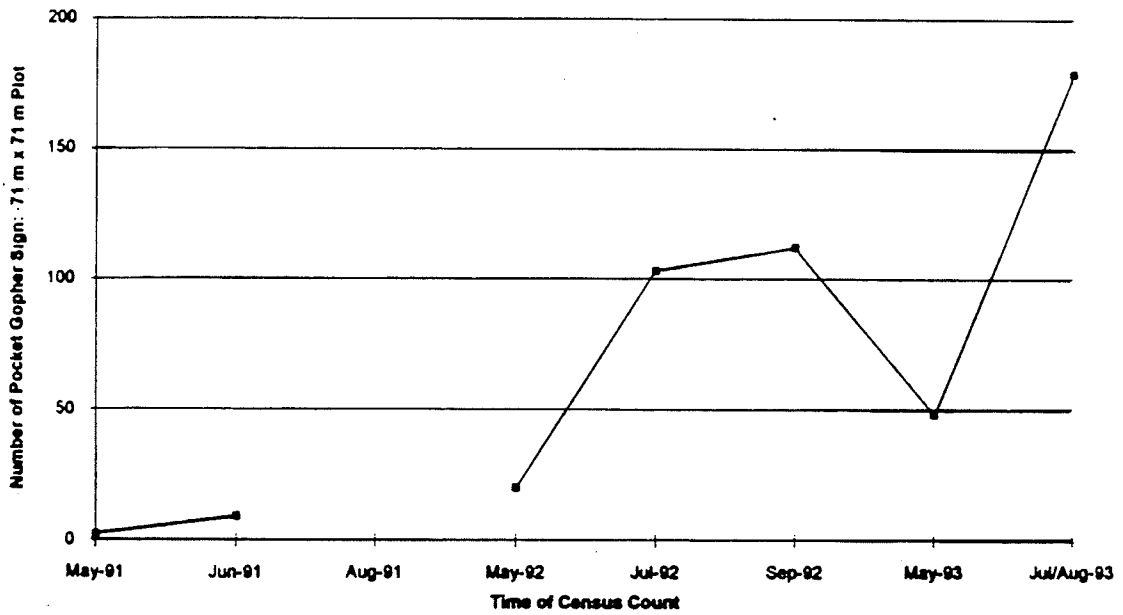
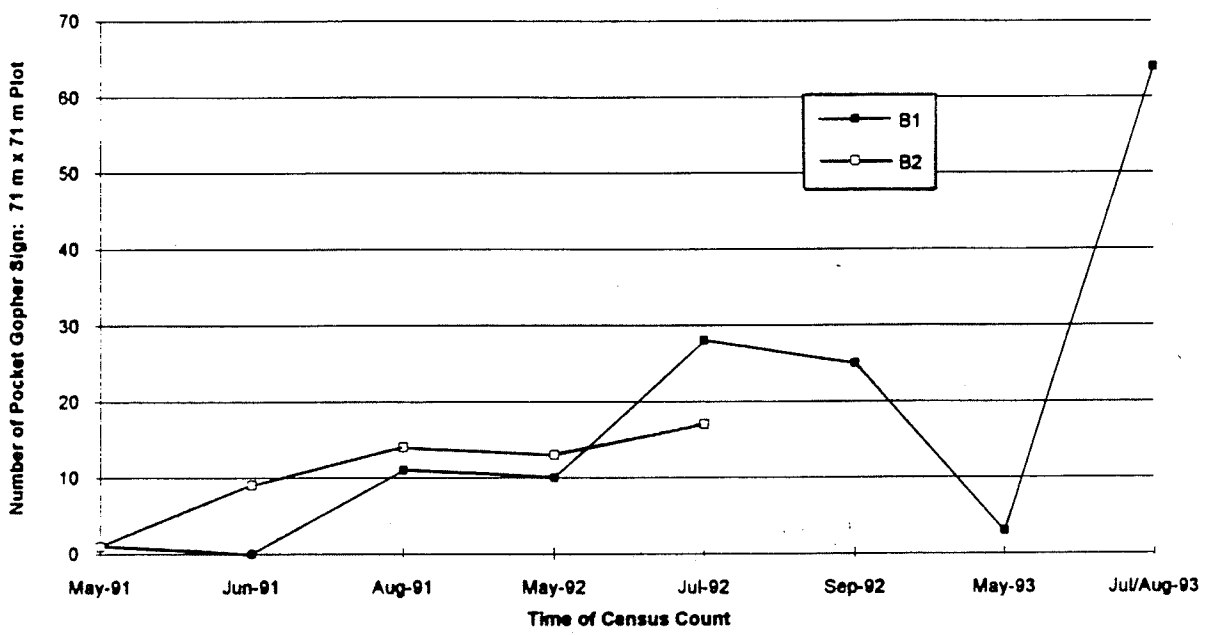


FIGURE 27: LIVE TRAPPING (NO TREATMENT) B1 AND B2 CENSUS COUNTS: 1991, 1992 AND 1993



The rodenticide **Maki** appeared to be effective in controlling pocket gophers in spring and fall (Figures 17 and 18). Therefore, it can be concluded that **Maki** can successfully control pocket gophers for at least part of the summer season. However, the most dramatic drop in numbers was after the fall treatments which implies that this rodenticide is more effective during this time.

The fall **Gophacide** rodenticide treatment appeared to be effective but not the spring treatment (Figures 19 and 20). Since this is one of the rodenticides most readily available and familiar to many farmers, it can be recommended for fall treatment. However, strychnine is not considered to be a very safe method of control and therefore, it should not be used after newer, safer products become available. All of the rodenticides, except **Gophacide**, were designed to limit their availability to non-target species, such as natural predators and dogs and cats.

The fall **Contrac** rodenticide treatment appeared to be somewhat effective but due to missing data, it is not possible to state this with much confidence. Therefore, further study into this product would be beneficial. Spring **Contrac** was not effective in controlling pocket gophers (Figures 21 and 22) and therefore can not be recommended at this time.

The spring **Quintox** rodenticide treatment appeared to be somewhat effective but not as much so in the fall treatment (Figures 23 and 24). Therefore, it can be concluded that it will control pocket gophers in the spring. and, since it has recently become available to farmers, it can be used as a possible control method.

Rodenticides appeared to be more effective on the pocket gopher numbers than trapping, but the gophers displayed a remarkable ability to rebound back (Figures 25 to 27 and 17 to 24). However, larger fields are easier to treat using rodenticides rather than trapping. Therefore, it can be concluded that on small acreage fields trapping can be undertaken but on large acreage fields rodenticides are more efficient.

Objective 3:

The majority of Manitoba farmers who responded to the questionnaire replied that pocket gophers are a serious problem. Those who did not feel they are a problem were from the Interlake region, where there are no gophers (Figures 2 and 3). Therefore, it can be concluded that the farmers are very concerned over the damage done by pocket gophers and that they are extremely interested in any reliable type of control.

Farmers offered many suggestions for pocket gopher control. Those given ranged from feeding spearmint gum to infecting gophers with disease. This shows that there is much interest in determining a reliable control method.

Sixty percent of questionnaire respondents felt that the natural predators of the pocket gopher offer some control but not enough (Figure 15). Therefore, it can be concluded that, again, farmers feel the need for better control.

According to the questionnaire results, Manitoba farmers felt that the most significant damage done by pocket gophers is first to machinery (44%), second to harvest reduction (29%) and third to crop consumption (18%) (Figure 14).

Gophers damage machinery, reduce yield and quality, consume the crop and reduce the life of the haystand. Their mounds dull swathing knives and often the cutter bar is raised in order to avoid them. The alfalfa is smothered by the mounds (Figures 4, 5, 6 and 7) and the gophers kill the plants by eating the roots.

Overall, the results of the questionnaire show that Manitoba forage producers perceive the pocket gopher problem as serious and much interest has been displayed in finding a solution to the problem.

Pocket gophers are an agricultural pest throughout most of the agricultural areas of Manitoba (Figure 2), throughout the Canadian prairies, and most of the United States (Figure 3). This brings the severity of the problem into perspective. Pocket gophers prefer alfalfa/hay but they will eat other tuberous root crops such as potatoes, carrots and parsnips. Therefore, they are not just a serious problem in alfalfa fields.

In Manitoba, there has never been a comprehensive study done on pocket gopher control until now even though much interest has been shown throughout the years.

Many different control methods have been studied throughout the United States and, more recently, in Canada. These range from trapping to fumigation to poisoning to exclosures. It can be concluded that the problem is considered very serious and that much interest had been displayed in developing a reliable control method.

Pocket gopher control is extremely important to Manitoba farmers since the damage they do is usually extensive (Figures 13 and 14). Reforestation projects, vineyards and specialty crop areas also suffer from pocket gopher infestation. Therefore, it can only be beneficial to continue doing research on gopher control.

Objective 4:

A total of 622 pocket gophers were captured. Of these, 287 were adult males, 173 adult females, 86 juvenile females and 76 juvenile males. Males were mostly caught during the spring, females and juveniles during the summer and juveniles in the fall. Adults were also captured during the summer and fall, but in much lower numbers (Figure 16). Removal of males in the spring can reduce the number of pregnant females while the captures of females during the summer can reduce the number of successful weanings. Captures of juveniles in the late summer/early fall reduces the success of future increases in populations.

Dissections showed that the average number of young per litter at St. Claude was 4.8. From measurements of pregnant female embryos, the breeding season was determined to be from mid April to the end of June. Young were born from May to July and juvenile dispersal occurred from the end of June to the end of August. From this, it can be concluded that the pocket gopher population in this area is capable of increasing quite rapidly. If every female is having 4 to 5 young, the potential for population growth is very high.

Juveniles were caught throughout both the summer and fall field sessions with the earliest capture occurring on 28 June 1991. Twenty-five "double catches"

per burrow system were made during the spring and summer sessions. In the spring, "double catches" were usually an adult male with an adult female. In the summer, they were usually an adult female with a juvenile male or female (22 July 1992 and 1 September 1992). A total of 25 "double catches" were made and one triple catch was recorded 13 August 1993. This supports multiple trap nights, that is, keeping traps in the same burrow for many nights, because it removes any remaining or re-invading gophers .

Results from the live trapping did not provide enough data to determine any new information on dispersal or foraging patterns.

5.2 Recommendations

1) Since trapping is so labour intensive, it can not be recommended as a management alternative. It would only be cost-effective to the farmers with very small acreage (under 10 acres) fields and/or in home gardens.

2) Rodenticide application, at this time, is the only practical method of control. However, more research should be undertaken to determine if multiple treatments (both spring and fall), annually, would be more effective, as well as to determine the number of treatments necessary and the cost-effectiveness. The Manitoba government in conjunction with the federal government should consider any and all research proposals concerning methods of pocket gopher control.

3) The feasibility of research into other methods of control, such as fumigation and the use of predator odours, should be examined more closely.

While research is being undertaken in North America, each geographical area (soil type, drainage patterns, etc.) is different, and thus will require unique consideration.

4) Information pertaining to all equipment needed for bait application should be readily available to Manitoba farmers and supplied by Manitoba Agriculture. Concerned farmers may decide to form a co-operative group which could purchase a burrow builder to rent to members. As well, a guide, similar to the **Guide to Crop Protection 1993**, should be developed. This guide would allow farmers to determine the extent of the damage in their fields and offer solutions to the problem, such as whether to plow the field under or to apply a commercially available rodenticide. Estimated costs would also be provided.

5) **Gophacide**, one registered rodenticide for pocket gopher control widely available in Canada, has shown to be most effective when applied in the fall (Figures 19 and 20). This could be due to the fact that the bait is water soluble and fall is generally drier. Therefore, it is recommended for application in the fall at least annually.

6) Both **Maki** and **Quintox**, when applied in the spring and fall, appeared to have reduced the resident pocket gopher populations (Figures 17 and 18 and 23 and 24). Therefore, these two offer some possible relief from pocket gopher infestation. Both are recommended for pocket gopher control in Manitoba, although only **Quintox** is currently available.

7) The rodenticide **Contrac** can not be recommended for pocket gopher

control based on the results of this study. Further research is necessary.

8) Not only should bait be applied mechanically, but it should additionally be done in surrounding ditches, fence lines and bluffs with a hand applicator. This would ensure that future invaders would also be poisoned. Spot treatments in the main fields should also be undertaken of those burrow systems missed by the machine application.

9) Herbicide application along ditches and roadsides to reduce forb growth could be done instead of hand baiting as it removes the gophers' food source. This could perhaps be undertaken more quickly and economically.

10) Continued research should also be undertaken on any new products that become available that offer a safer and more humane method of pocket gopher control (ie: more advanced rodenticides, predator odours, etc.). As well, research should be undertaken to develop a reliable census method for pocket gophers and to determine the cost-effectiveness of treatments based on the level of infestation of individual fields.

11) Educational information about the gopher and its natural predators should be readily available. This can be accomplished by providing fact sheets, videos and articles in producer publications which can update the public on any new developments. All information should be readily available to anyone who needs it. Shooting and poisoning of predators should be deterred and their benefits extolled.

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APPENDIX A
POCKET GOPHER QUESTIONNAIRE
AND
COVERING LETTER

190 Rupert Avenue
Winnipeg, Manitoba
R3B 0N2

June 19, 1991

Dear Sir/ Madam,

This letter is in regards to the northern pocket gopher (Thomomys talpoides) which may or may not be on your property (they are also known as "moles"). This pocket gopher is found all through the southern portion of the province of Manitoba and is considered a problem in the farming community.

The Manitoba Forage Council and the PFRA have recently funded a Northern Pocket Gopher Control Project which is being conducted in the St. Claude, Manitoba, area for three years, starting May 1991. The purpose of the study is to design management practices which will minimize pocket gopher damage. In addition to the literature survey 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 few minutes 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. We value very much your years of experience with these "moles", that cannot be duplicated in just three years with a few people. Thank you for your time.

Sincerely,

Jack Dubois
Associate Curator of Mammalogy

Yvette Deniset
Research Assistant

7. If so, have you noticed any difference in susceptibility to pocket gopher damage than standard tap-rooted varieties?

yes no

comments:

8. Have you noticed any effect of shelterbelts or other types of vegetation on the spread of pocket gopher?

yes no

comments:

9. If so, how many rows of what species of trees and/or shrubs seem to be the most effective?

10. What additional suggestions do you have for methods of pocket gopher control?

11. On your farm, in which field type do you find the largest population of pocket gophers?

cereal

alfalfa

pasture: tame

wild/native

other

none

comments:

12. How serious do you feel the problem is?

very serious

serious

not so serious

not serious at all

comments:

13. Do you believe that pocket gophers cause significant damage by:

consuming crops

damaging machinery

reducing harvest

comments:

14. On your farm, have you noticed the presence of:
coyotes
badgers
fox
weasels
owls
hawks

comments:

15. If so, do you feel that they help control the pocket gopher population?

yes no

comments:

Please provide the following information

Total acres of forage:

Acres affected by pocket gophers:

Please indicate legal land description, or town or rural municipality in which your affected fields are located:

If you have any additional comments you would like to make, please do not hesitate to write them down and send them along with the filled-in questionnaire.

If you would like to be kept informed of the progress of the project, please indicate below the type of information you would like to receive:

interim reports (yearly) and final report
final report only

The project will be ongoing for the growing seasons of 1991, 1992 and 1993, with interim reports prepared in the fall of each year and the final report by March 31, 1994. Thanks you again for your time. Please return in the stamped, addressed envelope attached. If the envelope is missing, please send to: Pocket Gopher Project, Mammalogy Department, Manitoba Museum of Man and Nature - 190 Rupert Avenue, Winnipeg, Manitoba, R3N 0N2.

**APPENDIX B
RODENTICIDE MANUFACTURERS'
SAFETY DATA SHEETS**

MAKI®

POCKET GOPHER BAIT

FOR EXPERIMENTAL USE ONLY

NOT FOR SALE OR DISTRIBUTION TO ANY PERSON OTHER THAN A RESEARCHER OR COOPERATOR.

DIRECTIONS:

USES: For control of Pocket Gophers (*Thomomys* sp. and *Geomys* sp.).

SELECTION OF TREATMENT AREAS: Rozol Pocket Gopher Bait is recommended for use on lawns, golf courses range land, and non-crop areas.

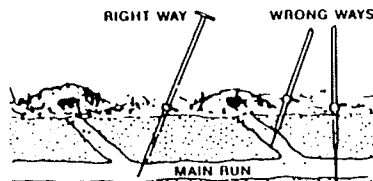
APPLICATION DIRECTIONS: Burrowing Pocket Gophers throw out low, fan shaped mounds on either side of underground tunnels. These lateral tunnels coming to the surface are on the flat side of the fan and these holes are plugged with loose soil.

Treatment: Can be made in one or both of the following ways:

1. With a long-handled tablespoon, carefully remove the plug on the flat side of the fan. Carefully insert 100 grams of bait as far down into the hole as possible. Reclose opening, being careful not to cover the bait with soil.

2. Using a metal rod, probe 15-30 centimeters deep to locate the main tunnel. Consult diagram below for location to probe. Drop 100 grams of bait into the tunnel and cover the hole so light will not enter the system.

Make 2-3 treatments per burrow system. Collect and dispose of all dead animals and unconsumed bait properly. Maintain a constant supply of bait in the burrow system for as long as there is gopher activity. Do not apply bait on surface soil.



The right and the wrong ways to use a probe for poisoning gophers are shown above. Be sure the bait is in the main runway - not in the laterals or imbedded in the bottom of the runway.

With hand baiting or if a burrow builder is used, apply the bait at a rate not to exceed 2 kgs per acre. Several days after applying bait, open burrows previously baited and leave open. If gophers or moles remain, they should plug the holes closed within one day. If this occurs, then the application should be repeated in the same manner.

WARNING

MISE EN GARDE

POISON

FOR EXPERIMENTAL USE ONLY

GUARANTEE/GARANTIE:

Bromadiolone.....0.005%

KEEP OUT OF REACH OF CHILDREN
GARDER HORS DE LA PORTEE DES ENFANTS

READ THE LABEL BEFORE USING
LIRE L'ETIQUETTE AVANT USAGE

NET CONTENTS/CONTENU NET

22.7 KG

RESEARCH PERMIT NO. 10-RP-91

PEST CONTROL
PRODUCTS ACT

LOI SUR LES PRODUITS
ANTIPARASITAIRES

Manufactured by:

LIPHA TECH

Manufactured by:

LiphaTech, Inc.

3101 West Custer Avenue
Milwaukee, WI 53209

PRECAUTIONS:

Keep out of reach of children, domestic animals, and pets. Keep away from feed or foodstuffs. Harmful or fatal if swallowed or absorbed through the skin. This material may reduce the clotting ability of the blood and cause bleeding.

This product should be handled with gloves. Do not get in eyes, on skin, or on clothing. Wash arms, hands, and face with soap and water after handling and before eating or smoking. This product is toxic to fish and wildlife. Keep out of lakes, streams or ponds.

DISPOSAL:

Do not reuse empty container. Destroy by perforating or crushing. Dispose of container in accordance with provincial requirements. For information on the disposal of unused, unwanted product and the cleanup of spills, contact the regional office of Conservation and Protection, Environment Canada.

FIRST AID INSTRUCTION:

Do not get in eyes. In case of eye contact, flush eyes with water for 15 minutes. Give patient water and induce vomiting. Contact a physician immediately.

TOXICOLOGICAL INFORMATION:

If swallowed by humans, domestic animals, or pets this material may reduce the clotting ability of the blood and cause bleeding. If swallowed, administer Vitamin K1 intramuscularly or orally as indicated in bishydroxycoumarin overdoses. Repeat as necessary based on monitoring of prothrombin times.

NOTICE TO THE USER:

This product is to be used only in accordance with the directions on this label. It is an offense under the Pest Control Products Act to use a control product under unsale conditions.

LIMITATION OF WARRANTY: Seller's guarantee shall be limited to terms set out on the label and subject thereto, the buyer assumes all risk to persons or property arising from the use or handling of this product on that condition.

DIRECTIONS FOR USE

USE LIMITATIONS: Treated baits must be placed in locations not accessible to children, pets, or domestic animals. QUINTOX may be used to control pocket gophers in landscape areas, and around homes.

APPLICATION DIRECTIONS

SPECIFIC DIRECTIONS FOR POCKET GOPHERS: Burrowing pocket gophers (*Thomomys spp.*) throw out low, fan-shaped mounds on either side of their underground tunnel. These lateral tunnels coming to the surface are on the flat side of the fan and are plugged with soil. With a long-handled spoon carefully remove the plug. Place 14 g (1/2 oz.) of QUINTOX in two different locations within the same tunnel system. Reclose opening, being careful not to cover bait with soil. Monitor burrows for activity. If activity exists 6-8 days after baiting, reapply bait. Additionally, bait can be applied using the probe method.

PROBE SELECTION: Reservoir-probe type manually operated dispensers can be used to locate runways and then deposit the bait. When only a few runways are to be treated, a steel rod, 0.6 cm (1/4 inch) in diameter and pointed at the tip, will serve to locate the tunnels. A larger rod or a broomstick can be used to enlarge the hole through which bait is to be deposited. If many runways are to be treated, it may be useful to obtain or construct a special metal probe.

BAIT APPLICATION: Use a probe to locate main runways. Runways usually go in a straight line between gopher mounds at depths of 15 to 20 cm (6 to 8 inches).

Probe around fresh mounds or between two fresh mounds as fresh digging indicates recent presence of pocket gophers. When a runway is located, resistance on the probe will decrease and it should drop about 5 cm (2 inches). Enlarge the probe hole by rotating the probe, by using a larger probe (or a larger end of the same probe), or by careful digging with a small

Quintox[®]
FIELD FORMULA

KILLS POCKET GOPHERS AND GROUND SQUIRRELS

REG. NO. 22234 P.C.P. ACT

DOMESTIC

GUARANTEE:

Cholecalciferol 0.15%

PRECAUTION

KEEP OUT OF REACH OF CHILDREN

READ THE LABEL BEFORE USING

NET WEIGHT: 500 g (1.1 lbs.)

Manufactured by:



Bell Laboratories, Inc.
MADISON, WI 53704 U S A

trowel. Insert 14 g (1/2 oz.) of QUINTOX through the enlarged probe hole. Reservoir type probes are used similarly to the above with the bait deposited mechanically through the hollow probe. Close hole with a clod of dirt or a rock to keep out light. Take care not to let dirt fall on bait.

SPECIFIC DIRECTIONS FOR GROUND SQUIRRELS: (*Richardson, Columbian, Thirteen Lined, and Franklin's*) Below Ground. Using a long handled spoon or other appropriate device, place 14g (1/2 oz.) of bait through burrow openings, 30 to 40 cm (12 to 15 inches) into the burrow. It is important to place bait well back into burrows. If placed too close to opening, baiting will be less effective. Above Ground: Place up to 200g of bait per placement. To avoid non-target hazards, placements should be in tamper resistant bait stations near burrow openings.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

PRECAUTION: Keep away from humans, domestic animals, and pets.

FIRST AID: If swallowed, drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Avoid use of all oils.

TOXICOLOGICAL INFORMATION: If serum calcium levels are elevated, treatment with calcitonin is effective in reducing calcium to normal levels. Continue monitoring serum calcium and treat as necessary for hypercalcemia (*Reference, AMA Drug Evaluations, Third Edition (1977), Chapter 16, pp. 248-251*).

ENVIRONMENTAL HAZARDS: Keep out of lakes, streams or ponds.

STORAGE AND DISPOSAL

STORAGE: Store only in original container in a dry place inaccessible to children and pets.

DISPOSAL: Do not reuse empty container. Securely wrap in newspaper and discard in garbage.

QUINTOX[®]

MSDS
Date of Issue:
AUGUST 1992

MANUFACTURERS ADDRESS: BELL LABORATORIES, INC. 3699 KINSMAN BLVD., MADISON WI 53704		Prepared by: VJD	TELEPHONE NO.: (608) 241-0202	EMERGENCY PHONE NO.: Contact your local Poison Control Center.
PRODUCT NAME: QUINTOX [®]			CAS NO.: 67-97-0	
CHEMICAL FAMILY: Sterol	CHEMICAL NAME & SYNONYMS: 9,10-Secocholesta-5,7,10 (19)-trien-3 betaol; activated 7 -dehydrocholesterol			
CHEMICAL FORMULA: C ₂₇ H ₄₄ O	TRADE NAME & SYNONYMS: Cholecalciferol (Vitamin D ₃)			
SECTION I. HAZARDOUS INGREDIENTS				
ACTIVE INGREDIENTS: Cholecalciferol		% .075	CURRENT TLV N.E.	
SECTION II. PHYSICAL DATA OF ACTIVE INGREDIENT				
APPEARANCE & ODOR: Odorless Crystal	MOLECULAR WEIGHT: 384.62	MELT POINT: 84-85° C	SPECIFIC GRAVITY: NA	
VAPOR DENSITY (AR=1): NA	COLOR: White	BULK DENSITY: (Finished Product) 43 lbs./ft ³	BOILING POINT: NA	
VAPOR PRESSURE: NA	SOLUBILITY: Insoluble in water.	WATER REACTIVE: NA	EVAPORATION RATE: NA	
SECTION III. FIRE & EXPLOSION DATA OF PRODUCT				
FLASH POINT F (METHOD USED): NA		FLAMMABLE LIMIT: NA	AUTOIGNITION TEMP.: NA	
EXTINGUISHING MEDIA: Extinguish with water, foam or inert gas.				
SPECIAL FIRE FIGHTING PROCEDURES: None				
UNUSUAL FIRE OR EXPLOSION HAZARDS: None				
SECTION IV. REACTIVITY HAZARD DATA OF ACTIVE INGREDIENT				
STABILITY: Stable.	CONDITIONS TO AVOID: None			
POLYMERIZATION: Will not occur.	CONDITIONS TO AVOID: None			
INCOMPATABILITY (MATERIALS TO AVOID): None	HAZARDOUS DECOMPOSITION PRODUCTS: None			
SECTION V. TOXICITY DATA				
LD50, ORAL (INGESTION): (100% AI) [Rat] 43.6 mg/kg	LD50, DERMAL (SKIN CONTACT): (.075% Bait) [Rabbit] greater than 2000 mg/kg	LD50, ORAL (INGESTION): (100% AI) [Mice] 42.5 mg/kg		
FISH, LC50 (LETHAL CONCENTRATION): NE	LD50, ORAL: (30% AI) [Mallard Duck] 2000 mg/kg	8 DAY LC50: [Mallard Duck] 4000 ppm (30% AI) [Bobwhite Quail] 2000 ppm		

SECTION VI. HEALTH HAZARD DATA OF PRODUCT			
PRIMARY ROUTE OF ENTRY: <input checked="" type="checkbox"/> Ingestion <input type="checkbox"/> Skin & eye contact <input type="checkbox"/> Inhalation <input type="checkbox"/> Skin absorption		MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: None	SIGNAL WORD: Caution
HEALTH HAZARDS: 1 - Caution		SIGNS & SYMPTOMS OF EXPOSURE: Hypercalcemia if ingested.	
EMERGENCY FIRST AID PROCEDURES: Eyes: Flush with water. Skin: Wash with soap & water. Inhalation: Non-hazardous. Ingestion: Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Avoid use of all oils.			
SPECIAL PROTECTION INFORMATION: If serum levels are elevated treatment with calcitonin is effective in reducing calcium to normal levels, continue monitoring serum calcium and treat as necessary for hypercalcemia. (Reference, AMA Drug Evaluations, Third Edition (1977), Chapter 16, pp. 248-251).			
SECTION VII. CONTROL & PROTECTIVE MEASURES OF PRODUCT			
RESPIRATOR TYPE: None			
EYE PROTECTION: None	GLOVES: Rubber gloves	VENTILATION: None	
OTHER PROTECTIVE MEASURES: Wash hands after use.			
SECTION VIII. SPILL OR LEAK PROCEDURE OF PRODUCT			
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: General clean-up.			
WASTE DISPOSAL METHOD: Wastes resulting from use may be disposed of on site or at an approved waste disposal facility.			
SECTION IX. SPECIAL PRECAUTIONS & STORAGE DATA OF PRODUCT			
STORAGE TEMPERATURE: Room temperature	AVERAGE SHELF LIFE: Bait is stable for more than 1 year when stored properly.		
SPECIAL SENSITIVITY (HEAT, LIGHT, MOISTURE): Keep out of direct sunlight and away from high heat and moist conditions.			
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: For best results store in a cool, dark, dry location. Store away from offensive odors.			
SECTION X. SHIPPING DATA OF PRODUCT			
D.O.T. SHIPPING NAME: QUINTOX	TECHNICAL SHIPPING NAME: Rodenticide containing Cholecalciferol (Vitamin D ₃).		
D.O.T. HAZARD CLASSIFICATION: Non-hazardous			
D.O.T. LABELS REQUIRED: None	FREIGHT CLASSIFICATION: Class 60		
WARRANTY: The information provided in this Material Safety Data Sheet has been obtained from sources believed to be reliable. Bell Labs provides no warranties, either expressed or implied and assumes no responsibility for the accuracy or completeness of the data contained herein. This information is offered for your consideration and investigation. You should satisfy yourself that you have all current data relevant to your particular use.			

CONTRAC®

MSDS
Date of Issue:
FEB 1992

MANUFACTURERS ADDRESS: BELL LABORATORIES, INC. 3699 KINSMAN BLVD., MADISON WI 53704		Prepared by: VJD/CAR	TELEPHONE NO.: (608) 241-0202	EMERGENCY PHONE NO.: Contact your local Poison Control Center.	
PRODUCT NAME: CONTRAC®			CAS NO.: 28772-56-7		
CHEMICAL FAMILY: Coumarin		CHEMICAL NAME & SYNONYMS: 3-[3-(4-Bromo-[1,1'-biphenyl]-4-yl)-3-hydroxy-1-phenylpropyl]- 4-hydroxy-2H-1-benzopyran-2-one			
CHEMICAL FORMULA: $C_{20}H_{17}BrO_4$		TRADE NAME & SYNONYMS: Bromadiolone			
SECTION I. HAZARDOUS INGREDIENTS					
ACTIVE INGREDIENTS: Bromadiolone		% 0.005	CURRENT TLV 500 mg/kg based on beagle dog		
SECTION II. PHYSICAL DATA OF ACTIVE INGREDIENT					
APPEARANCE & ODOR: White odorless powder	MOLECULAR WEIGHT: 527.4	MELT POINT: 200-210° C	SPECIFIC GRAVITY: NA		
VAPOR DENSITY (AR=1): NA	COLOR: White	BULK DENSITY: 0.33 gm/cc	BOILING POINT: NA		
VAPOR PRESSURE: NA	SOLUBILITY: 12 mg/l (water)	WATER REACTIVE: NA	EVAPORATION RATE: NA		
SECTION III. FIRE & EXPLOSION DATA OF PRODUCT					
FLASH POINT F (METHOD USED): NA	FLAMMABLE LIMIT: NA	AUTOIGNITION TEMP.: NA			
EXTINGUISHING MEDIA: Extinguish with water, foam or inert gas.					
SPECIAL FIRE FIGHTING PROCEDURES: None					
UNUSUAL FIRE OR EXPLOSION HAZARDS: None					
SECTION IV. REACTIVITY HAZARD DATA OF ACTIVE INGREDIENT					
STABILITY: Stable.	CONDITIONS TO AVOID: NA				
POLYMERIZATION: Will not occur.	CONDITIONS TO AVOID: NA				
INCOMPATIBILITY (MATERIALS TO AVOID): Strong Bases	HAZARDOUS DECOMPOSITION PRODUCTS: Carbon Monoxide/Carbon Dioxide				
SECTION V. TOXICITY DATA					
LD50, ORAL (INGESTION): 1.125 mg/kg [Rat] 1.75 mg/kg [Mouse]	(Tech)	LD50, DERMAL (SKIN CONTACT): 650 mg/kg [Rabbit]	(1% AI)	INHALATION: LC50 9.23 mg/l x 1 hr [Rat]	(1% AI)
FISH, LC50: 1.4 mg/l [Rainbow trout] 3.0 mg/l [Bluegill sunfish]	(Tech)	SKIN AND EYE IRRITATION: Non-irritating	(1% AI)	LD50 ORAL: 10 mg/kg [Dog]	(Tech)

SECTION VI. HEALTH HAZARD DATA OF PRODUCT			
PRIMARY ROUTE OF ENTRY: <input checked="" type="checkbox"/> Ingestion <input type="checkbox"/> Skin & eye contact <input type="checkbox"/> Inhalation <input type="checkbox"/> Skin absorption		MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: None	SIGNAL WORD: Caution
HEALTH HAZARDS: 1 - Caution: May be irritating.		SIGNS & SYMPTOMS OF EXPOSURE: May reduce clotting ability of the blood and cause bleeding.	
EMERGENCY FIRST AID PROCEDURES: Eyes: Flush with plenty of water. Skin: Wash with soap & water. Inhalation: None. Ingestion: Administer Vitamin K ₁ intramuscularly or orally as indicated in bishydroxycoumarin overdoses. Repeat as necessary based on monitoring of prothrombin times.			
SPECIAL PROTECTION INFORMATION: None			
SECTION VII. CONTROL & PROTECTIVE MEASURES OF PRODUCT			
RESPIRATOR TYPE: None			
EYE PROTECTION: None	GLOVES: Rubber gloves	VENTILATION: None	
OTHER PROTECTIVE MEASURES: None			
SECTION VIII. SPILL OR LEAK PROCEDURE OF PRODUCT			
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED: General clean-up.			
WASTE DISPOSAL METHOD: Product that cannot be used according to label instructions, must be disposed of according to applicable Federal, State or Local procedures.			
SECTION IX. SPECIAL PRECAUTIONS & STORAGE DATA OF PRODUCT			
STORAGE TEMPERATURE: Room temperature.	AVERAGE SHELF LIFE: Bait is stable for a minimum of 1 year when stored properly.		
SPECIAL SENSITIVITY (HEAT, LIGHT, MOISTURE): Avoid exposure to light and humidity.			
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Avoid lakes, streams or ponds.			
SECTION X. SHIPPING DATA OF PRODUCT			
D.O.T. SHIPPING NAME: Contrac	TECHNICAL SHIPPING NAME: Rodenticide containing Bromadiolone.		
D.O.T. HAZARD CLASSIFICATION: Non-hazardous			
D.O.T. LABELS REQUIRED: None	FREIGHT CLASSIFICATION: Class 60		
WARRANTY: The information provided in this Material Safety Data Sheet has been obtained from sources believed to be reliable. Bell Labs provides no warranties, either expressed or implied and assumes no responsibility for the accuracy or completeness of the data contained herein. This information is offered for your consideration and investigation. You should satisfy yourself that you have all current data relevant to your particular use.			

Material Safety Data Sheet
 May be used to comply with
 OSHA's Hazard Communication Standard,
 29 CFR 1910.1200. Standard must be
 consulted for specific requirements.

U.S. Department of Labor
 Occupational Safety and Health Administration
 (Non-Mandatory Form)
 Form Approved
 OMB No. 1218-0072



IDENTITY (As Used on Label and List) Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name <u>RUE R. ELSTON, INC.</u>	Emergency Telephone Number <u>POISON CONTROL CENTER 605-336-3894</u>
Address (Number, Street, City, State, and ZIP Code) <u>706 NORTH WEBER</u>	Telephone Number for Information <u>605-336-7716</u>
<u>SIoux FALLS, SOUTH DAKOTA 57103</u>	Date Prepared <u>MAY 24, 1990</u>
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
<u>STRYCHNINE ALKALOID - ACTIVE INGREDIENT</u>				
<u>MILO GRAIN - VEHICLE</u>				
<u>ADHESIVE - LIPADOL</u>				
<u>DYE BLUE</u>				

Section III — Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H ₂ O = 1)	N/A
Vapor Pressure (mm Hg.)	N/A	Melting Point	N/A
Vapor Density (AIR = 1)	N/A	Evaporation Rate (Burl Acetate = 1)	N/A
Solubility in Water	<u>SOLUBLE IN WATER</u>		

Appearance and Odor
MILO GRAIN DYED BLUE GREEN DISTINCTIVE APPEARANCE ODORLESS

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used) <u>N/A</u>	Flammable Limits <u>N/A</u>	LEL <u>N/A</u>	UEL <u>N/A</u>
Extinguishing Media <u>N/A</u>			
Special Fire Fighting Procedures <u>AVOID GETTING MATERIAL WET</u>			

Unusual Fire and Explosion Hazards
DO NOT BREATHE FUMES USE APPROPRIATE BREATHING DEVICES AND TAKE PRECAUTIONARY ACTION
IN HANDLING THIS MATERIAL, GLOVES, MASKS.

(Reproduce locally)

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable	X	DANGEROUS WHEN HEATED GIVES OFF TOXIC FUMES

Incompatibility (Materials to Avoid)

N/A

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur	X	Conditions to Avoid
	Will Not Occur		SPILLING AND HEATING

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? YES Skin? YES Ingestion? YES

Health Hazards (Acute and Chronic)

DO NOT BREATHE OVER PROLONGED PERIODS OF TIME 5 MINUTES OR MORE

Carcinogenicity: NTP? N/A IARC Monographs? N/A OSHA Regulated? YES

Signs and Symptoms of Exposure

STOMACH ACHE, CONFUSION

Medical Conditions

Generally Aggravated by Exposure COLDS, CHRONIC RESPIRATORY PROBLEMS, ASHMA

Emergency and First Aid Procedures

CALL A PHYSICIAN OR POISON CONTROL CENTER, DRINK 1 OR 2 GLASSES OF WATER AND INDUCE VOMITING BY TOUCHING BACK OF THROAT WITH FINGER, DO NOT INDUCE VOMITING OR GIVE ANYTHING TO AN UNCONSCIOUS PERSON.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled

DO NOT ALLOW BAIT TO BE EXPOSED ON SOIL SURFACE. DO NOT CONTAMINATE WATER BY CLEANING OF EQUIPMENT OR DISPOSAL OF WASTES. SWEEP UP ANY SPILLAGE OF BAIT CAREFULLY AND BURY IN GROUND.

Waste Disposal Method

BURY IN GROUND - CRUSH AND BURY EMPTY CONTAINERS.

Precautions to Be Taken in Handling and Storing

WEAR RESPIRATOR TYPE MASK (APPROVED FOR PESTICIDE APPLICATION)

Other Precautions

Section VIII — Control Measures

Respiratory Protection (Specify Type)

WEAR RESPIRATOR TYPE MASK (APPROVED FOR PESTICIDE APPLICATION)

Ventilation	Local Exhaust	YES	Special	N/A
	Mechanical (General)	N/A	Other	N/A

Protective Gloves YES Eye Protection NO

Other Protective Clothing or Equipment

MASK - GLOVES - LONG SLEEVED SHIRT, - CAP

Work Hygiene Practices

DO NOT REUSE EMPTY CONTAINERS - WASH HANDS, BRUSH OFF CLOTHING AND BOTTOM OF SHOES.