Effectiveness of Trapping to Control Northern Pocket Gophers in Agricultural Lands in Canada

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Abstract: The northern pocket gopher (*Thomomys talpoides*) is considered a major pest in haylands, particularly alfalfa, and surrounding crops and shelterbelts of western Canada. Although poison baits are often used with the objective to quickly reduce pocket gopher populations over large areas, recent investigations in western Canada have demonstrated that they were ineffective in reducing and controlling pocket gopher populations in haylands. This paper identifies the elements of an effective pocket gopher control program and demonstrates that, with a proper strategy to lay out killing traps in spring to remove breeders-of-the-year, and to intercept invading pocket gophers, trapping is the most effective method to control northern pocket gophers. This paper also describes an effective trapping program and identifies research needs to increase capture efficiency.

Key Words: northern pocket gopher, *Thomomys talpoides*, poisons, trapping, rodent control

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INTRODUCTION

The northern pocket gopher (*Thomomys talpoides*) is found throughout agricultural regions in Manitoba (DeWandel et al. 1997), Saskatchewan (Provincial Council of ADD Boards & Sustainable Production Branch 2001), and Alberta (Nietfeld and Roy 1992), and a few valleys in southern British Columbia (Banfield 1974). Pocket gophers' burrowing and feeding activities result in a reduction in forage yield and stand life, an increase in soil degradation and erosion, a greater forage contamination by soil and nematodes, an increase in operational costs because of significant machinery breakdown and repairs, and a reduction in the speed and efficiency of forage harvesting due to the roughness of the fields (Proulx 2002a). Pocket gopher population densities are so high that they are now affecting other crops such as peas and canola.

Nietfeld and Roy (1992) estimated that the annual economic loss caused by the northern pocket gopher in haylands ranged from CAN$14 to $30 million in Alberta, and they concluded that the problem was beyond control. In Manitoba, DeWandel et al. (1997) estimated that damages incurred by the northern pocket gopher exceeded CAN$15 million annually.

This paper identifies the elements of an effective pocket gopher control program, and intends to demonstrate that trapping is the most effective control method. It reviews proper trapping methodology and identifies research that is required to further improve capture efficiency.

ELEMENTS OF AN EFFECTIVE POCKET GOPHER CONTROL PROGRAM

A control program should aim to reduce the density of a population below its high rate of increase and, in the case of pocket gophers in western Canada, be effective during the short reproductive season during which the population increases sharply. In order to meet this objective, the control program must:

1. remove most of the breeders before the birth (April-May) (Proulx 2002b) or emergence of young (June) (Proulx 1997a);
2. eliminate immigration, usually associated with the dispersal of young-of-the-year from adjacent areas (Proulx 1997a);
3. be applicable independently of the quality and quantity of surrounding vegetation, and under diverse environmental conditions;
4. include a population monitoring strategy;
5. be species-selective;
6. be safe for humans to implement, and be socially acceptable; and
7. be financially viable.

TRAPPING AS THE MOST EFFECTIVE CONTROL METHOD

Documents discussing pocket gopher control usually list poison baiting and trapping as the most popular methods (Tietjen 1973, Bonar 1995). Research and control program assessments conducted in western Canada in the last decade have demonstrated that trapping, when used with a border control strategy to eliminate immigration (Proulx 1997a), is better suited than poison baiting to meet the elements of an effective pocket gopher control program.

Removal of Breeders Before the Birth or Emergence of Young

During the reproduction season, 50% of killing box traps set individually in burrow systems can successfully capture resident animals during the first trap-night (Proulx and Cole 1996, Proulx 2001). Also, Proulx (1997a) showed that control programs with only 48 traps strategically set in 8-ha alfalfa fields eliminated whole breeding populations with densities as high as 22 animals/ha within 1 month, before the birth or emergence of young. Similarly, in a 320-ha hayland, Cole and Proulx (1997) showed that trapping could be used to remove the majority of breeders before the emergence of young, and protect newly established shelterbelts from pocket gopher damage. The results of a community project in southern Manitoba also indicated that trapping was superior to poison baiting to remove breeding pocket gophers (Bonnefoy 2001).

Little work has been done on the ability of poison baits to control pocket gophers during the reproduction season. In Manitoba, Deniset (1993) applied cholecalciferol, bromadiolone, and strychnine baits with burrow-builders in alfalfa fields. She assessed the impact of treatments on populations with the mound-count method; however, mounding is highly variable (Miller 1948, Laycock 1957, Proulx et al. 1995a) and is not a sensitive measure of pocket gopher activity (Engeman et al. 1993). While Deniset (1993) reported that spring treatments first appeared to be effective on the basis of a reduction in gopher signs, she noted that pocket gopher numbers often rebounded quite drastically during the same summer. Deniset's (1993) results suggest that spring populations were not effectively reduced by the poison baits, as it had been suggested by mound counts, and that surviving breeders produced enough young to recolonize the treated fields.

Proulx (1998) assessed the ability of 0.4% strychnine-treated oats to control pocket gophers in spring, in alfalfa fields. He monitored the impact of treatments with the "open-hole" method that consists in opening the burrow system after treatment and returning 24-48 h later to determine whether the holes are still open or have been closed by the resident. Closure of the burrow openings indicates that the system is still "active" (Engeman et al. 1999). The "open-hole" method is the most reliable indirect activity measure (Engeman et al. 1993) as it takes into consideration the fact that pocket gophers do not leave their burrow system open when they are underground (Proulx et al. 1995b). Proulx (1998) reported that ≤17% of hand-baited (method that allows better control of the placement of bait within a tunnel) pocket gopher burrow systems became inactive in alfalfa fields after 3 bait-nights (Proulx 1998). Although no effectiveness data have been reported for 2% zinc phosphide-treated oats during the reproduction period, tests carried out in June also resulted in ≤17% control success (Proulx 1998). In southern Manitoba, farming communities abandoned both the burrow-builder and the hand-baiting applications of zinc phosphide-treated oats because of poor control results (Bonnefoy 2001). In laboratory, Proulx (1995) found that an anticoagulant diphacinone 0.005% grain mixture bar controlled only 10% of alfalfa-fed captive pocket gophers during the reproduction season.

It is noteworthy to mention that studies in simulated natural environments showed that pocket gophers spent more than 50% of their activity time excavating and inspecting their burrow system, and keeping it closed from outside intruders (Proulx et al. 1995a). It is impossible to bait a burrow system without causing some disturbance. Pocket gophers recognize areas of their burrow system that have been modified, even slightly, and often mix or cover the bait with soil, or use bait and soil to plug the disturbed portion of the tunnel (Tickes 1983, Proulx 1998).

Work carried out in western Canada suggest that trapping is more effective than poison baiting for the control of northern pocket gophers during the reproduction season.

Immigration Control

Pocket gophers can invade fields within 7 days after control (Tunberg et al. 1984, Sullivan 1986), and adopt old burrow systems (Proulx et al. 1995a). Proulx (1997a) showed that ≥20-m wide perimeter traplines, where traps are set in previously occupied burrow systems, could intercept ≥75% of pocket gophers immigrating into gopher-free alfalfa fields. Through regular checks, animals that crossed the border trapline to establish themselves in the fields could easily be located and removed. Proulx (1997a) also noted that, as animals were being removed at the edge of fields, more animals from adjacent areas extended their home range over the boundaries of the perimeter trapline or simply entered the depopulated area. As these animals were captured in the perimeter trapline, pocket gopher populations bordering managed fields were also reduced. With time, the decimation of adjacent populations resulted in a near complete elimination of immigration (Proulx 1997a).

Poison baits are not readily accepted by pocket gophers, and it is uncertain that immigrating pocket gophers entering a tunnel where the previous resident has been poisoned will ingest leftover bait. Furthermore, baits often are rapidly degraded and long-term control is unlikely (Godfrey 1987). In Manitoba, zinc phosphide-treated oats become moldy and unfit for consumption 7 days after application in a moist sandy soil (G. Bonnefoy, 2002, Manitoba Forage Council, pers. comm.). Paraffinized anticoagulant bars contain ample bait for multiple feedings, and Godfrey (1987) considered that they effectively controlled pocket gophers in orchards on the basis of mound-counts. Proulx (1995) found that, in no-choice tests, diphacinone 0.005% baits were effective. In two-choice tests with alfalfa, however, most baits were left untouched and only 10% control was achieved (Proulx 1995).

To date, only trapping appears to be a valuable method to control pocket gopher immigration.

Applicability in Various Agricultural Lands

In western Canada, trapping has been used in various agricultural lands such as alfalfa fields, annual crops and shelterbelts, under dry and wet conditions, and cold and warm weathers (Cole and Proulx 1997; Proulx 1998; Bonnefoy 2001; Proulx and Cole 2002a,b). Pocket gophers maintain a closed burrow system and "patrol" the system regularly; they are captured as they investigate, or attempt to repair, their burrow system (Witmer et al. 1999).

Poison baits may work well in no-choice tests or in land with poor or little vegetation, but are ineffective in presence of alfalfa (Proulx 1995). Tickes (1983) pointed out that gophers preferred fresh alfalfa over almost all other bait materials. Milo, wheat, oats, and barley are used by the pesticide industry because they are easily handled and last longer (Tietjen 1973); however, they are not accepted by pocket gophers (Tickes 1983). Furthermore, they often become damp, caked, or moldy and become less palatable (Marsh and Plesse 1960, Barnes et al. 1985).

In western Canada, only kill trapping effectively controls pocket gophers independently of the quality and quantity of surrounding vegetation, under diverse environmental conditions.

Monitoring

Because pocket gophers keep their burrow system closed from outside intruders (Proulx et al. 1995a), their presence can easily be monitored while trapping. As soon as an animal was captured, Proulx (1997a) moved a trap to another burrow system after plugging the burrow system and leveling mounds. However, because more than one gopher may inhabit a given burrow system in spring and early summer (Wight 1930, Hansen and Miller 1959), and gophers from adjacent areas may invade unused burrow systems, a 3-cm-diameter hole in the main tunnel of each trapped burrow system was kept open on the surface. The presence of open holes through the duration of the trapping season indicated that no other pocket gophers were occupying the trapped burrow systems (Proulx 1997a).

When hand-baiting, the opening in the burrow system must be plugged immediately after depositing the bait. Dirt plugs can be removed a few days after to monitor the killing efficiency of the toxic bait (Proulx 1998). Therefore, the "open-hole" method used in trapping can also be used with hand-baiting. The "open-hole" method could also be used after mechanical applications (e.g., probes or burrow-builders) if burrow systems are opened after treatment. However, because of the extent of artificial tunnel networks created with burrow-builders, the use of the "open-hole" method could become time-consuming and labor-intensive.

The "open-hole" method can be used to monitor the effectiveness of any control treatment. It is particularly easy to implement when removing a trap from a burrow system.

Selectivity

A variety of vertebrates inhabit pocket gopher burrow systems (Vaughan 1961, Whittaker et al. 1991). However, the probability of capture of non-target animals with well-placed traps in active pocket gopher burrow systems is low. Smeltz (1992) and Witmer et al. (1999) reported ≤3 non-target animals per 1,000 trap sets in forested situations. In orchards and vineyards, the capture of non-target animals is generally ≤1 per 5,000 trap sets (Witmer et al. 1999). On the other hand, poison baits can be dangerous for many non-target species, namely predatory and scavenging birds and mammals, granivorous and migratory birds, and various rodent species (Marsh 1985). Data on the potential secondary hazards of poison baits are lacking (see Bonar 1995) but, because of their unselective killing potential, poisons remain a source of concern for wildlife agencies (Mendenhall and Pank 1980, Littrell 1990).

Traps set in pocket gopher burrow systems are likely more species-selective than poison baits.

Safety and Social Acceptability

Most of the commonly used killing traps are durable and easy to use (Witmer et al. 1999) and generally are safe for the users (see Marsh 1997). In contrast, acute poisons such as strychnine and zinc phosphide may be dangerous to the users and must be carefully handled (Ali 1997).

Trapping is recognized as an important control method in today's societies but the public is concerned about the welfare of trapped animals. Proulx (1999) pointed out that, while little work has been carried out on the "humaneness" of traps, current models may be modified to quickly render animals unconscious. In contrast, acute poisons are not considered to be humane. For example, strychnine is believed to cause one of the cruelest deaths imaginable (Landals 1993), and the Canadian Council on Animal Care (1984) does not recommend strychnine for euthanasia. Strychnine does not have a depressing effect upon the central nervous system but acts at neuro-muscular junctions. Animals die by asphyxiation caused by paralysis of the respiratory muscles. Similarly, zinc phosphide produces phosphine gas, which is a slow acting acute rodenticide; death from asphyxia occurs ≤24 h after ingestion (Tickes et al. 1982; Proulx, unpublished data). The use of poison baiting can raise serious public concerns about animal welfare.

When compared to poison baits, kill trapping is safer for the users, and socially more acceptable.

Financial Benefits and Viability

Costs associated with trapping are difficult to assess as they are dependent on the number and type of traps used, the number and experience of trappers, soil and weather conditions, pocket gopher density and distribution over the trapped area, and the goals of the trapping effort (Witmer et al. 1999). In the United States, trapping programs aimed at reducing population levels to significantly minimize damages caused by pocket gophers reported costs of about US$100 per ha (Teipner et al. 1983, Smeltz 1992). In Alberta, Proulx (1997a) estimated that the maximum time required by one person to remove all breeders in an 8-ha field, within 5 weeks with 48 traps, was 20 h per week. For an hourly wage of CAN$8/h, the total removal of pocket gophers cost CAN$100 per ha in fields with high spring population densities (e.g., 22 animals/ha). The second year, after implementing the border control strategy, the removal of all animals cost only CAN$10/ha (Proulx 1997a). In Manitoba, Bonnefoy (2001) paid trappers CAN$2.60 per animal to remove pocket gophers within a 7680-ha area. With high spring density levels of 22 pocket gophers/ha, trapping costs would likely exceed CAN$60 per ha.

In Manitoba, DeWandel et al. (1997) estimated that applying a rodenticide annually ranged from CAN$30 per ha for strychnine baits to CAN$230 per ha for cholecalciferol. In Saskatchewan, pest control companies may charge approximately CAN$6/ha to treat fields with burrow-builders and strychnine or zinc phosphide baits (L. Bohrson, 2002, Irrigation Crop Diversification Co., pers. comm.).

With the exception of cholecalciferol, mechanical baiting is markedly cheaper than trapping. However, application costs are misleading. Control success achieved with current poison baits is at least 3 times less effective than that obtained with traps (Proulx and Cole 1996; Proulx 1998, 2001). Because poisoning leaves behind an important proportion of the gopher population that may reproduce and compensate for losses induced by baits, costs associated with poison baiting may be high in the long-term. In southern Manitoba where sandy soils are susceptible to wind and water erosion when cultivated, Bonnefoy (2001) reported that trapped fields remained productive for an extra 1-2 years longer than untrapped fields. Extending the fields' life expectancy reduced the negative impact of cultivation on soils and the costs associated with the re-establishment of alfalfa (Bonnefoy 2001), and represented an accrued income of at least CAN$250/ha/yr (DeWandel et al. 1997). Bonnefoy (2001) pointed out that trapped fields were superior to untrapped or baited fields for the following reasons: 18.2 to 27.8% increase in yield, smoother and more leveled fields allow for increased speed of operation, reduced machine repairs and downtime by 30 to 50%, and hay of greater quality.

The long-term management costs, harvest expenses, and average annual net revenues of trapped fields have never been compared to those of poison-baited fields. However, considering the poor performance of current poison baits that results in repetitive treatments and a reduction in forage stand life, trapping may be as cost-effective as poison baiting. Also, Bonnefoy (2001) pointed out that alfalfa growers that were outside his trapping area realized the benefits of trapped fields, and either began trapping themselves or hired someone to do it.

IMPLEMENTATION OF AN EFFECTIVE TRAPPING PROGRAM

The implementation of an effective program including the border control strategy consists of a series of steps that must be maintained in order to ensure a cost-efficient and long-term control of pocket gopher populations. The control program must start as early as possible in spring in order to remove reproducing females and eliminate the production of juveniles. Regardless of the size of the field (or region) to manage, trapping should be started at the center of the field and moved out toward the edges. Although burrow systems occupied by pocket gophers usually have mounds or earth plugs (Proulx 2002a), some active burrow systems may have little or no signs. Old burrow systems without fresh pocket gopher signs should still be monitored with the "open-hole" method. Traps should be set as per Witmer et al. (1999). Not all traps are equally efficient at capturing pocket gophers. Killing box traps with an open floor are particularly efficient as they allow continuous contact between the pocket gopher's feet and the soil so that the animal is less hesitant to enter the trap (Proulx 1997b). At least 48 traps/8 ha of hayland are necessary to develop an effective program. Leave traps in the burrow system for up to 48 h. When removing a trap, either because a pocket gopher has been captured or because the burrow system appears empty, plug all but one small hole in the tunnel and move the trap to another location. Monitor the small openings while walking across the field and, if a burrow system becomes plugged, it means that it is now occupied by a pocket gopher. When the pocket gophers have been trapped out, or significantly reduced, establish a ≥20-m trapline around the border of the field by setting traps in old burrow systems. Pocket gophers do not invade fields equally from all sides; e.g., more animals will enter from sides bordering alfalfa fields with a dense pocket gopher population than from sides bordering woodlots with only a few animals. Recognizing these areas will help to properly distribute traps around the field. Check the perimeter trapline at least once a week. Remove dead animals and reset traps. Inspect fields after hay cuts and immediately remove pocket gophers that have crossed the perimeter trapline and have established themselves in the field.

If done properly, trapping can effectively control pocket gopher populations, particularly if the program is implemented soon after the establishment of the field. The establishment of such a program requires a serious commitment from farmers particularly during the first year when many pocket gophers must be removed. If all the farmers of an area cooperate with each other to trap out pocket gophers and implement the border control strategy, pocket gopher control will be achieved more rapidly and with less effort. After the first year of trapping, control efforts are significantly reduced and farmers can keep pocket gopher populations under control (Proulx 1997a, Bonnefoy 2001). Needless to say, pocket gophers still play an important role in western ecosystems, and the species should not be extirpated from native range.

RECOMMENDATIONS

Despite its superior effectiveness compared to other methods, trapping still remains a time-consuming and labor-intensive method, and the use of an attractant would be useful to quickly remove breeders of the year. Research on the impact of female pheromones on the trappability of northern pocket gophers is underway (e.g., Proulx 2001). More trap development work should also be carried out to increase capture success by inciting animals to enter traps rather than "back filling" them with loose soil.

Proulx (1998) indicated that despite the obvious success accomplished with the border control strategy, research should be conducted to better understand animals' movements. The availability of empty burrow systems, intraspecific pressure, local soil or vegetation conditions, or individual variation in the pocket gopher exploratory behavior may all contribute to the fact that some pocket gophers move deeper than others into depopulated fields. In practice, a better understanding of pocket gopher movements would allow for a better distribution of traps along the edges of fields.

When one takes into consideration control performance and long-term benefits, trapping appears to be more valuable than any other method to control pocket gopher populations in western Canada alfalfa fields. Also, in Alberta, 30 (63%) of 48 municipalities with pocket gophers advocate trapping as a method of controlling pocket gophers; trapping is believed to be significantly more satisfactory as a control method than poisoning and other methods (Nietfeld and Roy 1992). Unfortunately, the belief that poisoning is more effective and economical than trapping still exists (Deniset 1993), even though poison baits control $\leq$7% of breeding populations (Proulx 1998). An education program is therefore required to properly inform farming communities about the greater performance and obvious advantages of trapping. More research should also be carried out to compare the short- and long-term costs and benefits of trapping compared to other control methods.

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