

Factors Contributing to the Outbreak of Richardson's Ground Squirrel Populations in the Canadian Prairies

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ABSTRACT: In the last decade, Richardson's ground squirrel populations have reached epidemic levels in western Canada. A review of socio-economic conditions and field research findings suggests that such outbreaks are the result of many factors working synergistically on ground squirrel population dynamics and dispersal: 1) drought conditions, 2) poor grassland management, 3) low cattle prices due to bovine spongiform encephalopathy, 4) inefficient rodenticides, 5) loss of predators, and 6) loss of family-size operations to large-scale landowners. In the light of recent outbreaks experienced in western Canada, we now know that the control of Richardson's ground squirrel populations requires a long-term management program, integrating sustainable grassland management techniques with an effective conservation of mammalian and avian predators, and the sensible use of effective rodenticides. The success of such a multi-faceted management program will depend on the establishment of an effective education program, the institution of incentive programs for a better management of grassland ecosystems, the implementation and enforcement of rules to better monitor the production and distribution of effective poisons, and minimizing excessive use by producers.

KEY WORDS: Alberta, Canada, drought, grazing, IPM, Richardson's ground squirrel, rodenticides, Saskatchewan, *Spermophilus richardsonii*

Proc. 24th Vertebr. Pest Conf. (R. M. Timm and K. A. Fagerstone, Eds.)
Published at Univ. of Calif., Davis. 2010. Pp. 213-217.

INTRODUCTION

In western Canada, the Richardson's ground squirrel (*Spermophilus richardsonii*) is second in prominence only to the grasshopper in the rogue's gallery of agricultural pests. Reliable and comprehensive data are scarce, but it is certain that this rodent did severe damage to crops over large areas of the Canadian Prairies in the last century, and generations of farmers waged battles to control this species (Isern 1988). In the early 1900s, both Saskatchewan and Alberta governments distributed strychnine poison to farmers. Although some farmers reported good success with it, others spoke of indifferent results, especially during droughts (Isern 1988). Yet, strychnine became the poison to use when controlling Richardson's ground squirrel populations in western Canada. Prior to 31 December 1992, farmers in Canada had access to a concentrated solution of 2% strychnine for the control of ground squirrels. In 1993, the Canadian Federal Government banned the popular strychnine solution (Owen Carter 1993), and it was not until 2007 that an emergency registration program of 2% liquid strychnine was granted by the Pest Management Regulatory Agency of Canada and became effective in 2008 (Wilk and Hartley 2008).

During the last decade, Richardson's ground squirrel populations reached spring densities often exceeding 40 adults/ha (Proulx and Walsh 2007, Proulx et al. 2009). In 2001, federal Members of Parliament and Senators argued that the loss of crops and millions of dollars was due to Richardson's ground squirrels, and the lack of control because liquid strychnine had been banned in the early 1990s (Government of Canada 2001, Standing Senate Committee on Agriculture and Forestry 2001). Farmers considered that Richardson's ground squirrel populations were unmanageable for the same reason (Cowley 2001, Farrell 2002).

In this paper, we intend to demonstrate that the high densities of Richardson's ground squirrel populations observed in the last decade in western Canada were due to a series of inter-related factors, some of them independent of the availability of strychnine poison. In the following, we review environmental and socio-economic factors that caused the outbreaks, and the maintenance of high Richardson's ground squirrel population densities. We also discuss how to deal with future population outbreaks through the implementation of an IPM program.

DROUGHT CONDITIONS

In 2000-2001, western and central Canadian prairies experienced a severe drought with a warm winter and low precipitations (Liu et al. 2004). Crop loss in a drought year may frequently exceed $\frac{1}{3}$ to $\frac{1}{2}$ the average yield, with disastrous consequences to a region's environmental and socio-economic conditions (Maybank et al. 1995). Droughts depress plant growth (Heath et al. 1973, Glickman 2000) and create ideal conditions for Richardson's ground squirrels, which prefer to establish their burrow systems in fields with shorter vegetation and good visibility (Yensen and Sherman 2003). The 2000-2001 Richardson's ground squirrel population outbreaks were caused by drier weather, a relationship that had been observed in previous years. For example, during the 1910-20 and 1930-39 droughts (Nkemdirim and Weber 1999), Richardson's ground squirrel populations grew and caused considerable damage to crops, even when farmers had access to strychnine poison (Isern 1988). While farmers believed that the use of an effective poison could have dampened population growth, the fact remains that ground squirrels were benefiting from optimal environmental conditions that launched an exponential growth across the Prairies. Unfortunately, rural commu-

nities were focusing on the wrong reason to explain such an outbreak. In the words of a Senator's deposition, "the gopher [*sic*] population has expanded and there has been talk of weather conditions and farming conditions as the cause, but the expansion took place because there has not been an effective control in place" (Standing Senate Committee on Agriculture and Forestry 2001).

POOR GRASSLAND MANAGEMENT

Statistics Canada (2001) reported that the number of cattle on Canadian farms rose 4.4% between 1996 and 2001. Most of the increase was in Alberta and Saskatchewan. The increased demand for beef and a growing export market to the United States, combined with serious drought conditions, were reflected in changes in land use. There was a significant increase in feed crops such as hay or alfalfa. It is difficult to grow hay when soils are dry, and an increase in the number of cattle lead to overgrazing. It is important to note, however, that even a range that was stocked within its carrying capacity with livestock may have become overgrazed due to additional pressure by ground squirrels. Rodents can consume large quantities of forage, and their impact on ranges is amplified during droughts and under overgrazing conditions (Phillips 1936). In 2001, poor grassland management exacerbated the drought situation and created good habitat for ground squirrels. This was a repeat of a common situation in the 1930s (Coventry and Dymond 1949, Isern 1988).

BOVINE SPONGIFORM ENCEPHALOPATHY

The announcement of bovine spongiform encephalopathy (BSE) – commonly called mad cow disease – in one cow in northern Alberta on May 20, 2003 led to a decision by more than 40 countries to immediately impose import restrictions on live ruminant animals, meat products, and animal by-products from Canada (Mitura and Di Piétro 2004). Receipts from international exports of live cattle and calves plunged 67%, and receipts for slaughter cattle dropped 23% as markets and prices both fell. Between May and July 2003, the price of cattle and calves dropped almost 50% (Standing Committee on Agriculture and Forestry 2004). The situation created a huge oversupply of live cattle, while there was a shortage of forage due to drier environmental conditions. This resulted in a surplus of animals on the range and overgrazing, which maintained ideal environmental conditions for ground squirrels.

INEFFICIENT RODENTICIDES

It is unlikely that Richardson's ground squirrel populations could have been effectively controlled by simply using a poison. Ground squirrels were running all over the place as pastures, grasslands, and crops were degraded. Yet, at the time, there was an obvious lack of control methods available to farmers. Following the ban of liquid strychnine in 1993, PMRA had allowed the sale of ready-to-use (RTU) strychnine-treated oats as a replacement toxicant. Producers reported poor performance of the product (Standing Senate Committee on Agriculture and Forestry 2001), and scientific research carried out from 2007 to 2009 showed that this poison

bait was ineffective for the control of ground squirrels (Proulx et al. 2010a). Some producers used other poisons such as anticoagulants, foam, gas cartridges, and nitrous ammonia, apparently without outstanding results (Proulx, unpubl. data).

LOSS OF PREDATORS

Even though RTU strychnine baits were not effective enough to control ground squirrel populations, they still killed some ground squirrels, non-target species, and predators feeding on poisoned animals (James et al. 1990, Proulx et al. 2010a). Secondary poisoning of terrestrial and avian predators has also been reported in many anticoagulant studies (Stone et al. 1999, Albert et al. 2009, Proulx et al. 2010a). The 2000 drought resulted in misuse of poisons in the Canadian Prairies, e.g., strychnine baits spread on surface, alteration of approved poison baits with other toxicants or attractants, poor bait station designs giving access to non-target species, etc. A decrease in predator populations certainly contributed to the expansion of ground squirrel populations during 2000-2009 (Proulx et al. 2009, 2010a).

LOSS OF FAMILY-SIZE OPERATIONS TO LARGE-SCALE LANDOWNERS

From 1941 to 2006, Saskatchewan farms declined in numbers, but their size increased (Encyclopedia of Saskatchewan 2006, Saskatchewan Agriculture and Food 2006). The number of farms larger than 896 ha (2,240 ac) increased by 37% from 2001 to 2006 (Saskatchewan Agriculture and Food 2006). In Alberta, the number of farms decreased from 1961 to 2006 (Alberta Agriculture, Food and Rural Development 2003, Statistics Canada 2006). The average farm size increased by 19% from 1980 to 2006 (Alberta Government 2008). Canada's farm population continued its long-term decline between 2001 and 2006 and got older (Statistics Canada 2006). In the early days, whole families participated in the control of ground squirrels on their family farm (Isern 1988). Nowadays, a few people cannot monitor, much less control, population irruptions over large areas.

LEARNING FROM THE PAST IN ORDER TO BE PREPARED FOR THE FUTURE

The 2000-2001 Richardson's ground squirrel population outbreaks were due to an agricultural drought, and high population densities were maintained during subsequent years because of poor grassland management and a series of socio-economic disasters. Drought is a chronic concern in the Canadian prairies (Liu et al. 2004). Since meteorological records began in the 17th century, almost every decade has featured at least one drought year. At least half of the years in decades 1910-20, 1930-39, and 1980-89 were drought stricken (Nkemdirim and Weber 1999). According to Phillips (2002), drought has never been as serious or extensive as in 2001. Even in the dust bowl of the 1930s, no single year was drier than in 2001. Decreases in summer precipitation and increases in arid conditions are projected in the future (Sauchyn et al. 2002, Barrow and Yu 2006, Barrow 2009), and many pest species populations, including Richardson's ground squirrels, will increase in numbers during years of warm,

dry weather.

Historical records showed that liquid strychnine, shooting, clubbing, trapping, and snaring all failed to stop the expansion of populations during previous droughts (Isern 1988). Although hundreds of thousands of tails have been turned in through bounty programs, and in spite of governmental programs refunding farmers the cost of poison, the efficiency of control programs to decrease ground squirrel populations and their depredations on crops during droughts was never demonstrated (Isern 1988). In 2000-2001, farmers and politicians invested all their efforts at reinstating access to concentrated liquid strychnine. Yet, it is unsure that 2% liquid strychnine would have succeeded in reducing the growth of ground squirrel populations. Recent research showed that liquid strychnine, as it is presently used and stored, may be unreliable to control Richardson's ground squirrel populations (Proulx et al. 2010b). Furthermore, it has been suggested that Richardson's ground squirrels inhabiting fields treated with strychnine could develop resistance to toxins by enhancing the functional capacity of enzymes responsible for detoxification (Ling et al. 2009).

In the early days, concerns about ground squirrel populations diminished once rainfalls returned (Isern 1988). In 2009, after a period of heavy rains and even flooding of fields, farmers inhabiting zones affected by the drought showed less interest in ground squirrel research (Proulx, pers. observations). Farmers dealing with droughts and ground squirrel population outbreaks certainly showed signs of resilience, which is commendable, but also of short-sightedness because drier weather will eventually come back and bring along more ground squirrel problems. It is when ground squirrel populations are less dense that farmers should work at developing a preventive program to better control future population outbreaks. Richardson's ground squirrel control programs should be pro-active rather than reactive.

THE NEED FOR AN IPM PROGRAM

An Integrated Pest Management (IPM) program is a pest control strategy where monitoring, preventive cultural practices, and various control methods (mechanical, physical, biological, and chemical) are strategically coordinated to maintain rodent population densities at acceptable pest levels (Witmer and Proulx 2010). Monitoring is an essential step in the control of ground squirrels. One must continuously assess and re-assess changes in the distribution and abundance of ground squirrels. Spring monitoring allows one to identify where ground squirrel concentrations exist, in order to stop the expansion of their populations at the local level.

Improved cultural methods are essential to create habitats that will be less favorable for the Richardson's ground squirrel. Past research demonstrated that vegetation height impacts on colonization by ground squirrels. Downey et al. (2006) concluded that ground squirrels selected against areas with tall grass (>30 cm). Proulx and MacKenzie (2009) and Proulx et al. (2010a) estimated that >15 cm vegetation had a significant impact on colonization of fields by ground squirrels. In order to maintain fields with >15-cm-high vegetation, farmers

need to better balance stocking rates with what the range can support. Rotational grazing, the seeding of a mixture of improved species of grasses and legumes, and the maintenance of dense grass cover (Heath et al. 1973) will reduce ground squirrel colonization and produce high quality forage that is more resistant to drought.

Mechanical control, e.g., tillage, may be needed to disrupt breeding populations in areas (e.g., the grassy borders of crop fields; Witmer et al. 2007) where larger concentrations of animals have been observed. Kill traps and shooting should be used to control small concentrations of ground squirrels.

Chemical control should be used judiciously in order to be effective, to minimize non-target hazards, and to be cost-effective (Witmer et al. 2007). The distribution of poisons to farmers, and their use in the fields, needs to be better monitored by regulating agencies. Ramsey and Wilson (2000) discussed ecologically-based baiting strategies for rodents in agricultural systems.

One cannot stress enough the importance of maintaining healthy, sustainable populations of birds of prey and terrestrial predators. These predators are the first line of defence against rodent population increases. They may not stop ground squirrel population outbreaks under drought conditions. However, during "normal" years, with the combined effect of cultural, mechanical, and chemical control methods, predation may be the factor that holds ground squirrel breeding populations at bay.

An IPM program cannot be effectively implemented during ground squirrel population outbreaks. This is a long-term pro-active program that needs to be developed with time, starting with sections of the farmland where risk of ground squirrel damage may be greater. For example, using poison baits in a specific quarter section for a short period of time, and collecting dead and moribund animals on surface, will stop a ground squirrel population from expanding without eliminating at the same time all the terrestrial predators of the area. In contrast, when farmers use chemical control during population outbreaks, they often saturate the whole section with poison baits though the use of multiple applications or bait stations (pers. observations) and end up killing everything. In the short term, they may control ground squirrels, but in the long term they handicap the whole wildlife community by primary poisoning of non-target species and secondary poisoning of predators.

Although farmers can significantly improve their ways of controlling ground squirrel populations, it is important to include government agencies and conservation groups in an IPM program. After all, grasslands and pastures are essential habitats for Prairie wildlife. Government funds should be allocated to farm operations that implement an IPM program and work at the conservation of biodiversity on farmlands. Conservation Groups (e.g., World Wildlife Fund, Nature Conservancy, and others) should also invest their conservation efforts in the development of effective IPM programs which, in the long run, will be beneficial to species at risk and landscape conservation. Finally, the development and implementation of an IPM program, and the judicious use of control methods, require that an education program be

offered to all farming communities. In 2006, 1 out of every 5 farm operators (a person responsible for the management decisions made in operating a farm) who reported a post-secondary certificate or diploma had studied in agriculture and related sciences. The most studied subjects were business management, marketing, and related support services (Statistics Canada 2006). There is a pressing need to educate farmers about sustainable control through an IPM program.

ACKNOWLEDGMENTS

I thank Neil and Julie MacKenzie from Alpha Wildlife, and Scott Hartley from Saskatchewan Ministry of Agriculture, for their input. I am grateful to Pauline Feldstein, Alpha Wildlife, for reviewing an earlier version of the manuscript.

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