March 1978

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ABSTRACT: The Columbian ground squirrel (Spermophilus columbianus), Richardson ground squirrel (Spermophilus richardsoni), and blacktail prairie dog (Cynomys ludovicianus) cause millions of dollars of loss to Montana agriculture each year. Montana's ground squirrel and prairie dog control programs are based upon local organization and operation with technical assistance being provided by the Montana Department of Livestock Vertebrate Pest Control Bureau. The results of field research programs using zinc phosphide, Compound 1080 and strychnine grain baits to control these species are reported.

INTRODUCTION

Montana, the fourth largest state, has a great deal of variation in topography and climate. In the western portion of the state, roughly defined by the Continental Divide, ranges of timbered mountains are divided by relatively temperate valleys. Glacier National Park and part of Yellowstone Park are found in the western third of Montana. As one travels east of the Divide, smaller mountain ranges are interspersed among the beginnings of the great prairie. Along the Canadian border grainfields grow on table-top flatlands. The rugged Missouri River Breaks and Yellowstone River Valley cut across sparsely populated rangeland in central and eastern Montana.

Montana's variety in topography and climate leads to variety in field rodent species. The western intermountain valleys are home for Columbian ground squirrels (Spermophilus columbianus). The Richardson ground squirrel (Spermophilus richardsoni) is found east of the Continental Divide and mostly north of the Yellowstone River. The blacktail prairie dog (Cynomys ludovicianus) lives on rangeland in the eastern two thirds of Montana. Some other species which are indigenous to Montana but rarely cause enough damage to warrant control are the thirteen-lined ground squirrel (Spermophilus tridecemlineatus), the golden-mantled ground squirrel (Spermophilus lateralis), and the whitetail prairie dog (Cynomys gunnisoni). The Uinta ground squirrel (Spermophilus armatus) is found in a small area of extreme southwestern Montana.

DAMAGE

Ground squirrel and prairie dog damage to food, fiber, and natural resources in Montana is widespread and locally severe. A 1973 survey of USDA Committees for Rural Development, Conservation Districts and other local agricultural groups listed more than $6.5 million economic loss due to damage by these species (Seyler, 1973). The loss was distributed as follows: $1.2 million-Columbian ground squirrel; $4.7 million-Richardson ground squirrel; $0.7 million-prairie dogs.

Types of damage frequently seen are: destruction of range and pasture forage, destruction of cultivated crops (most commonly cereal grains), and damage to harvesting equipment. Another type of damage which may be significant but is not well defined in Montana is erosion enhancement.

STATE RODENT CONTROL PROGRAM

Prior to 1975, Montana's field rodent control programs were administered and supervised primarily by the federal government through the USDA Bureau of Biological Survey and USDI Fish and Wildlife Service. By 1970, however, the federal field rodent control program in Montana was terminated except for the sale of grain baits, gas cartridges and other control materials.

The Montana State Legislature, at the request of agriculture producers and recommendation of the Governor's Advisory Council on Rodent and Rabid Skunk Control, enacted legislation giving the Montana Department of Livestock authority to administer and supervise rodent control programs.

The Department of Livestock Vertebrate Pest Control Bureau has three district biologists, each serving one third of the state. The biologists' duties are divided among predator, rabid skunk and field rodent control programs.

The primary objectives of Montana's field rodent control programs are: 1) Rodent damage assessment; 2) aiding in the implementation and operation of locally operated control programs; 3) public information and education; 4) evaluation of present control methods; and 5) research and development of new control methods.

Damage Assessment

The collection of scientifically sound economic loss data is as important as it is difficult. Techniques are available for assessing vegetation loss on a given site with exclusion cylinders (Sauer, 1977) and for determining the loss of livestock production due to ground squirrel damage to range forage (Howard, Wagnon and Bentley, 1959). The difficulty arises, however, when trying to establish the economic loss to agriculture on an area-wide basis. Extrapolation of data collected on one site to an entire county or region cannot be done without knowing the precise distribution and

densities of rodent populations in the region. That information is prohibitively expensive to collect in most cases. Even if this were accomplished, it would not account for other possible types of damage such as damage to harvesting machinery, erosion, damage to irrigation equipment, and weed dissemination.

Aerial infrared photographs (scale l:24;000) were used in Montana to delineate prairie dog towns in McCone County. It was not possible to use the photographs, however, to determine economic loss.

Due to the lack of a better method of reasonable cost, the collection of economic loss data in Montana has been limited to surveys. There is a definite need for more and better loss data, as vertebrate pest control professionals are increasingly required to justify control programs on an economic basis.

Local Rodent Control Programs

Primary responsibility for the operation of rodent control programs now lies with the counties. This is a new concept for Montana as field programs had previously been administered and supervised by the Fish and Wildlife Service. Since 1975, Rodent Control Boards have been appointed by Boards of County Commissioners in those counties desiring an organized rodent control program. Vertebrate Pest Control Bureau biologists work with these boards to aid in planning, operating and evaluating county programs. Rodent control personnel hired by the counties are trained by Bureau biologists in the biology and ecology of pest species, proper control techniques, and environmental and human safety. Upon completion of the training and passing of a written examination, the county personnel are licensed as government pesticide applicators by the Montana Department of Agriculture.

Information and Education

There are two major elements to the public information and education program: public rodent control training sessions and publication of control bulletins. The training sessions consist of slide presentations about the biology and control of pest species and field demonstrations of control techniques. These sessions provide opportunities to discuss such things as proper bait application techniques, proper timing of baiting programs, limiting baiting to once per year and the alternatives to the use of toxic baits such as trapping, shooting, toxic gases and habitat manipulation. Bulletins dealing with the biology and management of Montana field rodents are prepared by Bureau staff and provided to County Extension Agents and bait dealers for distribution to the public.

Evaluation

Applied research is conducted to evaluate the safety, efficacy and economics of present control methods. The distribution of Montana's ground squirrels and prairie dogs is such that each of the three district biologists may concentrate his research program upon the species causing the most damage in his district.

Research and Development

Where presently available, control methods do not provide adequate relief from rodent damage, alternative materials and control techniques are researched. This research can lead to the registration of more effective rodent baits or more efficient bait application techniques.

RESEARCH PROJECTS

The following is a brief overview of some of Montana's research activities dealing with ground squirrels and prairie dogs during 1976 and 1977.

Columbian Ground Squirrel

Most counties engaging in Columbian ground squirrel control purchase 0.5% strychnine grain bait from the U.S.D.I. Fish and Wildlife Service Pocatello Supply Depot for resale. Dissatisfaction with control success achieved using strychnine grain bait seems almost universal. Forty-nine percent of fanners and livestock producers surveyed in 1976 said their control success in the previous year had been poor.

Field tests were conducted in western Montana during June and July of 1976 to determine the relative efficacy of strychnine and Compound 1080 grain baits for Columbian ground squirrel control. Ground squirrel numbers were reduced 64% using 0.5% strychnine on steam-rolled oat groats, 68% and 81% using 0.5% strychnine on crimped "Pocatello" oats and 95% and 99% using Compound 1080 on steam rolled oat groats (Record, 1976).

Baiting for Columbian ground squirrels is limited to mid to late summer due to their foraging habits. They show such a strong preference for green forage (Shaw, 1916) during spring and early summer that baiting is not generally successful during that time period. Therefore control may not be undertaken until after most of that year's damage has occurred and the young of the year are actively foraging above ground. Even if 60 to 80% control is achieved at this point, the surviving population may be sufficient to repopulate the treated area in a single season. This means that there may be no net reduction in ground squirrel numbers at the time of the next breeding season and that the damage to agricultural crops may be about the same as during the previous year.

The precise reasons for strychnine grain bait's inadequate performance with this species have not been confirmed, but the properties of strychnine and the behavior of the Columbian ground squirrel provide the basis for two possible answers:

(1) Strychnine is commonly termed a "pouch" poison (Gabrielson, 1932). This means it is more effective when absorbed through the lining of the squirrel's cheek pouches than the stomach or intestine walls. One-fifth of the amount of strychnine needed to produce death through stomach absorption will kill a squirrel if it is absorbed through the cheek pouches (Merriam, 1910). Field studies were conducted during 1976 to determine if and when Columbian and Richardson ground squirrels pouch grain (Record, 1978). Of the Richardson ground squirrels examined, 51% had food in their cheek pouches but only 7% of the Columbian ground squirrels did. Strychnine grain bait seems to be effective for Richardson ground squirrel control. These facts support the hypothesis that pouching behavior may be important in achieving satisfactory control with strychnine grain bait.

(2) The second possible explanation for the difficulty with strychnine baits relates to strychnine's taste and fast action. Strychnine's bitter taste and short latent period may act to impede its effectiveness. This combination is undesirable because the fast action can cause illness before a lethal dose is consumed and the taste provides a readily available cue with which the squirrel can associate its illness. This can lead to poison or bait shyness. Compound 1080, on the other hand, is essentially tasteless and exhibits a relatively long latent period.

Due to the ineffectiveness of strychnine baits, the Department of Livestock made application to the Montana Department of Agriculture for a Special Local Need Registration (section 24 (c) FIFRA as amended) for sodium monofluoroacetate (1080) grain bait for Columbian ground squirrel damage control for 12 western Montana counties. The registration was approved at the state level and subsequently disallowed by the Environmental Protection Agency. The Montana Departments of Livestock and Agriculture have now applied for a Specific Exemption (section 18, FIFRA as amended) for the use of 1080 bait in the twelve counties. We are presently awaiting EPA's decision.

Richardson Ground Squirrel

Strychnine grain baits ranging in concentration from .35 to .44% registered for Richardson ground squirrel control in Montana seem to provide satisfactory control when properly applied. Difficulties arise when trying to hand bait the large acreages of range, pasture, and cropland infested with Richardson ground squirrels in central Montana.

A field test was conducted in June, 1977, in south-central Montana to determine whether broadcasting strychnine bait with a vehicle mounted Cyclone Seeder would be safe, effective and economical (Swick, 1977).

A Cyclone seeder was mounted on the front bumper of a four wheel drive vehicle. Application rates were calibrated using the methods developed by Marsh (1967) for calibration of aerially applied bait. Application rates investigated were from 3 to 10 pounds per swath acre at intervals of from 0 to 100 feet between the 20 foot wide swaths. These were compared with hand baiting by men on foot. The results are listed in Table 1. We are making application for registration of broadcast baiting with strychnine grain bait for Richardson ground squirrel control.

Table 1. Percent reduction in ground squirrel activity.

Site	Bait Density by Application Rate	Method of Application	Percent Reduction
1	10 lbs/swath-acre	strip (100)[1]	73%
2	10 lbs/swath-acre	strip (20)	97%
3	6 lbs/swath-acre	strip (100)	88%
4	--	non-treatment	29%
5	6 lbs/swath-acre	strip (20)	90%
6	6 lbs/acre	broadcast	63%[2]
7	0.22 oz/burrow	hand bait	94%
8	3 lbs/swath-acre	broadcast	87%
9	--	non-treatment	0%

[1]( ) distance in feet between swaths
[2]Flood irrigation may have accounted for low reduction

Blacktail Prairie Dog

Since the end of extensive Blacktail prairie dog control programs conducted during the past 50 years, Compound 1080 grain has not been available. Control personnel report that the registered alternatives, 2.0% zinc phosphide and 0.44% strychnine grain baits have not been effective. The Department of Livestock has conducted field trials to determine the relative efficacy of these three

toxicants. Swick (1976) found that prairie dog numbers were reduced 33% using 1.0% zinc phosphide on oat groats, 30% using 2.0% zinc phosphide on steam rolled oats, 57% using 0.44% strychnine on whole oats and 92% using 1080 on oat groats.

Field studies were also conducted during July, September and October, 1977, to evaluate prebaiting as a means of increasing the efficacy of the registered strychnine and zinc phosphide baits for prairie dog control. In the three months, without prebaiting, prairie dog numbers were reduced 83.2, 88.9 and 73.0% using strychnine on whole oats and 8.6, 84.1 and 50.0% using zinc phosphide on crimped ("Pocatello" oats. Prebaiting yielded 95.7, 96.3 and 98.0% reduction with strychnine bait and 66.2, 99.3 and 89.2% reduction with zinc phosphide bait (Sullins, 1977). Very little food was available to prairie dogs on the test sites due to drought conditions.

The marginal efficacy of zinc phosphide bait led us to request its chemical analysis. The analysis of the nominally 2.0% zinc phosphide bait showed a variation from 1.06 to 1.83% active ingredients in 5 subsamples from one bag (mean 1.4%, standard deviation 0.37).

The Black-footed ferret (Mustela nigripes) is an endangered species closely associated with the prairie dog. Ferrets live in prairie dog towns and prey upon prairie dogs. Black-footed ferret surveys are conducted prior to the use of zinc phosphide bait. Department of Livestock biologists were trained by ferret specialists in survey techniques. If ferrets are found, control is not implemented and the proper state and federal authorities are notified. The producer may in some situations be paid for the prairie dog damage in return for his agreement not to control them.

A management team has been organized in Montana to coordinate prairie dog control efforts and the management of Black-footed ferrets.

SUMMARY AND DISCUSSION

Montana's ground squirrel and prairie dog control programs are based upon local organization and operation with technical assistance being provided by the Department of Livestock. Each of the three district biologists also conducts applied research with the goal of providing safe and efficacious control of the depredating species. These studies may lead to registration of different pesticides or more effective use of currently available control methods and materials.

Montana finds itself in a situation where the presently registered toxicants do not provide adequate control for *every* depredating rodent species. We have therefore initiated registration actions, based upon available data and our own research, for toxicants which we have determined to be safe and effective. Additionally the Rebuttable Presumption Against Registration which is in process for strychnine and Compound 1080 also has the potential for severe effects upon the agriculture industry in Montana.

It has become apparent to us that we could greatly profit from close cooperation with other western states that find themselves in a similar situation. Such close cooperation might best be accomplished if there were an organization of persons responsible for rodent control in western states.

Specifically such an organization could:

1) Share information about state rodent control programs and identify areas of common concern.

2) Collect and make available new information resulting from field rodent control research.

3) Jointly sponsor applications for registration of rodenticides.

4) Encourage the development of new and innovative control techniques and more selective toxicants.

It is important to recognize that there is a great deal of expertise and experience in vertebrate pest control in county, state and federal agencies, colleges, and universities as well as the private sector that could be more fully utilized. The western state organization could consolidate and utilize that expertise and information.

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