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Brodifacoum in Bait Stations for Managing Columbian Ground Squirrels

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Abstract

A pelleted grain bait containing 0.005% brodifacoum was placed in bait stations to determine effectiveness for managing Columbian ground squirrels. Ground squirrel activity, measured by direct visual counts, was reduced an average 96.84% (range 95.43-100.00) on 3 treated plots. A total of 11.55 kg (25.46 lb) of bait was consumed by squirrels in treating 3.87 hectares (9.56 acres) of pasture or hayland.

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INTRODUCTION

Brodifacoum, a second generation anticoagulant, may be an effective toxicant for managing ground squirrels. The LD_{50} for the Richardson ground squirrel (Spermophilus richardsoni) was determined to be 0.130 mg/kg (95% CL = 0.062 - 0.188 mg/kg) (Baril and Pallister 1981), and is probably similarly low for the Columbian ground squirrel (S. columbianus) (Matschke, personal communication). Matschke et al (1983) showed that a 50 ppm bait applied once by hand (1 tbsp/burrow) reduced populations of Richardson ground squirrels by 96.8 ± 1.5%.

Currently, the efficacy of brodifacoum has not been field tested on the Columbian ground squirrel in Montana. This study was designed to test the efficacy of a commercially available bait containing 50 ppm brodifacoum (Talon-G TM Rodenticide) applied in bait stations to manage Columbian ground squirrels. Sullivan (1982) demonstrated that bait stations containing anticoagulant baits could be used to effectively manage this species, and that bait stations might reduce the hazard of primary poisoning of nontarget animals that can be associated with baits scattered on the ground.

METHODS AND MATERIALS

Plot Selection

Study plots were selected near Helena, Montana (Lewis and Clark County)

in April, 1983. This intermontane valley is at the eastern edge of the geographic range of Columbian ground squirrels.

Six plots, 3 controls and 3 test plots, were established on pasture and hay fields that were colonized by Columbian ground squirrels (Table 1). The distance between the two most distant plots was about 26.2 kilometers (16.25 miles), and plots were selected in proximal pairs consisting of one control and one test. Orginally, an attempt was made to select noncrop areas on which to conduct the test. This was abandoned because of difficulty in finding colonized areas not cropped or pastured and where vegetation height permitted visual observation of squirrels.

An additional criterion for plot selection was that squirrel colonies covered 1 to 5 acres and be confined by natural buffers or noncolonized areas. Colonies of this size provided a sufficient number of squirrels to monitor efficacy and natural buffers helped to preclude reinvasion of treated areas by dispersing squirrels. In all cases, plots included the entire colonized area.

Bait Stations

Because of immediate availability, two styles of bait stations were employed, a commercially available station (Eco-bait TM) and one constructed from government surplus 50 caliber metal ammunition boxes.

Table 1. Description of study plots.

Plot No.	Treatment	Size [a] (Hectares/acres)	Vegetation and Agricultural Use
1	Test	1.06/2.63	Grass; pasture/hay [b]
2	Control	0.47/1.16	Grass; pasture/hay [b]
3	Test	1.03/2.54	Grass and alfalfa; pasture/hay [b]
4	Control	1.05/2.60	Sage and grass border, alfalfa; pasture/hay [b]
5	Test	1.78/4.39	Grass; pasture
6	Control	1.66/4.10	Grass and alfalfa; pasture/hay [b]

[a] Includes gross treated area.

[b] Pasture/hay denotes areas used as pasture during fall, winter and spring with 1 or 2 hay crops harvested during the summer.

Both were tested by Sullivan (1982) against the Columbian ground squirrel and no differences in effectiveness were detected. Both styles allow access by squirrels to a protected source of bait. Descriptions of each were presented by Sullivan (1982). The stations were used in an equal ratio on all plots, 3 Eco-bait stations to 1 ammo box.

Bait stations were placed on each plot at intervals of 36.6 to 45.7 meters (120 to 150 feet). Where visual observation of squirrel burrows indicated population centers, the closer interval was used. Stations were arranged so that the approximate maximum distance from any single burrow on the plot to a bait station was 22.9 meters (75 feet). This was a reasonable distance considering the findings of Alsager (1972) who marked a number of Richardson ground squirrels within 100 feet of bait stations and, in an unspecified period of time, found that 77.7% of the marked individuals visited the stations.

Bait stations were placed on plots 1 through 5 on April 13 and on plot 6 on April 14, 1983. Initially, all stations were prebaited with commercial horse feed made from whole, rolled oats and molasses. Previous experience has shown this to be a palatable bait for Columbian ground squirrels. Stations were checked at 2 day intervals and bait replenished as necessary. When pretreatment visuals were complete prebait was replaced with Talon-G, a grain-based pellet containing 50 ppm brodifacoum, in the stations on test plots. Using the same criteria, bait in the stations on control plots was switched to nontoxic pellets used as rabbit feed containing alfalfa and grain.

Bait consumption was measured by recording the amount of bait added to stations minus that remaining at the completion of the study.

Efficacy Determination

Efficacy was determined by comparing pre and post treatment visual counts (activity indices) of squirrels on the entire treatment area following standard methods proposed by Fagerstone (1982). In a single exception a small baited area of plot 1 was not included in visual observations because of poor visibility. An advantageous location from which to conduct counts was established for each plot and used throughout the study.

Pretreatment counts were started when at least half of the prebaited stations were being used by squirrels, and counts were then conducted daily for 3 consecutive days, weather permitting, with the last count being just prior to the introduction of toxic bait (test plots) or nontoxic pellets (control plots). Post treatment counts were started 5 days after the introduction of toxic bait or rabbit pellets and conducted at 2 day intervals, weather permitting. Post-treatment counts were conducted over a period of 22 days.

Each daily visual count on a single plot was conducted by carefully counting all live squirrels on the counting area using 7 power binoculars. This was repeated 3 times at 5 minute intervals and the highest count of the 3 used for determining efficacy.

A paired t test was used to determine the statistical significance of the change in pre and post treatment activity indices (A.I.) on control plots. After it was determined that pre and post treatment activity indices from control plots were not significantly different; efficacy, or the percent change in activity post treatment, was determined for treated plots using the following formula:

$$\text{Percent Reduction In Activity} = \frac{\text{Average Pretreatment A.I.} - \text{Average Post Treatment A.I.}}{\text{Average Pretreatment A.I.}} \times 100$$

During bait station maintenance, plots were observed for the presence of carcasses of ground squirrels or nontarget animals.

RESULTS

Bait Consumption

On plots 1 and 2 squirrels began to investigate stations soon after placement and within 6 days over half of the stations were being used. On plots 4 and 5 initial use began after 5 days and after 7 days over half of the stations were used. On plots 3 and 6, initial use began after 8 days and not until 13 days after placement were half of the stations being used. After an initial period of accustomization, stations were readily utilized and commonly emptied of their contents (2 cups in Eco-baits and 4 cups in ammo box stations) in a day. At the time toxic bait was placed, nearly all of the stations were being used.

The net amount of toxic bait consumed by squirrels during the test was 11.55 kg (25.46 lb) or about 0.43 kg (0.95 lb) per station or 3.01 kg/hectare (2.55 lb/ac). The net amount of nontoxic pelleted bait consumed on control plots was 15.21 kg (33.53 lb) or 0.50 kg (1.75 lb) per station or 4.78 kg/hectare (4.27 lb/ac). Table 2 shows the amount of control bait and toxic bait consumed post treatment per plot.

The pelleted formulation of Talon-G was acceptable to squirrels; in fact, no apparent changes in bait consumption or station use were detected when prebait was replaced with Talon-G.

On plot 1 each station was replenished with approximately 200 grams of bait 3 days and 6 days after introduction of toxic bait. Very little additional bait consumption occurred after this. A single bait station on each of plots 3 and 5 was refilled 5 days after introduction of toxic bait; however, bait consumption had essentially ceased by this time.

Control stations were used consistently by squirrels throughout the post treatment period. However, there was some observational evidence that the alfalfa and grain pellets used as control bait were less acceptable than either the prebait or brodifacoum formulation.

Efficacy

From May 9 until May 13, visual monitoring was interrupted by a major spring storm which resulted in 6-8 inches of snow on the plots. Also

Table 2 Net amount of nontoxic and toxic bait consumed post treatment, and average pretreatment activity index per plot.

Plot	Bait Consumption (g)		Average Pre-treatment Activity Index
	Toxic	Nontoxic	
1	7275	-	27.33
2	-	9791	10.33
3	1547	-	12.33
4	-	1534	5.67
5	2731	-	15.33
6	-	3887	14.00

on May 2 and 6 visual observations were not conducted because of cool, wet weather and poor squirrel activity. Results of visual monitoring are presented in Appendix 1.

The combined average activity index for control plots was slightly lower pretreatment than post treatment (Table 3), although not significantly (paired t =2.56, d.f=2,p greater than 0.1). On treated plots, the average activity index declined significantly by the first post treatment visual counts 5 to 6 days post treatment. Activity indices on treated plots declined to zero by 17 to 18 days post treatment but by 22 days post treatment 4 squirrels were observed on plot 1, and 1 on plot 3.

Total numbers of ground squirrels counted on treated plots were lowest on day 12 post treatment and subsequent counts. Consequently, the 4 counts conducted on each treated plot after 12 days post treatment were compared with pretreatment counts to determine efficacy (Table 4).

Six days after stations were filled with toxic pellets, 4 moribund ground squirrels were present above ground on plot 1, and 8 days post treatment an additional 2 carcasses and 1 moribund squirrel were observed. Five days post treatment, 2 ground squirrel carcasses were observed on plot 3. No ground squirrel carcasses were found on control plots, and no carcasses of other animals were observed on any of the plots. Magpies (Pica pica) were observed feeding on squirrel carcasses on plots 1 and 3.

Table 3 Pre and post treatment Columbian ground squirrels activity indices and average indices for control plots and plots treated with 0.005% brodifacoum bait.

	Treated Plots				Control Plots			
Days Pre/Post	Plot Number				Plot Number			
Treatment	1	3	5	Ave.	2	4	6	Ave.
-2,3	28	11	13	17.33	10	3	12	8.33
-1	25	14	15	18.00	10	8	14	10.67
0[a]	29	12	18	19.67	11	6	16	11.00
+5-6	5	8	13	8.67	12	7	15	11.33
+8-10	6	5	5	5.33	17	6	14	12.33
+12-15	1	0	0	0.33	16	9	9	11.33
+17-18	0	0	0	0.00	21	7	8	12.00
+20	0	1	0	0.33	20	5	14	13.00
+22	4	1	0	1.67	15	5	15	11.67

[a] Day 0 corresponds to the day that toxic pellets or nontoxic pellets were placed in bait stations on treated and control plots, respectively.

Table 4 Efficacy of 0.005% brodifacoum bait placed in bait stations for control of Columbian ground squirrels.

	Average Activity Indices							
	Treated Plots				Control Plots			
	1	3	5	Ave.	2	4	6	Ave.
Pretreatment	27.33	12.33	15.33	18.33	10.33	5.67	14.00	10.00
Post treatment	1.25	0.50	0.00	0.58	18.67	5.67	12.33	12.22
Percent Change [a]	-95.43	-95.94	-100.00	-96.84	+80.74	0.00	-11.93	22.20

[a] + or - indicates increase or decrease in activity, respectively.

DISCUSSION

There is some indication that springtime activity was still increasing on plot 2 at the time pretreatment visual counts commenced on April 22. The first ground squirrels emerging from hibernation near the study area were observed on March 19 in a flat hay meadow. Shaw (1925a) indicated that emergence is sequential, adult males appearing first, followed by adult females about 7 to 15 days later. He indicated that yearlings might emerge even later. In a local area, emergence can vary as much as 10 days depending upon slope (Shaw 1925b), squirrels on north facing slopes emerging later. From this information it would appear that springtime activity across the area of the present study would have been sufficiently underway. However, this may not have been the case because, as shown in table 4, activity on plot 2 underwent a dramatic increase. Plots 1 and 2 were at a slightly higher elevation than other plots and on a decidedly north facing slope which may have caused emergence to be delayed compared to the other plots. Dispersal of yearling squirrels is another source of recruitment; however, it is not thought to be the cause of the increase. Recruitment was not observed to any appreciable extent on other plots and probably occurred at a later date than the observed population increases on plot 2 (Betts 1973).

Activity indices dropped to zero on all treated plots beginning about 15 days after stations were baited with brodifacoum pellets. Beginning about 20 to 22 days post treatment, a few active squirrels were

observed on plots 1 and 3. It is suspected that these squirrels had immigrated to the plot and were not survivors of the treatment. Later visual observations were conducted at a time when dispersal of yearlings is thought to occur, during the lactation period of adult females (Betts 1973). It may well be that the average 96.84% population reduction on treated areas is a slightly conservative estimate.

An initial period of about 7 to 14 days was required before significant use of stations by squirrels began to occur. This corresponds with other studies where an initial period of accustomization was noted (Clark 1978, Sauer 1976, Sullivan 1982) and may be due to a general reluctance of wildlife to approach new or novel objects in their environments. After their initial shyness of the bait stations, squirrels in this study readily consumed oats used as prebait and grain based pellets containing brodifacoum.

This study demonstrated that 0.005% brodifacoum bait (Talon-G) can be effectively used in bait stations for managing Columbian ground squirrels, is apparently readily accepted into the diet after a period of prebaiting, and can be effective early in the spring shortly after the squirrels emerge from hibernation.

LITERATURE CITED

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Appendix 1 Pretreatment and post treatment activity indices a and dates conducted to determine the efficacy of 0.005% brodifacoum for managing Columbian ground squirrels.

	Treated Plots			Control Plots		
Date	1	3	5	2	4	6
4-22	28			10		
4-24	25			10		
4-25	29[b]			11[b]		
4-27		11	13		3	12
4-28		14	15		8	14
4-29		12[b]	18[b]		6[b]	16[b]
5-1	5			12		
5-3	8			15		
5-4		8	13		7	15
5-5	4			19		
5-7	1			16		
5-8		5	5		6	14
5-13	0			21		
5-14		0	0		9	9
5-15	0			20		
5-16		0	0		7	8
5-17	4			15		
5-19		1	0		5	14
5-21		1	0		5	15

[a] Each index is the highest count of 3 consecutive counts taken on that date and location.

[b] Following the completion of these indices, 0.005% brodifacoum pellets or nontoxic rabbit food pellets were placed in the bait stations on treated and control plots respectively.