Integrated Pest Management Strategies for Round-tailed Ground Squirrels

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ABSTRACT: Round-tailed ground squirrels are common residents of natural areas throughout most of the desert southwest region of North America. They live in colonies of several adults, subadults, and young, and are diurnal during the active season that ranges from March to September. They are well adapted to desert life and live in burrows they excavate in the ground, but will also modify and occupy burrows created by other animals. Round-tailed ground squirrels are frequently seen in many human community environments. Their burrowing is usually not a significant cause of concern, nor do they cause severe damage to humans or their property. However, they very often cause concerns due to human-wildlife interactions that may include the squirrels themselves, but also their predators such as rattlesnakes, coyote, feral dogs, and other large mammals. Another cause for concern is that round-tailed ground squirrels can be hosts for fleas and other parasites and could vector plague or other diseases during human interactions. An integrated pest management strategy was successfully used at an archaeological site in Arizona to manage activity of these rodents, using a combination of monitoring, trapping, and repellents.

KEY WORDS: burrowing, integrated pest management, monitoring, repellent, round-tailed ground squirrel, *Spermophilus tereticaudus*, trapping

Proceedings, 29th Vertebrate Pest Conference (D. M. Woods, Ed.)
Paper No. 61. Published December 28, 2020. 4 pp.

INTRODUCTION

Round-tailed ground squirrels (*Spermophilus tereticaudus*, Sciuridae: Rodentia) are small rodents found widely distributed below elevations of 3,200 feet in the hot, arid Sonoran Desert in Arizona, Nevada, southeastern California, and northern Mexico (Olin 1982, Hoffmeister 1986). The adults measure 5-6 inches in length including the tail. The body is covered with uniform light brown to straw colored fur on the dorsal side, and the ventral side is lighter cream-colored. They have small ears, large eyes, and a short, sparsely-haired tail usually shorter than the body. Unlike antelope ground squirrels, round-tailed ground squirrels do not have stripes or spots on their body (Munroe 2011).

Round-tailed ground squirrels live in matriarchal colonies of at least several adult animals, subadults, and juveniles (Dunford 1977) and are diurnal during the active season that ranges from late winter to late summer (March to September) (Ernest and Mares 1987), and their activity patterns are significantly influenced by weather conditions. In Arizona, their preferred terrain is flat open areas with sparse desert-adapted vegetation such as creosote, mesquite, and paloverde. However, they frequently forage in human community environments such as parks, picnic areas, school grounds, or residential properties near such areas. They live in burrows they excavate in the ground and will also modify and occupy burrows created by other animals. Their burrowing usually does not result in severe damage to people or their property or structures; it is more of an aesthetic concern and may occasionally create trip-hazards. However, the presence of the squirrels in human community environments can result in human-wildlife interactions that may involve the squirrels themselves, or their predators such as rattlesnakes, coyote, feral dogs and other large mammals. Another cause for concern is that the squirrels can be hosts for fleas and other parasites and could vector plague or other diseases during human interactions.

In culturally important archeological sites that contain buried artifacts, or other protected and sensitive areas, burrowing by round-tailed ground squirrels is a more serious concern because it can affect the integrity of delicate structures. At the same time, these sites may be restricted in the strategies that can be used for pest management. For example, chemical rodenticides cannot be used in park areas that are frequented by visitors or non-target wildlife. Thus, in these situations it becomes imperative to use an integrated approach combining a number of techniques to manage these rodents.

This paper discusses a series of actions performed at the test site over a period of two years with the aim of reducing the round-tailed ground squirrel numbers to low levels. It must be mentioned that since 2013, the site has seen a decreasing trend in the population of round-tailed ground squirrels. This could be attributed to a number of factors including drought and lack of monsoon rains, abnormally high summer temperatures during the study period (2017-2019), and absence of cropping in adjoining fields that had become a potential source for food and water for the squirrels. However, in each year, there were short periods of moderate to high activity that warranted intervention to prevent damage to the culturally important artifacts.

METHODS

The study was conducted in an archeological site in Coolidge, Arizona during the period from 2017 to 2019. Round-tailed ground squirrels are an ongoing problem at the site, and population levels vary from year to year from approximately 300 to over 1,000 a year, over a 1-sq-mile area.

Integrated Pest Management Strategy

During the study period, the following actions were implemented:

- Systematic monitoring of natural areas to determine population, activity levels, damage risk to preserved sites, and pest related human risks.
- Monitor trapping in strategic spots using Victor® rat snap traps early in the active season (starting in March) to identify active spots and inform decisions regarding further, focused management measures.
- More intensive trapping and removal of squirrels in the identified active spots.
- Filling of burrows to reduce risks of tripping injury, and to aid in detecting new activity.
- Proper maintenance of landscape trees and shrubs by regular trimming.
- Prompt disposal of fallen fruits, beans, berries, nuts, and other products of landscape plants to prevent their use as food sources.
- Regular monitoring of irrigation to avoid leaks and water pooling in tree basins.
- Planned removal of creosote bushes, which are a favored food and shelter source for round-tailed ground squirrels.
- Using repellent treatments in high-activity areas.

Repellent Studies

The repellent effects of plant-based products and essential oils from lemongrass (Chomchalow 2003), balsam fir (Hansson 1975), neem (Schmutterer 2002), peppermint (Nerio et al. 2010), chili pepper (Parugrug and Roxas 2008), and garlic (Katz et al. 2008, Koul et al. 2008, Cowan et al. 2015) on multiple organisms including rodents has been widely researched and documented and merit further testing (Hansen et al. 2016). Predator odors have been found to be particularly repellent to rodents (Nolte et al. 1993, 1994), especially when they match the odors of the target species' natural predators (Apfelbach et al. 2005).

A preliminary observation study was conducted in 2017, to test a set of repellent materials and methods of placement. Two essential-oil-based liquid formulations, one solid (granular) formulation, and one sonic repeller were used in this study. Liquid formulations were applied by spraying directly into the soil in high activity spots, or soaking cotton balls with the formulation and placing them inside burrows. The solid formulation was applied by scattering directly on the soil in high-activity spots or enclosed in a cloth sachet and placing it inside burrows. The sonic repeller was a solar-powered device that could be driven into the ground at desired spots and would emit a high-pitched sound at regular intervals. Observations were recorded at weekly intervals for four weeks. All repellent materials except the sonic repeller showed repellent activity, as evidenced by reduced activity and abandoned burrows in the treated locations. The sonic repeller did not have any repellent effect on the round-tailed ground squirrels, and this was indicated by continued activity in sites where this treatment was performed. Consequently, the sonic repeller was not included in further testing. The best placement method for liquid formulations was found to be by applying the liquid on cotton balls, or other suitable carrier material to improve retention, as opposed to spraying directly into the soil, where they would be quickly absorbed and disseminated, or evaporate leaving no trace. For solid formulations, the best placement method was found to be enclosing the required quantity of the formulation in a cloth sachet and placing it inside the burrow, as opposed to scattering it on the ground.

Using these findings, we conducted another repellent study using 11 commercially available repellent materials:

1) Neem Pro (100% neem oil)
2) Cole's Wild Bird Products FS16 Flaming Squirrel Seed Sauce (chili pepper oil)
3) The Pee Mart Fox Urine P-Wick Combo (liquid)
4) Pete Rickard's Coyote Urine Hunting Scent (liquid)
5) Rodent Defense (0.00315% peppermint oil, 0.00125% garlic oil, 0.00156% white pepper)
6) Peppermint oil (pure essential oil)
7) Fresh Cab (2% balsam fir oil on sachet)
8) Eco Defense Mice Repellent (essential oil blend in pellets)
9) Shake-Away All-Natural Deer and Large Animal Repellent (coyote urine granules)
10) Luster Leaf Products Fend Off DR-50 organic garlic deer and rabbit repellent (clips)
11) Control (plain cotton ball)

All liquid treatments (1-6) were applied by soaking one cotton ball with the treatment material, securing the soaked cotton ball in a burlap sachet, and placing the sachet directly within an active burrow. The product 'Fresh Cab' is a 2.5-oz pre-filled sachet, and for application in our study, one pre-filled sachet was secured inside a plain burlap sachet and placed directly into an active burrow. For the other two solid treatments (8, 9), 2.5 oz of the product (for consistency with the Fresh Cab treatment) was secured directly inside a burlap sachet and placed directly into an active burrow. The garlic repellent (10) was pre-formulated into its own delivery system, consisting of a biodegradable plastic stick impregnated with the active ingredients. For application, one such stick was secured inside a burlap sachet and placed directly into an active burrow. The non-treated control consisted of securing a plain cotton ball inside a burlap sachet and placing that directly within an active burrow. All treated burrows were clearly marked with red flags and their GPS coordinates were recorded.

Each treatment was replicated four times. Observations on activity were recorded 30 days and 60 days after treatment. Activity levels were categorized as follows:

- H = High: Burrow entrance is wide open and clean, no sign of debris, pile of loose soil around burrow entrance, paw prints of squirrels.

- M = Moderate: Burrow entrance is open but has debris, no loose soil or paw prints.
- L = Low or inactive: Burrow entrance is filled in or closed, large amount of debris, webbing, firm soil all around.

RESULTS

IPM Strategy

Implementation of the integrated pest management strategy over two years was successful in maintaining the populations of round-tailed ground squirrels at lower levels. Squirrel numbers were estimated, based on trap catches only, at 100 (2017) and 130 (2019), as compared to over 1,000 in 2013.

Repellent Studies

Results of the repellent studies are presented in Table 1. Treatments that consistently showed little or no activity in all four replicates after 60 days were garlic-impregnated clips (10), predator urine (3, 4, 9), and peppermint oil (6). With respect to odor retention, it was found that the garlic essential oil clips, peppermint oil, liquid urine formulations (3, 4), and Fresh Cab sachet retained their odor after 60 days.

The oil-based treatments (1, 2) were least effective and turned rancid by the end of the first month. Urine granules were not effective and lost their odor by the end of the first month. The essential oil-based treatments (5, 8) were less effective, and lost their odor by the end of the first month. The neem oil treatment (1) was least effective of all: every replicate site showed signs of high activity. In two replicate sites, the burlap sachet containing the neem treatment was found outside the burrow and it seemed to have been bitten or torn at, evidenced by the condition of the fabric. Neem was the only treatment in which the burlap sachet had been dragged out of the burrow.

DISCUSSION

An integrated pest management strategy is the best way to manage pests in any situation. It is a combination of different techniques that are most feasible in a particular situation, are the most economical, and pose the least possible risk to people, property, and the environment. Each situation is unique, and the combination used in one situation may not work in another. In this study, the techniques were chosen based on feasibility and ease of application by available staff, which are important considerations. Decisions on actions were based on monitor trapping results, thus saving time and effort wherever possible.

The repellent studies were conducted to provide an additional level of control in high-activity spots only, and not throughout the site. The efficacy of individual treatments was not conclusive under open field conditions. The low number of treated burrows over two years prohibits statistically significant results. Moreover, low populations of squirrels may have affected observations. Further testing is required to ascertain the efficacy of repellent treatments on round-tailed ground squirrels. It is important to recognize that repellent treatments alone may not be effective in managing high populations of round-tailed ground squirrels. They should be combined with regular monitoring and trapping and should be taken up only if significant activity is observed. Care should be taken to use the effective repellent products in rotation, to avoid habituation in the target animals. Round-tailed ground squirrels are prominent components of the desert ecosystem. Complete eradication may be impossible and unnecessary, and therefore, making the habitat unfavorable in multiple ways would be the best and most sustainable option to manage these rodents.

ACKNOWLEDGMENTS

We thank the United States National Park Service for funding support. We gratefully acknowledge collaboration from the University of Arizona College of Architecture, Planning and Landscape Architecture, the Casa Grande Ruins National Monument, and the Arizona Pest Management Center during the study. We thank Mike Garcia, Katherine Shaum, and Alycia Hayes of the U.S. National Park Service for their technical support and advice.

Table 1. Round-tailed ground squirrel activity and odor retention in repellent treatments.

#	Treatments	30 days		60 days	
		Activity Around Burrow*	Odor	Activity Around Burrow*	Odor
1	Neem oil	H	Rancid	H	Rancid
2	Eco Defense Repellent Pellets	L-M	Faint	L-M	Faint
3	Garlic sticks	L	Strong	L	Strong
4	Squirrel Seed Sauce	L	Rancid	M-H	Rancid
5	Fox Urine	L	Strong	L	Strong
6	Coyote Urine	L	Strong	L	Strong
7	Coyote Urine Granules	L-M	Faint	L-M	Faint
8	Rodent defense	L-M	Faint	L-M	Faint
9	Fresh Cab	L	Strong	L-M	Strong
10	Peppermint oil	L	Strong	L	Strong
11	Control (plain cotton ball)	L	NA	L	NA

*H (high), M (moderate), L (low): see text for definitions.

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