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Fine Tuning Pocket Gopher Management (*Thomomys bottae*) in Alfalfa Fields of Southern Utah

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ABSTRACT: We compared trapping vs. traditional strychnine baiting to control pocket gophers in alfalfa fields in southern Utah. Additionally, we compared trapping efficiency of three different pocket gopher traps: Macabee, Cinch, and DK-1. Baiting and trapping resulted in similar levels of pocket gopher activity and reduced pocket gopher activity in study plots ($P = 0.02$). When comparing the three trap types, Macabee was the most successful at trapping pocket gophers ($P = 0.004$). Macabee traps were also the most time-efficient ($P = 0.02$). Trapping success was very low; future work needs to focus on increased study plot size, trapping density, and modifying traps to improve trapping success of larger animals.

KEY WORDS: alfalfa, pocket gophers, rodent control, *Thomomys bottae*, trapping, Utah

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INTRODUCTION

Valley pocket gophers (*Thomomys bottae*) are a common agricultural pest in many areas of Utah, Nevada, and California. Pocket gophers predominantly eat roots, although they will pull vegetation into their burrows and eat plants immediately adjacent to their burrow holes. Unlike other fossorial rodents, pocket gophers are active year-round throughout much of their distribution. In hotter climates, valley pocket gophers may exhibit short estivation periods (Cox and Hunt 1992). Activity patterns vary with climate; however, valley pocket gophers generally begin breeding activities in late March-early April, with young born in late May-June. Juveniles will begin dispersal in August. Their activity patterns and diet causes agricultural conflicts wherever the two overlap. For example, Luce et al. (1981) reported >40% decrease in alfalfa yields in fields with plains pocket gophers (*Geomys bursarius*) in Nebraska. Smallwood and Geng (1997) found a decrease in alfalfa yield related to an increase in valley pocket gophers, once the gopher density exceeded one burrow per 100 m. In a survey conducted by Messmer and Schroeder (1996), agricultural producers in Utah reported that pocket gophers were the most abundant threats to production, reported present on 124 (82.7%) of the farms surveyed.

In a landscape of native arid vegetation such as in the sagebrush steppe in the Great Basin of the Intermountain West, crops with large tap roots (e.g., alfalfa, *Medicago sativa*) are an attractant for pocket gophers, and they can serve to support year round reproduction and larger litter sizes than would be found in native habitats (Loeb 1990). Alfalfa is an important economic crop in southern Utah. The Utah Department of Agriculture and Food (USDA 2015) reports that 550,000 acres of Utah cropland were planted as alfalfa or mixed alfalfa hay in June 2015. Lands were producing 4.1 tons per acre, or an annual crop of 2,091,000 tons; these crops were sold for \$342,924,000. The alfalfa growing season is longer than many other crops in Utah; the first cutting can begin in

the last week of May and the last cutting usually occurs in October. This growing season encompasses the breeding, rearing, and dispersal seasons of valley pocket gophers. Thus, farmers require options for pocket gopher control to protect their crops throughout the season; often an integrated management approach is the most effective. To increase effectiveness, removing pocket gophers via lethal control during the breeding season is often preferred, because this removes the adult population and reduces the potential for juveniles during that season.

Of the lethal control methods available (e.g., trapping, rodenticides, fumigants), strychnine baits are the most common form of pocket gopher control in Utah because of the low cost and time associated with applying this method. In Utah, producers have observed that baiting within pocket gopher burrows during their reproductive season but prior to the green-up of alfalfa (i.e., March-April) is effective at reducing pocket gopher activity for that growing season; during this time, fields are barren with a low density (<5%) of living roots. However, baiting once alfalfa begins to grow is not effective (M. Nelson, Utah State University Extension Agent, pers. comm.). Similarly, in a study on northern pocket gophers (*Thomomys talpoides*), Proulx (1998) found that while two different strychnine baits peaked in effectiveness during the summer months and were also effective in during juvenile dispersal, neither was effective enough to be able to control pocket gopher densities. Producers in southern Utah, particularly Beaver County, use strychnine in the spring and then not again, if at all, until the harvest is concluded in October. In Utah, the timing of bait application to target reproductive adults in spring can be problematic; snow can remain on the ground through March, and snowstorms occur through April. Additionally, strychnine purchasing and application requires a pesticide applicators license, which is sometimes a hurdle for small-acreage or part-time producers. Furthermore, strychnine supplies have been low in the United States, with some companies no longer supplying the product

(M. Nelsen, Utah State University Extension, pers. comm.). Thus, agricultural producers are interested in other methods that might work once alfalfa production has begun, or that would not require a permit.

Traps are another form of pocket gopher control and often are used in conjunction with baiting, as an integrated pest management strategy. They can be used year-round but are most effective during the breeding season and dispersal, when animals are moving around the most. Trapping effectiveness is also dependent on the type of trap, the crop, soil type, and the size and sex of the pocket gopher. Studies have indicated that trapping may be more effective than rodenticide application at reducing the breeding population each spring (Proulx 1997).

The most commonly used kill trap is the Macabee (Macabee Gopher Trap Co., Los Gatos, CA), which was developed in 1900 (Marsh 1998). Another recently popular trap is the Death Klutch 1 (Model #DK-1, P-W Manufacturing Company, Henryetta, OK), which was patented in 1917 and is popular in the northwest (Marsh 1998). A third popular trap, the Cinch trap, was developed for use in Oregon and patented in 1910 (Cinch Traps LLC, Beaverton, OR; Marsh 1998). While there is little previous research conducted on valley pocket gophers in Utah, there have been several studies conducted in other states comparing the efficacy of different trapping methods for this species. For example, Baldwin et al. (2013) determined differences in trap type and trap set technique efficiency among season and size of the pocket gopher. While all have been proven effective at capturing pocket gophers in the western U.S., there may be differences in the efficiency of these traps in Utah. Trapping is more labor intensive than baiting, and therefore understanding the variability in the time efficiency of trapping success can assist in developing the most effective IPM strategy for farmers in the southern portion of the Great Basin.

Vertebrate pest management is most effective when agricultural neighbors work in concert to control pest populations. In small rural communities such as southern Utah, small-acreage producers are often limited in resources and time to control pocket gophers using a multiple-method approach, and as a result they can be inconsistent in their annual commitment to pest control. It is important to the overall success of the community of producers to provide control options to all producers in the area regardless of size or available labor force. Detailed information regarding the most effective method for controlling pocket gophers in the spring is one strategy for improving pocket gophers control in southern Utah.

The goal of this study was to determine if trapping was an effective and efficient option for reducing pocket gopher densities in southern Utah. The first objective of this study was to compare a common trap to the current baiting strategy used in southern Utah. The second objective was to then compare several traps to determine if one performed better under the soil conditions found in southern Utah.

STUDY AREA

The study was conducted in Beaver County, Utah.

The natural landscape in Beaver County is considered high desert, part of the Great Basin ecosystem as defined by West and Young (2000). Shrubs are generally <1 m in height and sparsely spaced with loamy surface soils and microphytic crusts. Grasses are also sparsely distributed. The elevation of the study area ranged from 1,493 m in Milford to 1,798 m in Beaver. The mean annual air temperature throughout the study area ranged from 7.2°–10°C, averaging 100–140 frost-free days annually. The average maximum temperature (1971–2000) occurred in July (31.3°C). The annual precipitation ranged from 23–30.5 cm, presenting predominantly as snow in March and April and rain in August, with a total annual average precipitation of 30.5 cm (1971–2000; Utah Climate Center 2016). The soils of the study area are considered a silty clay loam, of 0–2% slopes that USDA Natural Resource Conservation Service considers prime farmland if irrigated, and a gravelly loam of similar slope that is not classified as prime farmland (NRCS 2016). The water table was a minimum of 2 m below the surface.

Beaver County ranks 10th in the state in the number of acres in hay, grass silage, and greenchop production (113.31 km², 28,000 acres) with another 20.24 km² (5,000 acres) in corn silage, corn for grain, and wheat (USDA 2012). Farm production is located around three municipalities: Beaver, Milford, and Minersville. The largest municipality in Beaver County is the town of Beaver, with roughly 2,500 residents and another 500 persons living outside the municipal boundary (Figure 1). Milford, to the west, has 1,400 residents within its municipality and the surrounding areas.

METHODS

This study was conducted in two phases. In 2014, we compared baiting with strychnine, using the current method of Beaver producers, to trapping with DK-1 traps. In 2015, we compared the effectiveness and efficiency of several types of kill traps: Macabee, DK-1, and Cinch. In 2014, we had a sample of six fields; four fields were located outside Beaver, and two fields were located outside Milford. In 2015, we had a sample of four fields, each located outside Beaver.

Bait vs. Trap

To compare bait application to trapping, we selected six fields with known active pocket gopher activity. We selected fields by first contacting local producers to ensure they had not conducted vertebrate pest control measures that season. Then we surveyed the available fields to select ones that had active pocket gophers as indicated by mounds with fresh soil. Within each field, we designated three 2023.4-m² (0.5-acre) study plots, separated from each other by at least 100 m. The plots were designated using pin flagging around the perimeter of each 2,023-m² (0.5-acre) plot. We randomly selected the treatment of each plot as bait, trapping, or control. We began the study the first week of March 2014 and continued for six weeks.

The intensity of the control methods were distinctly different: one bait application compared to six weeks of trapping. While odd, the design reflected the current intensity and timing of baiting conducted in the study

Figure 1. The location of the general area of the study in Beaver County, Utah. 2014-2015. Map courtesy of Google.

area, comparing it to another single control method. This design allowed us to compare initial trapping success, as evidenced by reduction of pocket gopher activity, to that of baiting. It also allowed us to determine how long one would have to trap in order to observe the decrease in trap success that might indicate we had successfully removed all pocket gophers from the area.

Strychnine bait (0.5% strychnine alkaloid; Omega Gopher Grain Bait, RCO Pest Control Products, Harrisburg, OR) was applied according to label instructions in each plot designated for this treatment type. To apply the bait, we probed the area surrounding a pocket gopher mound to find a main (horizontal) runway. Once the runway was found, we inserted a teaspoonful of bait through the probe hole. We then covered the probe hole opening with a rock, clump of soil, or similarly hard substrate to block the opening from light without allowing soil to mix with the bait. We then repeating this process, probing the area for the continuation of the main runway on the other side of the burrow plug. As per label instructions, we treated up to five tunnels with a teaspoon of bait in each tunnel, if we found more than one main tunnel in association with a mound.

For each “trap” plot, we initially deployed ten Death

Klutch-1 torsional spring-loaded kill traps within the 2,023-m² (0.5-acre plot). Proulx (2002) suggested a trap density of 48/0.08 km²; this translates to 1.6/2,000 m². We intentionally saturated the study area with traps to attempt to eliminate the pocket gopher population within a few days. We chose DK-1 traps because they were comparatively inexpensive (\$5.00/each, at the time of the study) and were the smallest-size trap in comparison to other traps readily available at a local agricultural supply store. Traps were set by first locating a pocket gopher mound. Using a metal stake, we probed into the ground soil approximately 15-20 cm from the mound, in a circle around the mound, until we found the main tunnel. Using a shovel, we dug into the soil to expose the main tunnel. We dug a hole approximately 20-25 cm wide in order to have room to manipulate the trap into the main tunnel. Once we set a DK-1 into the main tunnel, we excavated the tunnel in the opposite direction, and set another trap along this portion of the tunnel. We did not cover the opening created by setting the trap. We checked pocket gopher traps every 48 hours for a trapped animal, plugged holes, or tripped traps with no capture. When an animal was trapped, or a trap was not tripped after 96 hours, we moved the trap to another active mound. We set a pin

flag within 1 m of each set trap to identify its location. For the control plot, we walked through the plot but did not apply treatment. All plots were established within two days.

To compare across methods, we counted the number of active mounds per study plot, as a metric of relative pocket gopher activity. We also recorded the number of pocket gophers we trapped using the DK-1. During the initial day of each study plot, we surveyed the area for active pocket gopher burrows, as indicated by fresh soil on a pocket gopher mound. While this method is not entirely precise, because some pocket gophers may be active without producing a soil mound, it is a common survey metric. We tallied and recorded the number of active burrows, “kicking down” and flattening each mound observed. Once a week, we surveyed each study plot, counted active pocket gopher mounds, and again kicked down each active mound recorded.

Comparison of Trap Types

In 2015, we began the first week of April and continued six weeks. We began later in the season to 1) ensure that we were trapping during the breeding season and 2) determine which trap would be most effective if used once alfalfa had begun to grow. We compared three types of kill traps to determine the most efficient for capturing pocket gophers. We selected study fields and study plots similar to our method in 2014. For each study field, we randomly designated each of the three 2,023-m² (0.5-acre) plots to one of three trap types: Macabee, DK-1, or Cinch (3-inch medium) pocket gopher trap. For each plot type, we set ten traps. To set a trap, we used methods established in 2014 to locate, excavate, and set traps in a main (horizontal) tunnel. We set up to two traps per pocket gopher mound, facing in opposite directions from each other along the main tunnel. In rare situations, the tunnel of the opposing direction could not be located, in which case we set only one trap at the burrow.

Cinch traps can be set in the main or lateral tunnel. While placing cinch traps in the lateral tunnel would have been faster, we set ours in the main tunnel to be consistent with the other two trap method sets. We excavated the hole such that the Cinch trap pinchers were in the main tunnel, with the pan flush with the ground, at the angle permitted by the main tunnel. Cinch trap pans are much larger than the diameter of Macabee and DK-1 traps (11.4×16.5 cm), requiring a larger space to allow for the pan to be secure against the ground.

To assess the effectiveness of the traps, we checked each study plot every 48 hours to record trapped animals, tripped traps, plugged holes, or no activity. When an animal was trapped or there was no activity on a set by the second visit, we moved the trap to another active burrow. During each visit to the study plot, we also recorded the length of time that we spent surveying the plot and checking and moving traps.

Statistical Analysis

We used the R Studio package (RStudio Team 2015) within R statistics (R Development Core Team 2008) to execute the comparisons of effectiveness between baiting

and traps and among trap types. Because our sample size was small, we used Kruskal-Wallis Rank Sum Test, a non-parametric, rank-based one-way analysis of variance. Comparisons were considered statistically different if the probability (P) was ≤0.05. Baiting should work to reduce populations faster than trapping, but trapping continues to control the population in the event that there is emigration. To compare between baiting and trapping, and changes to gopher populations over time, we compared the change in the number of mounds found from the initiation of the study to one, three, and six weeks after the initiation of the study.

RESULTS

Bait vs. Trap

There was no difference in the change in the average number of active pocket gopher mounds recorded at the initiation of the study to week one ($\chi^2 = 3.96$, $df = 3$, $P = 0.265$), week three ($\chi^2 = 6.74$, $df = 3$, $P = 0.08$), or week six ($\chi^2 = 5.16$, $df = 3$, $P = 0.16$) for areas treated by baiting, trapping, or receiving no treatment (Figure 2). Because baiting should affect the entire study area at once, we expected that we would see the sharpest reduction in the number of new mounds within the first three weeks, while trapping would reduce numbers gradually over a 6-week period. In fact, the reduction in the number of new mounds found in plots that were baited followed the same trend as those plots where DK-1 traps were deployed (Figure 2). To provide information regarding overall activity of the pocket gophers around the DK-1 traps, we compared the number of plugged sets (filled), tripped devices, and new mounds each visit. With a small sample size, we did not conduct an analysis on these data; however, visual observation determined that the average number of new mounds and the average number of filled mounds decreased between week one and week three and again in week six (Figure 3). While there was a general decreasing trend of trapped animals and sets tripped, the numbers were very low. For several weeks of the study, we had more traps plugged or tripped than we had pocket gophers trapped.

Figure 2. Comparison of the average number of new mounds among plots treated by baiting, trapping, or no treatment, Beaver County, Utah, 2014.

Figure 3. Comparison of filled mounds, tripped gophers traps, and gophers caught over time, Beaver County, Utah, 2014.

Table 1. The average number of pocket gophers trapped, set tripped or plugged, and average duration in the field by treatment type, Beaver County, Utah 2015.

Trap Type	Ave. Number Trapped Per Week $\pm$ Standard Error	Ave. Number Tripped or Plugged Per Week $\pm$ Standard Error	Ave. Duration in Field (minutes) Per Week $\pm$ Standard Error
Cinch	0.5 $\pm$ 0.16	1.2 $\pm$ 0.30	29 $\pm$ 3.5
DK-1	0.9 $\pm$ 0.27	2.3 $\pm$ 0.41	36 $\pm$ 2.4
Macabee	1.4 $\pm$ 0.22	2.5 $\pm$ 0.40	34 $\pm$ 3.0

Figure 4. Comparison of the average # of pocket gophers trapped per minute in the field among cinch, DK-1, and Macabee pocket gopher traps, Beaver County, Utah, 2015.

Comparison of Traps

Macabee traps attracted more attention (i.e., traps tripped, traps plugged) than cinch or DK-1 traps (Table 1). Overall, they were more effective (animals caught per animal visits to the trap) than the other trap types ($\chi^2 = 7.12$, $df = 2$, $P = 0.03$), but they were also tripped or plugged statistically more than the other two traps ($\chi^2 = 6.05$, $df = 2$, $P = 0.048$). Macabee traps were more time efficient than the DK-1 or Cinch traps, based on the

number of animals trapped per minute spent in the field ($\chi^2 = 10.2$, $df = 2$, $P = 0.006$); this is most evident during weeks three through six (Figure 4). Trapping effectiveness can be affected by the increase in the trappers' ability to set the traps (increased success) and the reduction in resident pocket gophers (decreased success). We look at the change in number of pocket gophers trapped weekly and the number of sets tripped or plugged weekly to determine trends in pocket gopher activity over time. Because of the small sample size, we did not make statistical comparisons of the weekly changes. However, there was a diminishing trend in both the change in the number of pocket gophers trapped and the change in the number of sets tripped for each trap type (Figure 4), suggesting reduced pocket gopher activity.

DISCUSSION

This study was designed to compare the baiting and trapping options most commonly available to producers in southern Utah, in order to determine a time-efficient method for reducing pocket gopher numbers. Based on our study, we considered trapping a possible viable alternative to using a single strychnine bait application, especially if a producer had missed the window to effectively treat using bait or did not want to use chemicals in their agricultural production.

Our study was comparatively small in sample size, landscape scale, and duration, but was reflective of the size and duration of treatment of the agricultural fields in Beaver County, Utah that have alfalfa production. This study is not meant as a comparison to larger operations or those with a different growing season and climate than that found in the Intermountain West's Great Basin. However, there are very few studies of valley pocket gopher control in this region, and thus are results may

assist Intermountain West farmers in the future.

While not statistically significant with the small scale of our study, baiting and trapping exhibited a trend of reducing pocket gopher activity over a 6-week period. Proulx (1998) suggested that a 75% reduction in the population was necessary to control pocket gopher densities; we achieved that level in both our baiting and our trapping, but not in the first few weeks. Cox and Hunt (1992) determined that tunneling by valley pocket gophers was directly related to reproductive activity; furthermore, female pocket gophers decreased their tunneling activity in the summer months. The reduced activity that we recorded may have been a natural trend, resulting from the duration of the study and if it synchronized with the reproductive activity of the pocket gopher breeding season. In the first week of the study, the baiting and trapping resulted in a reduction in new pocket gopher mounds, whereas the control did not see this decrease; however, the reduction in the number of new mounds in week three and week six in the control plots suggest that the continued decrease seen in all plots may actually be a natural effect. One concern we had regarding the treatment effects is the amount of time it took to obtain a reduction in recorded pocket gopher activity using strychnine bait. We expected that the baiting would result in a reduction of pocket gopher mounding activity within 1-3 weeks of its application, with less of a reduction in activity within the 6th week. This was not the pattern that we recorded in our study; in fact, the pattern in reduction was very similar to that of trapping. Furthermore, we did not see a reduction in pocket gopher mounding activity of 75% within the first few weeks of the study. If we started the study too late in the season, missing the height of activity as suggested by our control plot data, then perhaps this limited the effectiveness of the baiting. The results suggest that a reduction in activity is possible; however, waiting six weeks into the growing season to see this reduced activity would still result in a loss of crop production. Future studies should increase the sample size of study plots and replicate this study across several years to minimize the variability of the effectiveness that results from a limited sample size.

To determine which trap may be the most effective at capturing valley pocket gophers and was the most time efficient, we compared three commonly-used kill traps designed specifically to trap pocket gophers. The Macabee, a traditional trap, was the most effective trap in our study, although no trap was very effective. Macabee traps caught more pocket gophers per total visits to the trap, but there was also a large number of traps tripped or plugged each week. In contrast, Baldwin et al. (2013) determined that a torsion spring-loaded trap (Gophinator trap, Trapline Products, Menlo Park, CA), similar to the DK-1, was more effective than the Macabee trap. In their study, the torsion trap was more effective at trapping larger animals. We found that we frequently had tripped or plugged traps, indicating that we had missed a capture. It is possible that the Macabee traps, while attracting the most attention, were unable to capture larger animals. This could cause animals to become trap shy, ultimately reducing the possible effectiveness of the control

program. Baldwin et al. (2013) determined that covering the hole left by setting the trap increased their ability to capture heavier (and potentially older) adults. We did not collect data on weight or sex of pocket gophers in this study; therefore, we cannot determine which traps were better at capturing heavier animals. However, continuing the research by replicating the study with a covered trap set would be beneficial to determining if we could increase trap effectiveness among the different trap types.

The incidence of having traps tripped or plugged may also be related to user error, in that the researcher had to learn and acquire skill at setting each trap (Baldwin 2014). Pipas et al. (2000) evaluated the effectiveness of three pocket gopher traps, including Macabee and Cinch. In their study, Cinch traps were more effective. With their larger size, we found that the Cinch traps were difficult to set in a manner that would allow them to be stable and inconspicuous. This most likely affected our ability to be successful with the Cinch traps in our rocky terrain. Additionally, we chose to set the cinch traps in the main (horizontal) tunnels. However, setting them in the lateral tunnel may increase their effectiveness. The ability to set the traps and ease of setting the traps was also reflected in the number of pocket gophers trapped compared to the time spent in the field. Time efficiency increased in the Macabee each week, although there was a high degree of variability, related to the number of animals trapped in each plot.

Loeb (1990) indicated that irrigated pastures may support year-round reproduction, which would result in a situation where pocket gopher control would need to be continuous to maintain low densities of them in productive fields. Past studies have indicated that trapping may be more effective than poison bait at reducing the breeding population (Proulx 1997). Therefore, continued research to determine how to lower the number of traps tripped and increase trap effectiveness is needed. Additionally, comparing single-strategy methods to a combined strategy would be beneficial in determining if the combination of methods would increase efficiency.

In conclusion, we found that trapping to reduce pocket gopher activity could be a similarly effective option to strychnine baiting to provide to alfalfa producers in southern Utah, although neither method was very effective during 2014. When using traps, the Macabee trap was found to be the most effective at trapping pocket gophers and the most time-efficient trap used. This effectiveness was most likely a combination of the ease of learning to use this trap and trap size. Future studies should look at modifying the trapping methods to increase the effectiveness of traps; changing the timing and duration of control methods; and effectiveness of combining baiting with trapping to reduce the breeding population of pocket gophers in the Intermountain West's Great Basin.

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