Final Report to UC Statewide IPM Program:

Determining and Demonstrating the Importance of Training and Experience in Trapping and Baiting Programs for Controlling Pocket Gophers.

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Submitted: May 23, 2011

Abstract: Pocket gophers (*Thomomys* spp.) are one of the most damaging wildlife pests in the state of California and are a major pest throughout the U.S. Many techniques are used to control pocket gophers including trapping and poison baiting. Both methods are important components of an Integrated Pest Management (IPM) approach for controlling pocket gophers, although poison baiting is often considered to be quicker to apply than trapping, while reductions in gopher populations are often more consistent with trapping. Improved protocols to increase the efficacy of baiting programs, and quantifiable information on the time required to become a proficient gopher trapper, would assist individuals interested in developing an IPM program for controlling pocket gophers. Therefore, we initiated a study in spring 2011 to address these issues. Specifically, we tested: 1) the number of days required to become a proficient gopher trapper, and 2) the impact of a thorough training program on efficacy of a poison (strychnine) baiting program for controlling pocket gophers. Results from the trapping portion of this study indicated that novice trappers became proficient in just 3 days with novice trappers capturing gophers at 92% of the efficiency value obtained by the expert trapper. Capture rates for novice trappers also exhibited a dramatic increase in just 3 days, although rates were not as proportionally high (73% of expert trapper) when compared to the expert trapper. Clearly, the time required to set traps will continue to decrease as trappers gain more experience. Baiting trials indicated that individuals who received a through training program on bait application were 3.6 times more likely to attain greater efficacy from baiting programs than were individuals who received only limited training. Proper training, particularly on identifying active tunnel systems, appears to increase the efficacy of baiting programs. However, efficacy from the thoroughly trained individuals ($\bar{x}$ = 58%) was still lower than the minimum threshold (70%) typically required for effective control. Further investigation is needed to determine additional steps to consistently attain effective control of pocket gophers with poison baits. Nonetheless, our results should increase the applicability of both trapping and poison baiting for use in gopher control programs.

INTRODUCTION

Pocket gophers (*Thomomys* spp.) are one of the most damaging wildlife pests in the state of California (Marsh 1992) and are a major pest throughout the U.S. (Engeman and Witmer 2000). Damage caused by gophers is often varied but includes damage to irrigation drip lines from chewing, and consumption of plants and root systems resulting in reduced vigor and higher mortality in crops and lawns. Gopher mounds can also serve as weed seed beds, can result in a loss of irrigation water down mounds and tunnels, and can damage and/or injure farm equipment, people, and livestock from driving or walking over gopher mounds. Many control options are available for gophers including trapping and rodenticides.

Several studies have shown trapping to be an effective method for removing gophers from agricultural and forested areas (Proulx 1997a, 2002, Smeltz 1992). Trapping has many positive attributes including the fact that it is safe to users as it does not require the use of poison baits, there is no concern of primary or secondary non-target rodenticide exposure, trapping is one of the only methods available for controlling gophers in organic crops, trapping provides the added bonus of knowing whether or not you killed the invading gopher, and trapping has been shown to be both effective and cost-efficient once the user becomes proficient (Proulx 2002). However, it is this time-period to become proficient that often discourages many individuals from incorporating trapping into a control program as many individuals feel that trapping is too time consuming to be practical for large populations of gophers (Engeman and Witmer 2000). This may be true in areas with heavy soils or deep gopher burrows, but in areas with looser soils and shallower burrow systems (< 10 inches), trapping can be practical. Data exhibiting the period of time required to become proficient trappers is needed to provide growers and Pest Control Advisors (PCA's) with an expectation of what efficacy and efficiency they can hope to achieve if they decide to incorporate a trapping regimen into their gopher control program.

Poison baits are also frequently used to control pocket gophers. Several different active ingredients including strychnine, zinc phosphide, and anticoagulants have been used, although strychnine-laced grain has typically been reported as the most effective (Marsh 1992). Poison baiting for gophers is often considered a less laborious and quicker method for gopher control. However, numerous baiting trials with strychnine have yielded quite varied results, with efficacy ranging from 0–100% (Tickes et al. 1982, Evans et al. 1990). It is unclear why these results have varied so dramatically although possible reasons include: 1) differences in gopher species, 2) availability of alternative food sources, 3) seasonality, 4) soil type and soil moisture, 5) behavioral or physiological resistance to strychnine (e.g., Lee et al. 1990, Marsh 1992), and 6) bait applicator experience. Little can be done to remediate the impact of the first five listed possibilities in this list, but a thorough training program could increase applicator proficiency and result in a more effective gopher control program.

Although both trapping and baiting programs can be effectively used to control pocket gophers, relying on any single one of these approaches is not likely to be as efficacious as utilizing multiple methods of control (i.e., Integrated Pest Management [IPM]; Engeman and Witmer 2000). For an IPM program to be effective, all individuals should be properly trained to implement control methods as greater experience is likely to lead to greater control of gopher populations. Unfortunately, time is often limited for growers, so proper training of farm laborers may not always occur. Improper training has numerous potential ramifications including low efficacy of control methods, elimination of a control method from a management program given perceived low efficacy, increased damage to commodities due to low efficacy, and unwanted mortality of non-target species. For example, minimal training on bait application for pocket gophers may result in an insufficient amount of bait being applied to gopher burrow systems thereby reducing the efficacy of this approach. Alternatively, insufficient training on gopher trapping techniques could lead to low capture rates causing the grower to eliminate this tool from their control program given the perceived low efficacy of this approach. The extent to which proper training and experience reduces these pitfalls is currently unknown and in need of investigation. Therefore, we established the following objectives to elucidate the impact of user experience on trapping and baiting for gophers. Specifically, our objectives were to: 1) evaluate the progression in efficiency of newly trained gopher trappers, and 2) evaluate the merit of a thorough training session on bait application for gopher control. The results from this study should aid the development of an IPM program for controlling pocket gophers and will hopefully result in more efficacious and cost-effective control of this damaging pest in California agriculture.

METHODS

Trapping

This study was conducted at Laguna Ranch, which was located approximately 4 miles west of Santa Rosa, CA. Laguna Ranch is a vineyard owned and operated by Gallo Family Vineyards. For the trapping portion of this investigation, we selected 2 and 5 novice trappers to trap gophers in spring of 2010 and 2011, respectively. We provided a short 30-minute introduction on how to trap gophers to all participants. The time-period and depth of the training session was selected to represent what we believe is the typical level of training that most farm workers receive before starting a gopher-removal program.

Following this training session, the selected individuals initiated their trapping program. Laguna Ranch was separated into many different blocks of varying shapes and sizes. Gopher densities naturally varied across differing blocks, so it was important to keep each individual trapper within the same block for the duration of the study to maximize the probability that gopher densities would remain fairly consistent throughout the course of the trapping period. The two trappers that trapped in 2010 were in high gopher density areas; as such, they trapped for an 8-hour period. The individuals that trapped in 2011 were in somewhat lower density areas, so they trapped only until they placed traps in 40 tunnels per day. Trapping occurred for 4 days in spring 2010 (May 11–14), and 2011 (March 22–23 and April 3–4), although 1 individual was only able to trap for the first two days in 2011.

In addition to novice trappers, an expert trapper (experience of >2,000 trap sets placed) was also monitored to provide capture values to illustrate to what level of high efficacy novice trappers can attain after 4 days of trapping. This individual set a minimum of 20 trap-sets adjacent to each trapper so as to minimize potential differences in capture rates across field locations. The trap used for this study was the Gophinator (Trapline Products, Menlo Park, CA) which has proven to be an effective gopher trap for *Thomomys* spp. (Baldwin et al. 2010).

The general trapping protocol was to first use a probing device to locate a fresh gopher tunnel. Once located, we dug down to the tunnel, placed traps into all branches of the gopher tunnel, and staked the traps down with wire flags. We placed traps wherever we felt there was a moderate probability of separate mounds representing separate burrow systems (typically greater than 20 ft apart). This was determined by scanning for general mounding patterns to determine if it seemed particular mounds were likely connected to other adjacent mounds and by assessing the distance and freshness of adjacent mounds. We followed this protocol given that this is the strategy most trappers would employ when attempting to remove gophers from a given area. That being said, with this approach, many trap sets were not independent and would likely lead to lower capture success given the probability of capturing a gopher in one set thereby eliminating the possibility of capturing that same gopher in a separate set if it was located in the same tunnel system. Traps were placed and left overnight.

The time required to place all traps was recorded for each trapper per day. Traps were then checked for activity the following day. Each trap set was recorded as either: 1) a capture, 2) sprung or plugged, or 3) no action. Typically, only one gopher was captured per trap set given their solitary nature. However, when multiple captures were recorded at the same trap site, they were counted as a single capture event. All traps were removed after checking for activity regardless of action at that site.

Capture efficiency and capture rate were the two primary response variables of interest. Capture efficiency was defined as the number of trap sets with gopher captures per total number of trap sets; this proportion was multiplied by 100 to yield a percentage. Capture rate was defined as the number of gophers captured per hour and was determined by dividing the number of trap-sets with gopher captures each day by the time spent setting traps for that same day.

For statistical analyses, all daily values for each individual were corrected for potential site to site differences in gopher densities by dividing the experts capture efficiency and rate values by those obtained by each individual. These values were multiplied by 100 to provide a percentage estimate. This correction also provided the means to compare capture efficiency and capture rate of individuals to the expert trapper to illustrate the number of days of trapping experience required to reach the same level of proficiency as the expert trapper. Even with this correction, there was the potential for outliers given the possibility of pockets of dense gopher activity. As such, we looked for potential outliers using residual plots (Ramsey and Schafer 1997).

We used a two-factor ANOVA to test for potential differences in capture efficiency and capture rates across days. The factors included in this analysis were day ($n = 4$) and trapper ($n = 7$). There were not enough degrees of freedom to test for an interaction between these two factors. If day was determined to be a significant factor, we used Fisher's LSD to determine significant differences between days (Zar 1999).

Poison bait application

Six individuals were selected to apply strychnine (1.8%) treated milo grain (Gopher Getter "Restricted Use" Bait, Wilco Distributors, Inc.) for pocket gopher control at 3 fields of grapes at Laguna Ranch; the 3 fields ranged from 18.3–22.3 acres in size. The fields were split in half, with one half treated by an individual who received limited training on bait application, while the other half was treated by an individual who received thorough training. Each individual treated only ½ of 1 field (i.e., 3 individuals received limited training, and 3 individuals received thorough training). The limited training program was designed to mimic the training a typical farm laborer receives before starting bait application, as farm laborers are believed to be responsible for much of the gopher abatement work done in agricultural fields in California. This limited training program included information on how to identify gopher mounds, how to locate tunnel systems, how to dispense bait via the bait application probe, and how often to apply bait per burrow system (bait was applied 2–7 times per burrow system depending on the size of the burrow system). The entire training program lasted for approximately 15 minutes.

Individuals who received the thorough training program were instructed on the same points as those who received the limited training program. However, the thorough training program contained additional training components including more specific guidance on discerning between gopher and other burrowing mammal sign, an emphasis on the importance of properly functioning bait application equipment, and extensive training on finding active tunnel systems.

Of these additional training components, the most time was spent on finding active tunnel systems. The individuals who received thorough training were required to use their probe to find what they believed to be an active tunnel system (i.e., not back-filled). They then dug down into the soil to identify if they found an extant tunnel, or if they found a back-filled tunnel. They were required to repeat this exercise until they correctly identified extant tunnels 9 out of 10 times. This process took between 1 and 1 ½ hours for the 3 trainees. We felt it was important that bait applicators be able to discern back-filled tunnels from active tunnels, as bait applied to back-filled tunnels will not be consumed by gophers which will reduce the efficacy of the baiting program.

During the training period, the project leader continued to provide guidance to individuals receiving the thorough training program on techniques to increase the likelihood of finding extant tunnels, on differentiating between gopher mounds and other burrowing mammal sign, and by reminding applicators to regularly check their bait application equipment to ensure it was functioning properly. Such extensive training is rarely provided to novice bait applicators. All bait application training and actual bait application occurred from March 22–23, 2011.

To determine if thorough training increased the efficacy of a gopher baiting program, we needed to assess gopher activity before and after treatment. For this, we established fifteen 30 x 30 ft indexing plots in each treatment plot (n = 6). Within these plots, we used the open-hole method (Engeman et al. 1993) to determine gopher presence. This approach required digging a hole into a gopher tunnel. These holes were left open with a total of two holes opened per indexing plot. These plots were then checked 2 days later to verify presence or absence. If no holes were plugged, the plot was considered "unoccupied". If any of the 2 holes in that plot were plugged, it was considered "occupied". Pre-treatment indexing was completed the day before bait was applied. We again indexed gopher activity 13 days after bait application to identify the percent reduction in gopher occupancy post-treatment.

We used the Cochran-Mantel-Haenszel (Cochran 1954, Mantel and Haenszel 1959) test to determine potential differences in efficacy observed between individuals who received limited and thorough training. This approach allowed us to test for differences between the two training programs while accounting for potential differences across fields. If significant differences were detected, we used odds ratios to describe this relationship (Agresti 1996). In our case, the odds ratio described the probability that a thorough training program would result in an increase in efficacy. Finally, we used the Breslow-Day test (Breslow and Day 1987) to ensure that odds ratios did not differ between fields.

RESULTS

Trapping

During this study, 523 gophers were captured over 188.8 hours of trapping (see Table 1 for breakdown). Trapper 1 had very good capture success on day 1 (Table 1) given abundant gophers in his field. However, the abundance of gophers rapidly dissipated leading to substantially lower capture efficiency and capture rate values. Therefore, this outlier (day 1 results for Trapper 1) was removed from subsequent analyses.

Capture efficiency ranged from 10–74% and was generally below the level observed for the expert trapper, although in 3 situations, the novice trappers yielded higher values (Fig. 1). The

Table 1. Trapping data collected from 7 novice trappers and 1 expert over the course of 4 days from Laguna Ranch, CA, during spring 2010 and 2011. Data provided includes the individual trapping, the corresponding day of trapping, the field where trapping occurred, fate of trap sets (i.e., captures, sprung or plugged, or no action), the total number of trap sets per day, capture efficacy (number of captures per total number of trap sets), the time spent trapping, and the number of captures per hour spent trapping.

Trapper	Day	Field	Captures	Sprung or plugged	No action	Total sets	Capture efficacy	Time spent setting (hrs)	Captures per Hour
1	1	8	18	5	17	40	45%	6.48	2.78
1	2	8	11	3	26	40	28%	4.65	2.37
1	3	8	14	4	22	40	35%	7.42	1.89
1	4	8	15	5	20	40	38%	7.40	2.03
Expert		8	7	4	9	20	35%	2.92	2.40
2	1	2	4	8	28	40	10%	7.68	0.52
2	2	2	11	12	17	40	28%	6.05	1.82
2	3	2	14	12	14	40	35%	5.00	2.80
2	4	2	18	4	18	40	45%	4.62	3.90
Expert		2	11	2	7	20	55%	2.00	5.50
3	1	9	16	6	18	40	40%	6.60	2.42
3	2	9	14	3	23	40	35%	5.38	2.60
3	3	9	18	8	13	39	46%	8.33	2.16
3	4	9	19	9	12	40	48%	7.97	2.38
Expert		9	11	1	8	20	55%	3.17	3.47
4	1	5	12	4	24	40	30%	8.32	1.44
4	2	5	8	8	24	40	20%	7.60	1.05
4	3	5	25	4	11	40	63%	8.23	3.04
4	4	5	16	3	21	40	40%	6.92	2.31
Expert		5	9	1	10	20	45%	3.58	2.51
5	1	10	17	14	43	74	23%	7.17	2.37
5	2	10	30	10	35	75	40%	7.33	4.09
5	3	10	43	10	20	73	59%	7.50	5.73
5	4	10	14	3	2	19	74%	2.25	6.22
6	1	10	8	13	23	44	18%	7.17	1.12
6	2	10	19	14	22	55	35%	7.33	2.59
6	3	10	28	17	19	64	44%	7.50	3.73
6	4	10	9	9	3	21	43%	2.25	4.00
Expert		10	45	12	21	78	58%	6.33	7.11
7	1	2	10	5	26	41	24%	6.12	1.63
7	2	2	14	8	18	40	35%	5.77	2.43
Expert		2	15	4	1	20	75%	1.75	8.57

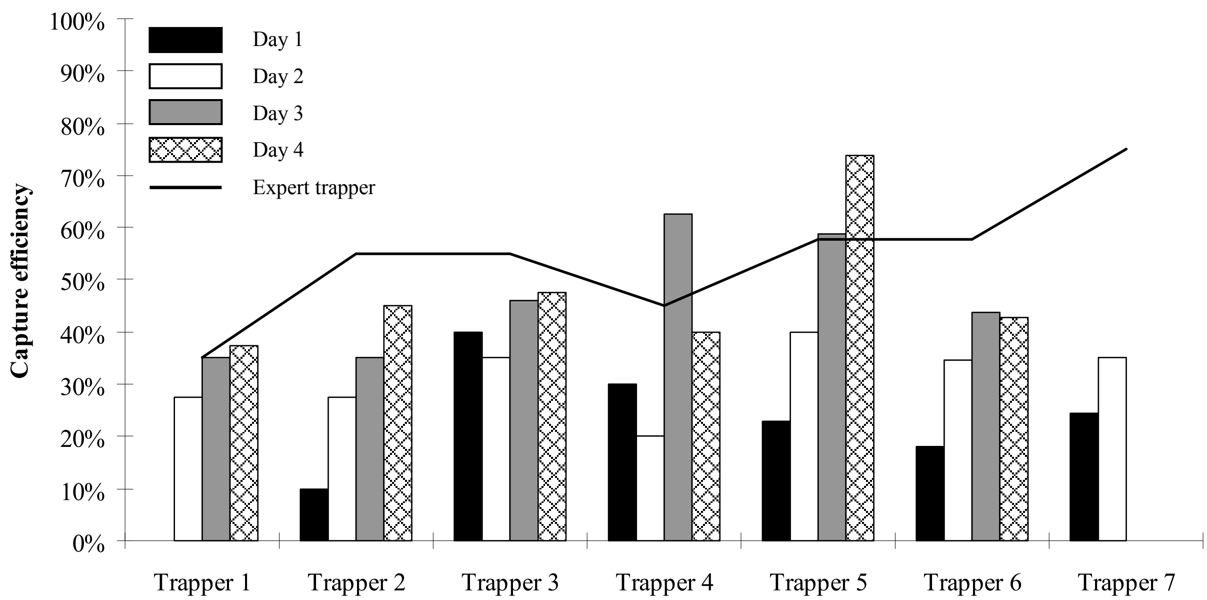

Figure 1. Capture efficiency (number of gophers captured per number of trap sets) of 7 novice pocket gopher trappers and 1 expert trapper over a 4-day trapping period at Laguna Ranch, CA, during spring 2010 and 2011.

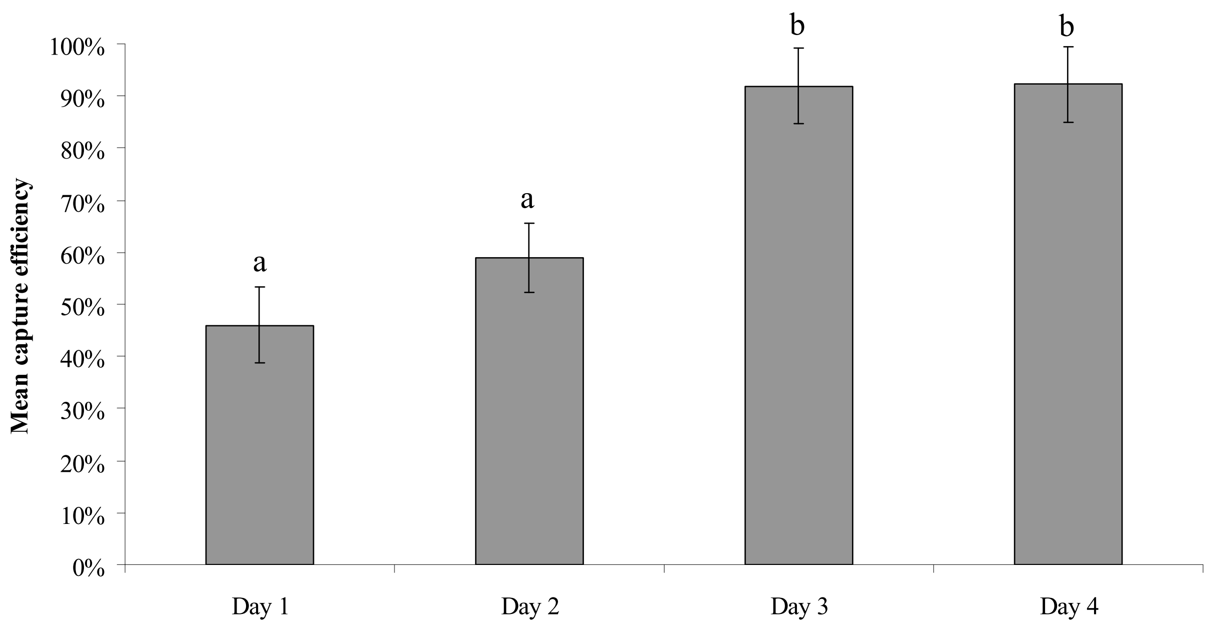

Figure 2. Mean capture efficiency and standard errors of 7 novice pocket gopher trappers over a 4-day trapping period adjusted for capture efficiencies attained by an expert trapper (see text for description of adjustment procedure) at Laguna Ranch, CA, during spring 2010 and 2011. Capture efficiencies for days denoted with the same letter did not differ ($\alpha = 0.05$).

novice trappers did exhibit a significant improvement in capture efficiency over the course of the 4-day period ($F_{9,15} = 6.0$, $P = 0.001$, $r^2 = 0.78$), as both day ($F_{3,15} = 10.1$, $P < 0.001$), and to a lesser extent, trapper ($F_{6,15} = 2.3$, $P = 0.089$), were significant variables in the model. Efficiency was significantly different across all days except for days 1 and 2 and days 3 and 4 (Fig. 2). By day 3, novice trappers were already capturing gophers at 92% of the efficiency value obtained by the expert trapper (Fig. 2).

The capture rate for novice trappers ranged from 0.5–6.2 gophers per hour (Table 1). Only once was capture rate for a novice trapper greater than that observed for the expert trapper (Fig. 3). The capture rate for novice trappers increased significantly over the 4-day period ($F_{9,15} = 5.2$, $P = 0.003$, $r^2 = 0.76$) with both day ($F_{3,15} = 4.9$, $P = 0.014$) and trapper ($F_{6,15} = 3.8$, $P = 0.018$) significant variables in the model. As with capture efficiency, capture rate was significantly different between all days except for days 1 and 2 and days 3 and 4 (Fig. 4). Although novice trappers showed the same trend in an increase in proficiency over time, they did not top out at the same level as that seen for capture efficiency (92% vs. 73% for capture efficiency and capture rate, respectively; Figs. 2 and 4) indicating that capture efficiency is more quickly attained than speed in setting traps.

Poison bait application

Individuals who received a thorough training program for poison bait application were consistently more successful in reducing gopher populations, with $\bar{x}$ reductions in plots occupied by gophers of 27% (SE = 10) and 58% (SE = 4) for limited and thorough training programs, respectively (Fig. 5); this difference was significant ($\chi^2_1 = 8.7$; $P = 0.003$). Odds ratios were not significantly different between fields ($\chi^2_2 = 5.0$; $P = 0.082$); individuals who received the thorough training program were 3.6 times (95% CI: 1.5–8.5) more likely to attain higher levels of control than were those who received only limited training.

DISCUSSION

Our results clearly indicated a substantial increase in capture proficiency of pocket gophers over as little as 3 days. This increase in proficiency was most strongly influenced by the novice trappers' ability to rapidly increase in capture efficiency with $\bar{x}$ capture efficiency at 92% of that attained by the expert trapper after just 3 days. High capture success is clearly an important component of an effective gopher control program. We observed higher capture efficiency for novice trappers by day 3 ($\bar{x} = 47\%$; Table 1) than has been reported in most other studies of presumably experienced trappers (e.g., $\bar{x} = 15–23\%$, Smeltz 1992; $\bar{x} = 16–35\%$, Proulx 1997b; $\bar{x} = 18–42\%$, Pipas et al. 2000). It was somewhat surprising that we would attain such high levels so quickly with the removal-style protocol that we used given that we did not establish a large set distance between trap sets to insure independence. One potential explanation could be our use of the Gophinator trap which has proven more effective than the Macabee trap (Macabee Gopher Trap Co., Los Gatos, CA) ($\bar{x}$ capture efficiency = 57% and 39% for Gophinator and Macabee traps, respectively; Baldwin et al. 2010), or it could be due to higher gopher densities in the sampled areas. Regardless, the rapid increase in efficiency of novice trappers indicates that trapping is a viable option to include in many gopher control programs.

Capture rates also substantially increased over the 4-day sampling period although this effect was not as pronounced as it was with capture efficiency. Clearly it requires a longer period of

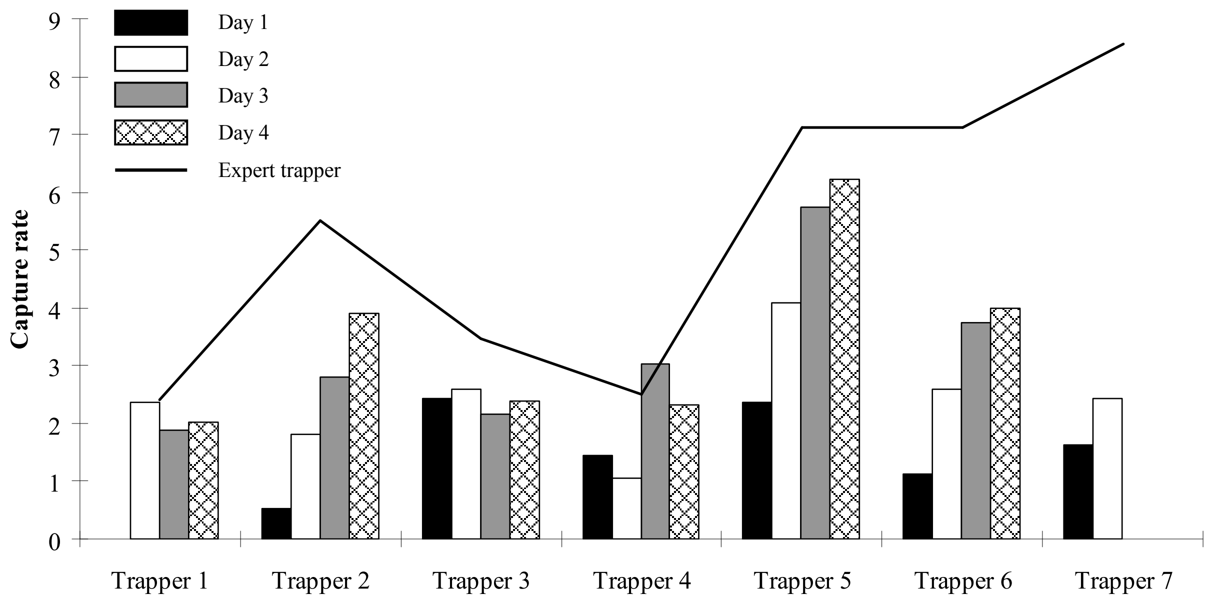

Figure 3. Capture rate (number of captures per number of hours trapped) of 7 novice pocket gopher trappers and 1 expert trapper over the course of a 4-day trapping period at Laguna Ranch, CA, during spring 2010 and 2011.

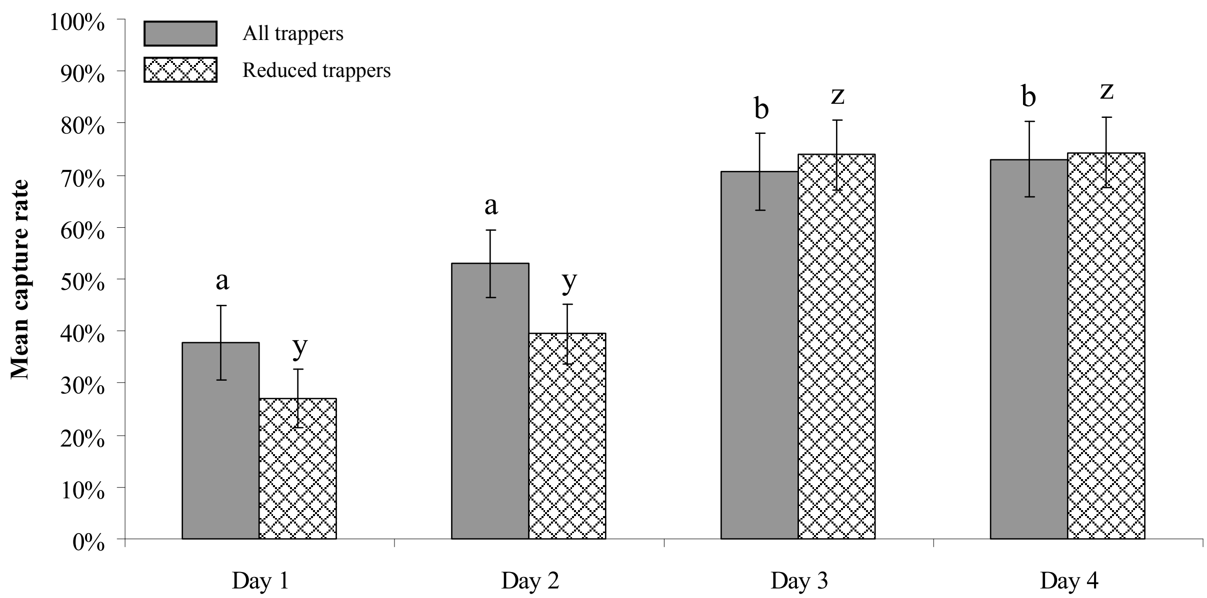

Figure 4. Mean capture rates (number of captures per number of hours trapped) and standard errors of 7 (all trappers [gray bars]) and 5 (excluded trappers 1 and 3; see text for reasoning [cross-hatched bars]) novice pocket gopher trappers over a 4-day trapping period adjusted for capture rates attained by an expert trapper (see text for description of adjustment procedure) at Laguna Ranch, CA, during spring 2010 and 2011. For each model above, capture rates for days denoted with the same letter did not differ ($\alpha = 0.05$).

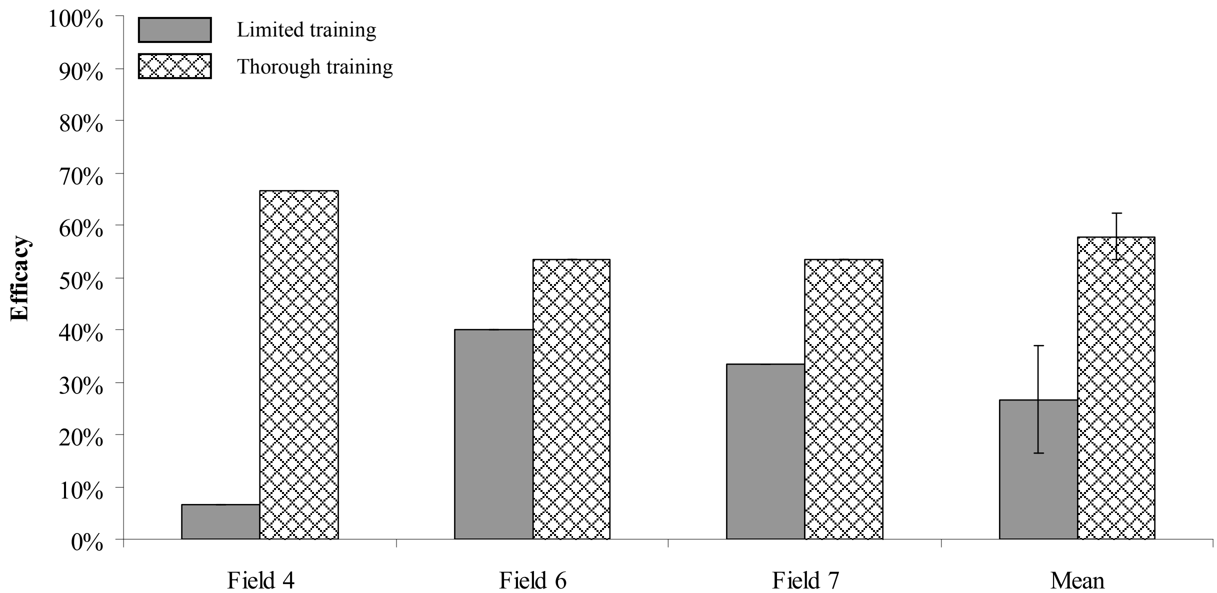

Figure 5. Percent efficacy of bait (1.8% strychnine) applicators who received limited and thorough training on bait application procedures for pocket gopher control across 3 fields of grapes at Laguna Ranch, CA, during spring 2011. Mean efficacy differed significantly between the individuals who received limited and thorough training ($\chi^2_1 = 8.7$; $P = 0.003$).

time for gopher trappers to gain speed than it does capture efficiency. Still, trappers were able to increase the number of gophers they removed per hour by approximately 200% after just 4 days (Fig. 4). The strength of these results is somewhat surprising given that the time required to place 40 trap-sets increased dramatically for Trappers 1 and 3 given a large unanticipated drop off in gopher densities from the first two days of trapping compared to the final 2 days ($\bar{x}$ time required to set 40 traps for first 2 days = 5.6 and 6.0 hours for Trappers 1 and 3 respectively; $\bar{x}$ time required to set 40 traps for last 2 days = 7.4 and 8.2 hours for Trappers 1 and 3 respectively). These were the only 2 fields that showed this sharp drop in population density. If we were to remove these two fields from analysis, the strength of the resultant model increases substantially ($F_{7,10} = 11.5$, $P < 0.001$, $r^2 = 0.89$). Although removing two whole fields from analysis is quite selective in nature, we feel the $\bar{x}$ capture rates (Fig. 4) may be more reflective of the actual increase in capture rate over a 4-day period given the inconsistent distribution of gophers throughout the sampling area for Trappers 1 and 3. Regardless of which model we used though, capture rates increased rapidly over 3–4 days although more experience would still be required to maximize the speed of trap setting.

The individual trapping also influenced trapper proficiency, although this effect was less pronounced than was trapper experience. As expected some trappers were more proficient than others. Nonetheless, all trappers exhibited an increase in capture efficiency over the course of a 4-day period indicating that most individuals can be trained to be efficient gopher trappers.

Past investigations have shown that gopher trapping can be an effective method for controlling pocket gophers in agricultural and forested areas (e.g., Smeltz 1992, Proulx 1997a). Even so, many growers and farmers do not consider trapping to be a viable tool for controlling gophers as they feel that trapping is too time consuming to be effective (Engeman and Witmer 2000). Part of their reasoning likely stems from low proficiency when they first initiate a trapping program. As we have shown, proficiency rapidly increases over the course of just a few days, thereby greatly increasing the viability of trapping as a tool for controlling pocket gopher. Even so, trapping is just one of several potentially effective tools for controlling pocket gophers.

Baiting with rodenticides such as strychnine is also extensively used and will likely continue to be an important component of an IPM program for controlling pocket gophers given the need for additional control methods to maximize control efficacy. Unfortunately, results from baiting programs have varied widely (e.g., 0–100%; Tickes et al. 1982, Evans et al. 1990). This was the case in our investigation as well, as we observed 7–67% reductions in gopher populations from strychnine application. A multitude of reasons may impact the efficacy of these baits (see Introduction for potential list) although most of the proposed possibilities remain in need of further investigation. That being said, applicator experience certainly appears to have an impact. Many growers and PCA's do not regularly manage croplands for vertebrate pests. Therefore, they may not have the experience required to implement, or effectively train individuals to implement, control programs. As such, many baiting programs likely fall short of potential control levels.

Based on our experience, the most important component of an effective training program is to ensure that bait is actually applied into the gopher tunnels. Gophers often back-fill old tunnels with loose soil that they remove while excavating new tunnels. Although these back-filled tunnels are filled with loose soil, it often still provides the same general feel as a non-filled tunnel when probing. An experienced prober is required to discern this difference. Based on our results, thoroughly training all individuals responsible for bait application to correctly identify active tunnels should provide a 360% increase in the probability of a more successful baiting program than if bait applications are conducted by lesser trained individuals.

Other aspects factor into a thorough training program as well including regular monitoring of bait application equipment and correct identification of gopher mounds as compared to other burrowing mammal burrow systems. For example, bait application equipment has a tendency to plug up, particularly in moist soil conditions. Reinforcing the need to regularly monitor for properly functioning equipment is needed to maximize efficacy as malfunctioning equipment will not apply the appropriate amount of bait. Likewise, it is important for bait applicators to identify the difference between pocket gopher, mole (*Scapanus* spp.), and vole (*Microtus* spp.) burrows so that applicators do not skip gopher mounds because they think they were created by other burrowing mammals.

Although training did significantly increase the efficacy of our baiting program, control levels obtained from bait application by thoroughly trained individuals ($\bar{x}$ = 58%) still fell short of the minimal level desired for rodent control (>70%; Capp 1976, Fagerstone et al. 1981). Other aspects likely contributed to the reduced efficacy that we observed including thick vegetative growth concealing mounds and partially muddy conditions potentially limiting bait applicator functionality. During spring 2011, above normal precipitation fell resulting in prolific vegetative growth. Additionally, the resultant wet soil conditions precluded mowing cover crops before baiting trials which likely limited the ability of bait applicators to find all gopher mounds. Although the thoroughly trained individuals were cognizant of the need to regularly check their equipment, the wet soil conditions still led to increased plugging of bait probes, which if unnoticed, could have lead to insufficient bait application in some burrow systems. Obviously, to maximize the efficacy of bait application on a consistent manner, we need to more thoroughly identify to what extent other factors influence the efficacy of baiting programs so that steps can be taken to increase the consistency of these baiting programs. Nonetheless, an effective training program is needed to increase the effectiveness of baiting programs for controlling pocket gophers.

MANAGEMENT IMPLICATIONS

Effective gopher control programs typically rely on several management tools including baiting and trapping. When effective, baiting can provide a relatively quick method for treating a large number of burrow systems. It is apparent that bait applicators need to be thoroughly trained to increase the efficacy of such baiting programs. Training sessions should focus largely on correct identification of active burrow systems. Other key factors to address are proper identification of gopher mounds and proper maintenance of bait application equipment. However, even with proper training, baiting alone may still not attain the level of control needed to effectively control gopher populations. Trapping has proven to be an effective tool in such situations, with novice trappers attaining effective trapping skills in as little as 3 days of trapping experience. We recommend that, where feasible, trapping be included into IPM programs for controlling gophers given its high efficacy and lack of secondary toxicity concerns.

OUTREACH/EXTENSION

We have two demonstrations planned for May 26–27, 2011, in Napa and Marin Counties, respectively, to provide an overview of our findings, as well as to demonstrate various aspects of pocket gopher control to participants. Additionally, the project leader will disseminate these findings at various Extension presentations throughout the year. Our findings will be included in various UC IPM and UCCE outlets including Pest Notes, Pest Management Guidelines, and IPM and ANR Production Manuals. Peer-reviewed journal articles will also be prepared and submitted.

ACKNOWLEDGMENTS

We wish to thank Dennis Devitt and Sam Ausburn from Gallo Family Vineyards for their tremendous assistance and support during the project. We also wish to thank Steve Albano and Trapline Products for providing us with traps, and Brent Hazen and Wilco Distributors, Inc. for providing the strychnine bait for the project. A special thank you is provided to Nick Brinton, Fiona Cambra, Allison Eichele, Matt Frank, Elise Hinman, Lindsay Jordan, Solomon Leung, Manny Lopez, Tony Rodriguez, Emily Sin, and Gretchen Wetzel for field assistance. This project was funded through a grant from the UC IPM Statewide Program.

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