1. **Date submitted:** April 9, 2010

2. **Project title:**

Determining and demonstrating effective trapping strategies for gophers to promote trapping as part of an IPM approach.

3. **Project leader:**

Roger A. Baldwin, IPM Wildlife Pest Management Advisor
U.C. Kearney Agricultural Center, 9240 South Riverbend Avenue, Parlier, CA 93648
Phone: 559-646-6583; E-mail: rbaldwin@uckac.edu

Collaborators and Cooperators:

Daniel B. Marcum, Farm Advisor – Shasta and Lassen Counties
P.O. Box 9, McArthur, CA 96056
Phone: 530-336-5784; E-mail: dbmarcum@ucdavis.edu

Steve B. Orloff, County Director and Farm Advisor, Siskiyou County
1655 South Main Street, Yreka, CA 96097
Phone: 530-842-2711; E-mail: sborloff@ucdavis.edu

Stephen J. Vasquez, Farm Advisor – Fresno Co., 1720 S. Maple Ave., Fresno, CA 93702;
Phone: 559-456-7567; E-mail: sjvasquez@ucdavis.edu

Cheryl A. Wilen, Area IPM Advisor – Los Angeles, Orange, and San Diego Counties,
5555 Overland Ave. Bldg 4, Suite 4101, San Diego, CA 92123
Phone: 858-694-2846; E-mail: cawilen@ucdavis.edu

4. **Nontechnical summary:**

Pocket gophers (*Thomomys* spp.) cause extensive damage to numerous crops, golf courses, recreational areas, and homeowner yards in California annually. Trapping has been widely used to control small populations of gophers in California for over a century. However, much ambiguity still exists with respect to trap types and trapping methodology for gophers. Therefore, we tested two factors of high importance to address some of these issues: 1.) trap type (Macabee vs. Gophinator), and 2.) covering trap-sets versus leaving trap-sets uncovered. Additionally, we tested the influence of gopher size, gender, and season on trap success. We found that Gophinator traps outperformed Macabee traps, primarily due to their ability to capture larger gophers; season and gender had no influence on these results. We found no significant difference in capture success for covered versus uncovered trap-sets, although covered sites did give slightly higher capture rates during spring/early summer than during autumn. Gender and weight did not influence these results. Covered sites took significantly longer to set; therefore, unless concerned about non-target captures, we recommend leaving trap-sets uncovered as uncovered sites are effective yet quicker to set. These results were presented and demonstrated at a number of sites and through several publications throughout California. Initial feedback has indicated an increase in knowledge and positive attitude towards the incorporation of trapping into an IPM gopher control program.

5. Objectives and progress:

Objective 1. Evaluate trap type, trap position, and open vs. closed trapping style to increase grower, PCA, and homeowner effectiveness at controlling this damaging pest.

Our goal was to assess the effectiveness of two different traps (Gophinator and Macabee) at capturing gophers, as well as testing the effectiveness of leaving trap-sets covered and uncovered. We also assessed how the weight and gender of individual gophers influenced this relationship, and if these factors varied by season. We had planned on testing for differences in efficacy when trapping in main and lateral tunnels as well. However, we were not able to consistently find enough lateral tunnels to incorporate this into our investigation.

During the late spring-early summer seasons, we trapped at 2 sites in northern California, 4 sites in the Central Valley, and 1 site in southern California resulting in a total of 269 gopher captures. The Gophinator was more effective (Fisher's exact $P < 0.001$), with 156 captures in Gophinator traps versus 113 in Macabee traps. This yielded a 57% capture rate for the Gophinator but only a 39% capture rate for the Macabee. During autumn, we trapped at 2 sites in northern California, 2 sites in the Central Valley, and 1 site in southern California resulting in a total of 202 gophers. Once again, the Gophinator was the more effective trap (Fisher's exact $P < 0.001$) resulting in 120 captures (57%) versus only 82 captures (39%) for the Macabee. The resultant capture percentages were identical for the two seasons indicating no seasonal effect of differing traps on capture success.

The disparity in capture rates was driven by the size of gophers (Fig. 1). Once gophers reached weights > 100 grams, the Gophinator trap became more effective than the Macabee, although below these weights, capture success was equivalent for the two traps. This same result was observed for both the spring/early summer and autumn seasons. Reasons for this difference in efficacy are not known, but could be due to the stronger spring used by the Gophinator, or perhaps due to the swinging-arm motion of the Gophinator versus the upward thrusting motion of the Macabee capture arms.

During spring/early summer, we captured 141 and 128 gophers in covered and uncovered trap-sets, respectively. During autumn, we captured 101 gophers in both covered and uncovered trap-sets. This indicated no statistical difference in capture success between the two methods for both the spring/early summer (Fisher's exact $P = 0.063$) and autumn (Fisher's exact $P = 0.696$) seasons, although the spring/early summer season results were close to significant. Capture success from covered and uncovered sites was not strongly influenced by weight, though there was a slight trend toward higher weights for covered sites in spring; there was no difference in autumn (Fig. 2). Collectively, covering trap-sets does not appear to be necessary, particularly during autumn trapping. Results were a little less clear for spring/early summer but still suggest only marginally higher capture rates and slightly larger gopher sizes associated with covered sites.

Gender ratios were 52% male:48% female (139 males:127 females) during spring/early summer and 42% male:58% female (84 males:114 females) during autumn. The greater number of females in autumn was expected; females typically outnumber males during autumn due to higher male mortality during and immediately prior to this time-period. Regardless, gender had little influence on capture success for Gophinator or Macabee traps (spring/early summer: Fisher's exact $P = 0.902$; autumn: Fisher's exact $P = 0.376$), nor for covered versus uncovered trap-sets (spring/early summer: Fisher's exact $P = 0.458$; autumn: Fisher's exact $P = 0.469$).

We also tested for differences in the time (in seconds) required to complete both Gophinator and Macabee trap-sets, as well as for covered and uncovered trap-sets. We found no difference ($t = -0.02$, $P = 0.981$) in time required to set Gophinator ($\bar{x} = 307$, SE = 9.1) and Macabee traps ($\bar{x} = 308$, SE = 9.6). However, there was a 35 second difference ($t = 2.64$, $P = 0.009$) in time required to set covered ($\bar{x} = 325$, SE = 9.9) and uncovered trap-sets ($\bar{x} = 290$, SE = 8.4). Given the greater time and subsequent cost associated with covering trap-sets, we recommend not performing this step when trapping large numbers of gophers. However, if in an area where covering trap-sets is needed for alternative reasons (e.g., restricting access to traps for children and pets, reducing the number of traps that are confiscated by predators and scavengers that are attracted to captured gophers), trapping in this manner will be equally and perhaps slightly more effective.

In order to maximize limited resources for research efforts, we sent all collected samples to the University of Memphis (UM) and Southwest Tennessee Community College (STCC) for morphometric and genetic analyses by Drs. Michael Kennedy and Juliann Waits, respectively. This research represents a partnership between the principal investigators at all institutions. Specifically, this collaboration supports the growth and development of undergraduate and graduate biological research at primarily minority institutions in the southern United States. These research projects are in various stages of implementation; gopher collections are continuing this spring 2010 through other UC projects and will allow for the sustained analysis and publication of multiple research-project findings over the next several years. Students will be actively engaged in the data collection for these projects and included in publications.

Objective 2. Demonstrate these outcomes to growers, landscapers, homeowners, PCA's and Farm Advisors through a combination of field days, presentations, and publications to illustrate effective gopher control through trapping. We provided 3 demonstration events and 1 public presentation specific to our findings. Additional outputs and outreach programs have either occurred or are planned and will be outlined in the following sections.

6. Outputs:

Specific outputs are as follows:

- Trained 5 UCCE Farm Advisors on gopher trapping techniques at a training workshop in Fresno County, May 2009.
- Provided presentation and field demonstrations on our findings in Shasta (16 attendees), San Diego (35 attendees), and Fresno (17 attendees) Counties.
- Provided presentation on findings in Siskiyou County (78 attendees).
- Production of an informational handout (provided as separate attachment) on management of gophers in an agricultural or landscape setting; distributed at all demonstrations and 5 presentations.
- Nine presentations were made to growers, PCA's, and landscapers statewide that included information from this study (800 attendees).
- Master Gardener presentations were provided for Amador/Calaveras, El Dorado, Inyo/Mono, and Orange Counties that included information from this study (189 attendees).
- Inclusion of findings in revised Pest Note for pocket gophers.
- Inclusion of findings in upcoming Almond Production Manual, Walnut Production Manual, and Nursery Production Manual.

- Inclusion of partial findings in 2 Cooperative Extension Newsletters and 1 ANR blog.
- Findings were cited in the Good Fruit Grower magazine, March, 2010.
- Videos were filmed on gopher trapping techniques; they are in production and will be made available to the public through the UC IPM website.
- A scientific publication on our findings is in preparation.

Our findings should be included in upcoming revisions of all Pest Management Guidelines, Pest Notes, Quick Tips, etc., for which gopher control is covered.

7. Impacts and potential impacts:

Impacts. To date, this project directed findings through presentations and demonstrations to 1,135 individuals ranging from growers, to PCA's, to the general public. An unidentifiable number of other individuals have been impacted through our newsletters and publications. All of these outputs have served to increase the public's knowledge on gopher control and how to incorporate trapping as part of an integrated approach to controlling these damaging pests. Additionally, in the past 4 months, I have had approximately 10 separate growers and home-owners who either observed one of these presentations or who read one of the articles indicate to me that they had switched to using gopher trapping as their preferred method for controlling this pest and have been happy with the results; they have been particularly pleased with the Gophinator trap and have found it to be superior to the Macabee.

More specifically, this project allowed us to work directly with growers in 5 different counties (Fresno, Madera, San Diego, Shasta, and Siskiyou) throughout the state to further their knowledge on gopher trapping procedures while also providing locations for our research purposes. Included in these locations was land owned by the Pala Band of Mission Indians who provided both sites and partial labor for our research and demonstration purposes in San Diego County. They incorporated knowledge gained from this project to administer an aggressive gopher control program to mitigate damage caused by these pests. Immediately following completion of our trapping trial, a grower in Fresno County initiated a trapping program to reduce gophers in their vineyards. Other growers expressed similar interests.

During our demonstrations, we presented the audience with an 8 question pre- and post-test to gauge their knowledge on gopher and meadow vole (*Microtus* spp.; a species often confused with gophers) biology and control. All three locations exhibited a significant increase in test scores following these demonstrations (Shasta: pre-test $\bar{x} = 63\%$, post-test $\bar{x} = 84\%$, $t = -2.09$, $P = 0.038$; San Diego: pre-test $\bar{x} = 70\%$, post-test $\bar{x} = 80\%$, $t = -1.95$, $P = 0.046$; Fresno: pre-test $\bar{x} = 63\%$, post-test $\bar{x} = 79\%$, $t = -2.23$, $P = 0.031$) suggesting an effective training program.

In addition to an increase in general knowledge, we were also interested in the participant's attitudes towards our research findings. For this, we asked pre- and post-test questions addressing the participants use and attitudes toward trapping, use of specific traps, and use of covered versus uncovered trap-sets. Of the 38 participants who completed both pre- and post-tests, 19 used trapping before this demonstration while 19 had not. In the post-test, 36 of 38 participants indicated they would incorporate trapping into their management programs which indicates a substantial positive shift (Fisher's exact $P < 0.001$) in their attitude toward the utility of trapping.

For trap selection, we received minimal feedback on trap selection from the pre-test as many individuals did not know what trap they used. Of those that were familiar with their

trap brand, 14 used the Macabee, 4 used box traps, 2 used the Victor Easy Set, 1 used the cinch trap, and only 1 used the Gophinator. However, 44 of 52 post-test respondents indicated they would use the Gophinator in future trapping efforts, 14 respondents indicated they would use the Macabee trap, while 1 indicated they would continue using box traps (note these do not add up to 52 as several respondents listed 2 trap types for future use). These results suggest a substantial positive increase in potential use of the Gophinator by post-test respondents.

Additionally, we tested participant's views on the need to cover trap-sets in the pre- and post-tests. From the pre-test, 25 individuals indicated they covered trap-sets, 3 individuals did not cover; in the post-test, 16 individuals indicated they would still cover trap-sets, 12 individuals indicated they would not cover. This represented a significant increase (Fisher's exact $P = 0.007$) in the number of trap-sets uncovered, although it was less substantial than what we expected. Reasons for this may include a desire to maximize capture success as covered sites often yielded slightly higher (though not significant) capture rates, the trappers desire to minimize non-target access to traps, or perhaps their familiarity and comfort in using covered trap-sets. Collectively, feedback from demonstrations was consistently positive; 45 participants provided positive feedback, 0 participants provided negative comments.

This project has also provided an opportunity for primarily minority undergraduate and graduate students to train in the use of morphological, statistical, and genetic methodologies. This training will allow them to prepare for future careers, while providing needed information on gopher population genetics to help guide future control strategies.

Potential Impacts. More successful trapping strategies determined from this project, in concert with extension of these findings to various publics, could lead to greater control of gopher populations. This could result in a number of positive benefits including greater production of garden and landscape plants, greater production of agricultural crops, less use of irrigation water given a reduced loss of water down burrow systems, and less damage to underground irrigation systems and electrical cables. Our findings could also reduce the use of rodenticides for controlling gophers, thereby limiting the potential for secondary and non-target poisonings. Additionally, findings from genetic and morphological analyses could provide basic information on gopher biology which could lead to the development of future control strategies.

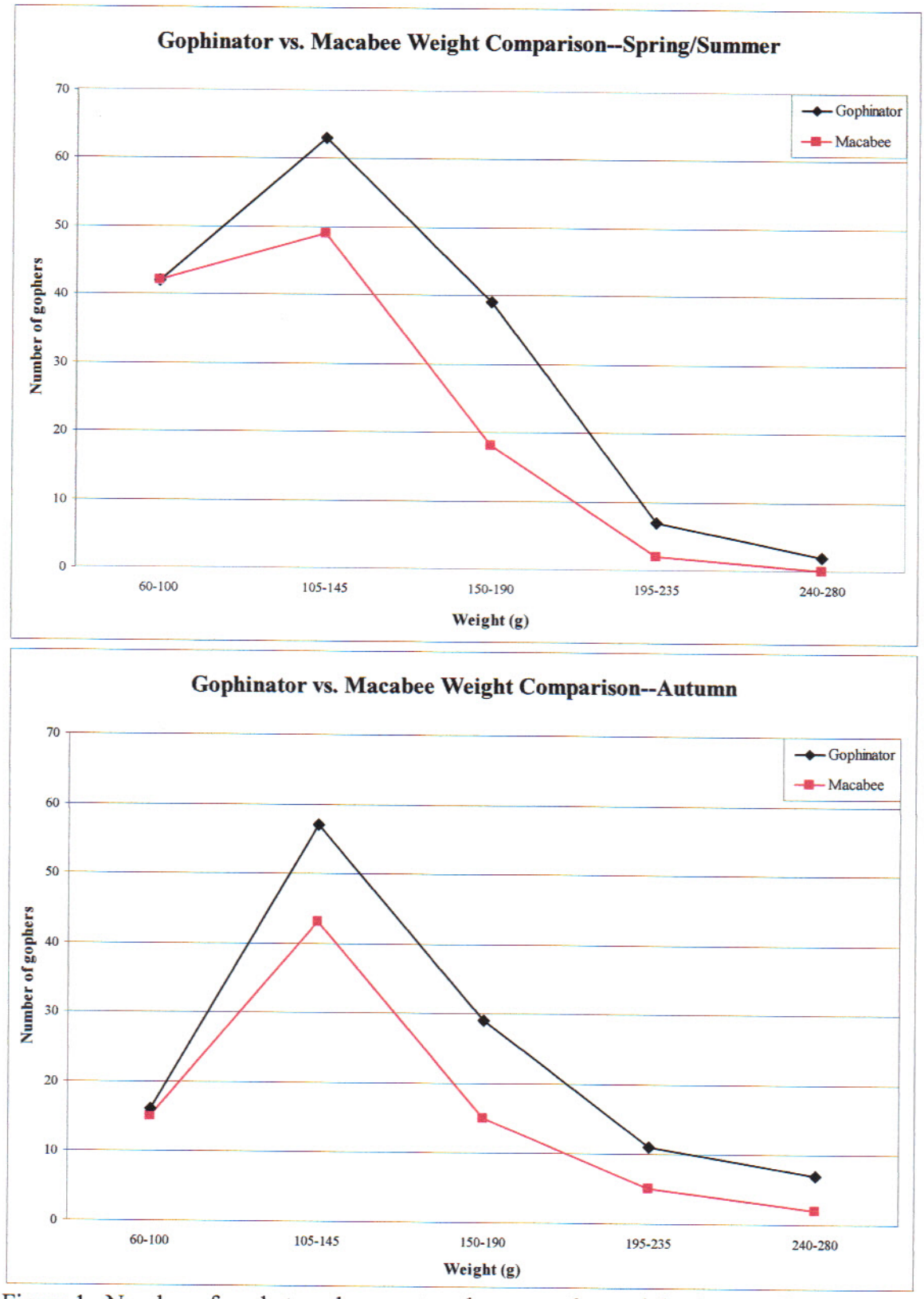
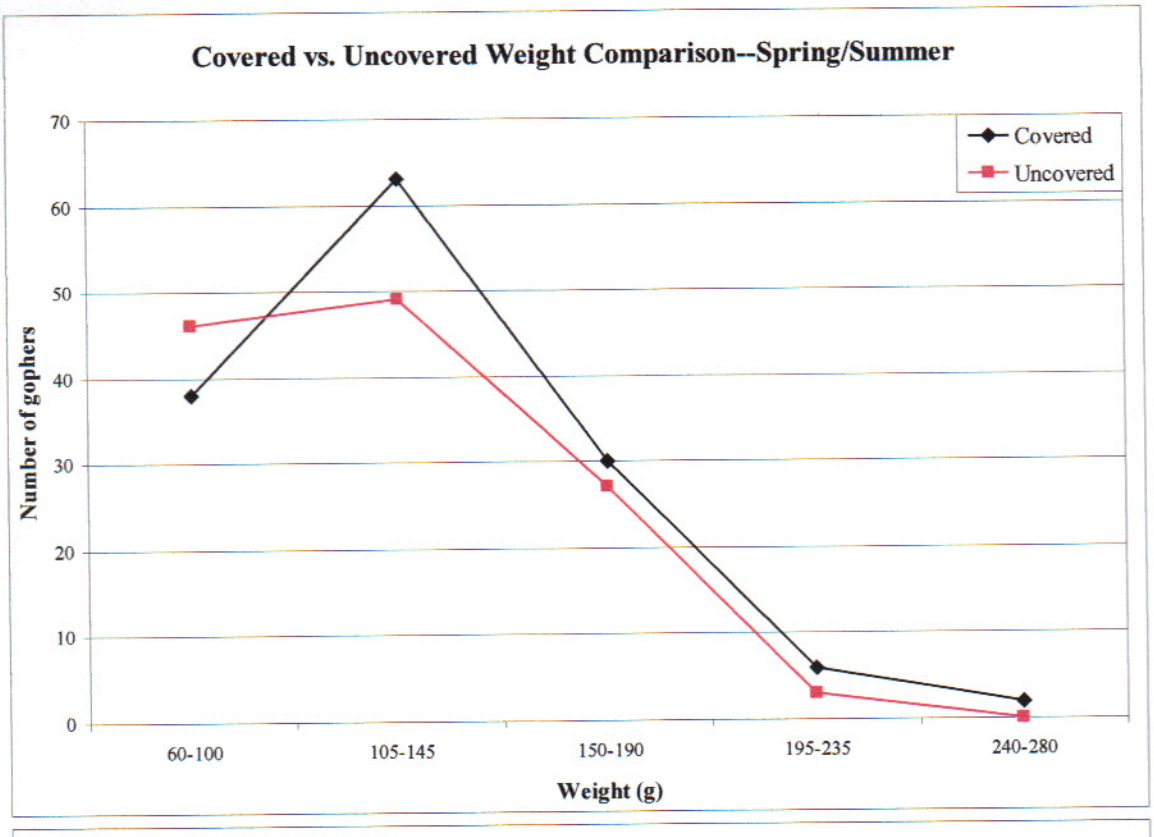


Figure 1. Number of pocket gophers captured compared to weight classes of pocket gophers for both Gophinator and Macabee traps during spring/early summer and autumn.



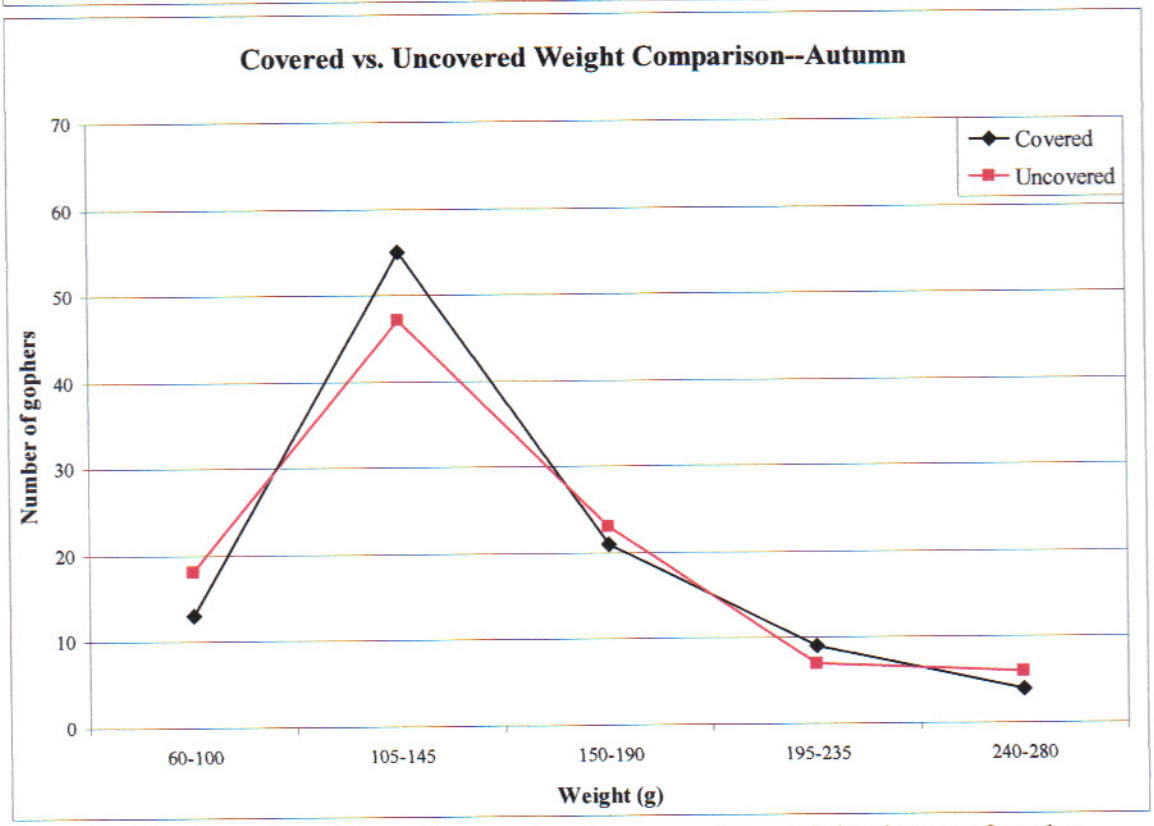


Figure 2. Number of pocket gophers captured compared to weight classes of pocket gophers for both covered and uncovered trap-sets during spring/early summer and autumn.