A. Cover Page

1. Project Title: Determining utility of carcass searches for reducing secondary exposure risk associated with ground squirrel rodenticide applications.

2. Project Leader:

Roger A. Baldwin, Ph.D.
Cooperative Extension Specialist
Dept. Wildlife, Fish, and Conservation Biology
One Shields Ave.
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3. Cooperators: NA

4. CDFA Funding Request Amount/Other Funding (Total = $62,673):

PY1 (2024-2025) = $52,610
PY2 (2025-2026) = $10,063

5. Agreement Manager:

Denise Ehlen
Executive Associate Vice Chancellor for Research
Sponsored Programs
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B. Executive Summary

1. Problem: Many rodents, including California ground squirrels (*Otospermophilus* spp.), cause extensive damage to California agriculture through direct crop loss, by posing as a potential food safety risk, and through damage to farm equipment and farm infrastructure. Rodenticides are commonly used to manage ground squirrels due to their high efficacy and cost-effectiveness, but concerns about secondary exposure of nontarget scavengers has led to several proposed actions to substantially limit their use. One of these proposed actions calls for conducting carcass searches at regular intervals to remove carcasses from the landscape. However, the effectiveness of these carcass searches is unknown, nor has the fate of carcasses been thoroughly investigated. Such information is vital to better inform regulations targeted at reducing secondary exposure risk.

2. Objectives, Approach, and Evaluation: The objective for this project is to determine the accuracy of carcass searches using both scent detection dogs and human observation. We will also determine the influence of several covariates (ground cover, vertical cover,

slope, location of carcass) on our ability to locate ground squirrels, and we will determine the general fate of carcasses over a 3-day observation period. For carcass searches, we will use a standard walking transect as well as driving transects to determine the utility of human observation for finding carcasses. We will also use specially trained detection dogs to determine if they are more effective than humans at finding carcasses. Carcass fate will be determined through the use of remote-triggered cameras which will document any losses of carcasses by scavengers. This study will provide much needed information on the utility of carcass searches for reducing secondary exposure from rodenticide applications.

3. Audience: The audience will be all individuals that might need to conduct carcass searches following a bait application program. This would apply to growers and ranchers, but also numerous other groups including state, county, and municipal governments that are involved in rodent control efforts.

C. Justification

1. CDFA VPCRAC Mission and Responsibilities: Rodenticides are commonly used to manage burrowing rodents in production agricultural systems due to their high efficacy and cost-effective nature. The proposed changes included in the U.S. EPA's Proposed Interim Decisions (PIDs) would substantially alter how these products can be used moving forward. One of the major mitigation efforts proposed in the PIDs are mandatory carcass searches that would need to be conducted every two days for up to two weeks following the completion of a baiting program. However, little guidance has been provided as to the proper strategy for conducting carcass searches, nor is there a clear understanding of the effectiveness of these carcass searches. It is likely that various factors, such as vegetative characteristics surrounding carcasses, as well as time of day when carcass searches are conducted, will influence the effectiveness of these searches, but their impact is currently unknown. As such, research into the effectiveness of carcass searches is needed to provide quantifiable data to regulatory agencies on this topic to better guide mitigation efforts. This topic fits squarely within the VPCRAC mission.

2. Impact: Burrowing rodents, such as California ground squirrels, are responsible for many types of damage in agricultural production systems including direct reduction in crop production, mortality of crops, damage to irrigation infrastructure, and by posing a human health and safety risk, just to name a few. Rodenticides are the primary tool used to manage rodent populations in many of these settings. Recently proposed changes to rodenticide labels by the U.S. EPA would substantially impact when and how rodenticides could be used moving forward. One major change would involve the requirement of carcass searches to be completed every two days during and following the completion of a bait application program. However, it is unclear what strategy should be used to conduct these carcass searches, nor is it known how effective these carcass searches are. An official assessment of the effectiveness of carcass searches, as well as strategies to increase the utility of this approach, could assist both regulatory agencies in determining the appropriate course of action, as well as by aiding growers and ranchers by defining the effectiveness and expected cost associated with these search efforts.

3. Long-Term Solutions: Rodenticides are an important part of an effective IPM program for ground squirrel control in many agricultural systems (Baldwin et al. 2014). However,

increasing regulation targeted toward rodenticide applications has led to additional requirements if rodenticides are to be used in various crop and rangeland settings. One of these requirements is the need to perform carcass searches at least every two days following bait application. Such carcass searches are time consuming, and the efficacy of these searches is unknown. We propose multiple search strategies to determine which, if any, of these approaches are effective, as well as potential factors which may increase the utility of carcass searches for removing carcasses from the landscape. This information is needed to better inform regulatory agencies as to the usefulness of this potential mitigation strategy.

Baldwin, R. A., T. P. Salmon, R. H. Schmidt, and R. M. Timm. 2014. Perceived damage and areas of needed research for wildlife pests of California agriculture. Integrative Zoology 9:265–279.

4. Related Research: Surprisingly little data is available with respect to the effectiveness of searches for locating ground squirrel carcasses. A previous study mimicking a pocket gopher baiting program indicated that carcass searches recovered only 25.4% of placed carcasses (Witmer et al. 1995). They did not note any overriding vegetative factors that influenced their ability to find carcasses, although vegetative characteristics did not vary much across their study sites, likely limiting their ability to adequately test the influence of such factors on detection probability. Some guidance is provided by U.S. EPA on carcass searches for black-tailed prairie dogs (https://www.epa.gov/endangered-species/carcass-search-recovery-guidelines-black-tailed-prairie-dogs). We propose to enact a similar strategy for walking and driving surveys in this study.

   The fate of ground squirrel carcasses was previously tested by Salmon et al. (2002). They documented that 42% of carcasses were removed or consumed within 3 days of placement on the ground. However, given limitations in technology at the time, they were not able to identify the species responsible for taking the carcass in many instances. They also did not report on time that scavenging occurred, which could assist in determining the optimal times to conduct carcass searches to minimize potential secondary exposure.

Salmon, T. P., D. A. Whisson, and W. P. Gorenzel. 2002. Field efficacy studies comparing 0.005% and 0.01% diphacinone and chlorophacinone baits for controlling California ground squirrels (*Spermophilus beecheyi*). Final Report to California Department of Food and Agriculture.

Witmer, G. W., M. J. Pipas, and D. L. Campbell. 1995. Effectiveness of search patterns for recovery of animal carcasses in relation to pocket gopher infestation control. International Biodeterioration & Biodegradation 36:177–187.

5. Contribution to Knowledge Base: Increasing regulation is substantially influencing when, where, and how rodenticides can be used. Many mitigation actions are being enacted to maximize safety for nontarget species, but it is currently unclear as to the effectiveness of some of these strategies. Carcass searches are one of the mitigation efforts for which effectiveness is unknown. This investigation will provide insight into the effectiveness of several carcass search techniques, as well as factors that might influence their effectiveness. Furthermore, this study will address the fate of carcasses located in

simulated treatment areas to determine scavenging rates and times when carcasses are scavenged to hopefully allow for a more rigorous design for carcass removal should this approach be deemed effective.

6. Grower Use: This study will provide details on which strategies are most effective for locating ground squirrel carcasses, and we will identify potential factors that might limit the effectiveness of these carcass searches. These results will be provided to U.S. EPA and other regulatory agencies that could use this information to guide future efforts to minimize nontarget exposure to anticoagulant rodenticides while still ensuring that such mitigation efforts are realistic. This information will be essential for ensuring continued use of rodenticides in a safe yet cost-effective manner.

D. Objectives: We have three primary objectives for this project: 1) determine the effectiveness of three search methods for locating carcasses (walking search, vehicular search, and a search using scent-detection dogs), 2) determine habitat features that might influence detection probability, and 3) determine the fate of carcasses left on the landscape for up to 4 days.

E. Work Plans and Methods (project dates: Apr 1, 2025, to Feb 28, 2026)

1. Work Plan:
    a. Carcass collection (PY1): We will collect ground squirrel carcass through currently on-going removal efforts in municipal parks in the East Bay area during late spring 2025.
    b. Carcass search trials (PY1–PY2): We will conduct carcass search trials in late spring through summer 2025.
    c. Carcass fate trials (PY1–PY2): We will conduct trials on the fate of ground squirrel carcasses in late spring through summer 2025.
    d. Impact of habitat features on carcass searches (PY1–PY2): We will determine the impact of habitat features on the ability of searchers to locate carcasses in late spring through summer 2025.
    e. Data analysis and final report: We anticipate a completion of analyses and the final report by February 28, 2026.
2. Methods: Initial efforts will center on collection of ground squirrel carcasses for use in this study. We plan to assist in trapping that will occur in municipal parks in the East Bay area for carcass collection. Once collected, ground squirrel carcasses will be frozen for later use.

    We plan to conduct trials across four rangeland sites and four nut orchards to determine if the efficacy of searches varies across land-use types where rodenticides are commonly used for ground squirrel control. At each site, we will establish a 10-acre study plot. Within each plot, we will place 20 ground squirrel carcasses in the late afternoon on the day before searches will be conducted. We will conduct three different kinds of carcass searches for this project: 1) walking search conducted by human, 2) driving search, and 3) search using scent-detection dogs. For walking searches, we will establish transects that will be separated by 15 m. Transects will be walked in one direction until the end of

the plot is reached. At that point, the searcher will move to the next transect line and walk it back the other way. Whenever a ground squirrel is detected, the location will be documented via a hand-held GPS unit.

For vehicular searches, we will use 30-m transect lines. The vehicle will drive no faster than 4 mph, and the observer will only search for carcasses on the left-hand side of the vehicle. Once the end of the transect is reached, the vehicle will turn around and travel back down the same line in the opposite direction again searching only on the left-hand side. Carcass locations will be documented via a hand-held GPS.

For scent-detection dogs, the dogs will initially be trained on ground squirrel carcass odors to acclimate them to the scent they are searching for. The dogs will then be worked through the study plot in a systematic manner to locate carcasses; the search pattern will be determined by K9 Conservationist's staff. The carcasses will be recorded via a hand-held GPS unit. We plan to operate dog searches first so that the dogs are not able to key in on human scent around the carcasses from searchers. Walking surveys will then be conducted second, and the driving surveys will be conducted last.

Upon completion of our searches, we will place remote-triggered cameras on the ground squirrel carcasses to document potential scavenging events. Cameras will be set to record 10-second videos to document scavenger behavior at the site. This will allow us to determine both the species that might scavenge a carcass, as well as the date and time that the carcass is scavenged. We plan to leave cameras in place for up to 4 days to document the fate of the carcasses.

We will also document habitat features at each carcass location to determine the potential influence these variables might have on the ability of the searcher to find each carcass. Habitat variables that we will assess may include percent vertical cover, height of ground cover (only in rangelands), percent canopy cover (only in orchards), percent ground cover by forbs and grasses, slope/aspect if relevant, and whether the carcass was on open ground or partially within a burrow entrance.

3. Experimental Site: Exact observation location will be determined at the time of the study based on current ground squirrel activity. That said, we anticipate sites occurring in the San Joaquin and Stanislaus County areas.

F. Project Management, Evaluation, and Outreach

1. Management: R. Baldwin will serve as the PI for the project and will oversee all aspects of the project. All aspects pertaining to detection dogs will be completed by K9 Conservationists

2. Evaluation: The overarching goal for this project revolves around the need to maintain rodenticide labels for use against burrowing rodents when needed. One mitigation effort proposed by U.S. EPA is to conduct carcass searches, yet little is known about their effectiveness. This project will be deemed successful if we are better able to define the utility of carcass searches for removing these potential hazards from treatment areas, as well as by providing additional clarity into the fate of carcasses on the landscape, ultimately providing data needed by regulatory agencies to determine the potential utility of proposed mitigation measures.

G. Budget Narrative

a. Personnel Expenses

Salaries - $21,026: *Salary costs use fiscal year 2024/2025 (July 1, 2024, through June 30, 2025) rates.*

Ryan Meinerz (Staff Research Associate II): Ryan will largely lead coordination of data collection. This will include travel to field sites to conduct all aspects of this study. Effort is estimated at 522 hours for year 1 and 174 hours for year 2 at a wage of $30.06 and $30.66, respectively (PY1 = $15,691, PY2 = $5,335).

Fringe Benefits - $10,887: *Employee Benefits are based on Federally Approved Composite Benefit Rates. The University of California's current Composite Benefit Rates have been federally reviewed and approved through June 30, 2025.*

Ryan Meinerz (Staff Research Associate II): Fringe benefits calculated at 51.4% for 2024/25 and 2025/26 (PY1 = $8,065; PY2 = $2,822).

b. Operating Expenses

Supplies - $5,600

Necessary field items (e.g., flags, data notebooks, gloves, Ziploc bags, etc. = $300)

Bait = $100

Trapping supplies = $1,250

Remote-triggered cameras = $3,000

Batteries = $500

Dry ice = $250

Odor collection and containment supplies for novel odor to train dogs = $200

Equipment:

N/A

Travel - $8,833:

Trip 1: From June 2 to June 7, 2025, SRA II will travel daily from Davis to a ground squirrel collection site in the San Jose area (TBD). This travel will correspond with the collection of ground squirrel carcasses for use in trials. Mileage is for a rental vehicle ($0.35/mile). Daily mileage is anticipated to be 220 miles (PY1 = $462).

Trip 2: From June 16 to June 19, 2025, SRA II will travel from Davis to anticipated field sites in the Westley area (TBD). This travel will correspond with identification of field site, site set up, and initial portions of the trials. Mileage will include travel to closest hotel locations, as well as to field sites in each area (anticipated at 304 miles round trip). Mileage is for a rental vehicle ($0.35/mile). The trip is anticipated to be 4 days/3 nights in duration with hotel ($135/night for 3 nights) and meals ($40/day x 4 days per trip) associated with this trip (PY1 = $662).

Trip 3: From June 16 to June 19, 2025, PI will travel from Davis to anticipated field sites in the Westley area (TBD). This travel will correspond with identification of field site, site set up, and initial portions of the trials. Mileage will include travel to closest hotel locations, as well as to field sites in each area (anticipated at 304 miles round trip). Mileage is for a personal vehicle ($0.67/mile). The trip is anticipated to be 4 days/3 nights in duration with hotel ($135/night for 3 nights) and meals ($40/day x 4 days per trip) associated with this trip (PY1 = $769).

Trip 4: From June 23 to July 1, 2025, SRA II will travel from Davis to anticipated field sites in the Westley area (TBD). This travel will correspond with the carcass search, habitat assessments, and carcass fate portions of the trial. Mileage will include travel to closest hotel locations, as well as to field sites in each area (anticipated at 680 miles round trip). Mileage is for a rental vehicle ($0.35/mile). The trip is anticipated to be 9 days/8 nights in duration with hotel ($135/night for 8 nights) and meals ($40/day x 9 days per trip) associated with this trip (PY1 = $1,678).

Trip 5: From June 23 to June 30, 2025, PI will travel from Davis to anticipated field sites in the Westley area (TBD). This travel will correspond with the carcass search, habitat assessments, and carcass fate portions of the trial. Mileage will include travel to closest hotel locations, as well as to field sites in each area (anticipated at 620 miles round trip). Mileage is for a personal vehicle ($0.67/mile). The trip is anticipated to be 8 days/7 nights in duration with hotel ($135/night for 7 nights) and meals ($40/day x 8 days per trip) associated with this trip (PY1 = $1,680).

Trip 6: From June 23 to June 30, 2025, Staff from K9 Conservationists will travel from Corvalis, OR to anticipated field sites in the Westley area (TBD). This travel will correspond with the carcass search portions of the trial. Mileage will include travel to closest hotel locations, as well as to field sites in each area (anticipated at 1,600 miles round trip). Mileage is for a personal vehicle ($0.67/mile). The trip is anticipated to be 8 days/7 nights in duration with hotel ($150/night for 7 nights) and meals ($70/day x 8 days per trip) associated with this trip (PY1 = $2,682).

Trips 7-8: Travel from Davis to VPCRAC meeting sites (TBD) to provide update on project. Mileage will include travel to closest hotel locations, as well as to meeting location (anticipated at 350 miles round trip). Mileage is for a personal vehicle ($0.67/mile). Trips are anticipated to be 2 days/1 night in duration with associated hotel ($135/night) and meals ($40/day x 2 days per trip) associated with each trip. Total cost per trip estimated at $450. Two trips are anticipated during the project period. Travel reimbursement will be claimed by R. Baldwin (PY1 = $450; PY2 = $450).

Other Expenses: $10,060

Service Contract - $6,460:

K9 Conservationists staff will provide 70 hours of field assistance for year 1 at a rate of $64/hour (PY1 = $4,480).

K9 Conservationists dogs will receive a rate of $60/day per dog for 2 dogs for 4 days, plus $1,500 for dog training preparations and testing (PY1 = $1,980).

Rental Truck - $3,600:

A rental truck will be needed to haul supplies around for project. The rental truck also comes with a lower mileage rate, which will save funds when compared to using a personal vehicle. The cost of the rental truck is $900/month. We will charge 3 months of the rental truck for field use in 2024-2025 and 1 month in 2025-2026 (PY1 = $2,700; PY2 = $900).

Indirect (F&A) Costs - $6,267

Indirect costs are calculated in accordance with the University budgeted indirect cost rate in Exhibit B.

Indirect costs are calculated in accordance with the University budgeted indirect cost rate for Total Cost (TC) TC per the sponsor's indirect cost policy for Vertebrate Pest Control Agriculture Industry Fund 9999000087 (PY1 = $5,261; PY2 = $1,006).

c. Other Funding Sources –

N/A

I. Appendices – Resume: Roger Allen Baldwin

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E-mail: rabaldwin@ucdavis.edu

EDUCATION

Ph.D. Wildlife Science/Range Science, Department of Animal and Range Sciences
New Mexico State University, Las Cruces, NM 88003. February 2008.

M.S. Biology, Emphasis on Vertebrate Zoology
The University of Memphis, Memphis, TN 38152. August 2003.

B.S. Wildlife Biology, Secondary Major in Natural Resource and Environmental Science
Kansas State University, Manhattan, KS 66506. May 2000.

CURRENT APPOINTMENT

Assistant (July 2013 to June 2015), Associate (July 2015 to June 2020), and Full Cooperative Extension Specialist (July 2020 – Present)—Human-Wildlife Conflict Resolution
University of California Cooperative Extension, Division of Agriculture and Natural Resources; and Department of Wildlife, Fish, and Conservation Biology, University of California, Davis.

RESEARCH FUNDING

Extramural grants: *Total funding $10,791,660*

Current and recent relevant titles:

Investigating invasive roof rat resistance by screening for genetic mutations and metabolic changes. Vertebrate Pest Control Research Advisory Committee (July 2022 – June 2023; Co-PI).

Determining utility of drones for monitoring ground squirrel burrow systems. Vertebrate Pest Control Research Advisory Committee (February 1, 2023 – January 31, 2024).

Developing and testing an IPM approach for managing roof rats in citrus. Vertebrate Pest Control Research Advisory Committee (March 2022 – February 2024).

Evaluation of use of owl nest boxes for rodent control in winegrape vineyards. USDA National Institute of Food and Agriculture-Crop Protection and Pest Management Plan (September 2022 – August 2024; Co-Investigator).

$146,503—Testing the applicability of new application strategies of zinc phosphide for managing ground squirrels. Vertebrate Pest Control Research Advisory Committee (August 1, 2023 – June 30, 2025)

Intramural grants: *Total funding $258,571*

Industry/programmatic funding and in-kind support: *Total funding $236,879*

REPRESENTATIVE REFEREED PUBLICATIONS

Baldwin, R. A., R. Meinerz, and J. A. Smith. 2024. Identifying black rat (*Rattus rattus*) movement patterns aids the development of management programs in citrus orchards. Wildlife Research 51:WR23149.

Baldwin, R. A., T. A. Becchetti, J. S. Davy, R. E. Larsen, F. E. Mashiri, R. Meinerz, R. K. Ozeran, and D. Rao. 2022. Estimating reduction in standing crop biomass from California ground squirrels in central California rangelands. Rangeland Ecology & Management 83:50–58.

Baldwin, R. A., R. Meinerz, and A. B. Shiels. 2022. Efficacy of Goodnature A24 self-resetting traps and diphacinone bait for controlling black rats (*Rattus rattus*) in citrus orchards. Management of Biological Invasions 13:577–592.

Baldwin, R. A., T. A. Becchetti, R. Meinerz, and N. Quinn. 2021. Potential impact of diphacinone application strategies on secondary exposure risk in a common rodent pest: implications for management of California ground squirrels. Environmental Science and Pollution Research 28:45891–45902.

Baldwin, R. A., T. A. Becchetti, N. Quinn, and R. Meinerz. 2021. Utility of visual counts for determining efficacy of management tools for California ground squirrels. Human-Wildlife Interactions 15:138–147.

Baldwin, R. A., H. Halbritter, R. Meinerz, L. K. Snell, and S. B. Orloff. 2019. Efficacy and nontarget impact of zinc phosphide-coated cabbage as a ground squirrel management tool. Pest Management Science 75:1847–1854.

Baldwin, R. A., R. Meinerz, and G. W. Witmer. 2016. Cholecalciferol plus diphacinone baits for vole control: a novel approach to a historic problem. Journal of Pest Science 89:129–135.

Baldwin, R. A., N. Quinn, D. H. Davis, and R. M. Engeman. 2014. Effectiveness of rodenticides for managing invasive roof rats and native deer mice in orchards. Environmental Science and Pollution Research 21:5795–5802.

Baldwin, R. A., T. P. Salmon, R. H. Schmidt, and R. M. Timm. 2014. Perceived damage and areas of needed research for wildlife pests of California agriculture. Integrative Zoology 9:265–279.

Baldwin, R. A., T. P. Salmon, R. H. Schmidt, and R. M. Timm. 2013. Wildlife pests of California agriculture: regional variability and subsequent impacts on management. Crop Protection 46:29–37.

PRESENTATIONS

Extension Presentations

Over 340 presentations to various commodity groups, advisory committees, Master Gardener groups, universities, and private organizations.

Professional Presentations

Over 90 presentations at a variety of professional meetings and conferences, including The Wildlife Society National Conference, the Vertebrate Pest Conference, and the American Society of Mammalogists.

2024/2025 VPCRAC Project Proposal
Budget Template

Complete the budget template below by filling in information. This template uses formulas to automatically calculate totals.**Do not** alter the formatting or formulas in cells. Rows may be added to accommodate additional personnel or funding sources, if necessary. Contact the CDFA staff at (916) 764-7759 or emily.schoenborn@cdfa.ca.gov for help filling out this template.

Project Title: Determining utility of carcass searches for reducing secondary exposure risk associated with ground squirrel roden
Project Leader(s): Roger Baldwin

	2024-2025	2025-2026	2026-2027	Total
A. PERSONNEL (name, role, % based on full time salary)				
Salary				
Ryan Meinerz, SRA II: $62,765 for 3 months at 100%,	$15,691.00	$5,335.00		$21,026.00
8 months @ 12.4%				$0.00
				$0.00
				$0.00
Salary Total	$15,691.00	$5,335.00	$0.00	$21,026.00
Benefits				
SRA II: 51.4% for 2024-25 and 52.9% 2025-26	$8,065.00	$2,822.00		$10,887.00
				$0.00
				$0.00
				$0.00
Benefits Total	$8,065.00	$2,822.00	$0.00	$10,887.00
Personnel Cost (A)	$23,756.00	$8,157.00	$0.00	$31,913.00
B. OPERATING EXPENSES				
Supplies	$5,600.00			$5,600.00
Equipment				$0.00
Travel	$8,833.00			$8,833.00
Professional/Consultant Services(Cannot exceed $65/hour)	$6,460.00			$6,460.00
Other	$2,700.00	$900.00		$3,600.00
Operating Cost (B)	$23,593.00	$900.00	$0.00	$24,493.00
TOTAL Costs (A+B)	$47,349.00	$9,057.00	$0.00	$56,406.00
C. Indirect Costs (Cannot Exceed 10% of Total Costs (A+B))	$5,261.00	$1,006.00	$0.00	$6,267.00
TOTAL CDFA FUNDING REQUESTED (A+B+C)	$52,610.00	$10,063.00	$0.00	$62,673.00
D. OTHER FUNDING SOURCES				
				$0.00
				$0.00
				$0.00
				$0.00
				$0.00
TOTAL OTHER FUNDING (C)	$0.00	$0.00	$0.00	**$0.00**
TOTAL PROJECT BUDGET (A+B+C+D)	$52,610.00	$10,063.00	$0.00	$62,673.00