A. Cover Page

1. Project Title: Investigating invasive roof rat resistance

2. Project Leaders:

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3. Cooperators:

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4. CDFA Funding Request Amount/Other Funding:

CDFA Funding Request:

PY 1 (January - June 2022) = $80,829.32

PY 2 (July 2022- June 2023) = $119,168.87

Other Funding:

5. Agreement Manager:

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Associate Director
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B. Executive Summary

1. Problem: Roof rats (*Rattus rattus*) cause extensive damage in both urban and agricultural sites. Several tree crops, including citrus and nuts, experience costly losses from rat damage to fruits and nuts, and from girdling of trunks and branches. Rats are also a significant public health threat in urban areas and pose food safety risks in crops from contamination with their urine and feces. Roof rat infestations in agricultural regions in CA may be recent as their impacts are not described in the older literature for field rodent pest species in California. This raises questions about whether something has changed in this species' distribution or physiology. The first-generation anticoagulants (FGARs) chlorophacinone and diphacinone are labeled to protect crops from roof rat damage and are replacing the now-banned second generation ARs for commensal uses. The risk of resistance to these compounds needs to be assessed in the context of strong selective pressure.

2. Objectives, Approach, and Evaluation:

Our specific objective for this project is to investigate the prevalence of rodenticide resistance in Rattus species in agricultural and urban areas in California.

The approach will be a combination of field and lab work. The field work will involve trapping (snap and live) rats in agricultural and urban areas in California to collect samples from geographically distinct locations. The lab work will involve both genetic analysis for identification of mutations of the VKORC1 gene that may confer anticoagulant resistance and *in-vitro* work that examines the functional resistance of these mutations. The *in-vitro* work will test the metabolic activity of liver microsomes that may be affected by alterations the VKOR enzyme. *In-vitro* work is critical as it will demonstrate the functional metabolic changes related to genetic mutations for specific active ingredients (first or second generation anticoagulants). No applied research related to resistance in *R. rattus* has been conducted in the US.

3. Audience:

Growers, vector control districts, pest management professionals and other applicators of anticoagulant rodenticides would be the primary beneficiaries of this research. This could have a substantial impact to California agriculture given the high value of nut and fruit crops in the state, the extensive damage that roof rats cause in both agricultural and structural environments, and the limited number of tools that can be used to successfully manage them. The current restrictions on the SGARs as a result of AB1788 are likely to exacerbate resistance in California, and seriously compromise the effectiveness of FGARs for rat management.

C. Justification

1. CDFA VPCRAC Mission and Responsibilities:

   This proposed research aligns with these VPCRAC objectives:

   - To continue the state's current vertebrate pest control product registrations until such time as effective alternative products are available.
   - To fund research for the development of scientific data required to maintain registrations.
   - To cooperate with U S Department of Agriculture in funding research programs to maintain, develop, and register vertebrate pest control materials used in California.

   To maintain the CDFA anticoagulant registrations, it is imperative to investigate the extent of rodenticide resistance so their efficacy can be monitored. Data collected from this research could be used to develop a resistance management program. This will provide methods to reduce the likelihood that rodenticide resistance will proliferate. This is critical to maintaining the efficacy of the registered active ingredients. The *invitro* data will assess the efficacy of registered anticoagulant active ingredients, which is scientific data required to maintain registrations. In keeping with the VPCRAC mission, this study utilizes the expertise of the USDA NWRC to assist in maintaining rodenticides that are critical to public health, structural pest control and agriculture in California.

   This proposed project compliments research already funded by VPCRAC. VPCRAC has identified projects that lead to more effective management of roof rats in citrus as a top priority. Field trials are currently underway testing the efficacy of diphacinone and chlorophacinone baits at reducing rat activity in citrus orchards. This proposed research supports the field assessment by directly evaluating the biochemical susceptibility of rats to these and other registered anticoagulant rodenticides.

2. Impact:

   Rats (Rattus spp.) are a common and very damaging invasive pest found throughout much of the world, with one projection of damage caused by rats in the U.S. estimated at $19 billion annually (Pimentel et al. 2005). Although much of the damage they cause occurs in residential areas, they are also common agricultural pests. In particular, nut and tree fruit crops can incur substantial damage from rats when present. For example, *R. rattus* cause an estimated 5–10% loss in developing macadamia nut crops in Hawaii each year (Tobin et al. 1997). Furthermore, roof rats cause frequent damage to citrus crops (Worth 1950), with anecdotal information suggesting roof rat damage is on the rise in citrus orchards in California. Industry surveys have shown that roof rat issues are also increasing in structural pest control across California and the rest of the US. It is unknown if the rapid expansion of rats into new tree crops like citrus, and their expansion across the US is related to their rodenticide resistance.

   With the passage of AB1788 and the subsequent regulations that severely restrict the application of SGARs under most circumstances in California, it is unknown what the future impacts will be. It is also uncertain if an overreliance on FGARs for structural pest management could impact the effectiveness of these active ingredients for agricultural

applications. In the UK, where resistance to certain anticoagulant rodenticides is widespread, the inability of pest management professional to use any of the effective active ingredients (potent resistance-breaking anticoagulants) for rat control has adversely affected the control of resistant rat infestations (Greaves, 1994. It may also have played a part in accelerating the spread of anticoagulant resistance and the proliferation of resistance mutations in the United Kingdom (Greaves 1994).

Effective management options for invasive rats are needed to minimize structural damage, spread of disease and losses in orchard systems.

3. Long-Term Solutions:

In California there continue to be new restrictions placed on already limited tools for rodent management. Being informed about rodenticide resistance can help drive resistance management plans. This proposed research is the first step in building resistance management plans for *Rattus rattus* in both urban and agricultural sites in California. The aim of a resistance management plan is to ensure active ingredients remain available and are used effectively. It is intended that results from the proposed research will better inform legislation in the future. As discussed above, restrictions on some active ingredients in the UK appears to have proliferated the spread of rodenticide resistance in the UK.

4. Related Research:

Resistance to anticoagulant rodenticides in the US was first discovered in Norway rats (*R. norvegicus*) in rural North Carolina in 1971. A nationwide surveillance program was initiated in 1977 to obtain statistically valid samples of rats from federally funded projects of the Urban Rat Control Program. This research involved both *R. norvegicus and R. rattus*. Results indicated that there was widespread resistance to warfarin across the US in *R. norvegicus* (Frantz and Padula,1980). From that time on, there is a dearth of research on anticoagulant resistance in the literature until 2020 when Diaz and Kohn (2020) published research on 6 SNPs (Single Nucleotide Polymorphisms) in house mice, 2 in *R. norvegicus* and one in *R. rattus*. Inferred resistance in the US in the roof rat population is thought to be 39%. Sampling for *R. rattus* anticoagulant resistance was limited to 27 rats from 5 states and did not include California. Furthermore, this sample only used the Tyr25Phe SNP to predict resistance.

Unlike in the US, anticoagulant rodenticide resistance is comprehensively studied in Europe. Studies have documented multiple resistance SNPs in *R. norvegicus*, house mice (*Mus musculus*) and *R. rattus* (McGee et al 2020). It has been acknowledged that widespread anticoagulant rodenticide resistance could potentially lead to a substantial reduction in AR efficacy, resulting in an impaired ability to manage rodent infestations in the future. However, the current state of knowledge regarding anticoagulant resistance mechanisms in common pest rodent species is still incomplete in Europe.

Information from this proposed research will assist in driving future research on rodenticide resistance. Information on the degree of resistance for identified SNPs will need to be carried out in the form of laboratory bioassays to evaluate current registered ARs. This will be extremely important for maintaining all current AR registrations and for obtaining future ones. The information generated from the proposed research will also be extremely important in the first steps for developing resistance management programs.

5. Contribution to Knowledge Base:

Rattus rattus cause extensive damage in tree crops, including citrus and nut. They are vectors of disease and can also cause structural damage in urban environments. Roof rat populations seem to be expanding and growing throughout many agricultural regions in California, while pest management professionals in urban areas are struggling to manage populations given the current constraints on the use of SGARs resulting from AB 1788. Management options for limiting these populations have been unsuccessful. Effective management of rodents is needed to protect public health, prevent damage to structures, and to protect valuable agricultural commodities in California such as citrus and nuts where rats have been identified as significant damaging pests. Information on rodenticide resistance is required to ensure that current registered anticoagulant rodenticides remain an efficacious option for the management of *R. rattus* in California for structural and agricultural uses.

6. Grower Use:

Tree and nut crops are significantly impacted by rodent damage. *Rattus rattus* cause extensive damage to fruit and nut crops through direct fruit consumption, through mortality of limbs from extensive girdling damage and through an increased food safety risk due to feces and urine contamination. This research will look for any genetic and metabolic changes associated with resistance to anticoagulant rodenticides, one of the most important tools in the IPM toolbox for the management of rats. As such, we expect that growers will have the ability to implement rodenticide resistance management programs that will be developed as a result of this research.

Literature cited:

Diaz, J. C., & Kohn, M. H. (2020). A VKORC1-based SNP survey of anticoagulant rodenticide resistance in the house mouse, Norway rat and roof rat in the USA. *Pest Management Science*, *77*(1), 234-242.

Frantz, S. C., & Padula, C. M. (1980). Recent developments in anticoagulant rodenticide resistance studies: Surveillance and application in the United States. In *Proceedings of the Vertebrate Pest Conference* (Vol. 9, No. 9).

Greaves, J. H. (1994) Resistance to Anticoagulant Rodenticides in Rodent Pests and Their Control (first ed.), A.P. Buckle, Smith (Eds.) R.H. CAB International, Wallingford, Oxon, UK (1994), pp. 197-217

McGee, C. F., McGilloway, D. A., & Buckle, A. P. (2020). Anticoagulant rodenticides and resistance development in rodent pest species–A comprehensive review. *Journal of Stored Products Research*, *88*, 101688.

Pimentel, D., R. Zuniga, and Morrison, D. (2005.) Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics 52:273–288.

Tobin, M. E., Koehler, A. E., and Sugihara, R. T. (1997). Effects of simulated rat damage on yields of macadamia trees. *Crop protection*, *16*(3), 203-208.

Worth, C. B. 1950. Field and laboratory observations on roof rats, *Rattus rattus* (Linnaeus), in Florida. Journal of Mammalogy 31:293–304.

D. Objectives

Our specific objective for this project is to investigate the prevalence of rodenticide resistance in *Rattus rattus* in agricultural and urban areas in California.

E. Work Plan and Methods:

1. Work Plan:

This proposed research aims to assess the prevalence of genetic mutations that confer resistance to anticoagulant rodenticides in both urban and agricultural populations of roof rats. To be cost effective, the project must be conducted in multiple phases. In the initial phase we will identify genetic mutations of the VKORC1 gene that have the potential for resistance. In phase 2, we will sample rats from these populations to determine if they are functionally resistant.

2. Methods:

To investigate if the VKORC1 gene has mutations that confer resistance, tail snips need to be collected from across urban and agricultural sites in California. Tail snips from 25 roof rats will be collected from each site (10 agricultural and 10 urban). N. Quinn and R. Baldwin will coordinate the collections of these tail snips and T. Piaggio will search for the presence of genetic mutations that may confer resistance. Tail snips will be collected from snap trapping programs conducted by N. Quinn and Staff Research Associate and by vector control districts, agricultural commissioners, PCAs, PMPs and from already in progress commensal rat research being conducted by N. Quinn and R. Baldwin.

In the lab, we will extract genomic DNA from the tail clippings using DNeasy blood and tissue kits (Qiagen, Hilden, Germany). Extractions will be performed in the NWRC Wildlife Genetics Laboratory (Fort Collins, Colorado) following manufacturer's protocols and automated with a QIAcube (Qiagen) robot. Each extraction will include a negative control containing only reagents and processed with each batch of samples to monitor for contamination. Extracted products will be stored at -20 °C until further processing. We will use primers to sequence the VKORC1 gene. Cycle sequencing reactions will be

performed with 1.0 µL of purified PCR product, 1.0 µM primer, 0.25 mL BigDye® v3.1, and 2.275 mL of buffer (Life Technologies, USA) in 10 µL reactions. Sequencing will be performed on an ABI 3500xl genetic analyzer (Life Technologies, USA) using manufacturer recommended settings. Sequences will be visualized and edited in Sequencher 5.4 (Gene Codes, USA). We will perform sequence analysis on an Applied Biosystems 3500 genetic analyzer (Life Technologies, USA). We will then search for single nucleotide polymorphisms that have been documented to be associated with resistance.

To confirm that the mutations identified on the VKORC1 gene are resistant to specific active ingredients, in –vitro analyses need to be conducted in the laboratory. This analysis will confirm if the mutations confer resistance. The tissue for this analysis needs to be collected from live-captured individuals from populations where genetic mutations have been identified. These individuals will be captured by N. Quinn and R. Baldwin and their staff. Rats will be euthanized using CO2 and livers will be frozen in liquid nitrogen and shipped to NWRC for analyses. Samples will be collected from most or all of the sites where potentially resistant rats have been identified.

Liver microsomes will be isolated according to established methods with minor alterations. Frozen liver samples will be minced using a scalpel until pieces of tissue are approximately 50 mm x 50 mm x 50 mm. Mincing will be done over ice to keep the sample as cold as possible. Then 10 g of minced sample will be homogenized with six passes of a Teflon pestle/glass homogenizer (Wheaton Overhead Stirrer, Millville, NJ USA) with the addition of 2 volumes (w/v) pH 7.4 homogenization buffer. Phenylmethanesulfonyl fluoride (Sigma-Aldrich, St. Louis, NJ USA) is added to the homogenization buffer (2.5 mL/mL). All homogenization is done on ice to ensure the samples remain cold. Liver microsomes are then isolated using differential centrifugation. Total protein in the liver microsome preparations will be assayed and diluted to not be significantly different between samples.

Microsome incubations will be done with various anticoagulant rodenticides to determine extent of metabolism. Incubations will be filtered and analyzed (HPLC) to determine anticoagulant concentrations.

3. Experimental Site:

Sampling sites will be determined at the time of the study and will be divided between production agricultural and urban residential and commercial sites. We anticipate sampling in areas with active rat research programs (Quinn, Horak and Baldwin), in agricultural sites with reports of rat activity, and in areas with Vector Control Districts with active rodent program (Orange, LA, San Diego, Alameda, Contra Costa County).

F. Project Management, Evaluation, and Outreach

1. Management:

N. Quinn and K. Horak will serve as the primary PIs for the project and will oversee all aspects of the project. K. Swift, R. Baldwin, and T. Piaggio will serve as Co-PIs and will be involved extensively in study design and data collection and will aid in analysis and report/publication writing. L. Krueger, D. Flores Rangal and M. Janowiecki will serve as cooperators on the project. They will provide extensive knowledge on roof rat ecology and management, molecular techniques, and assistance with coordination of sample collections from vector control districts, which will be helpful in study design and data collection. They will also provide an extensive review of the final report. N. Quinn and K. Horak will be responsible for coordinating all key contributors to this project.

2. Evaluation:

Success for this project will depend on our ability to identify SNPs that infer anticoagulant resistance. If we are successful, we would conduct additional research to identify how these SNPs could impact an applied management program by conducting laboratory bioassays with wild caught roof rats from populations with SNPs and metabolic changes identified in this study. This is beyond the current scope of this proposed research.

3. Outreach:

The initial results from this proposed research will be shared with anticoagulant rodenticide manufacturers and product registrants. This information will be an important first step in ensuring that the registration and use of active ingredients is prolonged. N. Quinn and R. Baldwin will share results in statewide extension programs to educate rodenticide applicators and pest management professionals on best management practices for bait applications.

G. Budget Narrative

Personnel Expenses

Salaries - $66, 288.54: Salary costs use fiscal year 2022/2023 rates.

Two Staff Research Associate II will largely lead coordination of data collection. This will include the coordination of sample collection for the DNA analysis and travel to field sites to conduct all trapping and liver tissue sampling for the resistance functional analysis portion of this study. Extensive lab time will be required for the processing of samples. Effort is estimated at 2396 hours at rates of $25.41 and $27.88. This is equivalent to 100% time for 1 year for one SRA and 17% time for another SRA.

Fringe Benefits - $39048: 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, 2023.

Staff Research Associate II: Fringe benefits calculated at 57.8% for UCANR SRA and 53.4 % for UC Davis SRA.

Operating Expenses

Supplies - $1088

Liquid nitrogen tanks and gas

Two liquid nitrogen tanks are required to store samples for functional analysis. The cost is approximately $380 per unit. It is estimated that we may require up to 6 liters of liquid nitrogen at a cost of $65.6 per liter.

Trapping supplies

All traps, baits and other trapping supplies will be provided in kind by project leaders Quinn, Baldwin and Swift.

Travel -

Vehicle Lease-$10,300: Vehicle is required for travel to sites which will be distributed throughout California (northern and southern). Approximately $858 per month is requested for 12 months. Trip length in km is dependent on field site location. Time for travel will be related to variables at sites. Almost all field work related travel will be conducted by the SRAs II described above.

Fuel-$4,920: It is likely because of equipment needed that all field work will be conducted using vehicle as air travel will not be feasible. Travel costs will be highly variable depending on the sites visited. The SRA based in Davis will concentrate on sites in closer proximity to their area as will the SRA based in Irvine. It is estimated that travel will cost approximately $475 a month during the field season

Accommodation $7,560: Hotel accommodation will be required for sample collection for many California sites. 12 nights ($105/night) of accommodation are requested each month for approx. 6 months. It is anticipated that most southern California sites can be serviced without accommodation.

Travel to VPCRAC meeting sites-$2612: Two trips are anticipated during the project period. Flights and accommodation will be required for PI's Quinn and Horak.

Subawardee (Consortium/Subrecipient) Costs: $50,000

NWRC Genetics: $25,000 will be used to determine VKORC1 gene mutations. This will cover technician time and reagents used in the analysis

NWRC Toxicology: $25,000 will be used to determine metabolic activity in liver microsomes from animals determined to have gene mutations. This will pay for technician time and analytical services (HPLC analysis)

Exhibit A6 – Current & Pending Support

CURRENT & PENDING SUPPORT

University will provide current & pending support information for Key Personnel identified in Exhibit A2 at time of proposal and upon request from State agency. The "Proposed Project" is this application that is submitted to the State. Add pages as needed.

Niamh Quinn

Status (currently active or pending approval)	Award # (if available)	Source (name of the sponsor)	Project Title	Start Date	End Date
Proposed Project	TBD	California Department of Food and Agriculture	Investigating invasive roof rat resistance	07/01/2022	06/30/2023
Current	NA	Anticoagulant Rodenticide Taskforce	Analysis of anticoagulant rodenticides in mammalian liver, fur, and feces	07/09/2021	03/31/2023
Current	19C0061	California Department of Pesticide Regulation	Development of best management practices to manage urban rats, protect public health, and reduce rodenticide use	09/01/2018	06/30/2023
Current	0000000000000 000000026727	California Department of Consumer Affairs	Investigation of Rodenticide Pathways in an Urban System Through the Use of Isotopically Labelled Bait	9/1/2018	12/31/2022

Roger A. Baldwin

Status	Award #	Source	Project Title	Start Date	End Date
Proposed Project	TBD	California Department of Food and Agriculture	Investigating invasive roof rat resistance	07/01/2022	06/30/2023
Proposed Project	TBD	California Department of Food and Agriculture	Developing and testing an IPM approach for managing roof rats in citrus.	03/01/2022	02/29/2024
Current	NA	Specialty Crop Research Initiative	Scientific challenges and cost-effective management of risks associated with implementation of produce safety regulations	09/01/2020	09/31/2024
Current	NA	California Department of Food and Agriculture	Development of a management program for voles in alfalfa.	09/01/2021	12/31/2022

Katie Swift

Status (currently active or pending approval)	Award # (if available)	Source (name of the sponsor)	Project Title	Start Date	End Date
Proposed Project	TBD	California Department of Food and Agriculture	Investigating invasive roof rat resistance	07/01/2022	06/30/2023
Current	0000000000000 000000026727	California Department of Consumer Affairs	Investigation of Rodenticide Pathways in an Urban System Through the Use of Isotopically Labelled Bait	9/1/2018	06/3/2022

Katherine Horak

Status	Award #	Source	Project Title	Start Date	End Date
Proposed Project	TBD	California Department of Food and Agriculture	Investigating invasive roof rat resistance	07/01/2022	06/30/2023
Current,	19-7483-1417-RA,	California Department of Food and Agriculture	Efficacy and palatability testing of a novel rat specific toxicant	09/01/2021	12/31/2021

Toni Piaggio					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Proposed Project	TBD	California Department of Food and Agriculture	Investigating invasive roof rat resistance	07/01/2022	06/30/2023

2020 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) 262-1102 or David.Kratville@cdfa.ca.gov for help filling out this template.

Project Title:	Investigating invasive roof rat resistance
Project Leader(s):	Niamh Quinn, Katherine Horak, Roger Baldwin, Katie Swift, Toni Piaggio

	Jan 22-Jun 22	July 22-Jun 23	2021-2022	Total
A. PERSONNEL (name, role, % based on full time salary)				
Salary				
Staff Research Associate II (C. Day UCANR)	$27,457.20	$29,129.34		$56,586.54
Staff Research Associate II (R. Meinerz UC Davis)	$9,702.00			$9,702.00
				$0.00
				$0.00
Salary Total	$37,159.20	$29,129.34	$0.00	$66,288.54
Benefits				
Staff Research Associate II (C. Day)	$16,186.00	$17,681.00		$33,867.00
Staff Research Associate II (R. Meinerz)	$5,181.00			$5,181.00
				$0.00
				$0.00
Benefits Total	$21,367.00	$17,681.00	$0.00	$39,048.00
Personnel Cost (A)	$58,526.20	$46,810.34	$0.00	$105,336.54
B. OPERATING EXPENSES				
Supplies				$0.00
Equipment	$200.00	$888.00		$1,088.00
Travel	$5,790.00	$19,602.00		$25,392.00
Professional/Consultant Services(Cannot exceed $65/hour)				$0.00
Other: Funds to NWRC for genetics and in-vitro metabolic	$10,000.00	$40,000.00		$50,000.00
Operating Cost (B)	$15,990.00	$60,490.00	$0.00	$76,480.00
TOTAL Costs (A+B)	$74,516.20	$107,300.34	$0.00	$181,816.54
C. Indirect Costs (Cannot Exceed 10% of Total Costs (A+B))	$7,451.62	$10,730.03		$18,181.65
TOTAL CDFA FUNDING REQUESTED (A+B+C)	$81,967.82	$118,030.37	$0.00	$199,998.19
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)	$81,967.82	$118,030.37	$0.00	$199,998.19

Katherine Horak, Ph.D.
Research Biologist
USDA National Wildlife Research Center (NWRC)
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Education
Ph.D., 2006, The University of Arizona, Tucson, AZ
Department of Pharmacology and Toxicology

B.S., 2000, Northern Arizona University, Flagstaff, AZ
Department of Mathematics, Honors
Department of Biology, Honors

Professional Positions 2006-present
Research Biologist, USDA-APHIS-NWRC, Fort Collins Colorado. 2012-present

Pharmacologist, USDA-APHIS-NWRC, Fort Collins Colorado. 2007-2012

Postdoctoral Fellow, The University of Arizona, Tucson, AZ. 2006-2007

Current Research Activities
- Develop multiple RNAi targets for the control of agricultural pests
- Research the effects of crude oil exposure on avian physiology and behavior
- Research rat specific toxicant in collaboration with an international research organization and a private business
- Determine efficacy of isomers of rodenticides with potential reduced risks to non-target species

None of these activities involve a time commitments that will impact the proposed project.

Publications (2019-present)

Werner S.J., DeLiberto S.T., McLean H.E., Horak K.E., VerCauteren K.C. 2021. Toxicity of sodium nitrite-based vertebrate pesticides for European starlings (Sturnus vulgaris). PLOS One. PLoS ONE 16(3): e0246277. https://doi.org/10.1371/journal.pone.0246277

Horak K.E., 2020. RNAi: Application in vertebrate Pest Management. Trends in Biotechnology. Invited submission. https://doi.org/10.1016/j.tibtech.2020.05.001

Horak K.E., Barrett N.L., Ellis J.W., Campbell E.M., Dannemiller N.G., Shriner S.A., 2020. Effects of Deepwater Horizon oil on feather structure and thermoregulation in gulls: Does rehabilitation work? Science of the Total Environment. 718. https://doi.org/10.1016/j.scitotenv.2020.137380

Dorr B.S., Mathewson P.D., Hanson-Dorr K.C., Healy K.A., Horak K.E., Porter W., 2020. Landscape scale thermoregulatory costs from sublethal exposure to Deepwater Horizon oil in the Double-crested Cormorant. Marine Pollution Bulletin. 152. https://doi.org/10.1016/j.marpolbul.2020.110915

Mauldin R.E., Witmer G.W., Shriner S.A., Moulton R.S., Horak K.E. 2020. Effects of brodifacoum and diphacinone exposure on four species of reptiles: Tissue residue levels and survivorship. Journal of Pest Science. doi: 10.1002/ps.5730

Horak K.E., Campton C.M., Volker S.F., 2020. Are reports of reduced field efficacy of diphacinone and chlorophacinone in California ground squirrels (Otospermophilus beecheyi) due to elevated rodenticide metabolism? Crop Protection. 127. E-publication doi: 1049698.

Rattner, B. A., Volker S. F., Lankton J. S., Beak T. G., Lazarus R. S., Horak K. E., 2019. Brodifacoum Toxicity in American Kestrels (Falco sparverius) with Evidence of Increased Hazard upon Subsequent Anticoagulant Exposure. Environmental Toxicology and Chemistry. doi: 10.1002/etc.4629.

Dannemiller N.G., Horak K.E., Ellis J.W., Barrett N.L., Wolfe L.L., Shriner S.A., 2019. Effects of external oiling and rehabilitation on hematologic, biochemical, and blood gas parameters in Ring-billed Gulls (Larus delawarensis). Frontiers in Veterinary Science. doi:10.3389/fvets.2019.00405.

Snow N.P., Horak K.E., Humphreys S.T., Staples L.D., Hewitt D.G., Vercauteren K.C., 2019. Low secondary risks for captive coyotes from a sodium nitrite toxic bait for invasive wild pigs. Wildlife Society Bulletin. 43(3). 484-490.

Dorr B.S., Hanson-Dorr K.C., Assadi-Porter F.M., Selin-Selen E., Healy K.A., Horak K.E. 2019. Effects of Repeated Sublethal External Exposure to Deep Water Horizon Oil on the Avian Metabolome. Scientific Reports. 9 (317).

Antoinette J Piaggio
Research Biologist
USDA National Wildlife Research Center (NWRC)
4101 Laporte Ave, Fort Collins, CO, USA
toni.j.piaggio@aphis.usda.gov 970-266-6142

Education

2000-2005 University of Colorado Boulder, Boulder, Colorado.
Ph.D. Ecology and Evolutionary Biology
1997-1999 San Francisco State University, San Francisco, California.
M.S. Conservation Biology/ Genetics and Systematics
1987-1991 Mills College, Oakland, California.
B.S. Environmental Science with a Biology emphasis

Professional Positions 2005-present

Research Biologist, USDA-APHIS-NWRC, Fort Collins Colorado. 2009-present

Animal Plant Health Inspection Services Science Fellow, USDA-APHIS-NWRC, Fort Collins Colorado. 2005-2009

Research Grants (active within last 4 years)

2019-2022 Testing and evaluation team DOD Intelligence Advance Projects Activity FELIX Program. Total award: $300,000 Role: Testing and Evaluation Laboratory.

2017-2019 "Developing a gene drive mouse for invasive mouse control" DOD Defense Advanced Research Projects Agency (DAPRA) Safe Genes Program. Total award: $6 million ($1.6 million to NWRC). Role: Co-PI.

Publications (last 2years) (* scientist/student from Piaggio lab**)**

2021 **Piaggio AJ** (2021) "Environmental DNA" in Conservation Technology book S. Wich and Piel (Eds.). Oxford University Press.

Morisette J, S Burgiel, K Brantley, WM Daniel, J Darling, J Davis, T Franklin, K Gaddis, M Hunter, R Lance, T Leskey, Y Passamaneck, **AJ Piaggio**, B Rector, A Sepulveda, M Smith, CA Stepien, T Wilcox (2021) Strategic considerations for invasive species managers in the utilization of environmental DNA (eDNA): steps for incorporating this powerful surveillance tool. *Management of Biological Invasions* 12:747-775.

Rodriquez MD*, PF Doherty, **AJ Piaggio**, KP Huyvaert (2021) Sex and next type influence avian blood parasite prevalence in a high-elevation bird community. *Parasites & Vectors* 14:1-12.

Oh KP*, AB Shiels, L Shiels, DV Blondel, KJ Campbell, JR Saah, AL Lloyd, PQ Thomas, F Gould, Z Abdo, JR Godwin, **AJ Piaggio** (2021) Population genomics of invasive rodents on islands: genetic consequences of colonization and prospects for localized synthetic gene drive. *Evolutionary Applications* 14:1421-1435.

Hopken MW*, **Piaggio AJ**, Pabilonia KL, Pierce J, Anderson T, Pierce CP, Abdo Z. (2021). Population genomic transformations induced by isolation of wild bird avian influenza viruses (Orthomyxoviridae) in embryonated chicken eggs. *Infection, Genetics, and Evolution* 90:104505.

Hopken MW*, L Reyes-Torres, N Scavo, **AJ Piaggio**, Z Abdo, D Taylor, J Pierce, D Yee (2021) Temporal and spatial blood feeding patterns of urban mosquitoes in the San Juan Metropolitan Area, Puerto Rico. *Insects* 12:129

2020 Long K.C, L Alphey, GJ Annas, CS Bloss, KJ Campbell, J Champer, C-H Chen, A Choudhary, GM Church, JP Collins, KL Cooper, JA Delborne, OR Edwards, CI Emerson, K Esvelt, SW Evans, RM Friedman, VM Gantz, F Gould, S Hartley, E Heitman, J Hemingway, H Kanuka, J Kuzma, JV Lavery, Y Lee, M Lorenzen, JE Lunshof, JM Marshall, PW Messer, C Montell, KA Oye, MJ Palmer, PA Papathanos, PN Paradkar, **AJ Piaggio**, JL Rasgon, G Rašić, L Rudenko, JR Saah, MJ Scott, JT Sutton, AE Vorsino, OS Akbari (2020) Core commitments for field trials of gene drive organisms, *Science* 370:1417-1419.

Hopken MW*, **Piaggio AJ**, Pabilonia KL, Pierce J*, Anderson T, Pierce CP*, Abdo Z. (preproof 2020). Population genomic transformations induced by isolation of wild bird avian influenza viruses (Orthomyxoviridae) in embryonated chicken eggs. *Infection, Genetics, and Evolution* 104505.

Borland E, D Hartman, **AJ Piaggio**, MW Hopken*, R Kading (2020) Technical limitations associated with molecular identification of arthropod bloodmeals taken from North American deer species. *Journal of Medical Entomology* 57:2002-2006.

Williams KE*, R Sherwin, K VanDalen, **AJ Piaggio** (2020) A noninvasive genetic technique for identification of *Corynorhinus townsendii* (Townsend's big-eared bat) maternity roosts using guano. *Western North American Naturalist* 80:476-482.

Shiels AB, M Khalsa, D Griffin*, DK Chow, P Baiao, SS Mann, **AJ Piaggio** (2020) Cattle egrets regurgitate house mouse carcasses onto a mouse-free island: implications for rodent eradications. *Wildlife Research* 47:436-440.

Guan X, E Britzke, **AJ Piaggio**, DL Bergman, L Van Pelt, R Lance (2020) Genetic assays for guano-based identification of species and sex in bats of the United States and Canada. *Journal of Mammalogy* 101:970-978.

Teem JL, L Alphey, S Descamps, M Edgington O Edwards, N Gemmell, T Harvey-Samuel, R. Melnick, KP Oh*, **AJ Piaggio**, JR Saah, D Schill, P Thomas, T Smith, A Roberts (2020). Genetic biocontrol for invasive species. *Frontiers in Bioengineering and Biotechnology* 8:452.

Smyser TJ*, MA Tabak, C Slootmaker, MS Robeson, II, RS Miller, M Bosse, H-J Megens, MAM Groenen, SR Paiva, DA de Faria, HD Blackburn, BS Schmit, and **AJ Piaggio** (2020) Rapid expansion of an invasive ungulate driven by bridgehead populations of admixed wild and domestic lineages. *Molecular Ecology* 29:1103-1119.

Davis AJ, DA Keiter, EM Kierepka, C Slootmaker, **AJ Piaggio**, JC Beasley, and KM Pepin. (2020) A comparison of cost and quality of three methods for estimating density for wild pig (*Sus scrofa*). *Scientific Reports* 10:2047.

Piaggio AJ, SA Shriner, JK Young, DL Griffin*, DJ Wostenberg*, EM Gese, MW Hopken* (2020) Predator salivary DNA persistence from multiple species and methods for optimal recovery from depredated carcasses. *Journal of Mammalogy* 101:298-306.

Hopken MW*, **AJ Piaggio**, KL Pabilonia, J Pierce*, T Anderson, Z Abdo (2020) Predicting whole genome sequencing success for archived avian influenza virus (Orthomyxoviridae) samples using real-time and droplet PCRs. *Journal of Virological Methods* 276:113777.

Book chapter: Clark L, J Eisemann, J Godwin, K Horak, KP Oh*, J O'Hare, **AJ Piaggio**, K Pepin, E Ruell (2020) Invasive species control and resolution of human-wildlife conflict: a framework for chemical and genetically-based management methods. In DL Hawksworth, MP de Miranda, and A Chaurasia (Eds.), *GMOs: Implications for Biodiversity Conservation and Ecological Processes*. Springer. https://www.springer.com/gp/book/9783030531829

Book chapter: Beasley JC, MJ Lavelle, DA Keiter, KM Pepin, **AJ Piaggio**, JC Kilgo, KC Vercauteren (2020) Research Methods for Wild Pigs *in* Invasive Wild Pigs in North America: Ecology, Impacts, and Management (VerCauteren K, J Beasley, SS Ditchkoff, JJ Mayer, GJ Roloff, BK Strickland, Eds.). CRC Press/Taylor and Francis Group, pp 199-228.

Book chapter: Mayer JJ, TJ Smyser*, **AJ Piaggio,** SM Zervanos (2020) Wild Pig Taxonomy, Morphology, Genetics, and Physiology *in* Invasive Wild Pigs in North America: Ecology, Impacts, and Management (VerCauteren K, J Beasley, SS Ditchkoff, JJ Mayer, GJ Roloff, BK Strickland, Eds.). CRC Press/Taylor and Francis Group.

Catherine (Katie) E. Swift
412 Hao Street
Honolulu, HI 96821
Cell: (808) 284-8322 Office: (414) 410-7258
email: swiftk@liphatech.com

EDUCATION

Thesis: Laboratory Bioassays with Wild-caught Black (*Rattus rattus*) and Polynesian (*R. exulans*) Rats to Determine Minimum Amounts of Ramik® Green (0.005% diphacinone) and Exposure Times for Field Broadcast Applications in Hawaii (GLP Study)

M.S., Zoology, University of Hawaii (1998)

B.S., Geology, California Institute of Technology (1990)

EXPERTISE

- Federal and state pesticide regulations (FIFRA, Clean Water Act)
- Generating data (including GLP) for pesticide registrations
- Registration of pesticides under FIFRA (section 24c, section 3, section 18)
- Use of pesticides, including Integrated Pest Management (IPM)
- Small mammal control techniques
- Rodent biology, ecology and behavior
- Ecotoxicological assessments and ecological risk assessments
- Symptoms and treatment of rodenticide poisoning for humans, pets, and wildlife
- National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), Animal Welfare Act
- Federal government contracting and grant management policies and procedures

SPECIALIZED EXPERIENCE

Manager of Regulatory Compliance 2016 -- present, Liphatech, Inc., Milwaukee, WI

Invasive Species Biologist 2008–2016, U.S. Fish and Wildlife Service, Honolulu, HI

Wildlife Biologist 2001-2008 U.S. Fish and Wildlife Service, Honolulu, HI

PUBLICATIONS and REPORTS

Quinn, N. and C.E. Swift. 2018. What Do We Need to Know to Assess Individual and Population-level Effects on Wildlife from Anticoagulant Rodenticides?. Proc. 28th Vertebrate Pest Conference: 235-242.

D'Alessio, M., T. Wang, C.E. Swift, M.S. Shanmungam, and C. Ray. 2018. A Tier-I leaching risk assessment of three anticoagulant compounds in the forested areas of Hawai'i. Science of The Total Environment, 630, pp.889-902.

Dunlevy, P., and C.E. Swift. 2010. Nontarget risk and environmental fate of the broadcast application of a diphacinone rodenticide at Mokapu and Lehua Islands, Hawai'i. Proc. 24th Vertebrate Pest Conference: 140-145.

Eisemann, J.D., C.E. Swift, P.A. Dunlevy, W.C. Pitt, and G.W. Witmer. 2010. Panel Discussion – Regulatory and policy issues around non-target mortality and environmental fate of rodenticides. Proc. 24th Vertebrate Pest Conference: 208-212.

Eisemann, J.D. and C.E. Swift. 2006. Ecological and human health hazards from broadcast application of 0.005% diphacinone rodenticide baits in native Hawaiian ecosystems. Proc. 22nd Vertebrate Pest Conference: 413-433.

Hess, S.C., C.E. Swift, E.W. Campbell III, R.T. Sugihara, and G.D. Lindsey. 2009. Controlling small mammals. Pp. 425-447 *in* T.K. Pratt, C.T. Atkinson, P.C. Banko, J.D. Jacobi, and B.L. Woodworth, editors, Conservation Biology Hawaiian Forest Birds. Yale University Press; New Haven, CT. 707 pp.

Pitt, W.C, J.D. Eisemann, C.E. Swift, R. Sugihara, B. Dengler-Germain, and L. Driscoll. 2005. Diphacinone residues in free-ranging wild pigs following aerial broadcast of a rodenticide bait in a Hawaiian Forest. Unpublished Report QA-1077, National Wildlife Research Center; Fort Collins, CO. 37 pp.

Swift, C.E. 1998. Laboratory bioassays with wild-caught black (*Rattus rattus*) and Polynesian (*R. exulans*) rats to determine minimum amounts of Ramik Green (0.005% diphacinone) and exposure times for field broadcast applications in Hawai‘i. University of Hawai‘i, Manoa, Honolulu, HI.

TRAINING AND COURSES

- Good Laboratory Practices (GLP) training (Robin Guy Consulting)
- Pesticide Risk Reduction; College of Tropical Agriculture and Human Resources, University of Hawaii, Honolulu
- Basic Financial Assistance (National Conservation Training Center (NCTC) course)
- Litigation Training (USFWS Course)
- Advanced Interagency Consultation for Endangered Species (NCTC course)
- Interagency Consultation for Endangered Species (NCTC course)
- Integrating NEPA in Fish and Wildlife Service Activities (NCTC course)

ROGER ALLEN BALDWIN

Department of Wildlife, Fish, and Conservation Biology
University of California, Davis
One Shields Ave., Davis, CA 95616

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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 $10,012,176*

Selected titles:

Development of a management program for voles in alfalfa. Vertebrate Pest Control Research Advisory Committee (September 2021 – December 2022).

A test of management tools for invasive roof rats in citrus orchards. Vertebrate Pest Control Research Advisory Committee (February 2021 – December 2021).

Scientific challenges and cost-effective management of risks associated with implementation of produce safety regulations. USDA/NIFA/Specialty Crops Research Initiative (September 2020 – August 2024).

An assessment of quantitative indexing tools and movement patterns in invasive roof rats in citrus orchards. Vertebrate Pest Control Research Advisory Committee (January 2020 – December 2020).

Reregistration of CDFA baits for control of roof rats and deer mice in agricultural fields. Vertebrate Pest Control Research Advisory Committee (April 2010 – March 2012).

Intramural grants: *Total funding $257,071*

Industry/programmatic funding and in-kind support: *Total funding $227,034*

REPRESENTATIVE REFEREED PUBLICATIONS

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.

Lloyd, M. G., and **R. A. Baldwin**. 2021. Burrowing rodents: developing a management plan for organic agriculture in California. University of California Division of Agriculture and Natural Resources, Publication 8688.

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., D. I. Stetson, M. G. Lopez, and R. M. Engeman. 2019. An assessment of vegetation management practices and burrow fumigation with aluminum phosphide as tools for managing voles within perennial crop fields in California, USA. Environmental Science and Pollution Research 26:18434–18439.

Baldwin, R. A., B. G. Abbo, and D. A. Goldade. 2018. Comparison of mixing methods and associated residual levels of zinc phosphide on cabbage bait for rodent management. Crop Protection 105:59–61.

Sellers, L. A., R. F. Long, M. T. Jay-Russell, X. Li, E. R. Atwill, R. M. Engeman, and **R. A. Baldwin**. 2018. Impact of field-edge habitat on mammalian wildlife abundance, distribution, and vectored foodborne pathogens in adjacent crops. Crop Protection 108:1–11.

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. 2016. Vertebrate Pests. In: UC IPM Pest Management Guidelines—Citrus. University of California Division of Agriculture and Natural Resources, Publication 3441.

Baldwin, R. A., R. Meinerz, and S. B. Orloff. 2014. The impact of attractants on pocket gopher trapping. Current Zoology 60:472–478.

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.

Quinn, N., and **R. A. Baldwin.** 2014. Managing roof rats and deer mice in nut and fruit orchards. Division of Agriculture and Natural Resources, Publication 8513.

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

Professional Presentations

Over 70 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.

NIAMH QUINN

HUMAN-WILDLIFE INTERACTIONS ADVISOR

CONTACT ME AT

7601 Irvine Blvd.,
Irvine, CA 92618

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www.UCscurri.com

cosmopolitancoyotes

@SCUWMCouncil

EDUCATION

PhD Small Mammal Ecoloy
National University of Ireland, Galway 2010

BSc Zoology
National University of Ireland, Galway 2005

CURRENT APPOINMENT

I am a University of California Cooperative Extension Human-Wildlife Interactions Advisor, based at the South Coast Research and Extension Center in Irvine with a focus directed on the coordination of Cooperative Extension programming regarding human-wildlife conflicts

RESEARCH AND EXTENSION FUNDING

Extramural grants: Total funding $1,022,367

Selected titles

- Can rodenticide toxicosis be mitigated by changes in management practices? Examination of two different bait stations, their placement, visitations by small mammals and birds, and their interaction with mesocarnivores- Pest Management Foundation
- Development of best management practices to manage urban rats, protect public health, and reduce rodenticide use- Department of Pesticide Regulation
- Investigation of Rodenticide Pathways in an Urban System Through the Use of Isotopically Labelled Bait- Department of Consumer Affairs
- Ground squirrel best management practices website- expansion of passive extension capacities- Department of Food and Agriculture

Industry/programmatic funding and in-kind support: Total funding $140,000

NIAMH QUINN

HUMAN-WILDLIFE INTERACTIONS ADVISOR

CONTACT ME AT

7601 Irvine Blvd.,
Irvine, CA 92618

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EDUCATION

PhD Small Mammal Ecoloy
National University of Ireland, Galway 2010

BSc Zoology
National University of Ireland, Galway 2005

PUBLICATIONS

- Burke, C. B., **Quinn, N. M.**, & Stapp, P. (2021). Use of rodenticide bait stations by commensal rodents at the urban–wildland interface: Insights for management to reduce nontarget exposure. Pest Management Science.
- Baldwin, R. A., Becchetti, T. A., Meinerz, R., & **Quinn, N.** (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, 1-12.
- Baldwin, R. A., Becchetti, T. A., **Quinn, N.**, & Meinerz, R. (2021). Utility of visual counts for determining efficacy of management tools for California ground squirrels. Human–Wildlife Interactions, 15(1), 19.
- **Quinn, N.** (2019). Assessing individual and population-level effects of anticoagulant rodenticides on wildlife. Human–Wildlife Interactions, 13(2), 7.
- **Quinn, N.**, Kenmuir, S., & Krueger, L. (2019). A California without rodenticides: challenges for commensal rodent management in the future. Human–Wildlife Interactions, 13(2), 8.
- Baldwin, R. A., Chapman, A., Kofron, C. P., Meinerz, R., Orloff, S. B., & **Quinn, N.** (2015). Refinement of a trapping method increases its utility for pocket gopher management. Crop Protection, 77, 176-180.
- **Quinn, N.**, and R. A. Baldwin. 2014.Managing roof rats and deer mice in nut and fruit orchards. Division of Agriculture and Natural Resources, Publication 8513.
- Baldwin, R. A., **Quinn, N.**, Davis, D. H., & Engeman, R. M. (2014). Effectiveness of rodenticides for managing invasive roof rats and native deer mice in orchards. Environmental Science and Pollution Research, 21(9), 5795-5802.

University of California
Agriculture and Natural Resources

Proposal to:

CDFA/VPCRAC

Submitting Organization:

The Regents of the University of California
Agriculture and Natural Resources
Office of Contracts and Grants
2801 Second Street
Davis, California 95618-7774

Title of Proposed Program: Investigating invasive roof rat resistance

Total Amount Requested: $199,998.18

Principal Investigator:	**Department:**	**Email:**
Niamh Quinn	UCCE Orange	nmquinn@ucanr.edu;

Checks Made Payable to: The Regents of the University of California

Send Checks to:

Cashier's Office
University of California
PO BOX 989062
West Sacramento, California 95798-9062

Send Award Notice to:

The Regents of the University of California
Agriculture and Natural Resources
Office of Contracts and Grants
2801 Second Street
Davis, California 95618-7774
(530) 750-1303, FAX (530) 756-1148
ocg@ucanr.edu

Institutional Reference Information

DUNS Number: 604591925 **EIN Number: 94-6036494**

Heidi von Geldern 09/17/2021

Heidi von Geldern, Contracts and Grants Officer Date
Authorized Organizational Representative

CITY OF NEW ORLEANS

NEW ORLEANS MOSQUITO, TERMITE & RODENT CONTROL BOARD

September 17, 2021

Dear VPCRAC Committee Members,

I am writing on behalf of the City of New Orleans Mosquito, Termite, and Rodent Control Board (NOMTRCB) to confirm that we are fully supportive of this grant proposal. NOMTRCB is willing and capable of participating as described in the proposal.

The NOMTRCB has a full service vector and urban pest program and since 1964 the Board has dealt with numerous epidemics of mosquito-borne and rodent-borne diseases as well as vector and pest problems after disasters. The Board is dedicated to decreasing the incidences of disease transmission, economic loss, and medical emergencies caused by pests to enhance the quality of life of the residents of New Orleans. This is achieved by managing pest populations through a series of integrated approaches including surveillance, source reduction, biological control, sanitation, community education, and abatement operations.

The Board is excited to collaborate with this team on this proposed rodenticide resistance research project. Our microbiologist, Dr. Mark Janowiecki, has already collaborated with Dr. Quinn and Orange County Vector and Mosquito Control District on preliminary rodenticide resistance research. Dr. Janowiecki has been providing molecular guidance to the team and is excited to continue this support.

The City of New Orleans Mosquito, Termite, and Rodent Control Board is prepared to dedicate the resources needed and excited to participate in this research. This collaboration will not only benefit the agricultural and urban communities in California but will assist our Board in making scientifically-informed management decisions for commensal rodent species in our city as well. We are fully supportive of this project and look forward to working with the partners if the project is funded.

Sincerely,

Claudia Riegel

Claudia Riegel, Ph.D.
Director

2100 Leon C. Simon Dr., New Orleans, LA 70122 Ph (504)658-2400 Fax (504)658-2405

Anticoagulant Rodenticide Task Force

Katie Swift, Chairperson
Telephone: (808) 284-8322
Email: swiftk@liphatech.com

September 10, 2021

Niamh Quinn
Human-Wildlife Interactions Advisor
University of California Agriculture and Natural Resources
South Coast Research and Extension Center
7601 Irvine Blvd.
Irvine, CA 92618

Subject: Support for the grant proposal 'Investigating Invasive Roof Rat Resistance'

Dear Dr. Quinn:

The Anticoagulant Rodenticide Task Force is in favor of conducting this project. The purpose of the Task Force is to support the generation of data in response to EPA's registration review of FGARs and SGARs, and the California Department of Pesticide Regulation (DPR)'s reevaluation of SGARs; and engage in joint advocacy efforts regarding the registration of FGARs and SGARs. We think the information gained from this project will provide urgency to the completion of DPR's reevaluation of the SGARs so that they can be returned to availability for use in commensal rodent control in California. This information is also essential for ensuring that the FGARs remain effective for controlling roof rats in agricultural settings.

No systematic survey for anticoagulant resistance in roof rats has been conducted in California, and we are very concerned that the significant changes resulting from the passage of AB1788 are resulting in resistant populations. This proposed study is the only project that has the specialized expertise and resources required to investigate this urgent issue.

Sincerely,

Katie Swift

Katie Swift, Chair

Member companies:

- Bell Laboratories, Inc.
- Central Garden & Pet Company
- Liphatech, Inc.
- Neogen Corp.
- PelGar International, Ltd.
- Scimetrics Limited Corp.
- Unichem d.o.o.
- VM Products
- Wilco Distributors, Inc.

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September 16, 2021

VPCRAC Grant Submission

RE: Letter of support for proposed work on Investigating Invasive Roof Rat Resistance

Dear VPRAC Selection Committee,

The Orange County Mosquito and Vector Control District (OCMVCD) fully supports the application for a Pest Management Research Grant as submitted by Dr. Niamh Quinn, Regents of the University of California, Agriculture and Natural Resources. The OCMVCD administers an education-based rat inspection program that provides inspection and consultation to residential property owners in Orange County. As part of District's commitment to Integrated Vector Management, the California Department of Pesticide Regulation awarded a 2017 Integrated Pest Management Award to OCMVCD, recognizing the significant reduction in rodenticides applied by the Agency in response to the implementation of best management practices for urban rat control.

Managing roof rats has become increasingly difficult in the State of California and preliminary research conducted by the OCMVCD has detected genetic mutations in roof rats that lead to rodenticide resistance. This grant is crucial to investigate the extent of rodenticide resistance in order to develop a resistance management program aimed at preventing rodenticide resistance from proliferating. In addition to improving our understanding of rodenticide resistance in commensal rodents, this proposed research will benefit homeowners, pest control operators, and agricultural producers who are managing vertebrate pests across the state.

The OCMVCD, specifically, Vector Ecologist, Laura Krueger, and Microbiologist, Dr. Daisy Flores Rangel, will provide technical advice already gained through work conducted on the preliminary project with the project investigators.
This project will greatly benefit the public by systematically studying the best rodent control measures. The OCMVCD looks forward to the collaboration with Dr. Quinn to better understand rodenticide resistance in California.

Sincerely,

Laura Krueger
Board Certified Entomologist, Vector Ecologist

Daisy Flores Rangel, PhD
Microbiologist