California's Rodenticide Surcharge Program: History and Accomplishments

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ABSTRACT: In 1990, the California Legislature passed a law to collect a $0.50 per pound surcharge on all vertebrate pest control materials sold by county agricultural commissioners throughout the state. These monies were to be used to fund research required to maintain the state's current vertebrate pesticide registrations, to improve existing rodenticides, and to find new materials and methods to solve California's vertebrate pest problems. An external advisory committee, the Vertebrate Pest Control Research Advisory Committee, was established to set research priorities and recommend expenditures from this fund. To date, this program has raised more than $6.5 million to meet its objectives. We summarize the history and operation of the surcharge fund as well as the accomplishments of the program. Data on rodenticide sales throughout this program's operation are presented. We describe the types of research funded to date, as well summarizing results of selected studies supported by this program. We also review accomplishments in education and outreach supported by this fund.

KEY WORDS: California, pesticide registration, research, rodenticide, surcharge fund

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INTRODUCTION

California's agricultural production, leading the nation at over $27 billion annually, is approximately twice the value of that the next-nearest state. Among the 350 distinct crops commercially produced are a number of specialty crops as well as agricultural commodities grown almost exclusively in California– for example, almonds, artichokes, dates, figs, kiwifruit, olives, pistachios, and walnuts (CDFA 2002).

California's diverse agriculture, coupled with its range of habitats and high diversity of vertebrate species, results in the widest array of vertebrate pest problems within the U.S. These conflicts, which are typically caused by rodents, birds, and various large mammals including predators, can cause significant economic loss to some agricultural commodities, even when corrective actions are taken.

Early in the 20th Century, few vertebrate pesticides were available for agricultural use. Because the market for such products was small, particularly for the more specialized crops, private manufacturers were generally not involved in developing, producing, and selling such materials. To address the serious vertebrate pest problems in the state, the California Department of Food and Agriculture (CDFA) was active in developing and assisting in registering rodenticides and avicides for use against agricultural pests (Salmon et al. 1999). The County Agricultural Commissioners in most California counties registered and manufactured vertebrate control materials. Primarily, these were rodenticides such as Compound 1080, strychnine, zinc phosphide and various formulations of anticoagulants, and strychnine for bird control. In addition, many offices sold fumigants such as carbon bisulfide, methyl bromide, and gas cartridges.

By the 1980s, changes in federal law regarding registration of pesticides had begun to affect the availability of vertebrate control materials to agricultural producers and others within California. Subsequently, the federal Environmental Protection Agency (EPA) revoked the registration of Compound 1080 (sodium fluoroacetate), used primarily against field rodents, because of lack of adequate data to support this use. A Federal court order stopped the aboveground use of strychnine, which had been used against both crop-depredating birds and against field rodents, leaving only underground baiting (i.e., for pocket gophers) for this material. There was no impetus for the manufacturer of Compound 1080 to bear the cost of developing re-registration data required by EPA, as the total amount of active ingredient used in the U.S. was small and not very profitable. Additionally, in California all Compound 1080 use was by or under the direct supervision of the county agricultural commissioners. Although it was regarded as the most effective and cost-efficient rodenticide against ground squirrels, its registration was lost because CDFA did not have the financial resources to meet EPA's registration requirements (Vertebrate Pest

development of new products and techniques would require a substantial research effort. At the time, funds were limited and both the University of California and CDFA were reducing their research efforts in vertebrate pest control. It seemed like regulators, special interest groups and concerned individuals could ask questions and CDFA had little or no ability to research the questions and find answers. Little data were available to answer critical environmental questions. Without data to support the continued use of vertebrate pest control products, it was clear that continued registration and use of these materials was problematic. CDFA's response was to propose and ultimately develop the Rodenticide Surcharge Program.

Part of the genesis of California's current Rodenticide Surcharge Program was the 1989 report of a Vertebrate Pest Control Task Force that had been envisioned by the California Agricultural Commissioners and Sealers Association and formed by action of the Secretary of CDFA. The report recognized the "need to develop data to satisfy EPA's recent requirements for maintaining registration of essential rodenticides, avicides, and predacides critical to California's agricultural production" (Vertebrate Pest Control Task Force 1989, p. 4). The report further suggested that CDFA explore "...alternative sources of funding... that may include establishment of a ...Trust Fund. These funds would be from an industry assessment and would be available for research... based upon a recommendation by the [Secretary's] Vertebrate Pest Advisory Committee" (Vertebrate Pest Control Task Force 1989, p. 6).

Purpose

The Rodenticide Surcharge Program was created in 1990 by passage of Assembly Bill 2776, sponsored by the agricultural industry, in the California Legislature. This legislation, which created Sections 6025 through 6029 of the state Food and Agricultural Code, provided for the following:

1) the establishment of a research program on the control of vertebrate pests,
2) the formation of a Vertebrate Pest Control Research Advisory Committee, and
3) the funding of the research program by means of a $0.50 per lb assessment on vertebrate pest control materials sold or distributed by the county.

The legislation contained a sunset provision whereby this act would be reviewed every 5 years and could be renewed for additional 5-year periods by the Legislature if desired. Currently, the program is authorized until 2006.

The vertebrate pest control research program was to be established and administered by the Secretary of CDFA, aimed at dealing with those species that posed "a significant threat to the welfare of the state's agricultural economy and the public". The specified purposes of this research program are:

1) to investigate effective and economical alternative materials for the control of vertebrate pests,
2) to support research for the development of control product registration [illegible] effective alternative products are available,
4) to fund research for the development of scientific data required to maintain registrations, and
5) to cooperate with USDA in funding research programs to maintain, develop, and register vertebrate pest control materials used in California.

Research Advisory Committee

The Vertebrate Pest Control Research Advisory Committee (VPCRAC) consists of the following members:

1) One representative of CDFA
2) One representative of the County Agricultural Commissioners and Sealers Association
3) Five representatives of the agricultural industry representing affected commodities
4) One representative of the University of California
5) One representative of the California State University
6) One representative of the California Dept. of Health Services, and
7) One representative of the general public, with consideration given to a person with expertise in animal welfare.

It is VPCRAC's charge to annually prioritize research needs regarding vertebrate pest control projects. In conjunction with CDFA staff, the Committee assists in administering the research program by issuing periodic calls for research proposals on topics related to California's vertebrate pests. The Committee reviews and recommends funding for research proposals received, monitors the progress of funded research, and advises the Secretary on emerging needs and priorities. The current membership of the VPCRAC is listed in Table 1.

Table 1. Current membership of the Vertebrate Pest Control Research Advisory Committee (VPCRAC).

Member	Representing
Duane Schnabel	CDFA
Dennis Bray	Agricultural Commissioners
Ellen Des Jardin Hirth	agricultural industry
Art Foster	agricultural industry
Marvin Meyers*	agricultural industry
Dan Spangler	agricultural industry
Edward Tully	agricultural industry
Robert Timm	University of California
Charles Crabb	California State University system
Mark Novak	Calif. Dept. of Health Services
George Simpson	general public

* committee chairperson

The assessment of the $0.50 per lb surcharge on vertebrate pest control materials was specified to be collected by county agricultural commissioners and paid into a newly established Vertebrate Pest Control Research Account in CDFA, to be appropriated by the Secretary of CDFA solely for the purpose of establishing and admin-

istering the research program. If necessary, the Secretary, following consultation with the VPCRAC, can raise the surcharge assessment to a maximum of $1.00 per lb of material distributed or sold.

At the present time, CDFA is the registrant for 8 products used in vertebrate pest control in California (Table 2). By far, the products most commonly manufactured and sold are baits manufactured with the active ingredient diphacinone, which account for approximately 75% of all sales, by weight.

Total pounds of vertebrate pest control materials sold annually, and the resulting surcharge income, have varied since the program's inception. Figure 1 shows trends in product use and surcharge income through time. Product use has range from a low of 606,052 lbs in FY1999 to a high of 1,415,475 lbs in FY1995, averaging 1,027,110 lbs annually. This has resulted in an inflow of surcharge funds varying between approximately $303,000 and $707,700 annually, averaging $513,600, for a total of approximately $6.4 million from 1991 through 2003.

During the late 1980s and early 1990s, changes in federal pesticide law established new data requirements for all new and existing pesticides. CDFA, along with other registrants of existing rodenticides and other vertebrate pesticides, was notified that additional scientific data about the toxicity, use, and environmental fate of zinc phosphide and anticoagulant rodent baits was required in order for the agency to consider renewing the registration of these products. Without these new data, these products would be prohibited from use in agriculture– a potentially devastating situation for California producers. Therefore, early in its history the VPCRAC placed a high priority on funding required studies to maintain CDFA's existing product registrations that utilized these active ingredients. At the same time, emphasis was given to discovering and evaluating alternative methods and materials for control of rodents and other vertebrate pests. The VPCRAC strongly supports integrated pest management approaches that incorporate new knowledge into developing more efficient, appropriate strategies for dealing with vertebrate pest conflicts.

PESTICIDE REGISTRATION MAINTENANCE

Given the critical need to maintain availability of its rodenticides to agricultural producers and other clientele, it is not surprising that a large proportion of the surcharge program's early efforts went into providing data deemed essential by EPA for continuing these registrations. Of 75 separate research projects funded from 1991 through 2003, 46 (61%) involved studies on the safe and effective use of chlorophacinone, diphacinone, and/or zinc phosphide, which are the active ingredients in CDFA's current field rodenticides (Table 2). The costs associated with these studies totaled about $3.3 million, or 65% of the approximately $5 million expended to data on vertebrate pest research (Figure 2). New information required by EPA during the data call-in process associated with re-registration of all rodenticides in the U.S. included such studies as those detailed in Table 3. These data are described as typical for each rodenticide

RESEARCH FUNDED

For another perspective, the research projects funded can be categorized according to taxonomic groups and other topics (Figure 2). It is readily apparent that rodent problems have been the dominant focus of research to date, driven in part by the data requirements by EPA associated with the re-registration process. When grouped according to rodent species, the California ground squirrel has been the predominant focus of nearly half of the studies (Table 4). While this emphasis likely is justified because of the widespread distribution of California ground squirrels in the state and the resulting conflicts they cause, it also resulted from the acute need to do research to support the continued registration of CDFA's zinc phosphide, chlorophacinone, and diphacinone ground squirrel baits.

Research on pest problems caused by birds and by predators is lower on a statewide scale than on rodents as a group, but they are far from insignificant. The relatively smaller number of projects, and amounts of funding expended, on birds and predators is partly an artifact of the need to maintain CDFA's rodenticide labels. Nevertheless, the VPCRAC has funded such studies as evaluating potential new bird repellents for lettuce, controlling bird feeding damage to grapes, and dispersing fruit and nut-eating birds from orchards. The Committee has also recently funded investigations into a potential new coyote toxicant, as well as a coyote bait delivery device. Both of these topics may provide future methods of managing coyote predation on livestock, a pressing need, especially in light of the 1998 California trap ban initiative that also banned use of Compound 1080 (in the livestock protection collar) and sodium cyanide (in the M-44 ejector device).

Recipients of research funding to date have included three universities (UC Davis, UC Berkeley, Utah State University), UC Cooperative Extension advisors, the USDA National Wildlife Research Center, and private research labs (EBA Inc., Genesis Laboratories Inc., HACCO Inc.).

OTHER NEEDS FUNDED

In addition to funding specific research needs, the program has funded several outreach components. During 1996, a series of five outreach meetings were held throughout California that provided an opportunity for agricultural stakeholders and others to learn from VPCRAC members and from CDFA staff the surcharge program's accomplishments, and to discuss the most important vertebrate pest management needs. Information obtained from these sessions assisted the Committee to prioritize current and developing research needs.

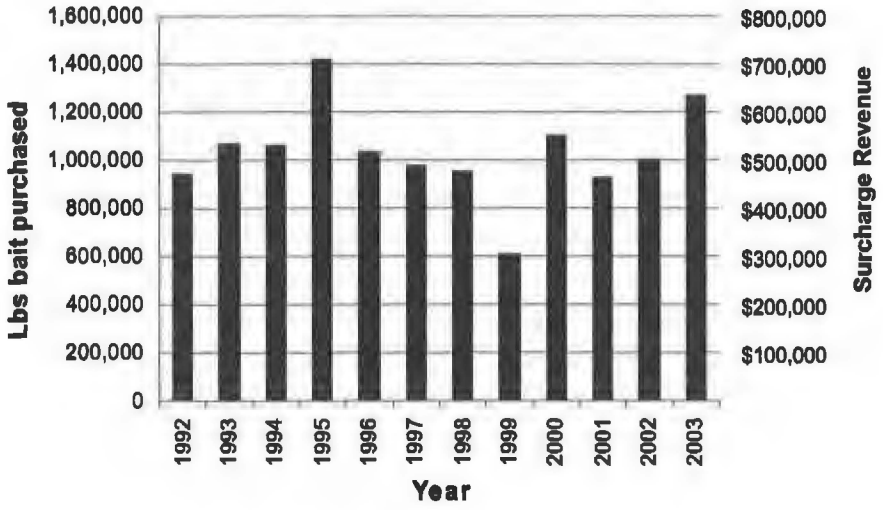
A specific outreach program funded in 1998 led to the publication of an extensive brochure, "Protecting California's Agriculture" (Salmon et al. 1999). This publication was targeted toward growers and other clientele of county agricultural commissioners, whose purchase of rodenticides supported the program. In addition to explaining some of the principles that guide vertebrate pest damage management, it recounted the idea for the surcharge program, how it was implemented, and

Name	Active ingredient	Percent a.i.	Target Species*
Rodent bait chlorophacinone treated grain	chlorophacinone	0.005%	C, GS, J, M, NR, V, RR, WR
Rodent bait chlorophacinone treated grain	chlorophacinone	0.01%	DM, GS, HM, PG
Rodent bait chlorophacinone treated artichoke bracts	chlorophacinone	0.01%	V
Rodent bait block diphacinone treated grain	diphacinone	0.005%	HM, M, NR, RR, WR
Rodent bait diphacinone treated grain	diphacinone	0.005%	C, GS, J, M, NR, RR, V, WR
Rodent bait diphacinone treated grain	diphacinone	0.01%	DM, GS, HM
Rodent bait zinc phosphide treated grain	zinc phosphide	1.0%	GS, NR, RR, V, WR,
Rodent bait zinc phosphide treated grain	zinc phosphide	2.0%	GS, NR, RR, V

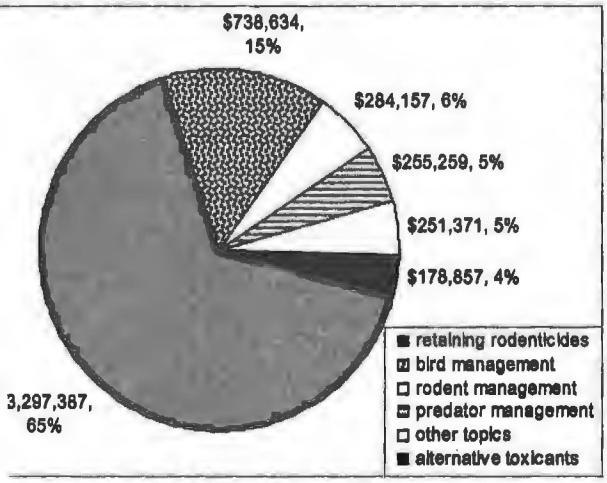
*C = chipmunks (*Eutamias* spp.)
DM = deer mice (*Peromyscus* spp.)
GS = ground squirrels (*Spermophilus beecheyi, S. beldingi, S. lateralis*)
HM = house mouse (*Mus musculus*)
J = jackrabbits (*Lepus californicus*)
M = muskrats (*Ondatra zibethica*)
NR= Norway Rats (*Rattus norvegicus*)
PG = pocket gophers (*Thomomys* spp.)
RR = Roof Rats (*Rattus rattus*)
WR = Wood Rats (*Neotoma* spp.)
V = voles (*Microtus spp.*)

Table 3. EPA data guideline requirements for CDFA's products in the rodenticide cluster.

DATA REQUIREMENT	
Guideline No.	**Guideline Name**
	Product Chemistry
61-1 / OPPTS 830.1550	Product identity and composition
61-2(a) / OPPTS 830.1600	Description of materials used to produce the product
61-2(a) / OPPTS 830.1620	Description of production process
61-2(a) / OPPTS 830.1650	Description of formulation process
61-2(b) / OPPTS 830.1670	Discussion of formation of impurities
62-1 / OPPTS 830.1700	Preliminary analysis
62-2 / OPPTS 830.1750	Certification of limits
62-3 / OPPTS 830.1800	Analytical method
63-2 / OPPTS 830.6302	Color
63-3 / OPPTS 830.6303	Physical state
63-4 / OPPTS 830.6304	Odor
63-7 / OPPTS 830.7300	Density
63-12 / OPPTS 830.7000	pH
63-14 / OPPTS 830.6314	Oxidizing or reducing action
63-15 / OPPTS 830.6315	Flammability
63-16 OPPTS 830.6316	Explodability
63-17 / OPPTS 830.6317	Storage stability
63-20 / OPPTS 830.6320	Corrosion characteristics
	Toxicity Data
81-1 / OPPTS 870.1100	Acute oral toxicity - rat
81-2 / OPPTS 870.1200	Acute dermal toxicity - rabbit/rat
81-3 / OPPTS 870.1300	Acute inhalation toxicity - rat
81-4 / OPPTS 870.2400	Primary eye irritation - rabbit
81-5 / OPPTS 870.2500	Primary dermal irritation
81-6 / OPPTS 870.2600	Dermal sensitization
	Efficacy Data
96-10	Efficacy - Commensal rodenticides (Norway rat – laboratory efficacy)
96-10	Efficacy - Commensal rodenticides (House mouse – laboratory efficacy)
96-12	Efficacy - Rodenticides on farms and rangeland (ground squirrels – laboratory efficacy)
96-12	Efficacy - Rodenticides on farms and rangeland (ground squirrels – field efficacy/bait stations)
96-12	Efficacy - Rodenticides on farms and rangeland (ground squirrels – field efficacy/spot baiting)
96-12	Efficacy - Rodenticides on farms and rangeland (ground squirrels – field efficacy/broadcast baiting)
96-12	Efficacy - Rodenticides on farms and rangeland (deer mouse – laboratory efficacy)
96-12	Efficacy - Rodenticides on farms and rangeland (deer mouse – field efficacy/broadcast baiting)
96-12	Efficacy - Rodenticides on farms and rangeland (vole – field efficacy/spot baiting)
96-12	Efficacy - Rodenticides on farms and rangeland (vole – field efficacy/broadcast baiting)
96-12	Efficacy - Rodenticides on farms and rangeland (pocket gopher – field efficacy / underground baiting)
70-C-SS Special Studies	Whole Body Residue, Target Species (Squirrels)
71-5 / OPPTS 850.2500	Field Testing for Terrestrial Wildlife (Non-Target Species Risk Assessment)
	Field Testing for Terrestrial Wildlife (Squirrels)
71-5 / OPPTS 850.2500	Underground Carcass Search



gure 1. Annual vertebrate pest control product use (lbs and resulting surcharge funding income since the nception of the program.



ure 2. Portion of funds expended on various aspects of ertebrate pest research. A total of $5,005,665 was pended on research from 1991 through 2003.

le 4. Rodent research studies funded by surcharge nd, listed by species of primary interest.

Species	Number of studies
California ground squirrel	23
Voles (*Microtus* spp.)	10
Belding ground squirrel	6
Rats & mice (commensal rodents)	5
Pocket gophers	5
Other rodents	5

As one of a small group of rodenticide registrants in th America, CDFA recognized, as did the commercial manufacturers, that pooling and sharing resources ld be cost-effective in responding to EPA's re-

VPCRAC chose to expend surcharge funds to join several consortia of registrants with similar rodenticide products. The VPCRAC also recognized the need to expend surcharge funds to employ the assistance of consultants having particular expertise and knowledge in the arena of pesticide registration.

The VPCRAC, in cooperation with CDFA, the California Agricultural Commissioners Association, and the University of California, continues to develop a comprehensive educational outreach program focused on vertebrate pests and their management. "Vertebrate Pest Review" newsletters were published and distributed, in 2000 and 2001. Educational presentations on vertebrate pest control method and technologies, which have been used both by UC Cooperative Extension specialist and advisors as well as by CDFA staff, have been developed. A CDFA-hosted web page that focuses on vertebrate pest issues continues to evolve and to provide current information, as well as guiding clientele to additional resources.

Since the surcharge program's inception, surcharge funds have supported the VPCRAC activities by reimbursing Committee members as needed for their travel costs in attending twice-yearly meetings. These meetings, in addition to providing an opportunity for the Committee to discuss and monitor ongoing research work, allow interested members of the public to attend and receive continuing education credits (typically 4 hours of laws and regulation, plus 4 hours of other credit) that apply toward California Department of Pesticide Regulation requirements to maintain pesticide applicator certifications and licenses.

As a result of the state's continuing budget crisis, the VPCRAC in spring 2003 voted to fund from surcharge monies an existing Senior Agricultural Biologist position within CDFA, because this position otherwise would

department. The Committee recognized that this position was critical to the administration and coordination of the surcharge program, as well as to the ongoing cooperative outreach efforts between VPCRAC and CDFA.

ACCOMPLISHMENTS

Among the many research accomplishments of the surcharge program are the following:

Rodenticide Re-Registration

The program funded research to collect all of the required new data on chlorophacinone, diphacinone, and zinc phosphide in regard to their agricultural uses in California, particularly in relation to CDFA's labeled products. Where existing data were present, CDFA staff, together with consultants, cooperated with other registrants to assure that EPA was in receipt of all pertinent information bearing on the re-registration decision. Currently, all registrants are awaiting final federal regulatory approval, which is expected to be forthcoming.

Artichoke Rodenticide Reformulation

The sole material commercially available to artichoke growers to protect their crop from California voles (*Microtus californicus*) has been a chlorophacinone oil concentrate. Because of recent federal re-registration requirements, the supplier of this product recently decided not to continue marketing this formulation. Left with no viable alternative control method, artichoke growers approached the VPCRAC asking for help. Research funded by the surcharge program was successful in creating a suspension of chlorophacinone in mineral oil that could be applied to artichoke bracts to make a treated bract bait with 0.01% active ingredient. The formulated bait is applied via hand placement at the base of artichoke plants in the field, as had been done with the previous product. The new formulation has received both state and federal regulatory approval and has replaced the pervious formulation. Concurrently, the surcharge program is funding continuing research to evaluate other rodenticides such as zinc phosphide as potential toxicants for voles in artichoke fields, while also examining the extent to which voles may have become resistant to anticoagulants after prolonged use.

Expanded Zinc Phosphide Use

Pen and field research on zinc phosphide baits, funded by the surcharge program, resulted in new approved uses for this rodenticide against voles. Recently, CDFA received state and federal regulatory approval, including a federal food tolerance, for use of zinc phosphide to control voles in alfalfa (see Ramey et al. 1994, 2000, 2004; Sterner 1998). This was achieved because the required tests demonstrated this rodenticide when applied to alfalfa resulted in no significant hazards to non-target species or to animals that would subsequently consume the forage crop.

Selective Bait Stations

Ground squirrel control via us of bait stations formerly was not feasible in regions inhabited by endangered kangaroo rats, as the anticoagulant grain bait would be toxic to the kangaroo rats if they ingested it. Two elevated bait station designs were developed. Through laboratory and field testing, it was shown that these new bait stations would permit ground squirrels to feed on toxic bait while excluding kangaroo rats. These stations, along with careful timing of baiting, minimize hazards to these endangered species, allowing landowners to conduct effective ground squirrel control (see Salmon et al. 1999).

Rodent Baiting Strategies

A major effort of VPCRAC was to address ground squirrel control baiting strategies. Concern was expressed about the potential hazards with the current anticoagulant labels, especially the 0.01% broadcast diphacinone and chlorophacinone materials. Several major projects were funded to evaluate the effectiveness and risks of spot and broadcast baiting strategies. A comparison between chlorophacinone and diphacinone was also funded. Earlier laboratory work demonstrated differences in effectiveness of various baiting strategies including bait strength and application timing. Through extensive field trials, VPCRAC was able to demonstrate the effectiveness of the registered materials, comparative differences, and potential risks associated with their use. Data from these studies were used extensively in support of the re-registration of diphacinone and chlorophacinone for California ground squirrel control.

VPCRAC has supported additional projects to evaluate alternative rodenticides and baiting strategies for ground squirrels, pocket gophers, voles and other vertebrate pests. Major projects are underway to evaluate anticoagulant baiting strategies for pocket gophers, underground baiting techniques for ground squirrels, fencing and trapping methods for jack rabbits, and damage and movement patterns for cottontail rabbits in nurseries. These studies demonstrate the diverse nature and ultimate value of research funded from the surcharge program to agriculture and citizens of California.

A Vole Activity Index

Effective control of California vole damage to agricultural crops often is dependent upon recognizing the beginning of a population irruption soon enough to apply control methods before the voles enter a steep rate of increase. The surcharge program funded a study to examine improved methods of indexing vole activity. Wax blocks (50% steam-rolled oats, 50% paraffin) provided the most sensitive index measurements and were the easiest to use of four techniques evaluated. Their placement in a regular grid pattern was effective and was not affected by observer bias, as was the formerly-recommended method of setting a transect of snap traps in locations of observed vole activity (see Whisson 2003).

Biosonics for Bird Control

Birds can cause significant losses to agriculture. At this time, there are few pesticides registered and used in California for bird control. Because of the tremendous damage caused by birds, VPCRAC funded a series of

projects focusing on the use of biosonics.

American crows (*Corvus brachyrhynchos*) damage almond and pistachio orchards, causing considerable economic loss. During summer 1997, researchers used a hand-held tape player to test a crow distress call as a new technique to reduce damage in almond orchards in the Sacramento Valley (Salmon et al. 1997). In most cases, crows responded to the taped call by leaving the orchards entirely. Damage is the orchards ranged from a low of $46/ac to a high of $1,015/ac. Despite expensive losses at some orchards, the damage was significantly below that expected if the call was not used. The results highlighted the serious damage crows cause and suggested that improved hardware and expanded treatment from dawn till dusk had potential to significantly reduce crow damage.

In 1998, improved, commercially available broadcast units were tested by the researchers (Salmon et al. 1999). Units were installed soon after the appearance of early flocks to discourage the birds from developing a feeding habit. The results, compared to 1997, showed a large reduction in crow numbers and damage. Losses ranged from $22/ac to $138/ac.

In 1999, a third study evaluated integrated control programs conducted by growers using the same broadcast units, propane cannons, pyrotechnics, and shooting. Based on bird counts, damage assessments, economic analysis, and grower response, the integrated program was successful (Salmon et al. 2000).

To overcome business and legal problems that prevented the availability of the units and calls used in the 1998 and 1999 studies, VPCRAC funded a 2-year study in 2001 to evaluate new broadcast units for crow control. The units were designed and constructed at the University of California Davis and broadcast uncopyrighted calls. The accompanying field study showed damage reductions of 73 to 81% (Houk et al. 2004). Plans for the broadcast unit and the crow calls have been made available on the internet (http://crowcontrol.engineering.ucdavis.edu/).

In an effort to extend the results of the crow studies to other crops plagued by birds, VPCRAC funded a project in 2002 to test broadcast units in vineyards. This project in progress will employ upgraded broadcast units playing calls of European starlings (*Sturnus vulgaris*), American robins (*Turdus migratorius*), and house finch (*Carpodacus mexicanus*).

CONCLUSION

The Rodenticide Surcharge Program has been instrumental in funding high-priority research to support registrations and re-registrations of important compounds that are effective in controlling vertebrate pests. As a direct result of these studies, CDFA's registered zinc phosphide and anticoagulant rodenticide products remain available today to agricultural producers and other users. In keeping with the enabling legislation, a number of studies have examined alternatives to chemicals and have sought safer methods of toxicant delivery so that hazards to non-target species are minimized.

Much has been accomplished during the years since the program's inception in the early 1990s. However, much remains to be done. With the recent conclusion of the rodenticide re-registration process for a number of products, surcharge program funds in future years will be more readily available to support research on alternative, creative approaches to solving wildlife damage problems affecting California's agriculture.

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