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January 16, 2019

VIA ELECTRONIC MAIL

Department of Pesticide Regulation
Pesticide Registration Branch
1001 I Street
P.O. Box 4015
Sacramento, CA 95812-4015

Re: Comments on Reevaluation of Second Generation Anti-Coagulant Rodenticides, Cal. Notice 18-22

To Whom It May Concern:

Please accept these comments on behalf of the Animal Welfare Institute ("AWI") regarding additional scientific studies and regulatory proposals that the Department of Pesticide Regulation ("DPR") should consider pursuant to its proposed decision to begin reevaluation of second generation anticoagulant rodenticides ("SGARs").[1]

The Animal Welfare Institute is a nonprofit charitable organization founded in 1951 and dedicated to reducing animal suffering caused by people. AWI engages policymakers, scientists, industry, and the public to achieve better treatment of animals everywhere—in the laboratory, on the farm, in commerce, at home, and in the wild.

The Director of DPR proposed to begin reevaluation of SGARs products containing the active ingredients brodifacoum, bromadiolone, difenacoum, and difethialone based on the potential for significant adverse impacts to non-target wildlife from SGARs exposure. In 2014, DPR adopted regulations designating SGARs active ingredients brodifacoum, bromadiolone, difenacoum, and difethialone as California restricted materials and added a number of use restrictions. After implementing these regulatory actions, however, DPR continued to receive reports claiming that SGARs may have caused or are likely to cause significant adverse impacts

[1] *See* Cal. Notice 18-22 (Nov. 16, 2018), Cal. Notice 18-23 (Dec. 10, 2018).

to non-target wildlife.[2] A 2018 investigatory report conducted by DPR[3] pursuant to 3 C.C.R. § 6220 found that while the 2014 regulations changed SGAR use patterns by restricting their purchase, sale, and use, reported rates of non-target wildlife exposure to SGARs have not decreased. Based on the 2018 report, the Director found that significant adverse impacts have occurred from the use of SGARs, which has prompted this proposed reevaluation.

These comments are divided into four sections. The first section provides factual background on anticoagulant rodenticides, including mechanisms of action, chemical composition, and half-life. The second section identifies and discusses scientific, peer-reviewed studies published between 2014 and 2018 that DPR should consider as part of its reevaulation. The third section addresses the implications of SGARs poisoning of species protected under the Federal Endangered Species Act, California Endangered Species Act, Migratory Bird Treaty Act, and Bald and Golden Eagle Protection Act. The fourth section outlines several additional regulatory proposals for DPR to consider adopting in order to further reduce the impact of SGARs on non-target wildlife in California.

I. Factual Background on Rodenticides.

Rodenticides are designed to kill small mammals such as rats, mice, gophers, ground squirrels, and prairie dogs. There are three general categories of rodenticides: non-anticoagulant rodenticides, first generation anticoagulant rodenticides ("FGARs"), and second generation anticoagulant rodenticides ("SGARs"). Non-anticoagulant rodenticides currently used in the United States include bromethalin, cholecalciferol, zinc phosphide, and strychnine. Each of these rodenticides work in a different way. Bromethalin, which has been registered with the EPA since 1984, is a single-dose rodenticide[4] that causes the cells of the central nervous system to swell, which puts pressure on the brain, causing paralysis and death.[5] Cholecalciferol, also known as vitamin D3, was registered as a rodenticide in 1984.[6] Vitamin D helps the body maintain calcium balance by enhancing absorption of calcium.[7] When rodents eat several doses of the poison, calcium in the blood becomes overabundant.[8] This overwhelms the body's ability to regulate the central nervous system, muscles, gastrointestinal tract, cardiovascular system, and the kidneys, resulting in death.[9] Zinc phosphide, which was first registered in 1947,[10] turns into

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[2] *See* Cal. Notice 18-22 (Nov. 16, 2018), Cal. Dept. Pesticide Regulation, An Investigation of Anticoagulant Rodenticide Data Submitted to the Dept. of Pesticide Regulation (Nov. 16, 2018) (2018 Cal. Investigation).
[3] 2018 Cal. Investigation, *supra* note 2.
[4] U.S. Environmental Protection Agency, Reregistration Eligibility Decision (RED) Rodenticide cluster (1998).
[5] J.D. Roder, Veterinary Toxicology 84, 106-108, 123 (2001).
[6] USEPA RED 1998, *supra* note 1.
[7] W.K. Rumbeiha, *Cholecalciferol*, *in* Small Animal Toxicology 629-642 (M.E. Peterson, P.A. Talcott eds., 2006).
[8] *Id.*
[9] *Id*.
[10] U.S Environmental Protection Agency, Analysis of Rodenticide Bait Use (2004).

toxic phosphine gas in the presence of water and acid in the stomach, which causes cell death.[11] Phosphine exposure is particularly damaging to the heart, brain, kidney, and liver.[12] Strychnine, the oldest of these commonly used rodenticides, affects the cells in the spinal cord, causing severe muscle spasms that lead to breathing paralysis and death.[13] Currently, strychnine can only be used below ground, and products with more than 0.5% strychnine can only be sold to certified professional applicators.[14]

Anticoagulant rodenticides, including both FGARs and SGARs, work by stopping the liver from recycling vitamin K to make blood clotting enzymes.[15] This causes uncontrolled bleeding throughout the body and eventual death.[16] Due to the metabolic processes involved in vitamin K recycling and blood clotting, there is a lag time between ingestion of the poison and death.[17] Treatment consists of vitamin K supplementation.[18] FGARs, which include chlorophacinone, diphacinone, and warfarin, were developed and marketed beginning in 1950. FGARs generally require an animal to eat multiple doses of bait over several days to accumulate a lethal dose.[19] SGARs were developed in response to target rodents' perceived resistance to the FGAR warfarin. SGARs, which include brodifacoum, bromadiolone, difethialone, and difenacoum, are single-dose anticoagulants that can deliver a lethal level of toxin in one feeding, with death resulting five to seven days later.[20] SGARs have the same mechanism of action as FGARs, but they have an increased affinity for the target enzyme (vitamin K epoxide reductase), an increased ability to disrupt the vitamin K-epoxide cycle at more points, and significantly longer half-lives in the blood and liver.[21] Although, SGARs were developed in response to a

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[11] J.C. Albretsen, *Zinc Phosphide*, *in* Clinical Veterinary Toxicology 456-459 (K.H. Plumlee, ed., 2004).
[12] *Id.*
[13] P.A. Talcott, *Strychnine*, *in* Small Animal Toxicology 1076-1082 (M.E. Peterson, P.A. Talcott eds., 2006).
[14] U.S. Environmental Protection Agency, R.E.D Facts Strychnine (1996).
[15] B.M. Masuda, et al., *Residue Profiles of Brodifacoum in Coastal Marine Species Following an Island Rodent Eradication*, 113 Ecotoxicology and Environmental Safety 1, 1 (2015). Available at: http://dx.doi.org/10.1016/j.ecoenv.2014.11.013.
[16] *Id.*
[17] California Department of Pesticide Regulation, Memorandum: Second Generation Anticoagulant Rodenticide Assessment (2013).
[18] S.A. Khan and M.M. Schell, *Anticoagulant Rodenticides (Warfarin and Congeners)*, *in* The Merck Veterinary Manual (Frederick W. Oehme, ed., 2012). Available at: http://www.merckmanuals.com/vet/toxicology/rodenticide_poisoning/anticoagulant_rodenticides_warfarin_and_congeners.html.
[19] USEPA RED 1998, *supra* note 1.
[20] U.S. Environmental Protection Agency, Risk Mitigation Decision for Ten Rodenticides (2008). Available at https://www.regulations.gov/document?D=EPA-HQ-OPP-2006-0955-0764.
[21] G. Herring, et al, *Characterizing Golden Eagle Risk to Lead and Anticoagulant Rodenticide Exposure: A Review*, 51 J. of Raptor Research 273, 276 (2017). Available at: https://bioone.org/journals/Journal-of-Raptor-Research/volume-51/issue-3/JRR-16-19.1/Characterizing-Golden-Eagle-Risk-to-Lead-and-Anticoagulant-Rodenticide-Exposure/10.3356/JRR-16-19.1.full.

perceived resistance to FGARs, the EPA noted in its 2008 Risk Mitigation Decision ("RMD") that it is unclear whether resistance exists and to what extent it presents a problem because there have been no systemic studies of FGARs resistance in the United States for nearly thirty years.[22] Furthermore, "resistance" to a rodenticide could mean that as little as five percent of the population is resistant.[23] Thus, it is unclear whether SGARs are actually more effective than FGARs, and if so, how much more effective they are.

What is clear, however, is that the chemical composition of SGARs makes them more deadly to non-target wildlife. Because it takes several days for rodents to die due to lag time between ingestion and death, animals often eat multiple doses, allowing for super-lethal concentrations of the rodenticide to accumulate in their bodies, and thus any non-target predator who consumes that rodent.[24] The half-life, or the amount of time it takes a substance to reduce its concentration by half, of most FGARs in both target and non-target wildlife is generally hours to days, compared to the half-life of SGARs, which is generally four months to a year.[25] The following table demonstrates the differences in the three different categories of rodenticide products in terms of dosage and half-life in the blood and liver:[26]

Table 1. Half-life (in days) of a single dose of rodenticides in the blood and liver of rats[1, 2].

Class of Rodenticide	Rodenticide	Dose (mg ai/kg)	Half-life (in days) in Blood	Half-life (in days) in Liver
Second Generation Anticoagulant Rodenticides	Brodifacoum	0.02 to 0.35	6.5 to 91.7[7]	113.5[3] to 350
	Bromadiolone	0.2 to 3.0	1.0 to 2.4	170 to 318
	Difenacoum[4]	1.2	NA	118
	Difethialone	0.5	2.3	126
First Generation Anticoagulant Rodenticides	Chlorophacinone	4 to 5	0.4	Less than 2
	Diphacinone	0.32	NA	Between 2 and 3[1, 3]
	Warfarin	NA[9], 1[3]	0.7 to 1.2[1]	7[1] to 26.2[3]
Non-anticoagulant Rodenticides[2]	Bromethalin[5]	NA[9]	5.5	NA
	Cholecalciferol[6]	NA[9]	1	~19[8]

1 Data summarized from Erickson and Urban, 2004, except where noted.
2. Data is not available for zinc phosphide, so it is not included on the chart.
3. Fisher et al, 2003.
4. U.S. EPA, 2007.
5. Spaulding and Spannring, 1988.
6. Marrow, 2001.
7. Vandenbroucke et al, 2008.
8. Body half-life (instead of liver half-life).
9. NA is defined as Not Available.

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[22] USEPA 2008, *supra* note 17, at 23.
[23] Angel Chiri, U.S. Environmental Protection Agency, Memorandum: Analysis of Rodenticide Bait Use 15 (2006).
[24] Herring, *supra* note 18, at 276.
[25] CA DPR 2013, *supra* note 14.
[26] *Id.*

If an animal who consumes an anticoagulant rodenticide is eaten by a predator, the predator can experience sub-lethal and lethal effects from the rodenticide due to bioaccumulation.[27] However, the ability of FGARs to bioaccumulate in target and non-target animals is considered low relative to SGARs.[28] This is due to the stark differences in half-lives of FGARs and SGARs, as detailed in the above table. Predators who eat poisoned rodents may ingest a toxic dose in small amounts over a long period of time because of the cumulative body burden of SGARs, as DPR has recognized.[29] This phenomenon has been the topic of significant scientific study, as described further in the following section.

II. Summaries of Recent Scientific Studies Published between 2014 and 2018.

This section summarizes peer-reviewed studies published between 2014 and 2018 that report findings on the impact of SGARs on wildlife and the environment. These studies were not cited in DNR's 2018 report, and therefore DNR should consider these studies as part of its reevaluation. These comments highlight the most relevant findings from each study. Copies of these studies are attached to these comments, unless otherwise noted.

A. E.V. Abernathy, et al., *Secondary Anticoagulant Rodenticide Exposure in Migrating Juvenile Red-Tailed Hawks (Buteo Jamaicensis) in Relationship to Body Condition*, 52 J. Raptor Research 225 (2018)

This study examined the extent to which migrating juvenile red-tailed hawks in California are exposed to anticoagulant rodenticides, and described sub-lethal effects of anticoagulant rodenticide ingestion.[30] The authors collected blood samples and body morphometrics from 97 juvenile red-tailed hawks migrating through Marin County between

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[27] B.A. Rattner, et al., *Adverse Outcome Pathway and Risks of Anticoagulant Rodenticides to Predatory Wildlife*, Envtl. Science and Tech. 8433, 8434, 8436 (2014); E.V. Abernathy, et al., *Secondary Anticoagulant Rodenticide Exposure in Migrating Juvenile Red-Tailed Hawks (Buteo Jamaicensis) in Relationship to Body Condition*, 52 J. Raptor Research 225, 226 (2018); M.W. Gabriel, et al., *Exposure to Rodenticides in Northern Spotted and Barred Owls on Remote Forest Lands in Northwestern California: Evidence of Food Web Contamination*, 13 Avian Conservation & Ecology 1, 1, 7 (2018), D. Fraser, et al., *Genome-wide Expression Reveals Multiple Systemic Effects Associated with Detection of Anticoagulant Poisons in Bobcats (Lynx rufus)*, 27 Molecular Ecology 1170, 1171, 1182 (2018).

[28] C.T. Eason and S. Ogilvie, *A Re-Evaluation of Potential Rodenticides for Aerial Control of Rodents*, Research & Development Series 312 (2009).

[29] CA DPR 2013, *supra* note 14; California Department of Pesticide Regulation, An Investigation of Anticoagulant Rodenticide Data Submitted to the Department of Pesticide Regulation (2018); U.S. Fish & Wildlife Service, Comments on EPA's Comparative Approach 3 (2005); U.S Environmental Protection Agency, Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: a Comparative Approach 72 (2004). Available at: http://www.fwspubs.org/doi/suppl/10.3996/052012-JFWM-042/suppl_file/10.3996_052012-jfwm-042.s4.pdf.

[30] E.V. Abernathy, et al., *Secondary Anticoagulant Rodenticide Exposure in Migrating Juvenile Red-Tailed Hawks (Buteo Jamaicensis) in Relationship to Body Condition*, 52 J. Raptor Research 225, 225 (2018).

2013 and 2015, and screened samples for the presence of anticoagulant rodenticides.[31] Specifically, the authors tested for the presence of FGARs chlorophacinone, coumachlor, diphacinone, and warfarin, and SGARs brodifacoum, bromadiolone, difethialone, and difenacoum.[32] Blood tests revealed that eight hawks (8.2 percent) tested positive for some amount of first-generation (diphacinone, chlorophacinone) and second-generation (brodifacoum, bromadiolone) anticoagulant rodenticides.[33] The authors cautioned that although this method of sampling the blood of live birds is novel and increased sampling capabilities because it allowed live animals to be tested for SGARs, the short half-lives of anticoagulant rodenticides in blood make it difficult to estimate population-wide exposure rates.[34] Of the hawks sampled in 2013, five of 25 hawks (25 percent) tested positive for anticoagulant rodenticides compared to three of 77 hawks (3.9 percent) tested in 2015.[35]

The authors noted that these findings differed from other studies. Specifically, Elliott et al. 2016 reported that anticoagulant rodenticide exposure in raptors from liver samples ranged from 19 percent to 100 percent, with an average exposure rate of 63 percent.[36] This led Abernathy et al. to hypothesize that the difference in exposure rates may be due to a number of factors including discrepancies in sampling protocol, the behavior of migratory versus resident birds, and whether or not blood sampling can give a true estimation of anticoagulant rodenticide exposure rates.[37] The half-life of anticoagulant rodenticides in the blood was found to be significantly shorter than the half-life in liver tissue, and that generally the highest concentrations of anticoagulant rodenticides occur in the liver and the lowest concentrations occur in the muscle, brain, blood, and fat.[38] They also hypothesized that raptors experiencing acute anticoagulant rodenticide toxicity may not be healthy enough to continue migration and therefore may not be available for sampling at migration stations used in the study.[39] Also, migrating birds may consume different prey than breeding or wintering birds, as many migrant species show extreme shifts in food selection during pre-migratory periods.[40] This comports with earlier studies that found adult hawks who spend a substantial amount of time in particular areas had significantly higher brodifacoum levels than juveniles who were not regularly feeding in a single area.[41] The authors also stated that although they did not find a relationship between anticoagulant rodenticide exposure and body condition because of the small sample size and low statistical power they could not conclude that anticoagulant rodenticide poisoning has no effect on relative body condition.[42]

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[31] *Id.*
[32] *Id.* at 227.
[33] *Id.* at 225, 227.
[34] *Id.* at 225.
[35] *Id.* at 227.
[36] *Id.* at 228.
[37] *Id.*
[38] *Id.*
[39] *Id.*
[40] *Id*.
[41] *Id.* at 228-29.
[42] *Id.* at 229.

B. U.S. Fish and Wildlife Service, Coastal Oregon and Northern Coastal California Populations of the Pacific Marten (*Martes caurina*) Species Report (2015)

This Species Report examined stressors on the pacific marten populations in northern coastal California and coastal Oregon. The Report identified widespread use of anticoagulant rodenticides and other pesticides at illegal marijuana grow sites as an emerging stressor and examined the potential individual and population level impacts to martens exposed to toxicants at grow sites.[43] The Report found that legal use of anticoagulant rodenticides may also pose risks to martens in some parts of their range both currently and over the next 15 years.[44] Among the pesticides found at marijuana grow sites, SGARs are the primary type of pesticide that has been analyzed in marten tissue.[45] The Report specifically highlighted the extent of illegal marijuana grow operations located on public land in California. National forests in California account for the largest marijuana plant eradication total from public lands in any region, and 60–70 percent of national marijuana seizures come from California, with 60 percent of that number coming from public lands. This is important for California's marten population because over 65 percent of the Northern Coastal California Extant Population Area[46] for martens consists of public lands (primarily Forest Service lands) and large numbers of illegal marijuana grows have been found on these lands.[47] The Report noted that anticoagulant rodenticides are widely available to those with a certified pesticide applicator's license and can be brought into California and the United States if purchased legally elsewhere.[48]

C. J.E. Elliott, et al., *Paying the Pipers: Mitigating the Impact of Anticoagulant Rodenticides on Predators and Scavengers*, 66 BioScience 401 (2016)

This study noted the increase in poisoning of non-target predators and scavengers by SGARs and proposed educational programs as one solution to help address this problem. The authors state that SGARs contamination and poisoning of non-target wildlife, particularly scavenging and predatory species such as raptors, foxes, and weasels, which also provide important ecosystem services—including the control of rodent populations—are increasing in degree and scale.[49] In increasingly human-dominated landscapes, many predators will switch their diets and prey on rats and commensal birds, which often are the most common prey

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43 U.S. Fish and Wildlife Service, Coastal Oregon and Northern Coastal California Populations of the Pacific Marten (*Martes caurina*) Species Report 54 (2015). Available at: https://www.fws.gov/oregonfwo/ExternalAffairs/News/2015/Coastal_Marten_Final_Species_Report_April_2015%20(1).pdf.
44 *Id.* at 55.
45 *Id.* at 56.
46 For a definition of the Northern Coastal California Extant Population Area, see page 36 of the Report.
47 *Id.* at 56.
48 *Id.* at 93.
49 J.E. Elliott, et al., *Paying the Pipers: Mitigating the Impact of Anticoagulant Rodenticides on Predators and Scavengers*, 66 BioScience 401, 401 (2016). Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1962&context=usgsstaffpub.

available.[50] To reduce the impact of SGARs on predators and scavengers, the authors recommend the development and implementation of outreach and educational stewardship programs by industry and government.[51] This study did not focus on a particular state or country.

D. Herring, et al., *Characterizing Golden Eagle Risk to Lead and Anticoagulant Rodenticide Exposure: A Review*, 51 J. of Raptor Research 273 (2017)

This study examines the risk that golden eagles face from anticoagulant rodenticides, and specifically evaluates the relative toxicity of different types of anticoagulant rodenticides to avian species. Golden eagles, similar to other avian predators, are particularly sensitive to anticoagulant rodenticides and may be exposed to these products because they commonly consume rodents and other animals that may have been poisoned by rodenticides.[52] The authors concluded, based on the data contained in the following tables,[53] that the SGARs brodifacoum and difethialone are extremely toxic to sensitive avian species like raptors, whereas SGARs bromadiolone and difenacoum tend to be only moderately toxic.[54]

Table 3. Most sensitive LD_{50} and descriptive toxicity for birds based on dosing studies derived from Erickson and Urban (2004), U.S. EPA (2007), and Rattner et al. (2011).

Type of Rodenticide	Rodenticide	Avian LD_{50} (ppm)	Descriptive Toxicity
SGAR	Brodifacoum	0.26	Extremely toxic
	Bromadiolone	138.00	Moderately toxic
	Difenacoum	66.00	Moderately toxic
	Difethialone	0.26	Extremely toxic
FGAR	Chlorophacinone	>100.00	Moderately toxic
	Diphacinone	96.80	Moderately toxic
	Warfarin	620.00	Slightly toxic

50 *Id.* at 402.
51 *Id.* at 404.
52 G. Herring, et al, *Characterizing Golden Eagle Risk to Lead and Anticoagulant Rodenticide Exposure: A Review*, 51 J. of Raptor Research 273, 274 (2017). Available at: https://bioone.org/journals/Journal-of-Raptor-Research/volume-51/issue-3/JRR-16-19.1/Characterizing-Golden-Eagle-Risk-to-Lead-and-Anticoagulant-Rodenticide-Exposure/10.3356/JRR-16-19.1.full.
53 *Id.* at 282.
54 *Id.* at 281-82.

Table 4. Half-life (d) of a single dose of rodenticides in blood or liver of rats and mice derived from Morrow (2001), Erikson and Urban (2004), Fisher et al. (2003), U.S. EPA (2007), Spaulding and Spannring (1988), and Vandenbrouke et al. (2008).

Type of Rodenticide	Rodenticide	Dose (AI[a]) (ppm)	Half-life (d) in Blood	Half-life (d) in Liver
SGAR	Brodifacoum	0.02–0.35	6.5–91.7	113.5–350
	Bromadiolone	0.2–3.0	1.0–2.4	170–318
	Difenacoum	1.2	NA[b]	118.0
	Difethialone	0.5	2.3	126.0
FGAR	Chlorophacinone	4.0–5.0	0.4	<2.0
	Diphacinone	0.32	NA	2.0–3.0
	Warfarin	1.0	0.7–1.2	7.0–26.2

[a] AI = active ingredient.
[b] NA = not available.

E. A. Justice-Allen and K.A. Loyd, *Mortality of Western Burrowing Owls (Athene cunicularia hypugaea) Associated with Brodifacoum Exposure*, 53 J. Wildlife Diseases 165 (2017)

This study examined the role that brodifacoum plays in nesting success of a burrowing owl population in Lake Havasu City, Arizona.[55] Data was collected from August 2013 to July 2015.[56] During this time, 22 adult burrowing owl carcasses, representing approximately 25 percent of the local adult population of around 88 individuals, were found.[57] There were no signs of predation.[58] Due to degradation, only four owls underwent toxicologic testing.[59] Brodifacoum was detected in all four owls,[60] was identified as the cause of death in three owls, and was suspected in the fourth owl.[61] For the owls that could not be tested due to degradation, the authors suspected that at least some of these birds were exposed to SGARs and died as a result, given the timing and location in relation to the confirmed cases, direct observation, and the absence of signs of predation or injury.[62] Notably, the authors highlighted a 2012 study conducted by Bartos et al. that found some California pest control operators distributed bait incorrectly by placing it as far as 60 feet from buildings.[63] The authors concluded by highlighting a recommendation by Gervais et al. (2003)[64] that a buffer zone of 500–600 m around burrowing owl sites be established to prevent secondary toxicity, but noted

55 A. Justice-Allen and K.A. Loyd, *Mortality of Western Burrowing Owls (Athene cunicularia hypugaea) Associated with Brodifacoum Exposure*, 53 J. Wildlife Diseases 165, 165 (2017). Available at: http://www.jwildlifedis.org/doi/full/10.7589/2015-12-321.
56 *Id.*
57 *Id.*
58 *Id.*
59 *Id.* at 165-66.
60 *Id*. at 166.
61 *Id*. at 168.
62 *Id.*
63 *Id.*
64 J.A. Gervais, et al., *Space Use and Pesticide Exposure Risk of Male Burrowing Owls in an Agricultural Landscape*, 67 J. Wildlife Mgmt. 155 (2003).

that their hunting radius may extend 1,200 m from the burrow. Minimizing the use of brodifacoum during the late summer when juveniles are dispersing was also advised.[65]

F. T.R. Kelley et al., *Causes of Mortality and Unintentional Poisoning in Predators and Scavenging Birds in California*, Veterinary Record Open 1 (2014)

This study evaluated the cause of mortality in avian predators and scavengers originating from 13 counties in California.[66] The authors evaluated 48 carcasses (21 golden eagles, 23 turkey vultures and 4 common ravens)[67] collected from 2007 to 2009.[68] Although these birds were evaluated before California's 2014 regulations went into effect, the results are informative, as is the authors' conclusion about the relative toxicity of the four types of SGARs. Anticoagulant rodenticides residues were detected in 84 percent of the birds tested. Rodenticide exposure was detected in 100 percent of the ravens, 95 percent of the turkey vultures, and 67 percent of the golden eagles.[69] Eight percent of the birds died due to anticoagulant rodenticide intoxication, all of whom were turkey vultures.[70] SGARs were the primary cause of mortality in four vultures.[71] Anticoagulant rodenticide intoxication was a contributing cause of mortality in two vultures who died due to collision-related trauma and in one vulture noted above with primary lead intoxication.[72] The authors stated that brodifacoum poses the greatest overall risk to non-target wildlife of all the four types of SGARs.[73]

G. K. Memmott, et al., *Use of Anticoagulant Rodenticides by Pest Management Professionals in Massachusetts, USA*, 26 Ecotoxicology 90 (2017)

This article reported the findings from a survey about rodent control practices sent to pest management professionals (PMPs) operating in Massachusetts. Although the findings from Massachusetts may not translate directly to the state of the profession in California, the study provides important insight into the industry and the great potential for additional education to combat the poisoning of non-target wildlife. The survey was sent between October and November 2015, and thirty-five responses were obtained.[74] The survey results indicated that the preferred rodent control method among responding PMP companies was chemical rodenticides, specifically the SGAR bromadiolone,[75] with 97 percent reporting the use of chemical

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[65] Justice-Allen, *supra* note 52, at 168.
[66] T.R. Kelley et al., *Causes of Mortality and Unintentional Poisoning in Predators and Scavenging Birds in California*, Veterinary Record Open 1, 4 (2014). Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4562445/.
[67] *Id.* at 4.
[68] *Id*. at 2.
[69] *Id.* at 5.
[70] *Id.* at 4.
[71] *Id.*
[72] *Id*. at 5.
[73] *Id*. at 1.
[74] K. Memmott, et al., *Use of Anticoagulant Rodenticides by Pest Management Professionals in Massachusetts, USA*, 26 Ecotoxicology 90, 90 (2017).
[75] *Id*. at 90, 93.

rodenticides more than half of the time.[76] SGARs accounted for 80 percent of the preferred chemicals.[77] Respondents showed a low level of awareness regarding SGAR potency and half-life, with only one respondent submitting an accurate answer of up to one year.[78] Of the remaining respondents, 34 percent of respondents were "unsure" about how long SGARs may remain toxic in the system of a mouse, 28 percent selected "1–3 days," and 19 percent selected "1 week."[79] Participants were asked to identify their level of concern regarding the potential negative impacts of anticoagulant rodenticides on both non-target wildlife (e.g., bird of prey, coyote, raccoon) and more specifically, birds of prey (falcons, hawks, owls). Half of the participants had a neutral or low level of concern across both groups.[80] The authors concluded that enhanced education focused on SGAR potency, bioaccumulation potential, exposure routes, and negative impacts on non-target wildlife may improve efforts made by PMPs to minimize risk to wildlife and decrease dependence on chemical rodenticide use.[81] The authors recommended further study to explore the threshold that determines PMPs' decision to use chemical rodenticides to determine if there is excessive dependence on poisons that could be reduced through education or regulation.[82]

H. M. Murray, *Anticoagulant Rodenticide Exposure and Toxicosis in Four Species of Birds of Prey in Massachusetts, USA, 2012-2016, in Relation to Use of Rodenticides by Pest Management Professionals*, 26 Ecotoxicology 1041 (2017)

This study examined 94 birds of prey found in predominantly suburban and urban areas of Massachusetts from 2012 to 2016 for the presence of SGARs. The tested birds included four species: red-tailed hawks, barred owls, eastern screech-owls, and great horned owls.[83] Ninety-six percent of all birds tested were positive for SGARs.[84] Brodifacoum was found in 95 percent of the birds,[85] and in 99 percent of the birds that tested positive for SGARs,[86] while 66 percent of the birds contained residues of two or more SGARs.[87] A significant increase in exposure to multiple SGARs occurred in later years in the study.[88] Notably, a statistically significant increase in multiple SGAR exposures in birds of prey was found for the time period 2014–2016 compared to 2012–2013.[89] This increase was driven by exposures to bromadiolone and

[76] *Id.* at 92, 95.
[77] *Id.* at 93.
[78] *Id.* at 90, 94.
[79] *Id.* at 94.
[80] *Id.*
[81] *Id.* at 90.
[82] *Id.* at 95.
[83] M. Murray, *Anticoagulant Rodenticide Exposure and Toxicosis in Four Species of Birds of Prey in Massachusetts, USA, 2012-2016, in Relation to Use of Rodenticides by Pest Management Professionals*, 26 Ecotoxicology 1041, 1042 (2017).
[84] *Id.* at 1041.
[85] *Id.*
[86] *Id.* at 1044.
[87] *Id.* at 1041, 1044.
[88] *Id.*
[89] *Id.* at 1047.

difethialone combined with continued high exposure to brodifacoum.[90] The figure[91] below demonstrates the study's findings:

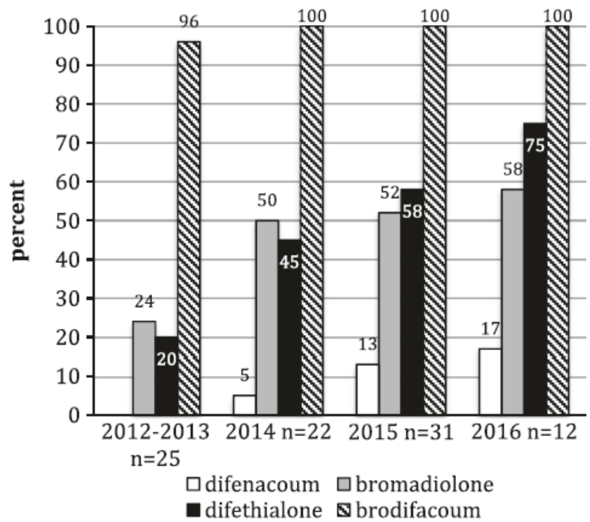

Fig. 2 Percentages of positive birds with residues of each SGAR in liver tissue per year

The authors also highlighted the results of industry-sponsored U.S. market studies from 2014 to 2016, which identified a trend toward increased demand for rodent control services.[92] The pest control industry indicates that this increased demand was influenced by larger rodent populations due to milder winters, expansions in urbanized areas, and the restriction on sale of SGARs through the general consumer market.[93]

I. T.M. Nogeire, et al., Land Use as a Driver of Patterns of Rodenticide Exposure in Modeled Kit Fox Populations, PLoS ONE 1 (2015)

The authors used an individual-based population model to assess potential population-wide effects of rodenticide exposure on the endangered San Joaquin kit fox.[94] The authors found that 36 percent of modeled kit foxes likely have been exposed to anticoagulant rodenticide,[95] resulting in a 7-18 percent decline in the range-wide modeled kit fox population that can be linked to rodenticide use.[96] SGARs exposure affected both the overall simulated kit fox population size and the distribution of the population.[97] Exposures of kit foxes in low-density

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[90] *Id.*
[91] *Id*. at 1045.
[92] Id. at 1047.
[93] *Id.*
[94] T.M. Nogeire, et al., Land Use as a Driver of Patterns of Rodenticide Exposure in Modeled Kit Fox Populations, PLoS One 1, 1 (2015). Available at: https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0133351&type=printable.
[95] *Id*. at 1, 7
[96] *Id*. at 1, 9.
[97] *Id*. at 8.

developed areas accounted for 70 percent of the population-wide exposures to rodenticides,[98] despite comprising only 16 percent of the total landscape.[99] The next highest exposure areas were orchards, which accounted for 17 percent of exposure rates, and urban areas, which accounted for 6.8 percent of exposure rates.[100] Roughly 12 percent of the most suitable, occupied kit fox habitat and 4.3 percent of occupied habitat of moderate suitability was predicted to have rodenticide use.[101] Rodenticide exposure occurred primarily around the edges of kit fox habitat, and in areas where habitat was more fragmented, primarily by agriculture.[102] Highly affected patches occurred around the Semitropic Ridge, Allensworth Natural Area, Lost Hills, and near the cities of Bakersfield, Taft and Maricopa, which host urban kit fox populations.[103] Unaffected habitat patches were found in the Carrizo Plain and in western Kern County.[104] The authors concluded that exposures of kit foxes could be greatly mitigated by reducing the use of SGARs in low-density developed areas near vulnerable populations[105] and that successful enforcement of SGARs regulations and additional regulations or education discouraging their use in low-density developments within the kit fox range could also increase kit fox population numbers.[106] They also noted that despite regulations adopted by U.S. Environmental Protection Agency and the California DPR, SGARs use may become even more widespread in response to projected climate change-induced rodent outbreaks.[107]

J. N. Ruiz-Saurez, et al., *Assessment of Anticoagulant Rodenticide Exposure in Six Raptor Species from the Canary Islands (Spain)*, 485-486 Sci. Total Environment 371 (2014)

This study examines anticoagulant rodenticide exposure pathways in raptors that consume birds, as opposed to small mammals. The authors found that raptors who feed on other birds have relatively high levels of exposure to anticoagulant rodenticides.[108] This is because the birds predated upon had themselves consumed anticoagulant rodenticides.[109] This is true not only of granivorous birds, which may ingest the anticoagulant baits through poisoned grain, but also of insectivorous birds because invertebrates feed on the baits without experiencing adverse effects, thus becoming "anticoagulant reservoirs."[110] Other notable findings include that nocturnal species were significantly more likely to have higher SGAR levels than diurnal

[98] *Id.* at 1, 11.
[99] *Id.* at 11
[100] *Id.* at 7.
[101] *Id.* at 6.
[102] *Id.*
[103] *Id.*
[104] *Id.*
[105] *Id.* at 1.
[106] *Id.* at 11.
[107] *Id.* at 2.
[108] N. Ruiz-Saurez, et al., *Assessment of Anticoagulant Rodenticide Exposure in Six Raptor Species from the Canary Islands (Spain)*, 485-486 Sci. Total Environment 371, 375 (2014).
[109] *Id.*
[110] *Id.*

species[111] and that sub-lethal impacts of chronic exposure to low levels of anticoagulants included reduced bone density and a higher frequency of bone fractures and osteoporosis.[112]

K. B.L. Cypher, et al., *Rodenticide Exposure Among Endangered Kit Foxes Relative to Habitat Use in an Urban Landscape*, 7 Cities and the Environment 1 (2014)

This study examined rodenticide exposure in the kit fox population that occurs in Bakersfield, California, which numbers several hundred individuals.[113] A total of 68 kit foxes met the criteria for inclusion in this study.[114] Collection dates for the carcasses ranged from 1985 to 2009, although most were collected from 1998 to 2009.[115] Anticoagulant residues were detected in 73 percent of the foxes tested and two or more rodenticides were detected in 42.6 percent of the foxes.[116] Brodifacoum and bromadiolone were the most commonly detected anticoagulant rodenticides and were found in 69.1 percent and 38.2 percent, respectively, of foxes tested.[117] Foxes who tested positive for SGARs were located more frequently on golf courses while those testing negative were located more frequently in commercial areas.[118] Some foxes had particularly high levels of ARs in their livers, with three out of four of these foxes appearing to have a strong association with golf courses.[119] A juvenile male had a brodifacoum concentration of 8,648 ng/g and 75 of his 79 locations were on a golf course.[120] An adult female had a brodifacoum concentration of 9,855 ng/g and 86 of her 92 locations were on a golf course.[121] Lastly, a juvenile female had a brodifacoum concentration of 11,000 ng/g.[122] Although only two locations were available for this particular fox, one was on a golf course and the other was at an office complex adjacent to the golf course.[123] The following figure[124] demonstrates the habitat types used by foxes in relation to the presence of SGARs in the foxes' livers.

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111 *Id.* at 374-75.
112 *Id.* at 376.
113 B.L. Cypher, et al., *Rodenticide Exposure Among Endangered Kit Foxes Relative to Habitat Use in an Urban Landscape*, 7 Cities and the Environment 1, 1 (2014).
114 *Id.* at 6.
115 *Id.*
116 *Id.* at 7.
117 *Id.*
118 *Id.* at 7, 12.
119 *Id.* at 10.
120 *Id.*
121 *Id.*
122 *Id.*
123 *Id.*
124 *Id.*

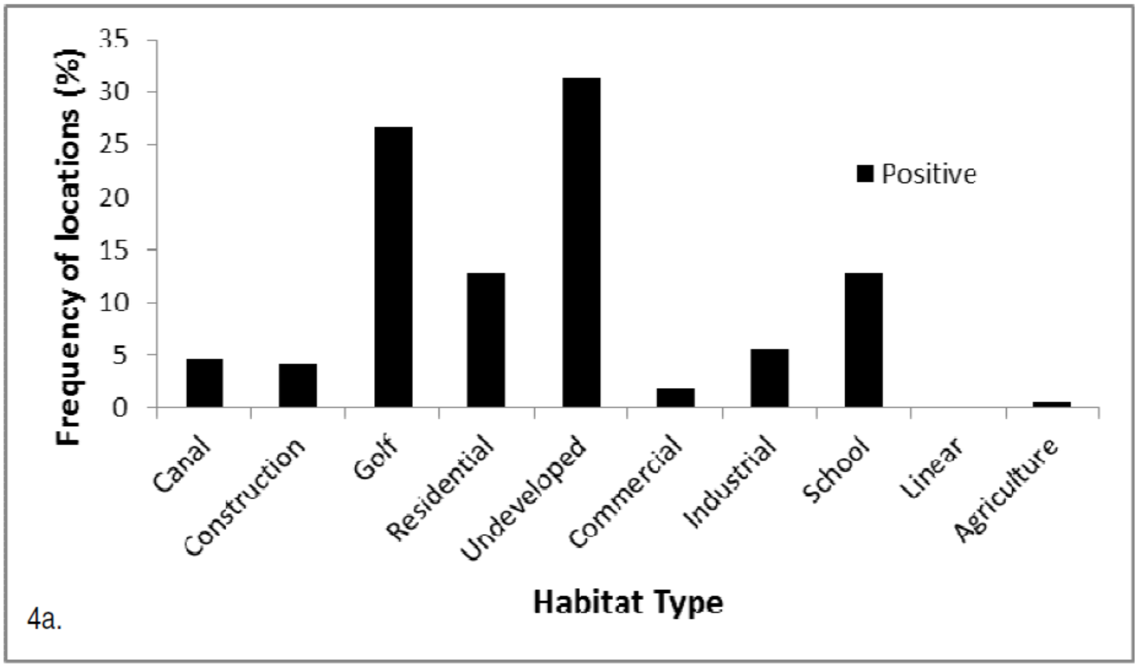

Figure 4. Proportional use of habitats by San Joaquin kit foxes that tested positive for (a.) second generation or (b.) first generation anticoagulant rodenticides, Bakersfield, CA, based on night locations

The authors recommended that an outreach program be conducted in an effort to further inform the public about proper use of rodenticides and risks to natural resources from improper and even proper use of SGARs.[125] The authors stated that this program should especially target groups that likely use rodenticides frequently and across large areas, such as school campus groundskeepers, canal operators, golf course grounds maintenance staff, and pest control applicators.[126]

L. J. Liu, et al., *Toxicity and Bioaccumulation of Bromadiolone to Earthworm Eisenia Fetida*, 135 Chemosphere 250 (2015)

This study examined whether earthworms are at risk from primary poisoning as a result of SGAR bait applications.[127] The authors specifically examined the risk of bromadiolone poisoning, as bromadiolone baits are usually distributed in soils by burying them in artificial galleries or storage cavities,[128] which the authors hypothesized would result in non-target species

125 *Id.* at 15.
126 *Id.*
127 J. Liu, et al., *Toxicity and Bioaccumulation of Bromadiolone to Earthworm Eisenia Fetida*, 135 Chemosphere 250, 251 (2015). Available at: https://docksci.com/toxicity-and-bioaccumulation-of-bromadiolone-to-earthworm-eisenia-fetida_5a4b5fc3d64ab2b9f53d0f15.html.
128 *Id.*

poisoning.[129] The authors found that bromadiolone bioaccumulates in earthworms, which results in toxicity.[130] Significant decrease in weight and growth of earthworms in all treatment groups was observed in a dose-dependent manner.[131] The authors stated that the fact that bromadiolone in soil is bioaccumulative to earthworms suggests that contaminated earthworms are a potential source of secondary exposure in non-target birds and invertebrates,[132] as earthworms form the base of many food chains.[133]

M. M. Kotthoff, et al., *First Evidence of Anticoagulant Rodenticides in Fish and Suspended Particulate Matter: Spatial and Temporal Distribution in German Freshwater Aquatic Systems*, Envtl. Science and Pollution Research (2018).

This study examined exposure of aquatic life to anticoagulant rodenticides and the accumulation of anticoagulant rodenticides in aquatic food webs in Germany.[134] The authors documented the first evidence of anticoagulant rodenticides in freshwater fish tissue,[135] and demonstrated that contamination of wildlife with anticoagulant rodenticides, especially SGARs, is not confined to predatory birds or mammals of the terrestrial food web.[136] They sampled the liver tissue of bream, a species of fish, from numerous sampling locations, including lakes and rivers, in 2011 and 2015.[137] Brodifacoum was the most prevalent anticoagulant rodenticide detected in the samples collected in 2015.[138] It was detected in 88 percent of the samples.[139] Difenacoum was found in 44 percent of the samples at lower concentrations than brodifacoum.[140] Bromadiolone was found in 17 percent of the samples, and difethialone was found in 6 percent of the samples.[141] An analysis of suspended particulate matter was also conducted in 2015, with bromadiolone being detected in 56 percent of the samples.[142] Although the authors tested the samples for FGARs, only SGARs were found at detectable rates.[143] The authors hypothesized that this could be related to the higher persistency and potential for bioaccumulation of SGARs relative to FGARs.[144] Notably, the prevalence of detectable rodenticide residues was described

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[129] *Id.* at 251, 253.
[130] *Id.* at 253-54.
[131] *Id.* at 253.
[132] *Id.* at 254.
[133] *Id.* at 251.
[134] M. Kotthoff, et al., *First Evidence of Anticoagulant Rodenticides in Fish and Suspended Particulate Matter: Spatial and Temporal Distribution in German Freshwater Aquatic Systems*, Envtl. Science and Pollution Research 1 (2018). Available at: https://link.springer.com/article/10.1007%2Fs11356-018-1385-8.
[135] *Id.* at 6.
[136] *Id.* at 8.
[137] *Id.* at 3.
[138] *Id.* at 6.
[139] *Id.*
[140] *Id.*
[141] *Id.*
[142] *Id.*
[143] *Id.* at 7.
[144] *Id.*

as "surprisingly high" due to the fact that Germany's use of anticoagulant rodenticide for rat control in sewers and above ground by municipal authorities in Germany consists of only 50 kg of active substance used annually.[145]

N. P.J. Thomas, et al., *Spatial Modelling of Non-target Exposure to Anticoagulant Rodenticides Can Inform Mitigation Options in Two Boreal Predators Inhabiting Areas with Intensive Oil and Gas Development*, 212 Biological Conservation 111 (2017)

This study investigated whether fisher and marten populations living near oil and gas operations in Alberta, Canada, showed evidence of SGARs exposure.[146] The food preferences of both species includes small to medium-sized mammals and birds, as well as carrion.[147] Both species are sensitive indicators of ecosystem function in the boreal region.[148] The livers of a total of 63 fishers and 30 martens were sampled.[149] The sampled animals had all been lawfully trapped pursuant to commercial fur trade permits.[150] Twenty-four percent of fishers tested positive for SGARs, with none testing positive for FGARs.[151] Ten percent of martens tested positive for SGARs, with none testing positive for FGARs.[152] Bromadiolone was the most frequently detected SGAR, showing up in 87 percent of positive cases, while brodifacoum was detected twice.[153] The authors stated that it was likely that actual exposure is greater than the level their findings indicate because individuals who died from anticoagulant rodenticide exposure or who had reduced fitness would not have been sampled by trapping.[154] The authors also postulated that sub-lethal levels of SGARs could pose a greater risk to fisher populations than lethal levels because compromised clotting functions could turn a minor wound into a lethal injury that the animal otherwise would have survived, which is particularly concerning for fishers, who actively pursue both terrestrial and arboreal prey.[155] Modelling was also used to evaluate spatial patterns exhibited by fisher exposure frequencies against variables such as anthropogenic disturbances and types of land cover.[156] Importantly, the authors stated that their results "demonstrate that use restrictions alone are not enough to completely eliminate non-target exposures to SGARs in mustelids"[157] because martens and fishers were contaminated with

[145] *Id.* at 8.
[146] P.J. Thomas, et al., *Spatial Modelling of Non-target Exposure to Anticoagulant Rodenticides Can Inform Mitigation Options in Two Boreal Predators Inhabiting Areas with Intensive Oil and Gas Development*, 212 Biological Conservation 111, 111 (2017). Available at: https://www.sciencedirect.com/science/article/pii/S0006320716309752.
[147] *Id.*
[148] *Id*. at 112, 118.
[149] *Id.* at 114-15.
[150] *Id*. at 112.
[151] *Id*. at 114.
[152] *Id.* at 115.
[153] *Id.* at 114.
[154] *Id.* at 116.
[155] *Id*.
[156] *Id.* at 113-14.
[157] *Id.* at 117.

SGARs that are restricted to indoor use in Canada.[158] Therefore, "[a]ssuming these compounds are being used legally by trained commercial applicators, poisoned rodents are likely moving in and out of doors, increasing the probability of being consumed."[159] These results are particularly important in informing fisher management, because:

> [S]ubtle changes in fisher survival were a stronger determinant of population growth than even fecundity. This demonstrates regulatory importance of reducing the number of fisher deaths caused by exposure to SGARs. Improving survival by 10% could change the growth trajectory for the local and regional fisher population from negative to positive (Sweitzer et al., 2015). Thus, an easily implementable mitigation action is the discontinuation of the use of SGARs. Based on this research, mitigation efforts should be focused on areas with higher population densities near prime fisher and marten habitat[.][160]

The authors specifically recommended that mitigation efforts include integrated pest management (IPM) to reduce poisoning of non-target wildlife.[161] IPM emphasizes the use of less toxic compounds, such as diphacinone, and incorporates "the use of biological, genetic, cultural, or mechanical control measures, including effective handling and removal of waste and exclusion measures to avoid infestations."[162]

O. A. Geduhn, et al., *Relation Between Intensity of Biocide Practice and Residues of Anticoagulant Rodenticides in Red Foxes (Vulpes vulpes)*, PLoS ONE 1 (2015)

This study examined the presence of anticoagulant rodenticides in red foxes in Germany, with an emphasis on the type of land use most likely to indicate anticoagulant rodenticide exposure in predators.[163] The authors analyzed 331 liver samples of red foxes for residues of eight types of anticoagulant rodenticides and found 59.8 percent of samples contained at least one rodenticide, with 20.2 percent of the samples containing residues at levels that would likely have biological effects.[164] SGARs, mostly commonly brodifacoum and bromadiolone, accounted for nearly 95 percent of residues, with FGARs accounting for approximately 5 percent of residues.[165] Local livestock density and urban areas were the strongest indicators for anticoagulant rodenticide residue in red foxes.[166]

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[158] *Id*. at 116.
[159] *Id*. at 117.
[160] *Id*. at 118.
[161] *Id.*
[162] *Id.*
[163] A. Geduhn, et al., *Relation Between Intensity of Biocide Practice and Residues of Anticoagulant Rodenticides in Red Foxes (Vulpes vulpes)*, PLoS One 1, 1-2 (2015). Available at:
https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0139191&type=printable.
[164] *Id.* at 6.
[165] *Id.* at 6, 10.
[166] *Id.* at 7-10.

P. W.C. Pitt, et al., *Non-target Species Mortality and the Measurement of Brodifacoum Residues After a Rat (Rattus rattus) Eradiciationon Palmyra Atoll, Tropical Pacific*, 185 Biological Conservation 36 (2015)

This study examined brodifacoum residues present in soil, water, birds, fish, reptiles and invertebrates, including insects and crabs, after the aerial and hand application of brodifacoum on a Pacific island as part of a rat eradication effort.[167] Brodifacoum residues were detected in all non-target animal groups sampled.[168] The authors posited that cockroaches, ants, fish, and hermit crabs likely suffered from primary poisoning, while geckos, some birds, and possibly fiddler crabs were more likely to experience secondary or tertiary exposure.[169] Brodifacoum residues were detected in the nine soil and one freshwater sample.[170] Brodifacoum residues detected in fish confirmed that the rodenticide moved into the marine system.[171] This study is important because it demonstrates widespread ecosystem contamination, including in species such as geckos that were not previously thought to be at risk of contamination.[172]

Q. H. Alomar, et al., *Accumulation of anticoagulant rodenticides (chlorophacinone, bromadiolone and brodifacoum) in a non-target invertebrate, the slug, Deroceras reticulatum*, 610-611 Science of the Total Environment 576 (2018)

This study examined the accumulation of anticoagulant rodenticides in slugs under laboratory conditions and in the field.[173] The study also tested whether invertebrates may cause lethal or sub-lethal poisoning of predators by calculating the dose of brodifacoum ingested daily by three carnivores, including the common shrew, the European starling, and the European hedgehog.[174] The results indicated that anticoagulant rodenticides accumulated in slugs rapidly, and then concentrations stabilized over time.[175] No mortality was observed in any of the slugs, which was unsurprising to the authors because blood-clotting mechanisms in invertebrates are different than those found in vertebrates, which makes invertebrates less sensitive to anticoagulant rodenticides.[176] In the field trial, nearly 90 percent of analyzed slugs were contaminated with brodifacoum, and the authors showed that the hedgehog, shrew, and starling

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[167] W.C. Pitt, et al., *Non-target Species Mortality and the Measurement of Brodifacoum Residues After a Rat (Rattus rattus) Eradiciationon Palmyra Atoll, Tropical Pacific*, 185 Biological Conservation 36, 36-37 (2015). Available at: https://pdfs.semanticscholar.org/3a01/f39cefbcc6c34178f37fa36ef8e04595c37d.pdf.
[168] *Id.* at 43.
[169] *Id.*
[170] *Id.*
[171] *Id.* at 44.
[172] *Id.* at 44-45.
[173] H. Alomar, et al., *Accumulation of anticoagulant rodenticides (chlorophacinone, bromadiolone and brodifacoum) in a non-target invertebrate, the slug, Deroceras reticulatum*, 610-611 Science of the Total Environment 576, 577 (2018).
[174] *Id.*
[175] *Id.* at 578.
[176] *Id.* at 578-79.

can be exposed to high doses of brodifacoum via slug consumption.[177] According to different scenarios of exposure, the authors found the hedgehog is exposed to the lowest median doses, the starling ingested doses approximately 10 times higher than the hedgehog, and the shrew was the most exposed predator.[178] The authors stated that slugs could be a pathway leading to lethal poisoning of hedgehog.[179] Therefore, they recommended implementing a protocol to mitigate the risk of anticoagulant baits for non-target invertebrates, including, for example, not applying bait during slug activity unless necessary and examining the bait stations every day to remove any slugs.[180]

R. S. Gottlieb, et al., *Statement from FDA warning about significant health risks of contaminated illegal synthetic cannabinoid products that are being encountered by FDA*, U.S. Food and Drug Admin. (July 19, 2018)

This statement by the FDA warned of reports of severe illness and death resulting from the use of synthetic marijuana products contaminated with brodifacoum.[181] These products are sold in convenience stores and gas stations, and pose a health risk to individuals and to the U.S. blood supply.[182] Hundreds of individuals in about 10 states have been hospitalized after experiencing complications, and several deaths have also been reported.[183]

S. J. Regnery, et al., *Rating the Risks of Anticoagulant Rodenticides in the Aquatic Environment: a Review*, Environmental Chemistry Letters (2018)

This study reviewed available information on the environmental fate and impact of anticoagulant rodenticides in the aquatic environment and direct and indirect routes of exposure.[184] The authors specifically examined studies on anticoagulant rodenticide presence in surface water, stormwater runoff, groundwater, wastewater treatment plants, soils and sediments, suspended particulate matter, aquatic organisms, avian and mammalian predators in the aquatic food web. Importantly, the authors found that SGARs "are unlikely to remain in the water column of surface waters. Thus, their residues are more likely to persist and accumulate in aquatic compartments such as suspended particulate matter, (organic-rich) sediments, and biological tissue of aquatic organisms.[185] This review prompted the authors to conclude that "[a]nticoagulants entering the aquatic environment and accumulating in aquatic wildlife are

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[177] *Id.* at 580.
[178] *Id.*
[179] *Id.*
[180] *Id.* at 581.
[181] S. Gottlieb, et al., *Statement from FDA warning about significant health risks of contaminated illegal synthetic cannabinoid products that are being encountered by FDA*, U.S. Food and Drug Admin. (July 19, 2018). Available at: https://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm614027.htm.
[182] *Id.*
[183] *Id.*
[184] J. Regnery, et al., *Rating the Risks of Anticoagulant Rodenticides in the Aquatic Environment: a Review*, Environmental Chemistry Letters 4 (2018).
[185] *Id.* at 9.

likely to be transferred in the food chain, causing potentially serious consequences for the health of wildlife and humans[.]"[186]

T. C. Gomez-Canela, et al., Occurrence, Elimination, and Risk of Anticoagulant Rodenticides and Drugs During Wastewater Treatment 21 Envtl. Science and Pollution Research (2014)

This study presented the first data on the occurrence and elimination of anticoagulant rodenticides in the wastewater treatment process.[187] Sampling occurred at multiple wastewater treatment plants ("WWTPs") in Spain. Anticoagulant rodenticides were detected in WWTP effluents, with warfarin being the most prevalent.[188] The authors stated that anticoagulants enter WWTPs as a result of their use as pest control in urban infrastructures, domestic application, and in agriculture.[189] Overall, the authors concluded that "aquatic risk is low, when measuring the LC50 with D. magna as a model aquatic organism."[190]

U. C. Gomez-Canela and S. Lacorte, Comprehensive Characterization of Anticoagulant Rodenticides in Sludge by Liquid Chromatography-tandem Mass Spectrometry, 23 Envtl. Science and Pollution Research 15739 (2016). Available at: https://www.researchgate.net/publication/301832060_Comprehensive_characterization_of_anticoagulant_rodenticides_in_sludge_by_liquid_chromatography-tandem_mass_spectrometry

This study demonstrates that anticoagulant rodenticides accumulate in sludge during sludge treatment and that the application of sludge as fertilizer may pose an environmental risk.[191]

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[186] *Id.* at 4.
[187] C. Gomez-Canela, et al., Occurrence, Elimination, and Risk of Anticoagulant Rodenticides and Drugs During Wastewater Treatment 21 Envtl. Science and Pollution Research 4 (2014). Available at: https://www.researchgate.net/publication/260760312_Occurrence_elimination_and_risk_of_anticoagulant_rodenticides_and_drugs_during_wastewater_treatment
[188] *Id.* at 4.
[189] *Id.* at 10.
[190] *Id.*
[191] C. Gomez-Canela and S. Lacorte, Comprehensive Characterization of Anticoagulant Rodenticides in Sludge by Liquid Chromatography-tandem Mass Spectrometry, 23 Envtl. Science and Pollution Research 15739, 15745-46, 48-49 (2016). Available at: https://www.researchgate.net/publication/301832060_Comprehensive_characterization_of_anticoagulant_rodenticides_in_sludge_by_liquid_chromatography-tandem_mass_spectrometry

V. K. Horak, et al., Pharmacokinetics of Anticoagulant Rodenticides in Target and Non-target Organisms, USDA National Wildlife Research Center 2091 (2018)

This study predicted toxicity and performed risk assessments of anticoagulant rodenticides based not simply on dose but also on data that includes absorption, distribution, metabolism, and excretion, known as ADME.[192]

W. Additional Studies

There are additional studies published between 2014 and 2018 that appear to be highly relevant to DPR's reevaluation, but for which AWI could not obtain full articles. AWI has requested these articles from the authors, and will provide the studies to DPR in supplemental comments if and when we receive the articles. The studies are as follows:

M. D'Alessio, et al., *A Tier-I leaching risk assessment of three anticoagulant compounds in the forested areas of Hawai'I*, 630 Science of The Total Environment 889 (2018). Abstract available at: https://www.sciencedirect.com/science/article/pii/S0048969718306570.

M. Elmeros, et al., *Exposure of non-target small mammals to anticoagulant rodenticide during chemical rodent control operations*, Environmental Science and Pollution Research (2019). Abstract available at: https://link.springer.com/article/10.1007%2Fs11356-018-04064-3.

N.W. van den Brink, et al., Anticoagulant Rodenticides and Wildlife (2018). Abstract available at: https://link.springer.com/book/10.1007/978-3-319-64377-9.

K. Ondracek, et al., Mixture Toxicity of Microcystin-LR, Paraoxon and Bromadiolone in Xenopus laevis Embryos, 36 Neuro Endocrinology Letters (2016). Abstract available at: https://www.researchgate.net/publication/290378438_Mixture_toxicity_of_microcystin-LR_paraoxon_and_bromadiolone_in_Xenopus_laevis_embryos.

II. Potential Legal Violations Resulting from Continued SGARs Registration.

This section addresses potential violations of the federal Endangered Species Act, the California Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act due to ongoing take of listed species due to SGAR poisoning.

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[192] K. Horak, et al., Pharmacokinetics of Anticoagulant Rodenticides in Target and Non-target Organisms, USDA National Wildlife Research Center, 98-102 (2018). Available at: http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=3089&context=icwdm_usdanwrc.

A. Federal Endangered Species Act.

California's current regulatory scheme for SGARs may violate the federal Endangered Species Act ("ESA") because it allows the sale of products that take listed species, and California has not obtained an incident take permit from U.S. Fish and Wildlife Service. Section 9 of the ESA prohibits any person from "taking" a listed species, which is broadly defined to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." *See* 16 U.S.C. § 1538(a)(1)(B)–(C); 16 U.S.C. § 1532(19). While "harm" flows from "an act which actually kills or injures wildlife," an endangered animal is "harassed" by any "intentional or negligent act or omission which creates the likelihood of injury . . . by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering." 50 C.F.R. § 17.3. The term "person" includes "any officer, employee, agent, department, or instrumentality . . . of any State, municipality, or political subdivision of a State . . . [or] any State, municipality, or political subdivision of a State . . . . ." *Id.* § 1532(13). Take need not be intentional. *Babbitt v. Sweet Home Chapter of Communities,* 515 U.S. 687, 704 (1995).

The ESA not only prohibits acts that directly cause a taking, but also bans acts of a governmental entity that can lead to such take. *Strahan v. Coxe*, 127 F.3d 155, 163 (1st Cir. 1997) *cert. denied,* 525 U.S. 830 (1998). The *Strahan* court found that "a governmental third party pursuant to whose authority an actor directly exacts a taking of an endangered species may be deemed to have violated the provisions of the ESA." *Id.* The court held that Massachusetts, through its licensing scheme of commercial fishing, was liable under the ESA for the incidental take of Northern Right whales. *Id.*; *see also, Seattle Audubon Society v. Sutherland*, 2007 WL 1577756 at *2 (W.D. Wash. May 30, 2007) (by regulating logging on private lands, the State has injected itself into a position in which it may be the proximate cause of an ESA take); *Pacific Rivers Council v. Oregon Forest Indus. Council*, 2002 WL 32356431 at *11 (D. Or. Dec. 23, 2002) (finding that state forester's authorization of logging operations that are likely to result in a take is itself a cause of a take). *Animal Protection Inst. v. Holsten*, 541 F. Supp. 2d 1073, 1079 (D. Minn. 2008) ("the DNR's licensure and regulation of trapping is the "stimulus" for the trappers conduct that results in incidental takings. Accordingly, the trappers conduct is not an independent intervening cause that breaks the chain of causation between the DNR and the incidental takings of lynx.").

The courts have made similar rulings in the context of registration of toxins. *See Defenders of Wildlife v. U.S. Envtl. Protection Agency,* 882 F.3d 1294 (8th Cir. 1989) (holding the EPA liable for take associated with the registration of strychnine even though the administration of the pesticide, which was known to poison endangered species, either directly or indirectly, was actually carried out by third parties). An agency's approval of activity that poisons prey of endangered species leading to take of the upper level predator also can constitute take by the approving agency. *National Wildlife Federation v. Hodel*, 1985 U.S. Dist. LEXIS 16490, *12-13, 1985 WL 186671 (E.D. Cal. 1985) (enjoining the use of lead shot in areas where the formerly endangered bald eagle preyed on carcasses with lead shot because of lead poisoning in bald eagles).

Under certain terms and conditions, the taking of a threatened or endangered species that is incidental to the purpose of otherwise lawful activity may be allowed. 16 U.S.C. § 1539(a)(1)(B). To escape liability under the ESA, however, the person must have received an incident take permit ("ITP"). 16 U.S.C. § 1536(b)(4), (o)(2). As a prerequisite to receiving an ITP, the applicant must submit a habitat conservation plan that specifies "(i) the impact which will likely result from such taking; (ii) what steps the applicant will take to minimize and mitigate such impacts, and the funding that will be available to implement such steps; (iii) what alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized; and (iv) such other measures that the Secretary may require as being necessary or appropriate for purposes of the plan." 16 U.S.C. § 1539(a)(2)(A). After consultation, the Secretary will issue an ITP if the Secretary concludes: (1) the agency's action, with any reasonable and prudent alternatives, is not likely to jeopardize the continued existence of protected species under the ESA; and (2) any incidental taking of these species is not likely to jeopardize their existence. 16 U.S.C. § 1536(b)(4); *see id.* § 1536(a)(2). The ITP will identify the expected impact of the incidental takings, the reasonable and prudent measures necessary to minimize the impact, and the terms and conditions that must be complied with to implement those measures. 16 U.S.C. § 1536(b)(4); 50 C.F.R. § 402.14(g)(7), 14(i).

Individuals of at least two listed species in California, the San Joaquin kit fox and the northern spotted owl, have been taken as a result of SGARs poisoning.[193] The kit fox has been listed as endangered under the ESA since 1967. The northern spotted owl has been listed as threatened under the ESA since 1990. While the northern spotted owl is found across the West Coast, California's population is the species' greatest stronghold, and protecting the owl in California is key to protecting the species at large. DPR's registration of SGARs results in ongoing take that violates the ESA. For such take to be lawful, California must obtain an ITP, which it has failed to do.

B. California Endangered Species Act.

With the passage of the California Endangered Species Act ("CESA"), Fish & G. Code, § 2050 *et seq*., the California Legislature declared that: "it is the policy of the state to conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat." "Central to CESA is its prohibition on the taking of an endangered or threatened species." *Envtl. Prot. & Info. Ctr. (EPIC) v. CA Dep't of Forestry & Fire Prot*., 44 Cal. 4th 459, 507 (Cal. 2008)

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[193] B.L. Cypher, et al., *Rodenticide Exposure Among Endangered Kit Foxes Relative to Habitat Use in an Urban Landscape*, 7 Cities and the Environment 1 (2014); T.M. Nogeire, et al., Land Use as a Driver of Patterns of Rodenticide Exposure in Modeled Kit Fox Populations, PLoS ONE 1 (2015); U.S Environmental Protection Agency, Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: a Comparative Approach 93 (2004). Available at: http://www.fwspubs.org/doi/suppl/10.3996/052012-JFWM-042/suppl_file/10.3996_052012-jfwm-042.s4.pdf; M. W. Gabriel, *Exposure to Rodenticides in Northern Spotted and Barred Owls on Remote Forest Lands in Northwestern California: Evidence of Food Web Contamination*, 13 Avian Conservation and Ecology 1 (2018). Available at: http://www.ace-eco.org/vol13/iss1/art2/.

(citing Fish & G. Code, § 2080). Section 2080 of the Fish and Game Code states: "[n]o person shall . . . take, possess, purchase, or sell within this state, any species, or any part or product thereof, that . . . [is] determin[ed] to be an endangered species or a threatened species." To "take" means to hunt, pursue, catch, capture or kill or attempt to hunt, pursue, catch, capture, or kill. Fish & G. Code, § 86. "Person" has been found to include state agencies. *Watershed Enforcers v. Dep't of Water Resources*, 185 Cal. 4th 969 (Cal. App. 2010). In reaching this conclusion, the Court found that "interpreting section 2080 to exclude state agencies would lead to the unreasonable result that major actors, whose operations result in the taking of endangered and threatened species, would be exempt from the general take prohibition." *Id.* at 983. The Court also noted "the general rule that '[l]aws providing for the conservation of natural resources' such as . . . CESA 'are of great remedial and public importance and thus should be construed liberally.'" *Id.* at 979. The prohibition against take applies to wildlife located on public as well as private land. *See* Fish & G. Code, § 2080.

As explained by the Supreme Court of California:

> CESA allows the [Department of Fish and Wildlife] to authorize a "take" that is incidental to an otherwise lawful activity if certain conditions are met. . . . At the heart of CESA is the obligation to mitigate such takes. The impacts of the authorized take shall be minimized and fully mitigated. The measures required to meet this obligation shall be roughly proportional in extent to the impact of the authorized taking on the species. Where various measures are available to meet this obligation, the measures required shall maintain the applicant's objectives to the greatest extent possible. All required measures shall be capable of successful implementation. For purposes of this section only, impacts of taking include all impacts on the species that result from any act that would cause the proposed taking.

EPIC, 44 Cal. 4th at 507 (citing Fish & G. Code, § 2081(b), Cal. Code Regs., tit. 14, § 783 *et seq*.).

Take of a listed species may occur pursuant to an ITP issued by the California Department of Fish and Wildlife ("CDFW"). No permit may be issued if it would jeopardize the continued existence of the species. Fish & G. Code, § 2081(c). In order to obtain a permit, applicants must submit an application to CDFW that addresses, among other topics: (1) an analysis of whether and to what extent the project or activity for which the permit is sought could result in the taking of species to be covered by the permit; (2) an analysis of the impacts of the proposed taking on the species; (3) an analysis of whether issuance of the incidental take permit would jeopardize the continued existence of a species; (4) a complete, responsive jeopardy analysis that shall include consideration of the species' capability to survive and reproduce, and any adverse impacts of the taking on those abilities in light of known population trends, known threats to the species; and reasonably foreseeable impacts on the species from other related projects and activities; (5) proposed measures to minimize and fully mitigate the impacts of the proposed taking; (6) a proposed plan to monitor compliance with the minimization and mitigation measures and the effectiveness of the measures; and (7) a description of the funding sources and the level of funding available for implementation of the minimization and mitigation measures. Under CESA, the County is required to obtain an ITP prior to engaging in activities that would result in the incidental take of CESA listed species.

Individuals of at least three listed species in California, the San Joaquin kit fox,[194] the pacific fisher,[195] and the northern spotted owl,[196] have been taken as a result of SGARs poisoning. The kit fox was listed as threatened under CESA in 1971. The Southern Sierra Nevada Evolutionarily Significant Unit of pacific fisher was listed as threatened in 2016 under CESA. In 2016, the northern spotted owl was listed as threatened under CESA. Regarding the conservation status and threats to northern spotted owls, CDFW stated that toxicants such as ARs from marijuana cultivation sites likely pose "a serious and widespread threat to northern Spotted Owls." DPR's registration of SGARs results in ongoing take of these three species contrary to CESA. DPR must therefore apply for and receive an ITP from CDFW to comply with CESA, which it has failed to do.

C. Migratory Bird Treaty Act.

Continued registration of SGARs by DPR leads to violations of the Migratory Bird Treaty Act ("MBTA"), 16 U.S.C. §§ 703–712. The MBTA prohibits the unlawful taking or killing, or an attempt to take or kill, by any means, any migratory bird native to the United States. 16 U.S.C. § 703(a). The MBTA protects over 800 species of birds, including red-tailed hawks, peregrine falcons, owls, and numerous other raptors affected by SGARs. Specific knowledge or intent to kill MBTA covered species is not necessary to violate the law; passive, unintentional actions are considered take under the MBTA. *United States v. Moon Lake Elec. Ass'n, Inc*., 45 F. Supp. 2d 1070 (D. Colo. 1999). The MBTA further prohibits poisoning migratory birds through the application of pesticides that kill covered species even when there is no intent to kill those species. *United States v. Corbin Farm Service*, 444 F. Supp. 510 (E.D. Cal. 1978), aff'd 578 F2d 259 (1978); *United States v. FMC Corp*., 572 F.2d 902, 908 (2d Cir. 1978).

D. Bald and Golden Eagle Protection Act

DPR's registration of SGAR's also violates federal law protecting golden eagles. The Bald and Golden Eagle Protection Act ("BGEPA"), 16 U.S.C. §§ 668–668d (1982), creates criminal and civil penalties for any unpermitted, knowing take of bald or golden eagles. 16

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[194] B.L. Cypher, et al., *Rodenticide Exposure Among Endangered Kit Foxes Relative to Habitat Use in an Urban Landscape*, 7 Cities and the Environment 1 (2014); T.M. Nogeire, et al., Land Use as a Driver of Patterns of Rodenticide Exposure in Modeled Kit Fox Populations, PLoS ONE 1 (2015).
[195] M.W. Gabriel, Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore, 7 PloS ONE 1 (2012). Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0040163.
[196] M. W. Gabriel, *Exposure to Rodenticides in Northern Spotted and Barred Owls on Remote Forest Lands in Northwestern California: Evidence of Food Web Contamination*, 13 Avian Conservation and Ecology 1 (2018). Available at: http://www.ace-eco.org/vol13/iss1/art2/.

U.S.C. § 668(a)-(b). Take in the context of the BGEPA includes poisoning, wounding, killing, molesting or disturbing. 16 U.S.C. § 668(c). Disturbing is defined as behavior that agitates or bothers a bald or golden eagle to a degree that "causes, or is likely to cause . . . (1) injury to an eagle, (2) a decrease in its productivity . . . or (3) nest abandonment." 50 C.F.R. § 22.3. If an actor is "'conscious from . . . knowledge of surrounding circumstances and conditions that [the actor's] conduct will naturally and probably result in injury' to a protected" bald or golden eagle, the BGEPA applies. *Moon Lake Elec. Ass'n*., 45 F. Supp. 2d at 1074 (quoting S. REP. NO. 92-1159, at 5 (1972)). The poisoning of golden eagles by SGARs is well documented.[197] These activities result in killing, molesting, and disturbing eagles through death, injury, interfering with normal behavior, and impacting productivity, which constitutes take under the BGEPA. DPR's registration and authorization of SGARs in California will continue to lead to eagle deaths, poisonings, and take unless DPR's regulations are changed to reduce the harm to eagles.

V. Additional Regulatory Proposals.

This section identifies four regulatory proposals for DPR to consider adopting in order to further reduce the impact of SGARs on non-target wildlife. The proposals are as follows: (1) ban brodifacoum and difethialone; (2) develop an educational program for certified commercial and private applicators of SGARs; (3) educate consumers on the risks of SGARs; and (4) ban the use of SGARs on golf courses in San Joaquin kit fox habitat.

A. Ban Brodifacoum and Difethialone.

DPR should strongly consider banning products containing the active ingredients brodifacoum and difenthialone due to their extreme toxicity to non-target mammals and birds. The ban of these two active ingredients would not unduly impact certified commercial and private applicators because DPR data indicate that these products are not heavily relied upon by pesticide applicators. This proposal would remove the most dangerous products from use while still allowing for the use of a wide range of other rodenticide products. Two additional SGARs active ingredients, bromadiolone and difenacoum, would still be available for use, as would all FGARs and non-anticoagulant rodenticide products.

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[197] G. Herring, et al., *Characterizing Golden Eagle Risk to Lead and Anticoagulant Rodenticide Exposure: A Review*, 51 J. of Raptor Research 273, 274 (2017). Available at: https://bioone.org/journals/Journal-of-Raptor-Research/volume-51/issue-3/JRR-16-19.1/Characterizing-Golden-Eagle-Risk-to-Lead-and-Anticoagulant-Rodenticide-Exposure/10.3356/JRR-16-19.1.full.; K.H. Langford, *The Occurrence of Second Generation Anticoagulant Rodenticides in Non-Target Raptor Species in Norway*, 450-451 Science of the Total Environment 205 (2013); U.S Environmental Protection Agency, Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: a Comparative Approach 84, 90, 95, 99-100, 107, 187, 211 (2004). Available at: http://www.fwspubs.org/doi/suppl/10.3996/052012-JFWM-042/suppl_file/10.3996_052012-jfwm-042.s4.pdf.

The following table, contained in DPR's 2018 report[198] clearly demonstrates that brodifacoum and difethialone are uniquely toxic to mammals and particularly to birds, relative to bromodiolone and difenacoum, and to all types of FGARs.

Table 1 – Comparison of toxicity values for birds and mammals for ten rodenticides.

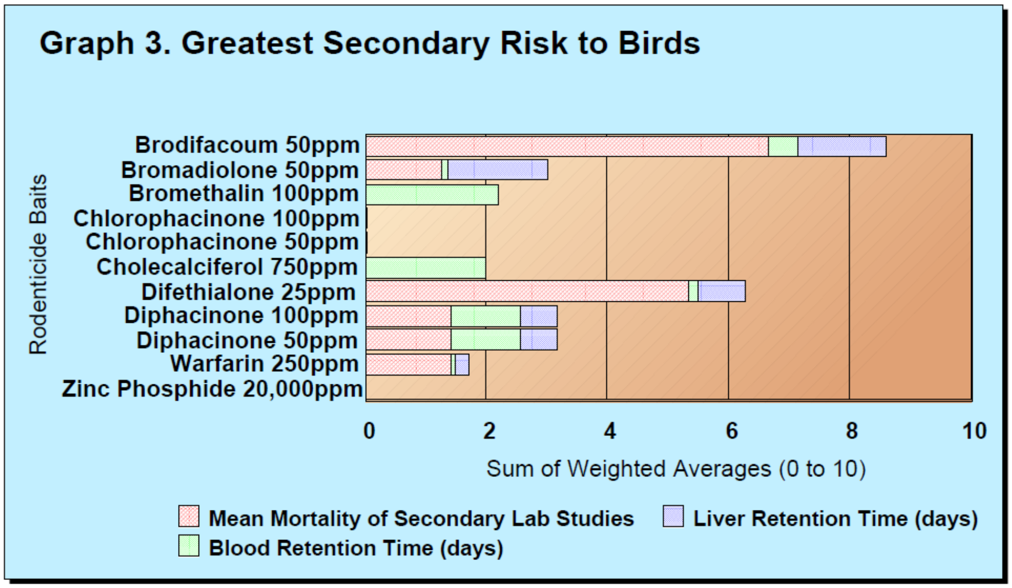
Type of Rodenticide	Active Ingredient	Most Sensitive LD_{50} for Birds (mg ai/kg bw) [a, b]	Most Sensitive LD_{50} for Mammals (mg ai/kg bw) [a, b]
SGARs	**Brodifacoum**	**0.26**	**0.13**
	Bromadiolone	138	0.56
	Difenacoum	66	0.45
	Difethialone	**0.26**	**0.29**
FGARs	Chlorophacinone	>100	0.49
	Diphacinone	96.8	0.2
	Warfarin	620	2.5

Bold font represents those active ingredients that have similar LD_{50} values for mammals and birds. The other active ingredients have a substantial difference between the LD_{50} values for mammals and birds.
[a] Data summarized from DPR, 2013
[b] LD_{50} values presented in units of milligrams of active ingredient per kilogram of body weight

DPR's findings are also supported by data from the U.S. Environmental Protection Agency, which stated in a 2004 report that "[b]ased on the data from secondary hazard laboratory studies and the data available on retention times in blood and liver of target species, the comparative analysis model indicates that brodifacoum and difethialone pose the greatest potential secondary risks to birds"[199] as demonstrated by the following table:[200]

[198] Cal. Dept. Pesticide Regulation, An Investigation of Anticoagulant Rodenticide Data Submitted to the Dept. of Pesticide Regulation 3 (Nov. 16, 2018).
[199] U.S Environmental Protection Agency, Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: a Comparative Approach 82 (2004). Available at: http://www.fwspubs.org/doi/suppl/10.3996/052012-JFWM-042/suppl_file/10.3996_052012-jfwm-042.s4.pdf.
[200] *Id.* at 83.

Figure 4. Comparative Analysis Model Summary Values For Secondary Risk to Birds



DPR's findings are also supported by Herring et al. (2017).[201] The reason that brodifacoum and difethialone pose a greater risk to birds and mammals is explained in part by differences in dosage and half-life in the blood and liver, as demonstrated in the following table:[202]

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[201] Herring, et al, *Characterizing Golden Eagle Risk to Lead and Anticoagulant Rodenticide Exposure: A Review*, 51 J. of Raptor Research 273, 281-82 (2017). Available at: https://bioone.org/journals/Journal-of-Raptor-Research/volume-51/issue-3/JRR-16-19.1/Characterizing-Golden-Eagle-Risk-to-Lead-and-Anticoagulant-Rodenticide-Exposure/10.3356/JRR-16-19.1.full.

[202] 23 DPR 2013.

Table 1. Half-life (in days) of a single dose of rodenticides in the blood and liver of rats[1, 2].

Class of Rodenticide	Rodenticide	Dose (mg ai/kg)	Half-life (in days) in Blood	Half-life (in days) in Liver
Second Generation Anticoagulant Rodenticides	Brodifacoum	0.02 to 0.35	6.5 to 91.7[7]	113.5[3] to 350
	Bromadiolone	0.2 to 3.0	1.0 to 2.4	170 to 318
	Difenacoum[4]	1.2	NA	118
	Difethialone	0.5	2.3	126
First Generation Anticoagulant Rodenticides	Chlorophacinone	4 to 5	0.4	Less than 2
	Diphacinone	0.32	NA	Between 2 and 3[1, 3]
	Warfarin	NA[9], 1[3]	0.7 to 1.2[1]	7[1] to 26.2[3]
Non-anticoagulant Rodenticides[2]	Bromethalin[5]	NA[9]	5.5	NA
	Cholecalciferol[6]	NA[9]	1	~19[8]

1 Data summarized from Erickson and Urban, 2004, except where noted.
2. Data is not available for zinc phosphide, so it is not included on the chart.
3. Fisher et al, 2003.
4. U.S. EPA, 2007.
5. Spaulding and Spannring, 1988.
6. Marrow, 2001.
7. Vandenbroucke et al, 2008.
8. Body half-life (instead of liver half-life).
9. NA is defined as Not Available.

According to DPR's pesticide use and sales data, brodifacoum and difethialone are not widely used or sold in large amounts, relative to other anticoagulant rodenticide active ingredients.[203] As shown in the tables below, Brodifacoum sales have decreased since the 2014 regulations went into effect, from 34.5 pounds in 2013, to a low of 3.5 pounds in 2015, and a slight increase to 5.7 pounds in 2017.[204] Difethialone sales have remained relatively stable at approximately 4 pounds between 2014 and 2017.[205] In terms of pounds of active ingredient used, approximately 3 to 6 pounds of brodifacoum have been used each year from 2014 to 2017, while approximately 10 pounds of difethialone have been used each year from 2014 to 2017.[206] In its 2018 report, DPR specifically noted that "[b]rodifacoum use has always been relatively low compared to other ARs, because it is not favored by professional applicators."[207] Based on their relatively low use, banning brodifacoum and difethialone is a viable option that would not have a significant impact on certified commercial and private applicators' ability to control rodents in light of other, safer products that are much more commonly used.

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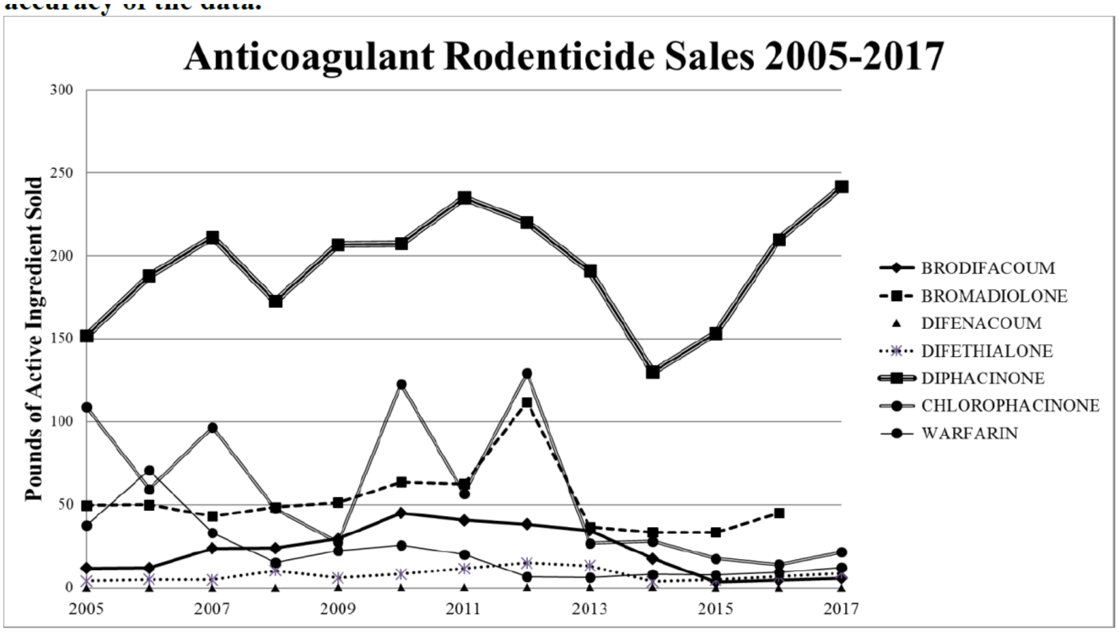
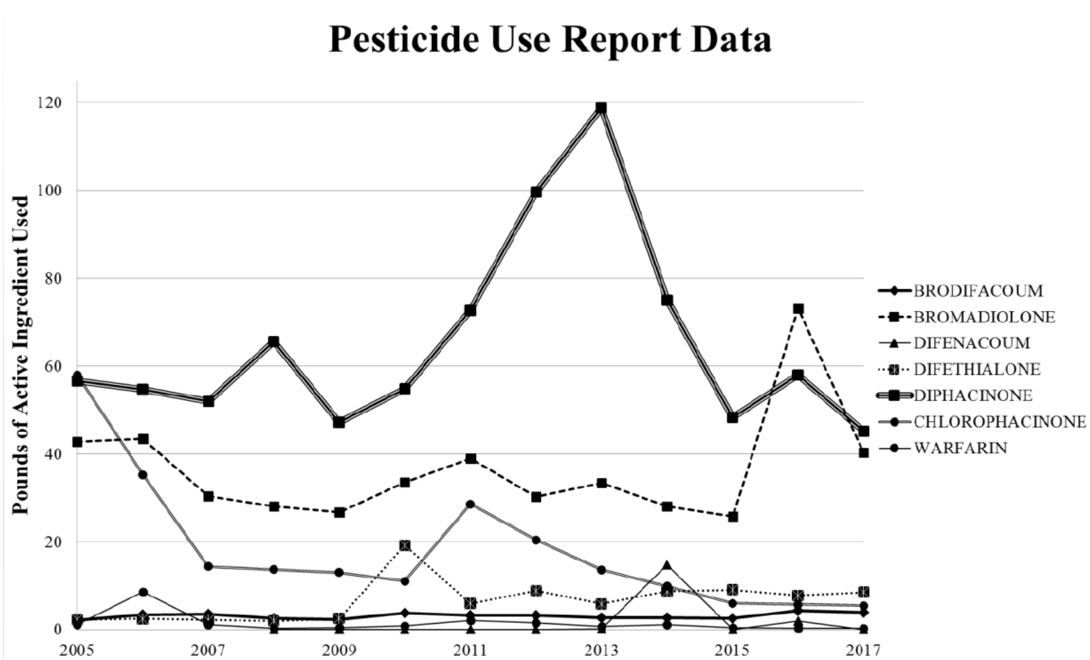
[203] Cal. Dept. Pesticide Regulation, An Investigation of Anticoagulant Rodenticide Data Submitted to the Dept. of Pesticide Regulation 29-31 (Nov. 16, 2018).
[204] *Id.* at 29.
[205] *Id.* at 31.
[206] *Id.* at 30.
[207] *Id.* at 29.

accuracy of the data.



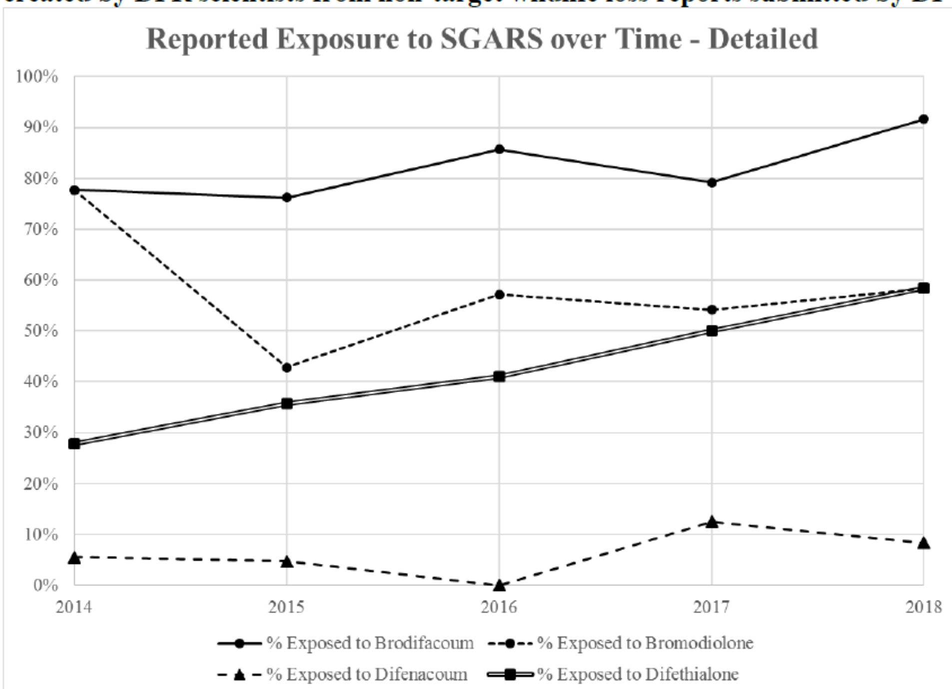


Although brodifacoum and difethialone are not commonly used in California, data presented in DPR's 2018 report demonstrate that non-target wildlife exposure rates to these two active ingredients are incredibly high relative to their usage. As demonstrated by the following figure,[208] from 2014 to 2018, approximately 80 to 90 percent of tested non-target wildlife

[208] *Id.* at 6.

contained brodifacoum residue.[209] Over the same time period, the rate of difethialone residue detected in tested non-target wildlife doubled, from approximately 30 percent to 60 percent.[210] These values are striking, considering that less than 10 pounds of both active ingredients were sold and used each year from 2014 to 2017. In its 2018 report, DPR stated that "decreased sales of brodifacoum do not appear to have led to decreased exposure rates among non-target wildlife."[211]

Figure 2 – Exposure rates of individual SGAR active ingredients from 2014-2018 (chart created by DPR scientists from non-target wildlife loss reports submitted by DFW).



Overall, banning brodifacoum and difethialone is a viable solution that is likely to have a strong positive impact on reducing lethal and sub-lethal poisoning of non-target wildlife in California while having little adverse effect on certified commercial and private applicators' ability to control rodents.

B. Develop an Educational Program for Certified Commercial and Private Applicators.

Several studies have demonstrated that pest control operators incorrectly apply SGARs bait,[212] have a low level of understanding of SGARs toxicity, and are unknowledgeable about

[209] *Id.*
[210] *Id.*
[211] *Id.* at 29.
[212] M. Bartos, et al., *Use of anticoagulant rodenticides in single-family neighborhoods along an urban-wildland interface in California*, 4 Cities and the Environment 1 (2012). Available at:

SGARs' impacts on non-target wildlife.[213] These studies suggest the need for California to develop and implement an outreach and educational program for its certified commercial and private applicators, both as part of its certification program and as part of an ongoing educational requirement. The educational requirement should address integrated pest management that includes habitat alteration, sanitation, exclusion of commensal rodent species, and other practices such as concealing bait to minimize non-target exposure, carcass disposal, and removing bait at the end of treatment. To develop this educational program, DPR may wish to review the program adopted by the United Kingdom in 2016 that has been led by an industry consortium working with relevant government agencies.[214] The foundation of the program is a code of best practice[215] that involves multiple activities, including approval and certification of training courses and a requirement of proof of competence at the point of sale of professional products. DPR may also wish to examine the European Union's guidelines on best practices for the use of rodenticides.[216] In combination with an educational requirement, DPR may wish to initiate research into the knowledge, awareness, and use of rodenticides by certified commercial and private applicators to better understand how to minimize the risks posed by SGARs to non-target wildlife.

C. Education of Consumers.

It is also important to educate consumers who employ the services of certified commercial applicators on the effects of SGARs on non-target wildlife and pets. A study on chemical rodenticide use by homeowners found that increased awareness of impacts on non-target wildlife translated to a higher likelihood of behavioral changes that decreased wildlife exposure risk.[217] Even when products are used in accordance with the law, enhancing overall awareness may increase the efforts made to minimize excess use of chemicals and reduce the risk posed to non-target wildlife.[218] In many instances, residents do not know which chemicals

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https://digitalcommons.lmu.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=1100&context=cate.

[213] K. Memmott, et al., *Use of Anticoagulant Rodenticides by Pest Management Professionals in Massachusetts, USA*, 26 Ecotoxicology 90, 90 (2017).

[214] Think Wildlife: Campaign for Responsible Rodenticide Use. Available at: *www.thinkwildlife.org/stewardship-regime*.

[215] Think Wildlife: Campaign for Responsible Rodenticide Use, UK Code of Best Practice (2015). Available at: *www.thinkwildlife.org/crru-downloads/crru-uk-code-of-best-practice*.

[216] Guideline on Best Practice in the Use of Rodenticide Baits As Biocides in the European Union; European Biocidal Products Forum, The European Chemistry Industry Council: Brussels, Belgium, 2013; http://www.cefic.org/Documents/About-Us/Industry%20sectors/EBPF/Guideline-on-Best-Practice-in-the-Use-of-Rodenticides-in-the-EU.pdf.

[217] Memmott, *supra* note 204, at 95 (citing A.T. Morzillo and A.G. Mertig, *Linking human behaviour to environmental effects using a case study of urban rodent control*, 68 Inat'l J. Environmental Studies 107 (2011)).

[218] *Id.* (citing R.A. Mcdonald and S. Harris, *The use of fumigants and anticoagulant rodenticides on game estates in Great Britain,* 30 Mammal Rev 57 (2000).

are used to control rodents on their properties, nor the mode of action of these chemicals.[219] However, owners are generally interested in learning about the effects rodenticides have on non-target species, suggesting that education programs could help reduce the impact of anticoagulant rodenticide usage.[220] Certified commercial applicators should be required to inform customers of the dangers of SGARs to pets and non-target wildlife before utilizing SGARs by providing a written information sheet that requires the customer's signature.

D. Ban Use of SGARs on Golf Courses in San Joaquin Kit Fox Habitat.

Based on the findings of B.L. Cypher, et al., (2014)[221] and Nogeire, et al. (2015),[222] described in Section II, DPR should consider implementing a ban on the use of SGARs on golf courses within San Joaquin kit fox habitat in the following California counties: Alameda, Contra Costa, San Joaquin, Santa Clara, Fresno, Kings, Madera, Merced, San Benito, Stanislaus, Tulare, Monterey, Kern, San Luis Obispo, and Santa Barbara. The ban could include very limited exceptions, such that SGARs may be used: (1) only as a last resort in the event that a federal, state, or local public health authority makes a finding that a public health emergency exists, there is demonstrated local resistance to FGARs by the target species, and other, less-toxic measures have been implemented, including sanitation and trapping, and have been found insufficient to control the hazard; or, (2) federal or state authorities determine that conditions exist that require the use of SGARs to control, eradicate, or prevent the invasion of non-native and invasive species that pose direct or indirect significant harm to imperiled species or threaten ecosystem integrity in a given area, and other, less-toxic measures have been demonstrated to be ineffective and not feasible in the specific circumstances. Applicators should identify locations where these rodenticides are used by specific coordinates and submit that information to DPR as part of a pesticide use report.

VI. Conclusion.

Thank you for your consideration of these comments. If you have any questions or if there is any additional information we can provide at this stage, please do not hesitate to contact me.

Sincerely,

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[219] T.M. Nogeire, et al., Land Use as a Driver of Patterns of Rodenticide Exposure in Modeled Kit Fox Populations, PLoS ONE 1, 11 (2015).
[220] *Id.*
[221] B.L. Cypher, et al., *Rodenticide Exposure Among Endangered Kit Foxes Relative to Habitat Use in an Urban Landscape*, 7 Cities and the Environment 1 (2014).
[222] Nogeire, *supra* note 210.

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