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Via Federal Express & Electronic Mail

Linda Irokawa-Otani, Regulations Coordinator
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Re: Proposed Regulations Designating Brodifacoum, Bromadiolone, Difenacoum, and Difethialone as Restricted Materials – DPR Regulation No. 13-0002

Dear Ms. Irokawa-Otani:

I am writing in regard to the proposed regulations referenced above. I am a biologist and Ph.D. Candidate at the University of California, Los Angeles. For the past 7 years, I have been studying the impacts of anticoagulant rodenticides on bobcats in Los Angeles, Ventura, and Orange Counties.

The Department of Pesticide Regulation (“DPR”) proposes to designate the active ingredients brodifacoum, bromadiolone, difenacoum, and difethialone as California restricted materials. This action would make all second-generation anticoagulant rodenticide (“SGAR”) products restricted materials. DPR also proposes to prohibit most above-ground placement of SGARs further than 50 feet from structures and to broaden the definition of persons that can obtain certification from DPR to use SGARs to include livestock, poultry and fish producers.

I agree wholeheartedly with DPR’s findings that “SGAR exposure to nontarget wildlife is a statewide problem, regardless of setting” and that “use of SGARs presents a hazard related to persistent residues in target animals resulting in impacts to nontarget wildlife.” I support DPR’s decision to take regulatory action to address impacts to nontarget wildlife. I believe that designating SGARs as California restricted materials would be an important first step in promoting the conservation of nontarget wildlife in California. However, it is apparent that DPR’s proposed regulations do not go far enough in preventing adverse impacts to non-target wildlife. Accordingly, I urge DPR to adopt the additional restrictions on use set forth below.

Background

Chemical contaminants are the third leading cause of endangerment to imperiled species worldwide [1]. The consequences of contaminant exposure can vary by species, but may include direct mortalities [2], reproductive impairment [3-7], decreased immune competence [7] and increased disease susceptibility or emergence [2,8] and overall declines of nontarget species populations [9,10].

Anticoagulants rodenticides (ARs) represent a group of compounds increasingly gaining attention for the threat they pose to nontarget wildlife [11-13]. ARs are Vitamin K antagonists that interrupt the production of Vitamin K-dependent blood clotting proteins. For animals that ingest a lethal dose, mortality
occurs by hemorrhage. ARs fall into two classes: “first-generation” and “second-generation.” Although rats developed genetic resistance to first-generation compounds (FGARs), which lead to the development of more toxic second-generation anticoagulant rodenticides (SGARs), both classes are still widely used in urban and agricultural areas. Second-generation anticoagulant rodenticides (“SGARs”) include brodifacoum, bromadiolone, difenacoum, and difethialone, are acutely toxic. SGARs have increased potency and prolonged efficacy, with hepatic half-lives that can extend for more than 120 days in some species [14]. As a result, predatory birds and mammals that feed on poisoned (live or dead) rodents are especially vulnerable to secondary poisoning from second-generation anticoagulants. First generation compounds, on the other hand, have considerably shorter hepatic half-lives and must be consumed in multiple feedings to reach a lethal dose [13].

**Research Findings**

Although they are the number one method of rodent control used worldwide, the breadth of the consequences of AR exposure in nontarget wildlife remains unknown. With my research, I am examining how ARs influence bobcat populations in Southern California. In one portion of my study area, from 2002-2005, a nootoeidic mange epizootic associated with secondary anticoagulant poisoning was a primary source of mortality for bobcats. Since 2005, mange associated with secondary AR exposure has been observed to cause population declines in other regions of California including Northern and Southern California. However, fine scale information about risk factors for bobcat AR exposure is lacking. Additionally, the breadth of the sublethal consequences of AR exposure for bobcats is unknown. I measured how widespread geographically, AR exposure is across 3 Southern California Counties over a 16-year period from 1996-2012 using samples from approximately 200 bobcats. I also collected disease data with the aim to measure sublethal consequences of AR exposure for bobcats.

Bobcat exposure to ARs is widespread across 3 Southern California Counties. Ninety-four percent of animals were found exposed to ARs, with 78% exposed to multiple compounds. Exposure to ARs was not limited to bobcats that primarily reside in or near urban areas. Even those individuals that were never observed to leave protected State Park boundaries were found exposed to SGARs. I have found that toxicant loads varied spatially by County and bobcat land-use, and exposure and load were highly associated with residential and altered park areas. In particular, bobcats that used habitat patches adjacent to single-family high density residential and golf course areas were more at risk for exposure to SGARs and carried higher toxicant loads than bobcats that resided within protected park areas. Across sample years from 1996-2012, > 60% of animals were exposed with exposure twice as frequent during dry seasons. The finding that exposure is twice as frequent during the dry season correlates with increase rodent abundance during the dry season in Southern California.

No demographic risk factors were associated with exposure. This finding is likely the result of SGARs significantly saturating the environment and prey base for bobcats such that despite age and sex, individuals are equally at risk for AR exposure. I have documented fetal transfer of multiple ARs, suggesting that chronic AR exposure can begin during prenatal development. One bobcat fetus was exposed already to 5 different AR compounds which included 4 SGARS. These findings are particularly troublesome. Reproductive consequences associated with AR exposure have included increased probability of miscarriage, in utero toxicity, and decreased sperm counts in humans [15], dogs [16], and sheep [17]. Fetuses are considered more susceptible to maternal anticoagulant toxicity because the placenta is the only source of Vitamin K for the developing fetus, and placental Vitamin K transfer is slow. Further, anticoagulants cross the placenta to enter fetal circulation, putting the fetus at risk for adverse effects [18]. Early studies found increased risk of fetal and neonatal hemorrhage when pregnant dogs or rabbits were dosed with coumarin [19]. Prenatal exposure to coumarin has been associated with increased risk of central nervous system abnormalities that included both physical and developmental defects in humans [15,20]. Abortions, stillbirths, and neonatal deaths were observed in 17% of women that received therapeutic doses
of coumarin during pregnancy [15]. Similarly, pregnant ewes dosed with pindone experienced an increase in stillborn, nonviable lambs, and lambs with congenital deformities [17]. White rats exposed to coumatetralyl during organogenesis were more likely born with skeletal abnormalities [21].

Consequences of SGAR ingestion during pregnancy are lesser known but the effects of ARs on fertility and pregnancy are not restricted to first generation compounds. Brodifacoum toxicosis was documented in neonatal puppies, although the dam was exposed four weeks prior to whelping[16]. Administration of ewes with brodifacoum resulted in 50% of lambs being aborted or being stillborn (reported in Robinson et al. 2005). Because of the increased potency and tissue retention of the compounds, SGARs may pose an even greater risk to developing fetuses than FGARs and so our findings of prenatal exposure to multiple AR compounds is concerning. Female bobcats are more sensitive to urbanization than males [22], and AR exposure may be an important challenge for population viability in urban areas – if chemical contamination creates inhospitable environments for reproduction, the population viability inevitably will decrease.

Although anticoagulant exposure detection was high in my study, AR exposure does not appear to be a significant source of direct mortality for bobcats. Only one individual was observed to die directly of anticoagulant toxicity in the study area [2] and in a broader study of poisoning cases of wildlife in California, Hosea (2002) observed clinical signs consistent with anticoagulant toxicosis in 2 bobcats exposed to ARs. However, in Ventura and Los Angeles Counties, secondary anticoagulant rodenticide exposure was associated a population decline that occurred due to notoedric mange, and ectoparasitic disease. Of 39 bobcats with advanced mange, they tested positively for ARs, and the authors described a statistical association between notoedric mange and total AR residues ≥ 0.05ppm [2]. In a recent study, AR exposure was implicated in gastrointestinal bleeding in bobcats that died of severe mange and were exposed to SGARs (Serieys et al., in press). Notoedric mange remains is a primary source of mortality for bobcats in regions of the study area and with the exception of 1 case, all bobcats that have died with severe mange were exposed to ARs. In contrast with Riley et al. [2], with my enhanced sample size, I detected a potential threshold between total AR residues ≥ 0.25ppm and death with severe notoedric mange. I also detected a strong association between notoedric mange and exposure to multiple compounds. Bobcats that were exposed to 2 or more compounds were 12 times more likely to die of notoedric mange than those exposed to 0-1 compounds. These findings are perhaps more compelling evidence of an association between ARs and notoedric mange. The proposed threshold of 0.05ppm has been criticized for being equivalent to detection AR exposure because the lower detection limits of some compounds, including bromadiolone, warfarin, and coumachlor, are 0.05ppm. Interestingly, twice as many mange cases occur during the dry season than the wet season (Serieys, unpubl.data), coincident with my findings of increased AR exposure during the dry season.

Notoedric mange is an ectoparasitic disease that has generally only been reported in isolated cases in wild felids; other than Riley et al. [2] who first documented the mange epizootic in bobcats in Los Angeles and Ventura Counties, there are no previous published reports of epizootics of notoedric mange in wild cat populations. Thus, population declines in wild felid populations are unusual and warrant examination of factors influencing mange dynamics in these populations. Notoedric mange is an expanding issue for bobcats in California, with cases now documented in 9 counties in Northern and Southern California. Across these areas, animals that died of notoedric mange were exposed to ARs (Serieys et al. in press, Clifford, pers.comm.). Severe mange in wild and domestic animals is often associated with immune compromise) and Riley et al. [2] has proposed that chronic, sublethal AR exposure immunocompromised bobcats making them more susceptible to severe notoedric mange.

The mode by which anticoagulant rodenticide exposure could compromise bobcat immunity is unknown. However, laboratory experiments have shown that interactive effects between sublethal exposure to anticoagulants and other stressors can induce mortality. For laboratory rat and rabbit populations, sublethal anticoagulant doses produced 40-70% mortality when combined with other stressors, such as frostbite [23]. Similarly, when stressed by shearing and captivity, merino sheep exposed required lower doses of pindone to succumb to the effects of the AR [17]. Recently, a potential interaction between the toxic effects of chlorophacinone, a first generation anticoagulant, and a bacterial pathogen, Francisella
tularensis, in common voles (Microtus arvalis) [24] was described. Voles that were infected with *F.tularensis* required lower lethal doses of chlorophacinone than uninfected voles. Tularemia prevalence was also higher in areas treated with chlorophacinone and the authors suggested that the AR field treatment may have also facilitated the spread of the disease in the vole population affected.

Even without interactive effects between ARs and environmental stressors, sublethal AR exposure may negatively affect individuals and potentially cascade into population effects if AR prevalence is high. In Denmark, there was a negative association between anticoagulant exposure and body condition in weasels and stoats [12]. A reduced escape response has been observed in rats dosed with ARs [25], and if carnivores secondarily exposed to ARs experience similar reduced response to threats, they may be more vulnerable to vehicle collisions or predation. Overall, higher levels of ARs may contribute to increased risk of mortality directly due to anticoagulant toxicity or indirectly due to other sources of mortality.

**The Proposed Additional Use Restrictions Are Inadequate to Protect Non-target Wildlife.**

The proposed regulations would prohibit placement of products containing second-generation rodenticides more than 50 feet from a man-made structure. The proposed regulations may not adequately protect wildlife from secondary exposures through consumption of poisoned rodents. Nontarget wildlife may approach within 50 feet of human infrastructure. Additionally, because targeted small mammals can live for up to 10 days after lethal ingestion of ARs, they may wander beyond the 50-foot radius. Further, the proposed regulations give certified applicators broad discretion to decide when a larger placement radius is needed.

**DPR Must Adopt Additional Restrictions to Protect Non-Target Wildlife from SGARs.**

Designating SGARs as California restricted materials is an important first step in reducing impacts to non-target wildlife. However, DPR must take additional steps to impede impacts for nontarget wildlife. Specifically, I believe that DPR should adopt a policy that SGARs are to be used as a last resort with conditions for use falling under one or more of the following conditions:

1) A federal, state, or local public health agent discovers that a significant public health hazard exists, there is demonstrated local resistance to first generation anticoagulant rodenticides by the target species, and other, less-toxic measures have been implemented, including sanitation, trapping and structural reinforcement of human infrastructure.

2) SGARs are found necessary to control, eradicate, or prevent the invasion of non-native species that pose significant harm to imperiled species or threaten ecosystem integrity of any island or designated mainland area, and other, feasible, less-toxic measures are unlikely to be effective. “Imperiled species” include protected, threatened or endangered species, or wildlife that are candidates for protection under federal or state endangered species laws.

3) Applicators, including those businesses conducting residential, industrial, structural, and other non-agricultural applications, shall identify locations where SGARs are used by specific coordinates to be included in standard pesticide use reports.

In addition, DPR should work with DFW to rapidly develop and implement an incident reporting system for non-target animal poisonings.

For all the aforementioned reasons, I urge DPR to adopt the additional restrictions on SGARs described in these comments to protect wildlife.
Citations used in this comment letter


