Protecting Nontarget Wildlife from Effects of Vertebrate Pesticides

Stella C. McMillin, Wildlife Investigations Laboratory, California Department of Fish and Game, Rancho Cordova, California

Abstract: The California Department of Fish and Game (DFG) recognizes the need for the availability of a variety of tools for vertebrate pest control and has a strong interest in ensuring that these tools are used in a way that minimizes impacts to nontarget wildlife. From 1992 to 2011, the DFG has investigated 44 cases of wildlife kills caused by vertebrate pesticides, resulting in the loss of 258 animals. While anticoagulant rodenticides were responsible for the loss of the highest number of incidents, incidents involving acute toxicants, such as strychnine and zinc phosphide, typically involved a greater number of animals per incident. Incidents of intentional poisoning of wildlife usually involved strychnine. There were no documented losses due to fumigants; however, such incidents are likely to go unnoticed because the carcasses remain underground.

Key Words: anticoagulant, fumigant, nontarget loss, primary exposure, rodenticide, secondary exposure, strychnine, vertebrate pest control, wildlife loss, zinc phosphide

Proc. 25th Vertebr. Pest Conf. (R. M. Timm, Ed.)
Published at Univ. of Calif., Davis. 2012. Pp. 131-133.

INTRODUCTION

The California Department of Fish and Game (DFG) has been investigating pesticide-related wildlife losses since 1956. Determination of pesticide-related wildlife impacts is recognized to be a responsibility shared by DFG, the California Department of Pesticide Regulation (CDPR), and the County Agricultural Commissioners. When pesticides are suspected to be responsible for a nontarget wildlife loss, DFG undertakes a field investigation that includes necropsy of affected animals and chemical analysis of appropriate samples. In cooperation with DFG, the County Agricultural Commissioners help determine the source of the pesticide and the legality of the application. In the case of wildlife losses caused by illegal pesticide applications, enforcement cases are pursued by DFG and the County Agricultural Commissioners. Data is collected on wildlife losses caused by both legal and illegal pesticide applications. When a pattern of wildlife losses from legal pesticide use is observed, monitoring studies are often initiated to better define the problem and determine mitigation measures.

Wildlife losses due to vertebrate toxicants are of particular interest to DFG, as there is a potential to impact sensitive species. Vertebrate toxicants pose significant risks to nontarget species because of their non-specific toxicity to vertebrates and their use as poison baits that can be attractive to nontarget species. Further, burrow fumigants can be lethal to all burrow-dwelling species.

SUMMARY OF LOSSES 1992-2011

DFG attributed 44 incidents of wildlife loss to vertebrate toxicants from 1992 to 2011, resulting in the death of 258 animals (Table 1). When a loss was attributed to more than one kind of vertebrate toxicant, it is listed in tables for both kinds (for example, in 1998 a great horned owl was determined to contain residues of both diphacinone and brodifacoum). Incidents involving anticoagulant rodenticides were more numerous than those involving acute rodenticides but generally resulted in fewer individuals per incident. Anticoagulant rodenticide incidents generally resulted from secondary exposure, whereas there were no incidents of secondary exposure from acute rodenticides. Raptors and canids were the wildlife most commonly impacted by anticoagulant rodenticides, while waterfowl were most commonly impacted by acute rodenticides. Most incidents of intentional baiting of wildlife involved strychnine. No losses were attributed to burrow fumigants.

FIRST-GENERATION ANTICOAGULANT RODENTICIDES

Although also registered for use on commensal rodents, in recent years the most common use of first-generation anticoagulant rodenticides (FGARs) in agriculture is the control of California ground squirrel (*Spermophilus beecheyi*), vole, (*Microtus* spp.) and jackrabbit (*Lepus californicus*) populations. The active ingredients most often used in California are chlorophacinone and diphacinone, with over 1 million pounds of formulated baits being sold annually by County Agricultural Commissioners (CDPR 2010a,b).

From 1992 to 2011, DFG documented 10 incidents of wildlife losses from FGARs, resulting in the loss of 82 animals (Table 2). One incident, in Monterey County in 2008, resulting in the loss of 70 Canada geese (*Branta canadensis*),

Table 1. Pesticide losses investigated by the California Department of Fish and Game 1992-2011.

Pesticide	Number of Incidents	Number of Individuals	Species Involved
First-Generation Anticoagulant Rodenticides	10	82	Raptors, coyotes, kangaroo rat, bobcat
Second-Generation Anticoagulant Rodenticides	23	45	Raptors, coyotes, foxes, bobcats, fox squirrels, mountain lion
Strychnine	10	120	Waterfowl, doves, foxes, gull
Zinc Phosphide	1	11	Waterfowl
total	**44**	**258**	

Table 2. Wildlife losses in California from first-generation anticoagulant rodenticides, 1992-2011.

Year	Species (number)	County	Pesticide
1995	Bobcat (1)	Marin	Chlorophacinone
1997	Coyote (1)	Los Angeles	Chlorophacinone
1997*	Coyote (1)	Ventura	Brodfiacoum, Diphacinone
1997	Coyote (1)	Los Angeles	Diphacinone
1997	Turkey vulture (1)	Alameda	Diphacinone
1998*	Great horned owl (1)	Alameda	Brodifacoum, Diphacinone
2006	Coyote (1)	Santa Cruz	Chlorophacinone, Coumatetralyl, Diphacinone, Warfarin
2008	Canada goose (70) Barn owl (1) Turkey vulture (2)	Monterey	Chlorophacinone
2010*	Turkey vulture (1)	San Luis Obispo	Brodfiacoum, Diphacinone
2011	Barn owl (1)	Contra Costa	Brodifacoum, Diphacinone

*Loss attributed to more than one vertebrate toxicant class and is also listed in another table.

Table 3. Wildlife losses in California from second-generation anticoagulant rodenticides, 1992-2011.

Year	Species (number)	County	Pesticide
1996	Golden eagle (1)	San Benito	Brodifacoum
1997	Golden eagle (1)	Santa Clara	Brodifacoum
1997	Mountain lion (1)	Riverside	Brodifacoum
1997	Red fox (2)	Fresno	Brodifacoum
1997	Coyote (1)	Los Angeles	Brodifacoum
1997	Coyote (1)	Los Angeles	Brodifacoum
1997*	Coyote (1)	Ventura	Brodfiacoum, Diphacinone
1997	Coyote (1)	Los Angeles	Brodifacoum
1997	Bobcat (1)	Ventura	Brodifacoum
1997	Golden eagle (1)	Alameda	Brodifacoum, lead
1998*	Great horned owl (1)	Alameda	Brodifacoum, Diphacinone
1999	Golden eagle (1)	Contra Costa	Brodifacoum
1999	Fox squirrel (8)	Sacramento	Brodifacoum
1999	Great horned owl (1) Barn owl (4)	San Bernardino	Brodifacoum, Bromadiolone
1999	Bobcat (1)	Riverside	Brodifacoum
2000	Coyote (1)	Los Angeles	Brodifacoum, Bromadiolone
2001	Red-tailed hawk (1)	San Joaquin	Brodifacoum
2001	Great horned owl (2) Cooper's hawk (1)	Los Angeles	Brodifacoum, Bromadialone
2002	Barn owl (1)	Sacramento	Brodifacoum
2004	San Joaquin kit fox (1)	Kern	Brodifacoum
2007	Barn owl (9)	Yolo	Brodifacoum
2010*	Turkey vulture (1)	San Luis Obispo	Brodfiacoum, Diphacinone
2011	Barn owl (1)	Contra Costa	Brodifacoum, Diphacinone

*Loss attributed to more than one vertebrate toxicant class and is also listed in another table.

a barn owl (*Tyto alba*), and 2 turkey vultures (*Cathartes aura*) from chlorophacinone exposure, led to an amended product label (McMillin and Finlayson 2010). The source of the exposure is seldom found for losses resulting from secondary exposure to anticoagulant rodenticides.

SECOND-GENERATION ANTICOAGULANT RODENTICIDES

Second-generation anticoagulant rodenticides (SGAR) include the active ingredients brodifacoum, bromadiolone, and difethialone, and are registered for use for commensal rodents. Brodifacoum is used in island conservation projects. These materials are more toxic and persistent in tissue than the older FGARs (Erickson and Urban 2004). From 1992 to 2011, there were 23 wildlife loss incidents involving SGARs, resulting in the loss of 45 individuals (Table 3). The majority of these incidents involved raptors, canids, and felids and were likely the result of secondary exposure. Intentional poisoning was not indicated for any of the losses. Brodifacoum was involved in all of the incidents. These investigations are consistent with field monitoring studies of raptors (Lima and Salmon 2010), San Joaquin kit foxes (*Vulpes macrotis mutica*) (McMillin et al. 2008), and felids (Riley et al. 2007), which show that the majority of predators and scavengers tested in California have been exposed to SGARs.

STRYCHNINE

Strychnine is an acute toxicant registered only for underground use in controlling pocket gophers (CDFA 2009). A total of 5,718 lbs of strychnine (as active ingredient) was sold in California in 2010 (CDPR 2010c), including 1,395 lbs reported being used for commercial and agricultural applications (CDPR 2010b). Agricultural and commercial uses require a Restricted Use Permit from the County Agricultural Commissioner.

From 1992 to 2011, there were 10 cases of strychnine-caused wildlife mortality in California, killing 120 animals (Table 4). Many of these cases involved apparently intentional poisoning. For example, in 1999, there were several cases of rock doves (*Columba livia*) being poisoned by strychnine in parking lots in Sausalito, Marin County. As strychnine is legally applied only underground, this was an illegal use, and presence of strychnine in nearby seed or grain indicates intentional poisoning.The circumstances causing the 2010 loss of 4 San Joaquin kit foxes (a federally endangered species) from strychnine poisoning in Kern County are unknown.

Table 4. Wildlife losses in California from strychnine, 1992-2011.

Year	Species (number)	County	Use
1994	Canada geese (31) Hybrid goose (1) Mallard (2) Gull (1)	El Dorado	Intentional
1994	Geese (17)	Fresno	Misuse / Intentional
1996	Mallard (30)	San Bernardino	Intentional
1997	Mallard (3)	Inyo/Mono	Misuse / Intentional
1999	Rock dove (4)	Marin	Intentional
1999	Rock dove (7)	Marin	Intentional
1999	Rock dove (2)	Marin	Intentional
1999	Rock dove (17)	Marin	Intentional
2011	Red fox (1)	San Luis Obispo	Intentional
2011	San Joaquin kit fox (4)	Kern	Unknown

ZINC PHOSPHIDE

Zinc phosphide is an acute toxicant available in grain baits and pellets and used to control voles, pocket gophers, ground squirrels, Norway rats (*Rattas norvegiens*), Polynesian rats (*Rattas exulans*), cotton rats (*Sigmodon hispidus*), and nutria (*Myoeaster coypus*). Some uses require Restricted Use Permits. Approximately 22,461 lbs of zinc phosphide were sold in California in 2010 (DPR 2010c).

One wildlife loss in California was attributed to zinc phosphide from 1992 to 2011. In 2007, 11 Canada geese died after consuming a zinc phosphide oat bait formulation intended for ground squirrels. The application was found to not conform to all label requirements as pre-baiting was not done to ensure uptake only by the target species.

FUMIGANTS

Fumigants used in California to control burrowing rodents include aluminum phosphide and acrolein, as well as carbon monoxide from gas cartridges. DFG has no reports of nontarget losses from fumigation of rodent burrows; however, any nontarget losses would occur underground. As fumigants are toxic to any active vertebrate, the only way to prevent nontarget losses is to determine that the only occupants of the burrow to be treated are the target pests.

CONCLUSIONS

Two decades ago, most pesticide-related wildlife losses were caused by organophosphate or carbamate use in agricultural areas. As some of the more toxic of these materials have been phased out, fewer losses are attributed to them. The most likely cause of a pesticide-related wildlife loss in California is now vertebrate toxicants, such as anticoagulant rodenticides or strychnine. Misuse of strychnine was responsible for the majority of individuals lost. The greatest number of incidents were caused by SGARs. It is unknown whether these SGAR-caused losses were due to legal or illegal use.

As recent regulations on SGARs, FGARs, and aluminum phosphide burrow fumigants take effect, it is important to continue to monitor the rodenticide effects on nontarget wildlife. Continued research is needed into rodenticide use practices that yield successful rodent control while not impacting nontarget wildlife.

LITERATURE CITED

CDFA (California Department of Food and Agriculture). 2009. California Vertebrate Pest Control Handbook. California Department of Food and Agriculture, Sacramento, California. http://vpcrac.org/about/handbook.php.

CDPR (California Department of Pesticide Regulation). 2010a. Product/Use Database. http://www.cdpr.ca.gov/docs/label/labelque.htm.

CDPR (California Department of Pesticide Regulation). 2010b. Summary of pesticide use report data 2010. Indexed by Chemical. California Environmental Protection Agency, Department of Pesticide Regulation, Pest Management and Licensing Branch, Sacramento, CA.

CDPR (California Department of Pesticide Regulation). 2010c. Reports of pesticides sold in California. http://www.cdpr.ca.gov/docs/mill/nopdsold.htm.

Erickson, W., and D. Urban. 2004. Potential Risks of Nine Rodenticides to Birds and Nontarget Mammals: A Comparative Approach. Office of Pesticide Programs Environmental Fate and Effects Division, U.S. Environmental Protection Agency, Washington, DC. 230 pp.

Lima, L. L., and T. P. Salmon. 2010. Assessing some potential environmental impacts from agricultural anticoagulant uses. Investigation of chlorophacinone-related goose deaths in Monterey County, California. Proc. Vertebr. Pest Conf. 24:199-203.

McMillin, S. C., R. C. Hosea, B. J. Finlayson, B. L. Cypher, and A. Mekebri. 2008. Anticoagulant rodenticide exposure in an urban population of the San Joaquin kit fox. Proc. Vertebr. Pest Conf. 23:163-165.

McMillin, S. C., and B. J. Finlayson. 2010. Investigation of chlorophacinone-related goose deaths in Monterey County, California. Proc. Vertebr. Pest Conf. 24:178-180.

Riley, S. P. D., C. Bromley, R. H. Poppenga, F. A. Uzal, L. Whited, and R. M. Sauvajot. 2007. Anticoagulant exposure and notoedric mange in bobcats and mountain lions in urban-Southern California. J. Wildl. Manage. 71(6):1874-1884.