



PESTICIDE EXPOSURES & MORTALITIES IN NON-TARGET WILDLIFE

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

2021 Annual Report
Wildlife Health Laboratory
28 November 2022

2021 SUMMARY OF PESTICIDE EXPOSURES & MORTALITIES IN NON-TARGET WILDLIFE

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State of California
Natural Resources Agency

INTRODUCTION

It is the mission of the California Department of Fish and Wildlife (CDFW) to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. As such, a memorandum of understanding was developed between the California Department of Pesticide Regulation (CDPR), the County Agriculture Commissioners (CAC), and the CDFW. The purpose of the memorandum is to ensure that pesticides registered in the state of California are used in a manner that protects non-target fish and wildlife resources, while recognizing the need for responsible pest control.

In partial fulfillment of the MOU, this 2021 annual report summarizes documented pesticide exposure and toxicosis in California's fish and wildlife for the respective authorities of CDPR, CAC, and CDFW. These data represent a minimum number of reports and are subject to change as new information becomes available.

DATA COLLECTION & ANALYSIS

The Wildlife Health Laboratory (WHL, formerly the Wildlife Investigations Laboratory) was established in 1941 and is mandated by Fish and Game Code Section 1008 to investigate all diseases and problems relating to wildlife. The WHL has accomplished this goal through collaboration with the public and various organizations to record, collect, and submit wildlife mortalities of interest to the WHL for examination and further diagnostics as needed. The WHL continues communication with interested parties as new information is discovered to aid further cooperation in the goal of maintaining healthy wildlife populations throughout the state.

Programmatically the WHL is divided into three units which address health issues: 1) avian, 2) large game, 3) small and non-game species. The avian unit oversees nearly 600 avian species

including non-game (e.g., songbirds, raptors, shorebirds, waders, and seabirds) and game species (e.g., doves, pigeons, quail, turkey, and waterfowl). The large game unit primarily oversees black bear, bighorn sheep, deer, elk, pronghorn, and wild pig with shared responsibility of small game such as tree squirrels, rabbits, and hares. In addition to sharing health surveillance responsibilities with the large game unit, the non-game unit also oversees native non-game mammals, fur bearers, reptiles, and amphibians. This includes a consortium of species such as California tiger salamander, Western Pond turtles, pika, riparian brush rabbits, skunks, raccoons, foxes, bobcats, mountain lions, and gray wolves.

Wildlife Submissions

Wildlife remains are submitted to the WHL in various ways, primarily by the public – either direct submissions of deceased wildlife to the WHL, submission of living or deceased wildlife to wildlife rehabilitation centers (“rehab”), notification of mortalities to CDFW staff and law enforcement, or other government agency reports (e.g., animal control, sheriff, state and federal Department of Agriculture, U.S. Fish and Wildlife Service, the Park Service, etc.). The WHL also collaborates with universities, non-governmental organizations (NGO), and other agencies on statewide population monitoring projects and provides diagnostic support by conducting postmortem examinations. The WHL contracts with the California Animal Health and Food Safety (CAHFS) Laboratory for further disease and toxicology testing.

Postmortem Examination

Postmortem examinations (necropsies) are performed on wildlife remains at the WHL or the CAHFS Laboratory. If remains cannot be examined within 48-hours of collection, they are stored in a -20°C freezer until an examination can be performed. Prior to necropsy, frozen carcasses are thawed for a few days at 4°C or

room temperature until they are ready for necropsy. Sex, age class, body condition and, when possible, the cause of death is determined. In addition to necropsy, mortality investigations often include microscopic evaluation of tissues (histology) and ancillary disease and toxicology testing. Tissue samples are collected and placed in 10% formalin for histological evaluation and a complimentary set of tissues are archived in -20C° freezers until submitted to the CAHFS Laboratory for analysis.

Carcasses in advanced stages of decomposition and autolysis are necropsied but formalin tissues may not be collected or submitted since autolysis can obscure or destroy microscopic lesions. In these cases, necropsies are performed, and tissue samples are collected for toxicology testing to rule out pesticide exposure but not necessarily toxicosis.

Anticoagulant Rodenticides. Anticoagulant rodenticides are grouped into two categories: “first generation anticoagulant rodenticides” which include warfarin (war), coumachlor (cou), diphacinone (diph), and chlorophacinone (chl) and the more toxic “second generation anticoagulant rodenticides” which include brodifacoum (brd), bromadiolone (brm), difenacoum (dfn), and difethialone (dif).

Liver samples are submitted to the CAHFS Laboratory for testing.

Non-Anticoagulant Rodenticides & Other Pesticides. A number of acutely toxic compounds such as bromethalin, strychnine, zinc phosphide, cholecalciferol, organophosphates, and carbamates are also used to manage rodent and insect pests. Like anticoagulant rodenticides, these compounds, or their metabolites, have been documented in non-target wildlife as a form of mortality or exposure.

Appropriate tissue samples (e.g., gastrointestinal contents, adipose, brain, spinal cord, kidney, liver) for requested tests are also submitted to the CAHFS Laboratory for testing.

Exposure & Toxicosis

Pesticides, including anticoagulant rodenticides, are not always acutely fatal and there is a high degree of variability among species and individuals in their vulnerability. In the absence of a universal threshold residue value that could indicate anticoagulant rodenticide “toxicosis,” we must also rely on antemortem and/or postmortem evidence of coagulopathy unrelated to another identifiable cause of hemorrhage (e.g., trauma, disease, infection).

Individuals are considered to have anticoagulant rodenticide “exposure” if their livers had detectable levels of one or more anticoagulant rodenticide residues (regardless of concentration, reported in parts per billion or ppb) and lack antemortem and/or postmortem evidence of coagulopathy.

For non-anticoagulant rodenticides, diagnosing toxicosis requires the detection of the compound in the appropriate tissue sample or gastrointestinal contents, and antemortem and/or postmortem evidence in the absence of another identifiable cause (e.g., disease, infection, trauma).

In some cases, rodenticide residues are detected in the tissue sample, but postmortem evidence could not confirm or exclude toxicosis due to advanced decomposition which precludes a definitive diagnosis. Therefore, these diagnoses are reported as “suspected” or “undetermined” toxicosis.

It is important to note that exposure in the absence of toxicosis should not be ignored¹. The uncertainties about the magnitude and drivers of chronic exposure and/or sub-lethal levels of rodenticide exposure demonstrate the need for continued monitoring. Exposure to anticoagulant rodenticides may predispose wildlife to excessive hemorrhage following an otherwise non-lethal traumatic injury or increase sensitivity to additional exposure(s)¹.

AVIAN SUMMARY

According to CDFW records at the time of this report, 657 birds were submitted to the WHL for necropsy and/or toxicology testing in the calendar year 2021.

Birds were submitted for various reasons by wildlife rehabilitators, members of the public, non-profit organizations, universities, CDFW staff and law enforcement, and other agencies (Table 1). Wildlife rehabilitators made up the majority of submissions, followed by agencies and specifically, CDFW. However, it should be noted that the majority of these reports originated with a member of the public.

Anticoagulant Rodenticide Exposure & Toxicosis

Of the necropsied birds, 70 were tested for pesticide exposure. Tested birds represent 83% (48/58) of California counties (Table 2). All age classes and sexes were represented in submitted carcasses.

Raptors accounted for the largest percentage of birds submitted and were the largest group to have anticoagulant rodenticide exposure to one or more analyte and/or toxicosis (Table 3). Of the 68.6% of tested birds with exposure (48/70) 35.4% (17/48) were cases of anticoagulant rodenticide toxicosis.

Additionally, one common raven and two American crows were screened for anticoagulant rodenticides (Table 3). The common raven died on an elementary school ground in Kern County where anticoagulant rodenticide toxicosis was determined to be the cause of death, primarily difethialone. The American crows were collected in Monterey County; one had trace exposure to difethialone and one had trace exposure to diphacinone.

More than half of the exposed birds had two or more second generation anticoagulant rodenticides detected in the submitted liver sample (Figure 1). Brodifacoum, bromadiolone, and diphacinone were the most common analytes detected in liver samples (Figure 2). None of the tested bird samples had detectable levels of exposure to warfarin, difenacoum, or coumachlor.



Table 1. Total number of wild bird remains submitted to the Wildlife Health Laboratory for necropsy in 2021 based on the primary submitter's affiliation. Many submissions that are non-public originated as a public report.

Submitter Affiliation	No. Birds Submitted
CDFW	91
NGO/Non-Profit	8
Other Government Agency / Military	52
Private Consultant / Energy	35
Public	51
Rehab / Zoo / Sanctuary	417
University Affiliate	3
Total	657

Table 2. Exposure prevalence and number of confirmed toxicosis cases of anticoagulant rodenticides in 70 tested wild birds submitted to the Wildlife Health Laboratory in 2021 by county. After postmortem examination, livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA.

County	No. Birds Tested	No. Birds w/Exposure	Exposure Prevalence	No. Confirmed Toxicosis
Alameda	1	1	100.0	0
Calaveras	1	1	100.0	0
Contra Costa	6	5	83.3	2
El Dorado	1	1	100.0	0
Humboldt	1	0	0.0	0
Kern	5	4	80.0	2
Kings	1	1	100.0	1
Los Angeles	14	11	78.6	5
Marin	3	0	0.0	0
Monterey	2	2	100.0	0
Napa	1	1	100.0	1
Plumas	2	1	50.0	0
Riverside	1	1	100.0	1
Sacramento	2	2	100.0	1
San Bernardino	3	2	66.7	0
San Diego	2	1	50.0	0
San Luis Obispo	1	1	100.0	0
San Mateo	2	2	100.0	0
Santa Barbara	2	1	50.0	0
Santa Clara	2	0	0.0	0
Santa Cruz	4	2	50.0	0
Shasta	1	0	0.0	0
Sonoma	4	3	75.0	1
Tuolumne	1	0	0.0	0
Ventura	7	5	71.4	3
Total	70	48	68.6	17

Other Pesticides

Other pesticide-related investigations involved three incidents of mass-mortalities including: 1) rock pigeons in Santa Barbara County, 2) mourning doves in Fresno County, and 3) Canada geese in Orange County. Avitrol was detected in a rock pigeon submitted from Santa Barbara County where multiple pigeons were reported with seizures before death. Strychnine was detected in mourning doves from Fresno County where at least 6 doves were reported dead in a

residential neighborhood. Strychnine was detected in geese from Orange County where at least 6 Canada geese and one domestic goose were observed at a residential community park having seizures before death.

Table 3. Exposure prevalence and number of confirmed toxicosis cases of anticoagulant rodenticides in 70 wild birds submitted to the Wildlife Health Laboratory in 2021 by species (common name). After a postmortem examination, livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA.

Avian Species	No. Tested	No. Exposure	Exposure Prevalence	No. Confirmed Toxicosis
American crow	2	2	100.0	0
Bald eagle	2	2	100.0	0
Barn owl	14	7	50.0	3
Burrowing owl	1	0	0.0	0
Common raven	1	1	100.0	1
Cooper's hawk	3	0	0.0	0
Ferruginous hawk	1	0	0.0	0
Golden eagle	7	7	100.0	0
Great gray owl	1	0	0.0	0
Great horned owl	21	17	81.0	10
Northern harrier	1	0	0.0	0
Red-shouldered hawk	4	4	100.0	1
Red-tailed hawk	7	5	71.4	2
Rough-legged hawk	1	0	0.0	0
Sharp-shinned hawk	1	0	0.0	0
Turkey vulture	3	3	100.0	0
Total	70	48	68.6	17



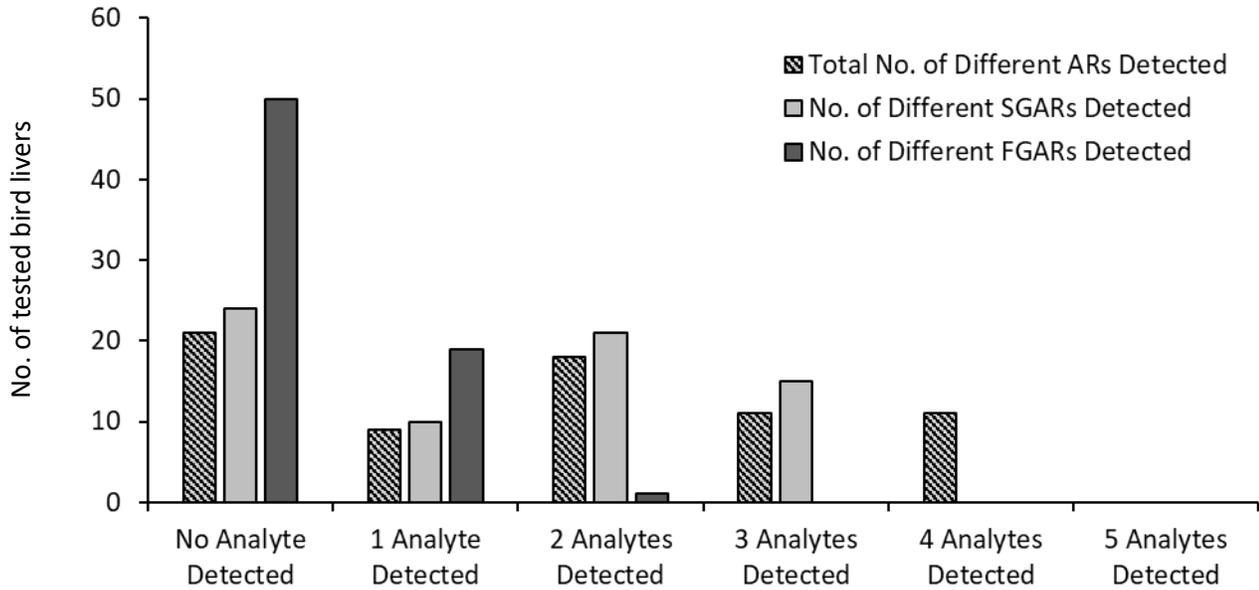


Figure 1. Number of anticoagulant rodenticide residues detected in the livers of 48 wild birds submitted to the Wildlife Health Laboratory for postmortem examination in 2021. After postmortem examination, livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA.

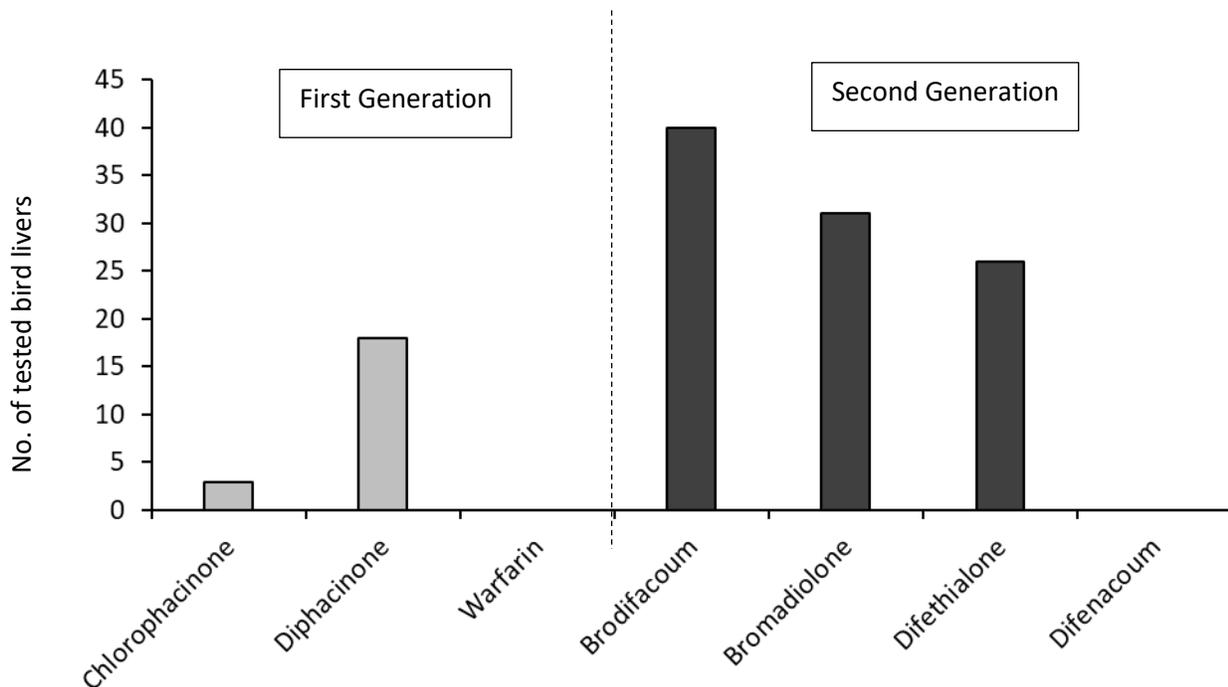


Figure 2. Anticoagulant rodenticide residues detected in the livers of 48 of the 70 tested wild birds submitted to the Wildlife Health Laboratory in 2020. Anticoagulant rodenticides were not detected in 6 of the tested bird livers. After postmortem examination, livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA.

LARGE GAME SUMMARY

The remains of 105 large game mammals were submitted to the WHL for necropsy and/or toxicology testing in the year 2021 (Table 4).

Table 4. Number of wild large game remains submitted to the Wildlife Health Laboratory in 2021 by species and sub-species.

Large Game Species	No. Large Game Animals Submitted
Black bear	60
Black-tailed deer	27
California mule deer	9
Desert bighorn sheep	1
Pronghorn antelope	3
Rocky mountain elk	2
Rocky mountain mule deer	1
Roosevelt elk	1
Tule elk	1
Total	105

Approx. 88% (92/105) of the large game carcasses were submitted by the CDFW and other agencies (Table 5). However, it should be noted that public reports represent the original source for most CDFW submissions.

Large game mammals were submitted from 28 of the 58 counties in California (Table 6). All age classes and sexes were represented in submitted carcasses.

Anticoagulant Rodenticides

Of necropsied bears, two adult female black bears from El Dorado County were tested for anticoagulant rodenticide exposure. In one of the adult females, four anticoagulant rodenticides were detected in the liver: brodifacoum (2400 ppb), bromadiolone (1900 ppb), difethialone (trace), and difenacoum (trace). In the second female, two anticoagulant

rodenticides were detected in the liver, bromadiolone (550 ppb) and bromethalin (69 ppb). Toxicosis was surprisingly not observed in either animal.

Table 5. Total number of wild large game remains submitted to the Wildlife Health Laboratory for postmortem examination in 2021 based on the primary submitter's affiliation. Most submissions that are non-public originated as a public report.

Submitter Affiliation	No. Large Game Animals Submitted
CDFW	92
Rehab / Zoo / Sanctuary	8
Other Government Agency	2
Public	3
Total	105



Table 6. Total number of wild large game mammals remains submitted to the Wildlife Health Laboratory for postmortem examination in 2021 by county.

County	No. of Large Game Animals Submitted
Alpine	2
Calaveras	3
Contra Costa	1
El Dorado	12
Fresno	2
Humboldt	36
Inyo	1
Kern	5
Lassen	1
Los Angeles	3
Marin	1
Mendocino	7
Modoc	1
Mono	1
Napa	1
Nevada	2
Placer	1
Plumas	2
Sacramento	2
San Bernardino	1
San Luis Obispo	3
San Mateo	2
Santa Barbara	1
Sierra	1
Siskiyou	8
Trinity	2
Tuolumne	2
Yolo	1
Total	105

Other Pesticide Exposure

Adipose or brain from six black bears were tested for exposure to the neurotoxic rodenticide, bromethalin. Three of the tested animals had exposure to bromethalin and two bears did not have detectable levels in the submitted sample. One case is currently pending results. Of the three cases where bromethalin

was detected, toxicosis was not identified as the cause of death.

General toxicology panels (GMCS/LCMS) were performed on one black bear from Nevada County. Test results are still pending at the time of this report.

Acetylcholinesterase (AChE) activity was measured on 6 black bears. Some pesticides, such as carbamates and organophosphates, can exert toxicity by inhibiting AChE activity, causing major drops in AChE levels. Measuring AChE concentrations in brain is a useful tool to help determine toxicosis. Five of the six black bears had normal AChE levels and one black bear had elevated levels. It is not known what elevated levels mean in this species and is likely an incidental finding and neurologic clinical signs were not reported.



SMALL GAME AND NON-GAME SUMMARY

There were 258 herpetiles and mammals submitted to the WHL for necropsy and/or toxicology testing in 2021. This included remains submitted primarily for specialized disease surveillance such as rabbit hemorrhagic disease virus (lagomorphs), snake fungal disease (snakes), and white-nose syndrome (bats).

Small game and non-game animals were submitted for various reasons by wildlife rehabilitators, members of the public, non-profit organizations, universities, CDFW staff and law enforcement, and other agencies. Wildlife rehabilitators made up 39.7% (102/257) of submissions, followed by CDFW (37%; Table 7).

Toxicology testing was not performed on the herptiles. Therefore, the remainder of this section will address test results for mammals.

Anticoagulant Rodenticide Exposure & Toxicosis

Of necropsied mammals, 178 were tested for pesticide exposure across 37 of the 58 counties in California (Table 8). All age classes and sexes were represented.

Mountain lions and bobcats accounted for the largest percentage of mammal samples submitted with anticoagulant rodenticide exposure (Table 9). In total, 125 of 178 (70.2%) mammals tested had exposure to one or more anticoagulant rodenticide and almost half of the tested animals had exposure to three or more anticoagulant rodenticides regardless of first- or second generation (Figure 3). One adult male gray fox from Contra Costa County had exposure to seven different anticoagulant rodenticides.

Two of the 125 exposures (1.6%) resulted in cases of anticoagulant rodenticide toxicosis (Table 9). Anticoagulant rodenticide toxicosis was suspected in 8% (10/125) of animals with

Table 7. Total number of small game and non-game remains submitted to the Wildlife Health Laboratory for postmortem examination in 2021 based on the primary submitter’s affiliation. Most submissions that were non-public originated as a public report.

Submitter Affiliation	No. Small and Non-Game Animals Submitted
Animal Control	9
CDFW	96
NGO/Non-Profit	5
Other	2
Other Government Agency	11
Private Biological Consultant	11
Public	17
Rehab/Zoo/Sanctuary	102
University Affiliate	5
Total	258

livers that had detectable residue exposure, however toxicosis could not be ruled in or out in 10 of the cases due to advanced stages of decomposition, making gross and histological interpretation of the tissues difficult.

Brodifacoum, bromadiolone, and diphacinone were the most common analytes detected in liver samples (Figure 4).

None of the tested samples had detectable levels of exposure to coumachlor.



Table 8. Exposure prevalence and number of confirmed toxicosis cases of anticoagulant rodenticides in the livers of 178 small game and non-game remains submitted to the Wildlife Health Laboratory for postmortem examination in 2021 by county. Livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA. In some cases, rodenticide residues were detected in the liver, but postmortem evidence could not confirm or exclude toxicosis due to advanced decomposition. Therefore, these diagnoses are reported as “undetermined” toxicosis.

County	No. Tested	No. Exposed	Exposure Prevalence	No. Confirmed Toxicosis	No. Undetermined Toxicosis
Amador	3	1	33.3	0	0
Calaveras	3	3	100.0	0	0
Contra Costa	5	4	80.0	0	2
Del Norte	1	1	100.0	0	0
El Dorado	4	3	75.0	0	0
Fresno	1	0	0	0	0
Inyo	3	1	33.3	0	0
Kern	7	4	57.1	0	1
Lake	2	2	100.0	0	0
Los Angeles	21	20	95.2	0	1
Madera	1	1	100.0	0	0
Marin	4	1	25.0	0	0
Mendocino	1	1	100.0	0	0
Modoc	1	1	100.0	0	0
Monterey	7	6	85.7	0	0
Napa	7	1	14.3	0	0
Nevada	5	5	100.0	0	0
Orange	2	2	100.0	0	0
Placer	3	1	33.3	0	1
Plumas	1	0	0	0	0
Riverside	11	5	45.5	0	0
Sacramento	8	2	25.0	0	0
San Bernardino	5	2	40.0	0	0
San Diego	11	10	90.1	0	1
San Luis Obispo	2	1	50.0	0	0
San Mateo	3	3	100.0	0	0
Santa Barbara	4	2	50.0	0	0
Santa Clara	6	4	66.7	1	0
Santa Cruz	10	10	100.0	0	0
Shasta	3	3	100.0	0	0
Siskiyou	3	2	66.7	0	0
Solano	2	1	50.0	0	0
Sonoma	18	14	77.8	0	3
Ventura	10	8	80.0	1	1
Total	178	125	70.2	2	10

Table 9. Exposure prevalence and toxicosis of anticoagulant rodenticide residues detected in the livers of 178 small game and non-game mammals submitted to the Wildlife Health Laboratory for postmortem examination in 2021 by species. Livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA. In some cases, rodenticide residues were detected in the liver, but postmortem evidence could not confirm or exclude toxicosis due to advanced decomposition. Therefore, these diagnoses are reported as “undetermined” toxicosis.

Small Game and Non-Game Species	No. Tested	No. Exposed	Exposure Prevalence	No. Confirmed Toxicosis	No. Undetermined Toxicosis
Bobcat	57	40	70.2	0	1
Brush rabbit	1	0	0.0	0	0
Coyote	10	9	90.0	0	2
Desert cottontail	1	0	0.0	0	0
Desert kit fox	7	3	42.9	0	0
Douglas squirrel	1	1	100.0	0	0
Eastern fox squirrel	6	1	16.7	0	0
Eastern gray squirrel	2	1	50.0	0	0
Fisher	1	1	100.0	0	0
Gray fox	18	16	88.9	1	2
Gray wolf	1	1	100.0	0	0
Long-tailed weasel	3	2	66.7	0	0
Mountain lion	38	36	94.7	1	1
Northern flying squirrel	1	1	100.0	0	0
Opossum	5	1	20.0	0	0
Raccoon	8	6	75.0	0	3
Red fox	1	1	100.0	0	1
River otter	1	0	0.0	0	0
San Joaquin kit fox	4	2	50.0	0	0
Striped skunk	6	2	33.3	0	0
Vole	1	0	0.0	0	0
Western gray squirrel	5	1	20.0	0	0
Total	178	125	70.2	2	10



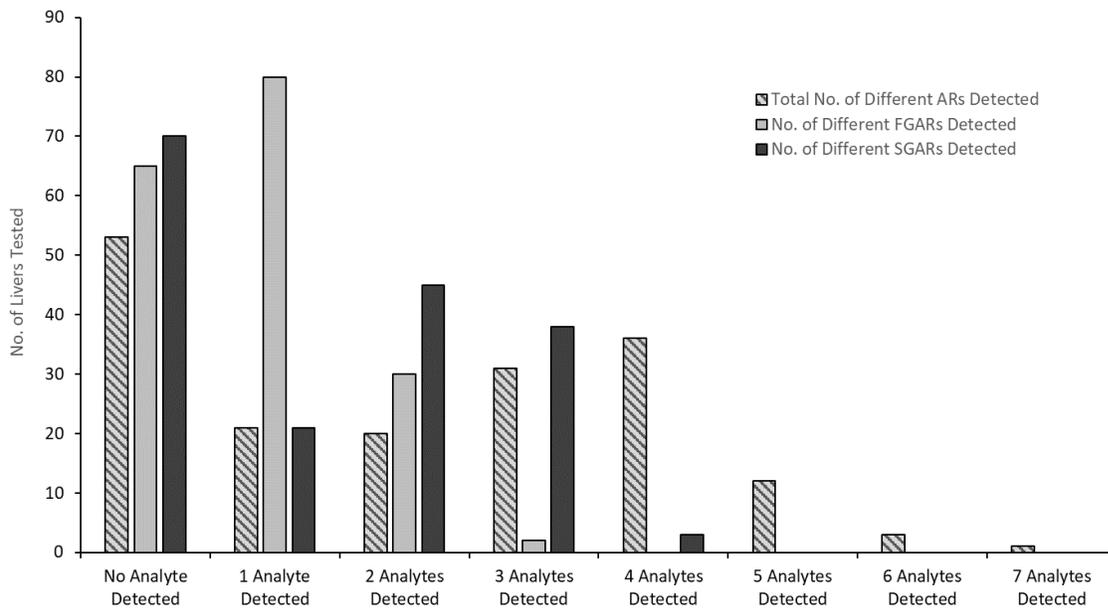


Figure 3. Number of anticoagulant rodenticide residues detected in the livers of 178 small game and non-game mammals submitted to the Wildlife Health Laboratory for postmortem examination in 2021. After postmortem examination, livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA.

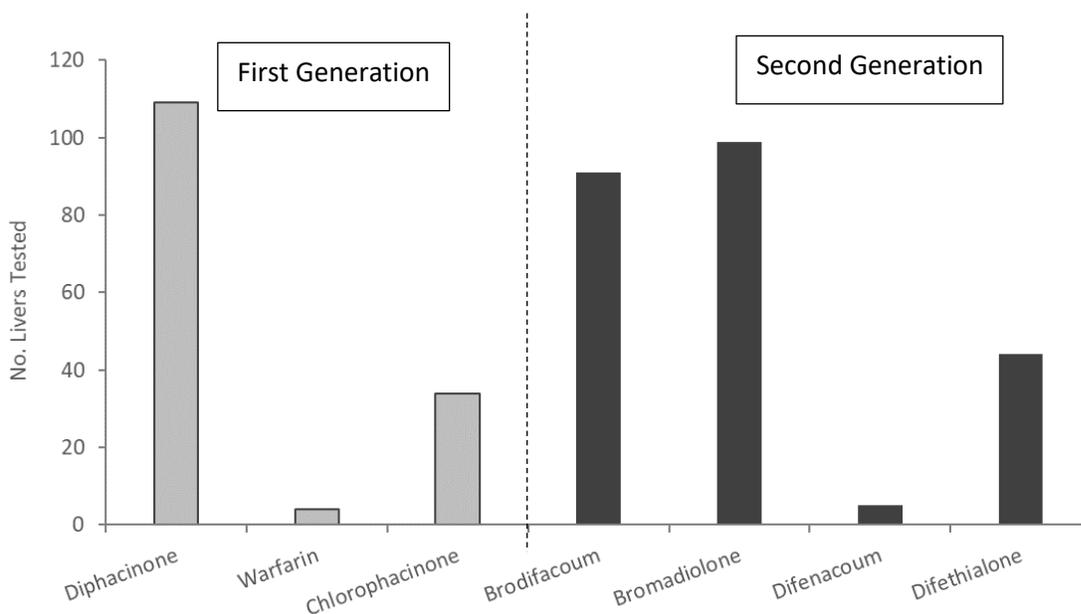


Figure 4. Anticoagulant rodenticide residues detected in the livers of wild small game and non-game mammals submitted to the Wildlife Health Laboratory for postmortem examination in 2021. After postmortem examination, livers were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA.



Other Pesticide Exposure

Thirty-nine animals were tested for additional pesticides, including bromethalin, strychnine, ethylene glycol, organophosphates, and carbamates.

Adipose or brain from 147 animals across 33 counties was tested for exposure to the neurotoxic rodenticide, bromethalin (Table 10 and 11). Thirty-two of the tested animals had exposure to bromethalin and 12 of those exposures resulted in mortality ($n = 11$) or suspected mortality ($n = 1$). Advanced decomposition likely precluded the identification of any lesion(s) that may be associated with bromethalin toxicity in the long-tailed weasel with exposure. Further, it had a clinical history of depressed behavior with possible neurologic signs prior to death but these signs were not described in detail by the submitter. Thus, it is undetermined if exposure may have resulted in clinical signs and toxicosis.

One mountain lion was tested for another neurotoxic rodenticide, strychnine; test results were positive and the case is currently under investigation by law enforcement.

Vitamin D3 levels were tested in another mountain lion after tubular mineralization of the

kidneys was observed to rule out Vit-D3 toxicosis. Vitamin D3 levels were within normal limits and the mineralization observed is suspected to be due dehydration as a result of kidney failure.

In Yolo County, a large die-off of various fish was observed in a wildlife area. Water and sediment samples as well as several fish were tested for pyrethrins and testing was negative. Heavy metal testing was also performed on the tissue samples from several fish and values were presumptively determined to be normal limits.

A general toxicology panel (GMCS/LCMS) was performed on a bobcat from Riverside County whose cause of death was undetermined. Testing was negative.

In Merced County, a die off in a private stock of shad fish occurred after the recent aerial spraying of an adjacent orchard with methoxyfenozide. A sample of dead fish were collected days later and submitted to the CAHFS Lab in Davis for testing. Methoxyfenozide was not detected in the tested fish tissues.

Table 10. Bromethalin exposure and toxicosis in wild small game and non-game wildlife submitted to the Wildlife Health Laboratory in 2021 by county. Adipose or brain were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA. In some cases, bromethalin were detected in but antemortem and postmortem evidence could not confirm or exclude toxicosis due to advanced autolysis which may preclude histologically significant lesions or the inability to observe the animal while alive. Therefore, these diagnoses are reported as “undetermined toxicosis.”

County	No. Tested	No. Exposed	Exposure Prevalence	No. Confirmed Toxicosis	No. Undetermined Toxicosis
Amador	2	1	50.0	0	0
Calaveras	3	0	0.0	0	0
Contra Costa	5	2	40.0	2	0
Del Norte	1	0	0.0	0	0
El Dorado	1	1	100.0	0	0
Fresno	1	0	0.0	0	0
Inyo	3	0	0.0	0	0
Kern	4	1	25.0	0	0
Lake	2	0	0.0	0	0
Los Angeles	20	2	10.0	0	0
Madera	1	0	0.0	0	0
Marin	4	1	25.0	0	0
Mendocino	1	0	0.0	0	0
Modoc	1	0	0.0	0	0
Monterey	5	0	0.0	0	0
Napa	6	2	33.3	2	0
Nevada	4	0	0.0	0	0
Orange	2	0	0.0	0	0
Placer	2	0	0.0	0	0
Plumas	1	0	0.0	0	0
Riverside	4	0	0.0	0	0
Sacramento	7	2	28.6	0	0
San Bernardino	3	0	0.0	0	0
San Diego	10	3	30.0	0	0
San Luis Obispo	2	1	50.0	0	0
San Mateo	3	0	0.0	0	0
Santa Barbara	4	1	25.0	0	0
Santa Clara	5	2	40.0	0	0
Santa Cruz	9	2	22.2	0	0
Shasta	3	0	0.0	0	0
Siskiyou	2	0	0.0	0	0
Sonoma	17	9	52.9	7	1
Ventura	9	2	22.2	0	0
Total	147	32	21.8	11	1

Table 11. Bromethalin exposure and toxicosis in wild small game and non-game wildlife submitted to the Wildlife Health Laboratory in 2021 by species. Adipose or brain were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA. In some cases, bromethalin were detected in but antemortem and postmortem evidence could not confirm or exclude toxicosis due to advanced autolysis which may preclude histologically significant lesions or the inability to observe the animal while alive. Therefore, these diagnoses are reported as “undetermined toxicosis.”

Small Game and Non-Game Species	No. Tested	No. Exposed	Exposure Prevalence	No. Confirmed Toxicosis	No. Undetermined Toxicosis
Badger	1	0	0.0	0	0
Bobcat	55	11	20.0	0	0
Coyote	7	2	28.6	0	0
Eastern fox squirrel	6	1	16.7	0	0
Eastern gray squirrel	2	1	50.0	0	0
Fisher	1	0	0.0	0	0
Gray fox	16	1	6.3	1	0
Gray wolf	1	0	0.0	0	0
Long-tailed weasel	3	2	66.7	0	1
Mountain lion	32	4	12.5	0	0
Opossum	5	0	0.0	0	0
Raccoon	7	5	71.4	5	0
San Joaquin kit fox	2	0	0.0	0	0
Striped skunk	4	3	75.0	3	0
Western gray squirrel	5	2	40.0	2	0
Total	147	32	21.8	11	1



ADDITIONAL SURVEILLANCE

Suspicious food from Los Angeles County

CDFW law enforcement was alerted to an individual leaving out “soaked” kibble and hot dogs. Samples were collected and submitted to the CAHFS Lab in Davis for a general toxicology panel (GMCS/LCMS). These general screens are designed to potentially detect a large number of organic compounds belonging to diverse chemical classes (pesticides, environmental contaminants, drugs and natural products). Propylene glycol was the only detected analyte in the hot dog mix but, per the veterinary toxicologist, this detection is unlikely to be significant and might actually be an ingredient of the product. No analytes were detected in the kibble sample. It is also important to note that a “non-detection” does not necessarily preclude the presence of a chemical of concern since the screens are not considered to be comprehensive (there is no single test that can completely rule out the presence of a toxic compound in a tested sample). However, based upon the negative MS screens, strychnine, OPs, and carbamates can be excluded as being present in the tested samples.

Suspicious food from San Luis Obispo County

Several trays of unknown meat were found outdoors in a community and reported to CDFW law enforcement. The meat looked similar in appearance to tuna. According to a neighbor, their dog had consumed some of the meat and within 24 hours their dog became ill and died.

Three different samples of meat were collected from three of the trays recovered by CDFW and frozen. It was noted that none of the samples were frozen despite being stored in the freezer. Meat samples from each tray were submitted to the CAHFS Lab in Davis for a general toxicology panel (GMCS/LCMS). Ethylene glycol, methyl benzotriazole, and diethylene glycol were found in all the samples in very high concentrations.

The samples were also tested for strychnine and testing was negative.

Environmental Samples

CDFW law enforcement submitted several containers with unknown liquid collected from illegal marijuana grow sites in Madera County that are under investigation. These samples were tested for toxic compounds, including organophosphates where carbofuran was detected.

Evaluation of Assembly Bill 1788

A temporary moratorium was placed on the public sales and use of second generation anticoagulant rodenticides (SGARs) on January 1, 2021 under [AB1788](#). Given the long half-lives of many SGARs and their ability to bioaccumulate in the livers of living animals, evaluating any immediate changes resulting from this temporary moratorium may be difficult. The CDFW proposed guidelines for monitoring the short-term, immediate effects of AB1788s as well as the continued long-term monitoring and surveillance of anticoagulant rodenticide exposure in non-target wildlife, especially given the special exceptions to this moratorium that still allow for SGAR use.

Short-term evaluation of the efficacy of AB1788 include looking at animals born or hatched after January 1, 2021 and cases of exposure and/or acute toxicosis. Our reasoning is that most wildlife born or hatched after implementation of AB1788 should not have exposure to SGARs (although there is a chance that mammals could have been exposed in utero²⁻⁷). A study by CDFW looking at anticoagulant rodenticide exposure in mountain lions found that cubs are less likely to have SGAR exposure when compared to adults⁸ despite evidence of fetal exposure². Further, we posit that wildlife that have died from acute toxicosis were likely recently exposed at concentrations large enough to cause coagulopathy and death rather than chronic

exposure accumulating over time. It is important to note, however, that most wildlife have more than one analyte detected in their livers belonging to both first generation and second generation anticoagulant rodenticides. Additionally, there is no minimum threshold concentration indicative of anticoagulant rodenticide toxicosis and determining whether toxicosis was due to a first generation or second generation is difficult in the presence of multiple analytes and lack of information on the cumulative effects.

Twenty-nine wild birds and mammals were determined to have died, or suspected to have died, from acute coagulopathy due to anticoagulant rodenticide toxicosis (Table 12).

Twenty-three wild birds and mammals under the age of a year in calendar year 2021 had exposure to one or more anticoagulant rodenticide(s) (Table 13). Age and age classes were determined based on plumage and/or the presence of a bursa (for avians), dentition (mammals), and date of death since most species have reproductive seasons in which they predictively mate and produce offspring.



Table 12. Summary of cases of anticoagulant rodenticide (AR) toxicosis in non-target wildlife since the implementation of AB1788 on January 1, 2021. Livers from necropsied wildlife were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA. In some cases, rodenticide residues were detected in the liver, but postmortem evidence could not confirm or exclude toxicosis due to advanced decomposition. Therefore, these diagnoses are reported as “undetermined” toxicosis.

SGAR = second generation anticoagulant rodenticide, FGAR = first generation anticoagulant rodenticide

Date of Death	Species	County	Sex	Age Class	AR Toxicosis	No. of SGARs Detected	No. of FGARs Detected
AVIAN SUBMISSIONS							
1/1/2021	Great horned owl	Los Angeles	F	Adult	Yes	3	0
2/1/2021	Red-tailed hawk	Los Angeles	F	Juvenile	Yes	2	0
2/8/2021	Red-tailed hawk	Los Angeles	F	Adult	Yes	3	0
2/9/2021	Barn owl	Los Angeles	F	Adult	Yes	3	1
3/5/2021	Red-shouldered hawk	Contra Costa	M	Adult	Yes	2	1
3/30/2021	Great horned owl	Los Angeles	M	Juvenile	Yes	3	1
4/12/2021	Great horned owl	Riverside	F	Adult	Yes	3	0
5/1/2021	Great horned owl	Kings	F	Juvenile	Yes	0	1
5/21/2021	Common raven	Kern	F	Adult	Yes	2	1
5/24/2021	Great horned owl	Contra Costa	M	Adult	Yes	3	1
5/29/2021	Great horned owl	Ventura	M	Adult	Yes	2	0
8/1/2021	Great horned owl	Ventura	F	Adult	Yes	3	1
9/29/2021	Barn owl	Kern	F	Adult	Yes	3	1
10/1/2021	Great horned owl	Ventura	M	Adult	Yes	3	1
10/13/2021	Great horned owl	Sacramento	F	Adult	Yes	2	0
11/21/2021	Barn owl	Sonoma	F	Adult	Yes	3	0
12/31/2021	Great horned owl	Napa	F	Adult	Yes	2	0
MAMMAL SUBMISSIONS							
1/28/2021	Red fox	Kern	F	Yearling	Undetermined	3	1
2/28/2021	Raccoon	Sonoma	M	Adult	Undetermined	3	2
3/4/2021	Raccoon	Sonoma	M	Adult	Undetermined	2	0
3/9/2021	Gray fox	Sonoma	M	Adult	Undetermined	3	1
5/10/2021	Raccoon	Contra Costa	F	Yearling	Undetermined	2	1
6/7/2021	Mountain lion	Ventura	M	Adult	Yes	3	2
6/12/2021	Coyote	Contra Costa	M	Pup	Undetermined	0	1
6/24/2021	Mountain lion	San Diego	M	Adult	Undetermined	3	2
7/13/2021	Coyote	El Dorado	F	Pup	Undetermined	2	1
8/24/2021	Gray fox	Ventura	F	Adult	Undetermined	0	1
10/7/2021	Bobcat	Los Angeles	F	Adult	Undetermined	3	2
not specified (2021)	Gray Fox	Santa Clara	M	Adult	Yes	2	1

Table 13. Summary of cases of anticoagulant rodenticide (AR) exposure in non-target wildlife born or hatched after the implementation of AB1788 on January 1, 2021. Age classes were determined based on plumage, dentition, and reproductive phenology of the species. Livers from necropsied wildlife were submitted for toxicology testing to the California Animal Health and Food Safety Laboratory in Davis, CA. In some cases, rodenticide residues were detected in the liver, but postmortem evidence could not confirm or exclude toxicosis due to advanced decomposition. Therefore, these diagnoses are reported as “undetermined” toxicosis.

SGAR = second generation anticoagulant rodenticide, FGAR = first generation anticoagulant rodenticide

Date of Death	Species	County	Sex	Age Class	AR Toxicosis	No. of SGARs Detected	No. of FGARS Detected
AVIAN SUBMISSIONS							
6/4/2021	American crow	Monterey	M	Juvenile	No	0	1
7/7/2021	Barn owl	San Diego	M	Juvenile	No	1	0
7/28/2021	Red-shouldered hawk	Santa Cruz	F	Juvenile	No	2	1
7/31/2021	Great horned owl	Los Angeles	M	Juvenile	No	1	1
10/14/2021	Great horned owl	San Luis Obispo	F	Juvenile	No	1	1
11/24/2021	Turkey vulture	Contra Costa	M	Juvenile	No	3	0
12/30/2021	Red-shouldered hawk	Santa Cruz	M	Juvenile	No	1	0
12/30/2021	Red-tailed hawk	Los Angeles	F	Juvenile	No	1	1
MAMMAL SUBMISSIONS							
1/28/2021	Coyote	Santa Cruz	M	Juvenile	No	2	2
2/7/2021	Bobcat	Lake	M	Juvenile	No	2	1
2/23/2021	San Joaquin kit fox	Kern	F	Juvenile	No	2	1
5/22/2021	Mountain lion	Nevada	M	Pup/Cub	No	2	2
6/24/2021	Gray fox	Nevada	F	Pup/Cub	No	2	1
6/25/2021	Coyote	Los Angeles	M	Pup/Cub	No	1	0
7/2/2021	Mountain lion	Sonoma	M	Pup/Cub	No	2	2
7/2/2021	Mountain lion	Sonoma	F	Pup/Cub	No	2	2
7/8/2021	Gray fox	Nevada	F	Pup/Cub	No	2	1
7/22/2021	Bobcat	San Mateo	M	Pup/Cub	No	1	1
8/26/2021	Mountain lion	Los Angeles	M	Pup/Cub	No	2	1
09/24/21	Black bear	El Dorado	M	Juvenile	No	1	1
10/2/2021	Bobcat	Santa Cruz	F	Pup/Cub	No	1	1
10/15/2021	Bobcat	San Diego	M	Juvenile	No	3	1
12/1/2021	Mountain lion	Ventura	F	Pup/Cub	No	2	1
12/2/2021	Mountain lion	Ventura	F	Pup/Cub	No	2	1

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