Screening of Hawaiian Bird and Bat Carcasses for Rodenticide Residues

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April 18, 2019

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Suggested Citation:
Siers, S. R., S. F. Volker, C. G. Payne, R. T. Sugihara, C. E. Swift, J. T. Nelson, A. B. Shiels, and W. C. Pitt. 2019. Screening of Hawaiian bird and bat carcasses for rodenticide residues. Unpublished final report (QA-2240). USDA, APHIS, WS, NWRC. Hilo, HI.

Introduction

Rodenticide use has provided tremendous benefits to society through the reduction of rodent impacts, including damage to human food supplies, spread of disease, and damage to natural resources (Hadler & Buckle 1992, Buckle 1999, Witmer & Eisemann 2007, Witmer et al. 2007, Fall & Fiedler 2015). As with any activity that introduces toxins into the environment, the safe application of rodenticides requires appropriate accounting for the potential negative environmental and ecological consequences of their use.

Plans for responsible application of toxicants for rodent control must account for the risk of unintended exposure of humans and other animals besides the "target" rodent, or so-called "nontarget risk." Routes of nontarget wildlife exposure to rodenticides are most often categorized as primary or secondary. Primary exposure results from the direct ingestion of the rodenticide product by the nontarget organism (reviewed in Shore & Coeurdassier 2018). This is the intended route of exposure for target rodents. Secondary exposure occurs when a predator or scavenger consumes another organism (typically a rodent) that has been intoxicated or killed by ingestion of the rodenticide. This can have lethal or sublethal consequences for the predator (Kaukeinen 1982, Joermann 1998). Although little direct evidence exists, it is also theoretically possible that an insectivorous bird or mammal (e.g., a bat) might become secondarily exposed to rodenticides by consuming insects or other invertebrates that have fed on rodenticide products (Dennis & Gartrell 2015). Tertiary exposure, consumption of another animal that has been exposed via a secondary route, has also been implicated as a possible route

of wildlife poisoning (Elliott et al. 2014, Rueda et al. 2016).

Throughout the history of the use of rodenticides, cases of lethal and sublethal intoxication of nontarget wildlife species have been documented, including birds (Stone et al. 1999, Erickson & Urban 2004, Thomas et al. 2011, to name but few of many), mammals including bats (Shore et al. 2003, Brakes & Smith 2005, Dowding et al. 2010, Dennis & Gartrell 2015), reptiles (Rueda et al. 2016, Lohr & Davis 2018), fishes (Masuda et al. 2015, Pitt et al. 2015, Siers et al. 2018), and invertebrates (Ogilvie et al. 1997, Masuda et al. 2015, Siers et al. 2018). Erickson and Urban (2004) cite more than 300 documented incidents of nontarget wildlife exposure to rodenticides, including wild canids and felids, tree squirrels, raccoons, deer, and other mammals, and birds such as owls, hawks, eagles and crows. In some areas the problem has become pervasive (Newton et al. 1999, Hosea 2000, Sanchez-Barbudo et al. 2012, Hughes et al. 2013, Langford et al. 2013, van den Brink et al. 2018).

Rodenticides are generally classified into three groups. "First-generation anticoagulants," which interfere with the production of vitamin K in vertebrates necessary for generating blood clotting factors, typically cause death by internal hemorrhaging (Meehan 1984). They are slow acting, and usually require repeated feedings over multiple days for the animal to consume a lethal dose. "Second-generation anticoagulants" similarly impede vitamin K production, leading to death by hemorrhaging, but are faster acting and can be lethal with a single feeding. Their molecules are more lipophilic, binding more firmly to hepatic tissue; in addition to increasing toxicity, this also leads to persistence of higher-concentration residues in liver tissue (Lechevin & Vigie 1992, Fisher et al. 2003, Erickson and Urban 2004). "Acute toxicants" such as bromethalin produce rapid death through processes such as acute cell death or central nervous system effects. While anticoagulant poisoning can be treated with vitamin K_1, there are no antidotes to acute toxicants. Due to their chemical makeup and mode of action, acute toxicants pose a much lower risk of causing secondary poisoning than anticoagulant rodenticides.

Hawaii has no native land mammals aside from a single bat species, the Hawaiian hoary bat (*Lasiurus cinereus semotus*). Four species of invasive rodents have been introduced to Hawaii (*Rattus rattus*, *R. norvegicus*, *R. exulans*, and *Mus musculus*) which have had negative consequences through impacts on agriculture (Doty 1945, Taylor 1972, Shiels et al. 2014), human health (Katz et al. 2002, Shiels et al. 2014, Jarvi et al. 2017), and natural resources (Stone 1985, Jones et al. 2008, Shiels et al. 2014). The damage caused by these rodents is often mitigated by the application of rodenticides. Use of rodenticides in Hawaii poses risk of nontarget exposure to Hawaii's wildlife. Although nontarget exposure and deaths have resulted from the use of rodenticides in Hawaii (Pitt et al. 2005, Spurr et al. 2015), the scope and magnitude of the problem is uncertain. In this study, we sought to evaluate the evidence for exposure of a suite of Hawaiian birds and the Hawaiian hoary bat to common rodenticides by screening of tissues from carcasses opportunistically collected from various wildlife management and rehabilitation entities. By evaluating rodenticide residues in liver, kidney, and whole-carcass tissues, we characterize patterns in rodenticide detections and concentrations by chemical (rodenticide active ingredient), by species, and by island.

Sampling Methods

We obtained carcasses of four bird species and one bat species (Table 1), 163 in total (Table 2), from cooperating government conservation agencies and private wildlife rehabilitation facilities on the islands of Hawaii, Kauai, Maui, and Oahu (Table 3).

Chemistry Methods

We screened bird and bat carcasses for seven active chemicals (toxicants) in common rodenticide products (Table 4). Rodenticide products using these active ingredients come in various forms including pellets, blocks, soft baits, liquids, and tracking powders.

Homogenized avian liver (0.5g), kidney (0.25g) or carcass (0.5g) was weighed into a disposable 15-mL tube, fortified with five surrogate analytes, and cleansed using dispersive solid phase extraction (dSPE). Water and acetonitrile (ACN)

Table 1: Species for which carcasses were obtained and screened for rodenticide residues. "AOU" = American Ornithological Union standard four-letter code.

Common name	Latin name	Hawaiian	AOU	Status	Feeding
Hawaiian hawk	*Buteo solitaris*	ʻIo	HAWH	Native	Predator
Hawaiian short-eared owl	*Asio flammeus sandwichensis*	Pueo	SEOW	Native	Predator
Barn owl	*Tyto alba*	–	BANO	Nonnative	Predator
Hawaiian goose	*Branta sandvicensis*	Nēnē	HAGO	Native	Herbivore
Hawaiian hoary bat	*Lasiurus cinereus semotus*	ʻŌpeʻapeʻa	HOBA*	Native	Insectivore

* There is no standard code for mammals, we use this non-standard code for convenience

Table 2: Number of specimens screened by species and island. Species name abbreviations are based on American Ornithological Union standard four-letter codes as listed in Table 1.

Island	HAWH*	SEOW	BANO	HAGO	HOBA
Hawaii	15	15	35	9	3
Kauai	–	18	12	4	–
Maui	–	6	15	–	8
Oahu	–	–	14	–	9
TOTAL	15	39	76	13	20

* Hawaiian hawks are only found on Hawaii Island; whereas the other species are present on all 4 islands.

were added, and the sample was dispersed by shaking for 30 minutes. NaCl was added in excess to force a water/ACN phase boundary and the sample was again shaken for 30 minutes to extract the analytes into the ACN phase. The sample was centrifuged and an aliquot of the ACN phase was transferred to a dSPE tube containing magnesium sulfate (MgSO4), C18 sorbent, and primary-secondary amine (PSA) sorbent. The extract was exposed to the sorbents and MgSO4 by vortex mixing followed by centrifugation to clarify the supernatant. Hydrophobic and anionic chemical species from the tissue were adsorbed onto the C18 and PSA sorbents, and excess water was removed by the MgSO4. An aliquot of the supernatant was transferred to a microcentrifuge tube and the solvent removed in a 60°C N-Evap with a gentle flow of nitrogen. The analytes were reconstituted in mobile phase and analyzed by high-performance liquid chromatography combined with atmospheric pressure chemical ionization (APCI) and tandem mass spectrometry (HPLC-APCI-MS/MS). A more complete description of the analytical method is attached as Appendix 1.

Detection and quantitation limits for each of the seven analytes are detailed in Table 5. The detection limit ('DL') is the concentration below which an analyte could not be detected (sometimes referred to as the method limit of detection, or 'MLOD'). The quantitation limit ('QL') is the concentration above which residues can be reliably quantified. Concentration values between the detection limit and the quantitation limit should not be viewed as reliable indicators of relative analyte concentrations and should more conservatively be considered as detections that cannot reliably be quantified. Such detections often cannot be replicated, and in a large number of samples there is a chance of "false positives". Because we were unable to successfully quantify bromethalin, we evaluated concentrations of its primary metabolite, desmethyl bromethalin (or 'd-bromethalin'). The stereoisomers of bromadiolone elute as two peaks under the alkaline elution conditions of the multi-rodenticide method. Bromadiolone concentrations in this report are the sum of the diastereomers.

Because of the size and condition of carcasses, not all tissues could be analyzed for all specimens. Carcass samples comprised the whole body minus the liver, kidney, skin and feathers/fur, wings, and legs/feet below the last joint. When mass of liver or kidney tissue was not adequate for analysis, it was included in the carcass sample. When a residue >QL was detected the sample was run again for confirmation.

Statistical Methods

The primary results of this study are detections and concentration values that are best represented in tabular or graphical format. Upon review

Table 3: Sources of carcasses screened for rodenticides. DOFAW = State of Hawaii Department of Land and Natural Resources Division of Forestry and Wildlife; in many cases, carcasses were transferred to DOFAW by rehabilitators or other entities (see raw data for additional details). N = total number of carcasses provided; Dead = number dead upon collection; Exp = arrived alive, expired in custody; Euth = collected or arrived alive, later euthanized; Unk = collection condition unknown. In most cases, cause of death was not known or reported; the "Notes" column summarizes known causes of death or reasons for collection, with counts in parentheses.

Table 3-1.Hawaiian hawk carcass sources.

Island	Source	N	Dead	Exp	Euth	Unk	Notes
Hawaii	DOFAW	10	8	–	2	–	Vehicle strike (3)
	Hawaii Wildlife Center	5	–	–	3	2	None

Table 3-2. Hawaiian short-eared owl carcass sources.

Island	Source	N	Dead	Exp	Euth	Unk	Notes
Hawaii	DOFAW	1	1	–	–	–	None
	Hawaii Wildlife Center	12	6	–	6	–	Vehicle strike (2)
	Private rehabilitator	2	–	–	–	2	None
Kauai	DOFAW	12	9	1	2	–	Vehicle strike (2)
	Kauai Humane Society	6	1	4	1	–	Vehicle strike (1)
Maui	DOFAW	6	3	–	3	–	Vehicle strike (1)
							Wind turbine (2)

Table 3-3. Barn owl carcass sources.

Island	Source	N	Dead	Exp	Euth	Unk	Notes
Hawaii	DOFAW	13	8	–	2	3	None
	Hawaii Wildlife Center	12	8	–	4	–	Vehicle strike (1)
	Private rehabilitator	10	1	3	1	5	Window strike (1)
Kauai	DOFAW	9	9	–	–	–	None
	Kauai Humane Society	3	–	–	3	–	Vehicle strike (1)
Maui	DOFAW	15	3	3	9	–	Vehicle strike (2)
Oahu	USDA Wildlife Services	10	–	–	10	–	Shot* (10)
	Other	4	2	–	–	2	None

*Removed to mitigate bird air strike hazard at Honolulu International Airport.

Table 3-4. Hawaiian goose carcass sources.

Island	Source	N	Dead	Exp	Euth	Unk	Notes
Hawaii	DOFAW	8	7	–	1	–	Vehicle strike (2)
	Hawaii Wildlife Center	1	1	–		–	None
Kauai	Kauai Humane Society	4	–	–	4	–	Vehicle strike (1)
							Deformity (2)

Table 3-5. Hawaiian hoary bat carcass sources.

Island	Source	N	Dead	Exp	Euth	Unk	Notes
Hawaii	DOFAW	2	2	–	–	–	None
	Hawaii Wildlife Center	1	1	–	–	–	None
Maui	DOFAW	8	8	–	–	–	Wind turbine (2)
	Kawailoa Wind Farm	9	9	–	–	–	Wind turbine (9)

Table 4: Toxicants screened for in Hawaiian bird and bat carcass tissues. Abbreviated toxicant names are used elsewhere in this report. Information on product registration in Hawaii (# companies | # products) from NPIRS 2018.

Toxicant (abbrev.)	Mode of action	Common conc.	HI Reg. Co. | Prod.	HI registered trade names (list not complete)
Warfarin (Warf)	First-generation anticoagulant	0.025%	0 | 0	None†
Diphacinone (Diph)	First-generation anticoagulant	0.005%-0.2%	10 | 24	D-con®, Ditrac®, Ramik®, Rodentex®, Tomcat®
Chlorophacinone (Chlor)	First-generation anticoagulant	0.005%	5 | 10	AC Formula 90®, Revenge®, Rozol®, Harris Mouse Killer®
Brodifacoum (Brod)	Second-generation anticoagulant	0.005%	5 | 22	Final®, Havoc®, Jaguar®, D-con®, Talon®
Bromadiolone (Brom)	Second-generation anticoagulant	0.005%	9 | 39	Contrac®, Rodenthor®, Nectus®, Maki®, Brigand®
Difethialone (Difeth)	Second-generation anticoagulant	0.0025%	1 | 11	Generation®, Hombre®, FastDraw®,FirstStrike®
Bromethalin* (D-brom)	Acute toxicant (neurotoxin)	0.01%	11 | 48	Fastrac®, Rampage®, Tomcat®, Cykill®, Top Gun®

† A gel mole bait registration was accepted in 2018, subsequent to the sampling period.
* The primary metabolite of desmethyl bromethalin (see text).

of chemistry results, it was evident that many individual birds of prey exhibited residues of multiple second-generation anticoagulants. Post hoc, we evaluated whether detection of one second-generation anticoagulant in liver tissue was positively associated with others via a logistic regression with one analyte as the predictor variable and another as the response variable for all three possible pairings (brodifacoum ~ bromadiolone, brodifacoum ~ difethialone, and bromadiolone ~ difethialone). Similarly, a cursory review of residue detections suggested that birds of prey had higher rates of exposure to second-generation anticoagulants on the island of Hawaii compared to other islands; this *post hoc* hypothesis was tested with a logistic regression, with a response variable indicating detection or non-detection of at least one second-generation anticoagulant in liver tissue, with island as the sole predictor variable and pairwise comparisons of island detection rates using a Tukey's HSD test. For all statistical tests, significance was evaluated at $\alpha = 0.05$.

Results

Counts of samples tested, rodenticide detections, and concentrations above quantitation limits are summarized by species, island, tissue type, and rodenticide in Tables 6 to 10. Results from liver tissues (the most reliable source of quantifiable levels of rodenticide residues) are graphically represented in Supplementary Figures S-1 to S-7 at the end of this report. A full tabulation of all results can be found in the analytical chemistry report (#15-004/4) attached as Appendix 2.

Among birds of prey, which exhibited high rates of detection of second-generation anticoagulants, detection of brodifacoum in the liver was not associated with detection of bromadiolone ($p = 0.068$) or difethialone ($p = 0.990$). However, detection of bromadiolone was positively associated with detection of difethialone ($p = 0.019$).

Discussion

First-generation anticoagulants

Detections of first-generation anticoagulants were relatively uncommon. Warfarin was detected in 6/126 bird liver samples and 0/9 bat liver samples

Table 5: Detection and quantitation limits for seven rodenticides evaluated. Nanograms per gram (ng/g) is equivalent to parts per billion (ppb).

	Detection Limit (DL, ng/g)			Quantitation Limit (QL, ng/g)		
Analyte	Liver	Carcass	Kidney*	Liver	Carcass	Kidney*
Warfarin	4.8	9.4	8.6	15.9	31.4	28.6
Diphacinone	7.5	7.2	7.9	25.2	24.0	26.4
Chlorophacinone	4.8	4.3	4.7	16.0	14.4	15.7
Brodifacoum	3.3	3.3	4.0	11.0	11.0	13.3
Bromadiolone	2.2	4.9	2.3	7.4	16.1	7.6
Difethialone	6.9	6.9	6.7	23.0	23.0	22.2
D-bromethalin	14.0	37.0	8.8	46.8	125	29.4

* For 12 kidney samples run on 12 March 2015, DL and QL are 2 times the listed value due to a higher dilution factor used in an early version of the method.

(and 0/20 bat carcass samples). Most of the detections were <QL, and detection could not be confirmed in any of the tissues for most of the samples that were tested a second or third time. It is possible that these detections were false positives. At the time of sampling, there were no warfarin products registered in Hawaii (NPIRS 2018). Chlorophacinone was detected in only a single barn owl kidney sample and in no other tissues from this same bird; this value of 5.1 ng/g was only slightly over the detection limit of 4.7 ng/g, and a second test of the sample showed no detection; coupled with lack of detection in the liver of the same specimen, this detection may be spurious. It is uncertain what factors contributed to the low rates of detection of first-generation anticoagulants. This could be due to low usage of the products (having largely been replaced by more toxic second-generation anticoagulants) and/or shorter persistence of residues compared to second-generation anticoagulants with their more lipophilic molecules and longer half-lives.

Second-generation anticoagulants

Brodifacoum, bromadiolone, and difethialone residues were detected at much higher rates and concentrations than first-generation anticoagulants. Among Hawaiian goose liver samples, there was 1/13 brodifacoum and 1/13 difethialone detection. The only detection of second-generation anticoagulants in any bat tissues was a single liver sample that tested at 108 ng/g difethialone; however, this same sample was tested two more times with no detection in either of the subsequent replicates, demonstrating that the detection was not confirmed. These results suggest relatively low exposure of geese and bats to second-generation anticoagulants. However, based on our data, secondary exposure of birds of prey to second-generation anticoagulants appears to be common. Of the 113 birds of prey analyzed, 53 (47%) showed evidence of exposure to at least one of the three second-generation anticoagulants screened for, 14 (12%) had been exposed to two, and 7 (6%) had been exposed to all three, while 39 (35%) of liver samples did not show evidence of exposure to any of the three. Liver samples from 15 Hawaiian hawks, 30 Hawaiian short-eared owls, and 68 barn owls (113 birds of prey total) showed that 41 (36%) had been exposed to brodifacoum, 25 (21%) had been exposed to bromadiolone, and 15 (13%) had been exposed to difethialone. In contrast to first-generation anticoagulants, higher rates of detection of second-generation anticoagulants could be due to greater usage of the products and/or longer persistence of residues (Fisher et al. 2003, Erickson and Urban 2004). Brodifacoum and difethialone, in particular, have been singled out as the two rodenticides posing the greatest potential risk to avian predators and scavengers (Erickson and Urban 2004). Neither our data nor our knowledge of rodenticide-use patterns allow us to offer plausible hypotheses to explain the post hoc observation of a correlation between bromadiolone and difethialone detections.

Table 6: Hawaiian hawk carcasses screened for rodenticide residues by island, tissue, and rodenticide. A | B | C format: A = number of carcasses screened, B = number of detections (concentrations $\geq$ DL), C = number of detections above the quantitation limit (concentrations $\geq$ QL). Where samples were replicated, classification is based on the average of all observed concentrations; a conservative average was achieved by estimating non-detections at the detection limit. Abbreviated column names correspond to toxicants listed in Table 4.

Island	Tissue	Warf	Diph	Chlor	Brod	Brom	Difeth	D-brom
Hawaii	Liver	15 | 0 | 0	15 | 0 | 0	15 | 0 | 0	15 | 12 | 7	15 | 4 | 2	15 | 4 | 2	15 | 0 | 0
	Kidney	15 | 0 | 0	15 | 0 | 0	15 | 0 | 0	15 | 8 | 5	15 | 3 | 1	15 | 2 | 2	15 | 0 | 0
	Carcass	15 | 0 | 0	15 | 0 | 0	15 | 0 | 0	15 | 6 | 4	15 | 0 | 0	15 | 2 | 0	15 | 0 | 0

Table 7: Hawaiian short-eared owl carcasses screened for rodenticide residues by island, tissue, and rodenticide. A | B | C format: A = number of carcasses screened, B = number of detections (concentrations $\geq$ DL), C = number of detections above the quantitation limit (concentrations $\geq$ QL). Where samples were replicated, classification is based on the average of all observed concentrations; a conservative average was achieved by estimating non-detections at the detection limit. Abbreviated column names correspond to toxicants listed in Table 4.

Island	Tissue	Warf	Diph	Chlor	Brod	Brom	Difeth	D-brom
Hawaii	Liver	14 | 1 | 0	14 | 0 | 0	14 | 0 | 0	14 | 2 | 1	14 | 1 | 1	14 | 0 | 0	14 | 0 | 0
	Kidney	13 | 0 | 0	13 | 0 | 0	13 | 0 | 0	13 | 1 | 0	13 | 1 | 1	13 | 0 | 0	13 | 0 | 0
	Carcass	16 | 0 | 0	16 | 0 | 0	16 | 0 | 0	16 | 0 | 0	15 | 1 | 0	16 | 0 | 0	16 | 0 | 0
Kauai	Liver	12 | 1 | 1	12 | 0 | 0	12 | 0 | 0	12 | 2 | 1	12 | 2 | 2	12 | 0 | 0	12 | 0 | 0
	Kidney	13 | 1 | 0	13 | 0 | 0	13 | 0 | 0	13 | 2 | 1	13 | 3 | 0	13 | 0 | 0	13 | 0 | 0
	Carcass	18 | 0 | 0	18 | 0 | 0	18 | 0 | 0	18 | 2 | 0	18 | 1 | 0	18 | 0 | 0	18 | 0 | 0
Maui	Liver	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0
	Kidney	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0
	Carcass	6 | 0 | 0	6 | 0 | 0	6 | 0 | 0	6 | 0 | 0	6 | 0 | 0	6 | 0 | 0	6 | 0 | 0
TOTAL	Liver	30 | 2 | 0	30 | 0 | 0	30 | 0 | 0	30 | 4 | 2	30 | 3 | 3	30 | 0 | 0	30 | 0 | 0
	Kidney	30 | 1 | 0	30 | 0 | 0	30 | 0 | 0	30 | 3 | 1	30 | 4 | 1	30 | 0 | 0	30 | 0 | 0
	Carcass	39 | 0 | 0	39 | 0 | 0	39 | 0 | 0	39 | 2 | 0	39 | 2 | 0	39 | 0 | 0	39 | 0 | 0

Table 8: Barn owl carcasses screened for rodenticide residues by island, tissue, and rodenticide. A | B | C format: A = number of carcasses screened, B = number of detections (concentrations $\geq$ DL), C = number of detections above the quantitation limit (concentrations $\geq$ QL). Where samples were replicated, classification is based on the average of all observed concentrations; a conservative average was achieved by estimating non-detections at the detection limit. Abbreviated column names correspond to toxicants listed in Table 4.

Island	Tissue	Warf	Diph	Chlor	Brod	Brom	Difeth	D-brom
Hawaii	Liver	34 | 1 | 1	34 | 0 | 0	34 | 0 | 0	34 | 17 | 13	34 | 9 | 8	34 | 9 | 2	34 | 0 | 0
	Kidney	30 | 0 | 0	30 | 0 | 0	30 | 1 | 0	30 | 12 | 7	30 | 8 | 5	30 | 5 | 1	30 | 0 | 0
	Carcass	35 | 1 | 0	35 | 0 | 0	35 | 0 | 0	35 | 7 | 2	35 | 0 | 0	35 | 1 | 0	35 | 0 | 0
Kauai	Liver	7 | 1 | 0	7 | 0 | 0	7 | 0 | 0	7 | 2 | 1	7 | 1 | 1	7 | 0 | 0	7 | 0 | 0
	Kidney	7 | 0 | 0	7 | 0 | 0	7 | 0 | 0	7 | 1 | 0	7 | 1 | 0	7 | 0 | 0	7 | 0 | 0
	Carcass	12 | 0 | 0	12 | 0 | 0	12 | 0 | 0	12 | 0 | 0	12 | 0 | 0	12 | 0 | 0	12 | 0 | 0
Maui	Liver	13 | 1 | 0	13 | 0 | 0	13 | 0 | 0	13 | 3 | 3	13 | 3 | 2	13 | 1 | 0	13 | 0 | 0
	Kidney	13 | 0 | 0	13 | 0 | 0	13 | 0 | 0	13 | 2 | 1	13 | 4 | 2	13 | 1 | 0	13 | 1 | 0
	Carcass	15 | 0 | 0	15 | 0 | 0	15 | 0 | 0	15 | 2 | 1	15 | 1 | 0	15 | 1 | 1	15 | 0 | 0
Oahu	Liver	14 | 0 | 0	14 | 0 | 0	14 | 0 | 0	14 | 3 | 1	14 | 5 | 3	14 | 1 | 1	14 | 0 | 0
	Kidney	14 | 0 | 0	14 | 0 | 0	14 | 0 | 0	14 | 2 | 1	14 | 5 | 2	14 | 1 | 1	14 | 0 | 0
	Carcass	14 | 0 | 0	14 | 0 | 0	14 | 0 | 0	14 | 0 | 0	14 | 0 | 0	14 | 1 | 0	14 | 0 | 0
TOTAL	Liver	68 | 3 | 1	68 | 0 | 0	68 | 0 | 0	68 | 25 | 18	68 | 18 | 14	68 | 11 | 3	68 | 0 | 0
	Kidney	64 | 0 | 0	64 | 0 | 0	64 | 1 | 0	64 | 17 | 9	64 | 18 | 9	64 | 7 | 2	64 | 1 | 0
	Carcass	76 | 1 | 0	76 | 0 | 0	76 | 0 | 0	76 | 9 | 3	76 | 1 | 0	76 | 3 | 1	76 | 0 | 0

Table 9: Hawaiian goose carcasses screened for rodenticide residues by island, tissue, and rodenticide. A | B | C format: A = number of carcasses screened, B = number of detections (concentrations $\geq$ DL), C = number of detections above the quantitation limit (concentrations $\geq$ QL). Where samples were replicated, classification is based on the average of all observed concentrations; a conservative average was achieved by estimating non-detections at the detection limit. Abbreviated column names correspond to toxicants listed in Table 4.

Island	Tissue	Warf	Diph	Chlor	Brod	Brom	Difeth	D-brom
Hawaii	Liver	9 | 1 | 1	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 1 | 0	9 | 0 | 0
	Kidney	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0
	Carcass	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0	9 | 0 | 0
Kauai	Liver	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 1 | 1	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0
	Kidney	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 1 | 1	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0
	Carcass	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0	4 | 1 | 0	4 | 0 | 0	4 | 0 | 0	4 | 0 | 0
TOTAL	Liver	13 | 1 | 1	13 | 0 | 0	13 | 0 | 0	13 | 1 | 1	13 | 0 | 0	13 | 1 | 0	13 | 0 | 0
	Kidney	13 | 0 | 0	13 | 0 | 0	13 | 0 | 0	13 | 1 | 1	13 | 0 | 0	13 | 0 | 0	13 | 0 | 0
	Carcass	13 | 0 | 0	13 | 0 | 0	13 | 0 | 0	13 | 1 | 0	13 | 0 | 0	13 | 0 | 0	13 | 0 | 0

Table 10: Hawaiian hoary bat carcasses screened for rodenticide residues by island, tissue, and rodenticide. A|B|C format: A = number of carcasses screened, B = number of detections (concentrations $\geq$ DL), C = number of detections above the quantitation limit (concentrations $\geq$ QL). Where samples were replicated, classification is based on the average of all observed concentrations; a conservative average was achieved by estimating non-detections at the detection limit. Abbreviated column names correspond to toxicants listed in Table 4.

Island	Tissue	Warf	Diph	Chlor	Brod	Brom	Difeth	D-brom
Hawaii	Liver	3|0|0	3|0|0	3|0|0	3|0|0	3|0|0	3|0|0	3|0|0
	Carcass	3|0|0	3|0|0	3|0|0	3|0|0	3|0|0	3|0|0	3|0|0
Maui	Liver	4|0|0	4|0|0	4|0|0	4|0|0	4|0|0	4|1|1	4|0|0
	Kidney	4|0|0	4|0|0	4|0|0	4|0|0	4|0|0	4|0|0	4|0|0
	Carcass	8|0|0	8|0|0	8|0|0	8|0|0	8|0|0	8|0|0	8|0|0
Oahu	Liver	2|0|0	2|0|0	2|0|0	2|0|0	2|0|0	2|0|0	2|0|0
	Carcass	9|0|0	9|1|0	9|0|0	9|0|0	9|0|0	9|0|0	9|1|0
TOTAL	Liver	9|0|0	9|0|0	9|0|0	9|0|0	9|0|0	9|1|1	9|0|0
	Kidney	4|0|0	4|0|0	4|0|0	4|0|0	4|0|0	4|0|0	4|0|0
	Carcass	20|0|0	20|1|0	20|0|0	20|0|0	20|0|0	20|0|0	20|1|0

Acute toxicants

The only acute toxicant that we tested for was bromethalin since it is the only commonly used acute toxicant legally available in Hawaii for which tissue residues can be analyzed. We only detected desmethyl-bromethalin residues in one barn owl kidney sample and one bat carcass. The barn owl kidney detection could not be replicated (a second test showed no detection and there were no detections in the liver or carcass from the same specimen); the bat carcass detection was not re-tested. This provides little to no unequivocal evidence of exposure of Hawaiian birds and bats to bromethalin. Although the detection and quantification limits for bromethalin are somewhat higher than those for the anticoagulants, the concentration of bromethalin in rodenticide products is also two to four times that of most anticoagulants (0.01% vs. 0.0025–0.005%). Far less is known about residues of bromethalin and other acute toxicants compared to anticoagulants.

Birds of prey

Hawaiian hawks, Hawaiian short-eared owls, and barn owls are exclusively predators or scavengers of mammals, birds, and sometimes insects. It is almost certain that the high levels of exposure to rodenticides, primarily second-generation anticoagulants, is via predation or scavenging on rats or mice that had consumed rodenticide bait (secondary exposure), although Hawaiian hawks and Hawaiian short-eared owls also prey on many birds. Of Hawaiian hawk liver samples tested, 13/15 (87%) demonstrated exposure to at least one second-generation anticoagulant, with barn owls and Hawaiian short-eared owls exhibiting exposure rates of 50% and 20%, respectively. At first examination of the results, it might appear that birds of prey were exposed to second-generation anticoagulants at higher rates on the island of Hawaii as compared to other islands: on Hawaii, 36/63 (57%) of bird of prey livers exhibited detectable second-generation anticoagulant residues, while this rate was only 17/50 (34%) for all other islands combined. This could lead to speculation that the greater proportion of agricultural land on Hawaii led to more rodenticide use and more exposure of birds of prey. However, this apparent pattern was not significant when tested statistically (p-values for pairwise comparisons of Hawaii to Kauai, Maui, and Oahu were 0.105, 0.199, and 0.962, respectively). This pattern is also less apparent when considering that Hawaiian hawks currently only occur on the island of Hawaii.

Newton et al. (1999) considered liver residues of 100 to 200 ng/g to be in the "potentially lethal range" of exposure for barn owls, and Brown et al. (1996) stated that anticoagulant residues remaining after death by toxicosis are usually above

or around 100 ng/g. The USEPA Rodenticide Registrants Task Force proposed a "threshold of toxicity" of 700 ng/g for brodifacoum in liver tissue (Kaukeinen et al. 2000), though this threshold was based on few studies and there has been ample subsequent evidence that lower concentrations have been associated with lethal toxicity; Erickson and Urban (2004) state that this threshold "seems to be inappropriate" and "assumes that death is the only endpoint of interest." In an analysis of published data on liver rodenticide residues and associated signs of intoxication from 270 predatory birds exposed to second-generation anticoagulants, Thomas et al. (2011) employed logistic regression to predict the probability of a bird being symptomatic of anticoagulant poisoning as a function of liver residue concentrations. Based on pooling of data from barn owls, barred owls (Strix varia), great horned owls (Bubo virginianus), and red-tailed hawks (Buteo jamaicensis), they predicted that liver residues in predatory birds at 20 ng/g would correspond to a 5% probability of exhibiting signs of anticoagulant toxicosis, with 10% at 40 ng/g, 15% at 60 ng/g, and 20% probability at 80 ng/g. They also found significant species differences in sensitivity to second-generation anticoagulants. Summaries of specimens of Hawaiian birds of prey exhibiting high liver concentrations of second-generation anticoagulants are reported in Table 11. Threshold values from Newton et al. (1999) are also plotted in Supplementary Figures for raptor exposure to brodifacoum.

Notes on the conditions of these specimens are sparse. None of the notes indicated reasonable suspicion of anticoagulant intoxication (e.g. hemorrhaging; Murray 2018). However, none of these birds were necropsied with the intention of identifying rodenticide intoxication. At the observed residue levels from these specimens, it is clear that Hawaiian birds of prey are being exposed to second-generation anticoagulants at levels that have been considered predictive of sublethal and lethal effects for the species studiedin the previously-cited literature. By comparison, observed residues of first-generation anticoagulants were far fewer and at lower concentrations, and the majority of detections could not be replicated. Although warfarin was detected in 7 of 130 bird of prey specimens, all detections were in only one tissue type, most were <DL and, and almost all replicated tests failed to confirm detection. No diphacinone or chlorophacinone residues were observed in any liver tissues. One very low detection of chlorophacinone (<QL) in kidney tissue from a barn owl (S150226-15) could not be replicated in a second test, nor from any other tissues from the same specimen, and could be spurious. Similarly, the only detection of desmethyl-bromethalin in a bird of prey was <QL in kidney tissue from a barn owl (S150305-06), which could not be replicated in a second kidney sample or any other tissues, including liver which typically has the highest rodenticide concentrations.

Hawaiian geese

A summary of the record of one Hawaiian goose exhibiting a high liver concentration of second-generation anticoagulants is reported in Table 12. This specimen from Kauai (S150410-21) had a liver residue concentration of 314 ng/g brodifacoum, validated by replication at 299 ng/g and by detections in kidney and carcass tissues. This individual was reported as having been hit by a car; it cannot be known whether the vehicle strike or subsequent mortality were precipitated by anticoagulant intoxication. A goose found dead on a golf course on Hawaii (S150410-12) tested positive for a quantifiable concentration of warfarin in liver tissue (99.8 ng/g) but a second test failed to repeat this result (<DL). Another goose from Hawaii, for which no additional details were available, tested positive for difethialone in liver (<QL). Unreplicable results or concentrations <QL may be false positives, and do not provide strong evidence for significant exposure. However, the unambiguous evidence for significant residues in 1 out of 13 Hawaiian goose specimens demonstrates that exposure of geese to second-generation anticoagulants has occurred.

Hawaiian hoary bats

The only detection of any rodenticide residue in liver tissue from nine Hawaiian hoary bats (Table 13) was a concentration of 108 ng/g of difethialone measured in a decomposed specimen (S15-0108-04) from beneath a wind turbine (a significant

Table 11: Details of Hawaiian birds of prey with high second-generation anticoagulant residue concentrations in liver tissue (>100 ng/g).

Table 11-1. Hawaiian hawks with high second-generation anticoagulant residues in liver tissue.

Conc.	Toxicant	Island	Specimen #	Notes
146	Brodifacoum	Hawaii	S141208-12	Hawaii Wildlife Center; no condition notes
870	Brodifacoum	Hawaii	S141208-11	Hawaii Wildlife Center; no condition notes

Table 11-2. Hawaiian short-eared owls with high second-generation anticoagulant residues in liver tissue.

Conc.	Toxicant	Island	Specimen #	Notes
158	Bromadiolone	Hawaii	S150810-39	Found at Hawaii Ocean Science & Technology Park, Kailua-Kona; received from private rehabilitator; no condition notes

Table 11-3. Barn owls with high second-generation anticoagulant residues in liver tissue. Newton et al. (1999) suggest that 100 to 200 ng/g indicates a "potentially lethal range" of brodifacoum exposure for barn owls.

Conc.	Toxicant	Island	Specimen #	Notes
103	Brodifacoum	Hawaii	S150226-22	Hawaii Wildlife Center; found dead at Kapa'au, Hinahina Highway; no condition notes
157	Bromadiolone	Maui	S150305-06	Found alive with injured wing and leg along Kaheawa Wind Power access road below wind tower; later euthanized
165	Difethialone	Oahu	S150305-05	Found dead, emaciated under tree near chicken coop, Poola Street, Waialae Iki
167	Brodifacoum	Hawaii	S150226-11	Hawaii Wildlife Center; found dead at Waikaloa Village Market, off main road; no condition notes
168	Brodifacoum	Maui	S150810-19	Found standing but unable to open eyes at South Kihei Road; arrived live at Maui Humane Society, later euthanized
214	Brodifacoum	Maui	S150810-26	Found at Hailii Mailii with broken wing; euthanized by Makawao Veterinary Clinic
225	Brodifacoum	Hawaii	S150226-15	Received dead at Hawaii Wildlife Center; no condition notes
497	Brodifacoum	Hawaii	S150226-09	Received dead by HIDLNR-DOFAW, Hilo; no condition notes
540	Brodifacoum	Hawaii	S150810-36	Donated by private rehabilitator; no notes

Table 12: Hawaiian goose with high second-generation anticoagulant residues in liver tissue.

Conc.	Toxicant	Island	Specimen #	Notes
314	Brodifacoum	Kauai	S150410-21	Hit by car, euthanized by Kauai Humane Society

source of mortality for hoary bats; Kunz et al. 2007, Amlin & Siddiqi 2015). However, two attempts to replicate the result from this specimen failed to detect difethialone in the liver sample. Three additional carcass sample tests similarly failed to detect any rodenticide, suggesting that this result may be spurious. Of 20 carcasses sampled, diphacinone was detected at <QL in one specimen (S150410-08), and desmethyl-bromethalin was detected at <QL in another (S15-0410-01); both of these were also reported as turbine strikes from Oahu. Unreplicable results or concentrations <QL may be false positives; these results do not provide strong evidence for significant exposure of Hawaiian hoary bats to rodenticides.

Limitations on inference

Multiple factors limit the inferential value of these data. Multiple forms of sampling bias are likely to influence the frequency and magnitude of rodenticide detections. Because sampling was limited to specimens that were incidentally found, it is likely that sampling is biased toward areas of high human activity or infrastructure (particularly for bats; most bats with accession notes were collected from the vicinity of wind energy turbines). These areas of high human activity are likely to have higher levels of commensal rodents and rodenticide use than natural areas. However, outdoor use of rodenticides and potential exposure to wildlife is probably higher in agricultural and low density residential areas than urban population centers. Care should be taken not to unquestioningly extrapolate these values to natural areas which were not systematically sampled. Notes on the sources of donated carcasses vary in completeness. Many were donated by rehabilitation facilities, which are more likely to receive live birds than dead ones (no bats were received live). It is likely that there is a sampling bias toward live birds, which could underestimate the true frequency of lethal exposures. As an additional confounding factor, sublethal doses of toxicants may cause changes to health or behavior that put the animal at higher risk of other forms of mortality.

The high incidence of residues of second-generation anticoagulants in birds of prey is consistent with secondary exposure through the ingestion of intoxicated rodents (or also, less likely, other contaminated birds). The single incontrovertible exposure of a Hawaiian goose to rodenticide (brodifacoum) would logically be through primary exposure, ingestion of rodenticide pellets, consistent with omnivorous foraging behaviors of geese. However, tissue residues alone cannot confirm route of exposure, nor the source of the rodenticide (e.g. commensal or agricultural use).

Much ambiguity exists around the interpretation of residue concentrations. As previously mentioned, very low concentrations near the detection limit are less reliably interpreted as incontrovertible evidence of actual exposure. In our testing, even a small number of detections above the quantitation limit could not be replicated by repeated testing of the same or other tissues. It is possible that some detections are "false positives". Conversely, failure to detect a residue does not rule out exposure. Residue concentrations do not necessarily provide a reliable indicator of the severity of the exposure. Residue concentrations decrease with time, and more slowly for second-generation anticoagulants (Lechevin & Vigie 1992, Fisher et al. 2003). An animal surviving a high initial exposure may have decreasing residues the longer after exposure sampling occurs. It is also unclear whether an animal consuming multiple low-level doses could accumulate high tissue residues without ever achieving enough circulating rodenticide to pose risk of lethal or sublethal effects.

Our results cannot shed light on the general prevalence of use of, or exposure to, first- versus second-generation anticoagulants. Table 4 reflects that a multitude of rodenticide products are registered for use in Hawaii. Data are not available to document the relative frequency and intensity of use of each product type. While law strictly forbids the use of any pesticide in a way that

Table 13: Hawaiian hoary bat with high second-generation anticoagulant residues in liver tissue.

Conc.	Toxicant	Island	Specimen #	Notes
108*	Difethialone	Maui	S150108-04	Possible juvenile found dead, decomposed beneath wind turbine, Kahaewa Wind Power; (*) detection could not be replicated with two subsequent tests (possibly false positive)

is inconsistent with the restrictions on the label, we cannot confirm whether potential bird and bat exposures resulted from lawful or unlawful usage patterns (e.g., broadcast of bait labeled only for bait station use). However, the second-generation rodenticides are only allowed to be applied within 100 feet (30.5 m) of a structure. Rodents could travel some distance away from the application location, and all of the bird species' ranges overlap with areas of human habitation, but the large number of detections does raise the possibility of illegal use beyond 100 feet.

These limitations on inference from our data overlap with a number of factors listed by Erickson & Urban (2004) which contribute to the uncertainty of rodenticide use risk assessments: (1) missing data, including acute, chronic, and secondary toxicity as well as retention of some active ingredients in the liver, blood, and other body tissues; (2) the variable quality and quantity of existing data on metabolism and retention times in rodents and nontarget species; (3) specific use information by formulation, including typical amounts applied by use site, seasonally, and annually; distances applied from buildings; amounts used in rural versus urban areas; use by Certified Applicators versus homeowners and other non-certified applicators; and other such relevant information; (4) information on the number and species of birds and nontarget mammals frequenting baited areas and their likelihood of finding and consuming bait or poisoned primary consumers in the various use areas; (5) methods to determine liver concentration(s) and total body burdens of rodenticide that would corroborate death or even if such a cause-effect relationship is appropriate (e.g., the "threshold of toxicity" concentration); (6) not accounting for the impacts of sublethal effects on reproduction and nontarget mortality (e.g., clotting abnormalities, hemorrhaging, stress factors including environmental stressors, such as adverse weather conditions, food shortages, and predation); (7) not accounting for bioaccumulation of repeated sublethal exposures to bait or poisoned rodents utilized as food by predators and scavengers; and (8) lack of reporting of rodenticide-related wildlife exposure incidents.

The risks associated with rodenticide use, particularly anticoagulants, have stimulated research into factors that drive and modulate anticoagulant uptake by predators and other nontargets (e.g., Coeurdassier et al. 2018, Hindmarch & Elliott 2018), how anticoagulants should be regulated (Lohr & Davis 2018), and how risks can be mitigated including alternatives to anticoagulant use (Buckle & Prescott 2018. Witmer 2018).

Conclusions

Our results document that Hawaii's birds of prey are exposed to second-generation anticoagulant rodenticides. Evidence of exposure to first-generation anticoagulants or to the single acute toxicant screened for here is far more equivocal. While we were not able to attribute mortality to rodenticide intoxication for any of the specimens screened here, other studies conclusively demonstrate that birds of prey are indeed killed via secondary exposure, and some of the concentrations observed in our data are consistent with those in birds exhibiting clinical signs of lethal anticoagulant intoxication (Thomas et al. 2011, Murray 2018). To our knowledge, our results are the first to document the unequivocal exposure of a Hawaiian goose to a rodenticide, presumably from primary exposure (direct feeding). Based on a small number of mostly degraded samples, our results do not demonstrate unequivocal exposure of Hawaiian hoary bats to rodenticides. While high, the frequency of anticoagulant rodenticide residue detections in Hawaiian birds of prey do not exceed observations from other highly populated regions (Newton et al. 1999, Hosea

2000, Hughes et al. 2013, Sanchez-Barbudo et al. 2012). Although our results alone are of insufficient inferential value to properly evaluate risks to the health and persistence of populations of these species, they will be important in informing risk assessments for future regulation of rodenticide uses in Hawaii.

Author contributions

S. R. Siers assumed the role of study director toward the end of sample collection and analytical chemistry, summarized results, and prepared the first draft of the report. S. F. Volker performed analytical chemistry and authored chemistry reports. C. G. Payne and R. T. Sugihara collected specimens from donor centers, coordinated shipping and tracking of specimens to the NWRC Chemistry Lab Unit, and tabulated specimen information. W. C. Pitt, C. E. Swift, and J. T. Nelson conceptualized the study, solicited and provided funding, obtained cooperation for disposition of carcasses and State and Federal permits, and participated throughout the project including analysis of the results. A. B. Shiels was study director at the time of protocol submission and was the recipient and administrator of USFWS funding. All authors reviewed and participated in the editing of the final version of this report.

Acknowledgments

Funding for this study was provided by the US Fish and Wildlife Service (USFWS), Pacific Islands Fish and Wildlife Office (PIFWO). Courtesy review and valuable edits were provided by R. B. Phillips, USFWS-PIFWO. Carcasses were obtained through the cooperation of the USFWS-PIFWO, USDA Wildlife Services, Hawaii State Veterinary Office, Hawaii State Veterinary Laboratory, Hawai'i Department of Land and Natural Resources Division of Forestry and Wildlife, Hawaii Wildlife Center, Kauai Humane Society, Kawailoa Wind Farm, and an anonymous private wildlife rehabilitator. All work was conducted under research protocols approved by the NWRC Institutional Animal Care and Use Committee (QA-2240).

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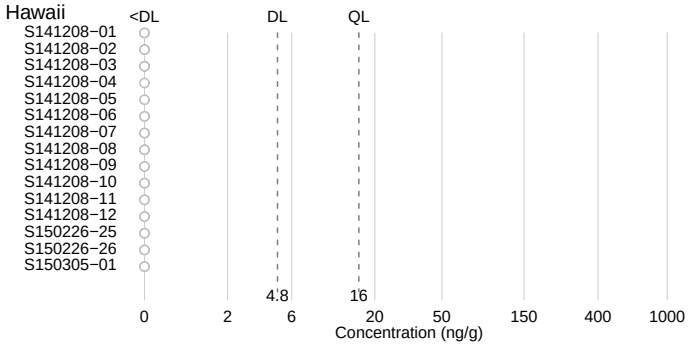

Figure 1: Warfarin detections in liver tissue of Hawaiian hawks by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

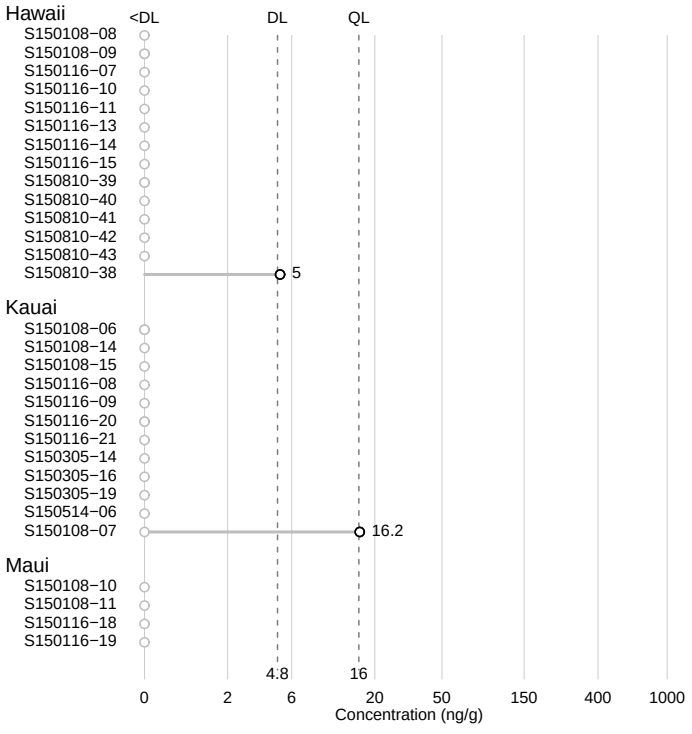

Figure 2: Warfarin detections in liver tissue of Hawaiian short-eared owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

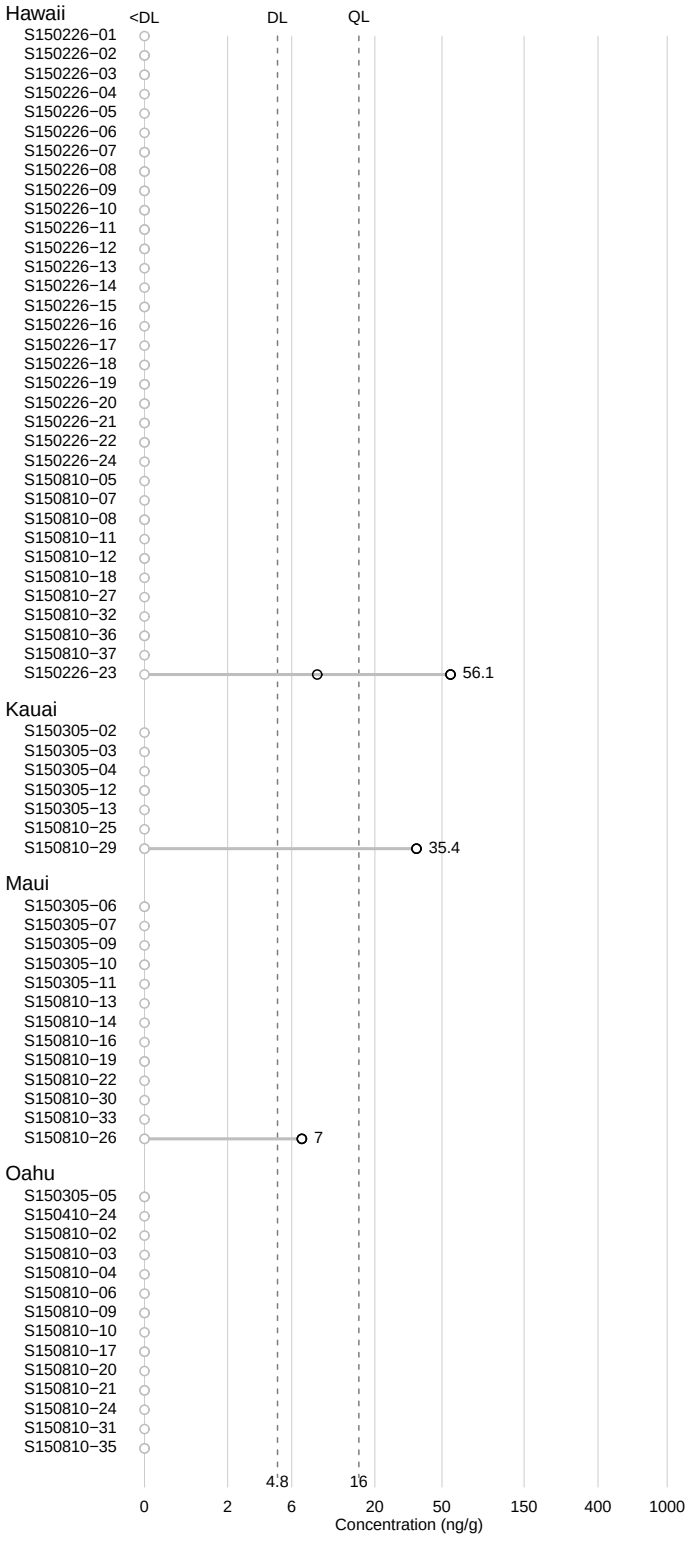

Figure 3: Warfarin detections in liver tissue of barn owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

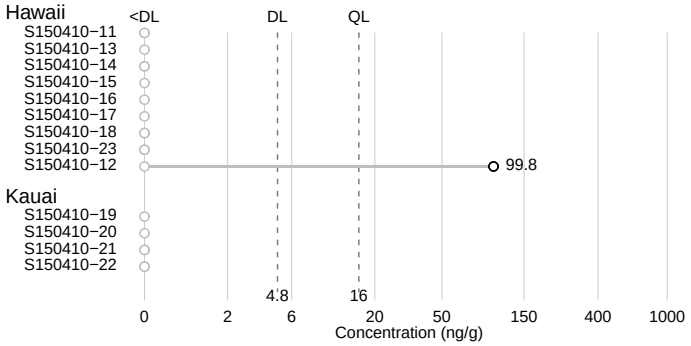

Figure 4: Warfarin detections in liver tissue of Hawaiian goose by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

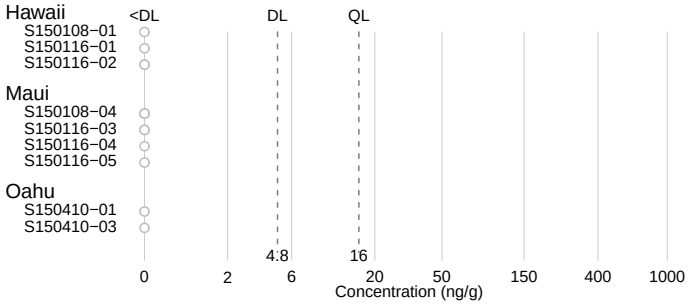

Figure 5: Warfarin detections in liver tissue of Hawaiian hoary bats by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

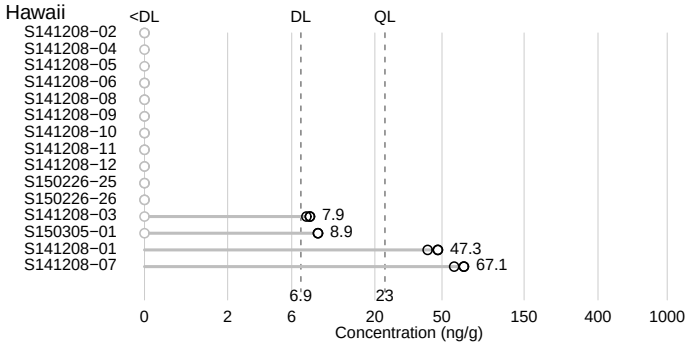

Figure 6: Diphacinone detections in liver tissue of Hawaiian hawks by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

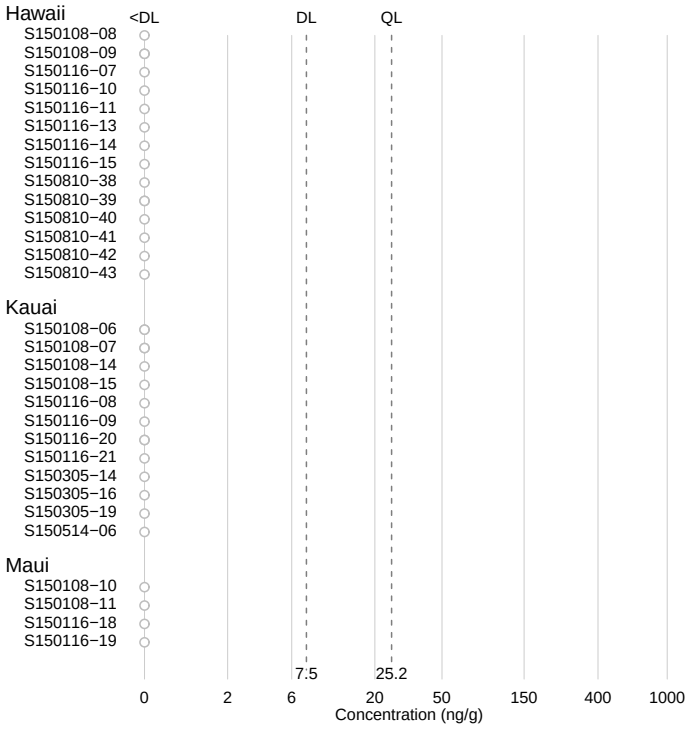

Figure 7: Diphacinone detections in liver tissue of Hawaiian short-eared owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

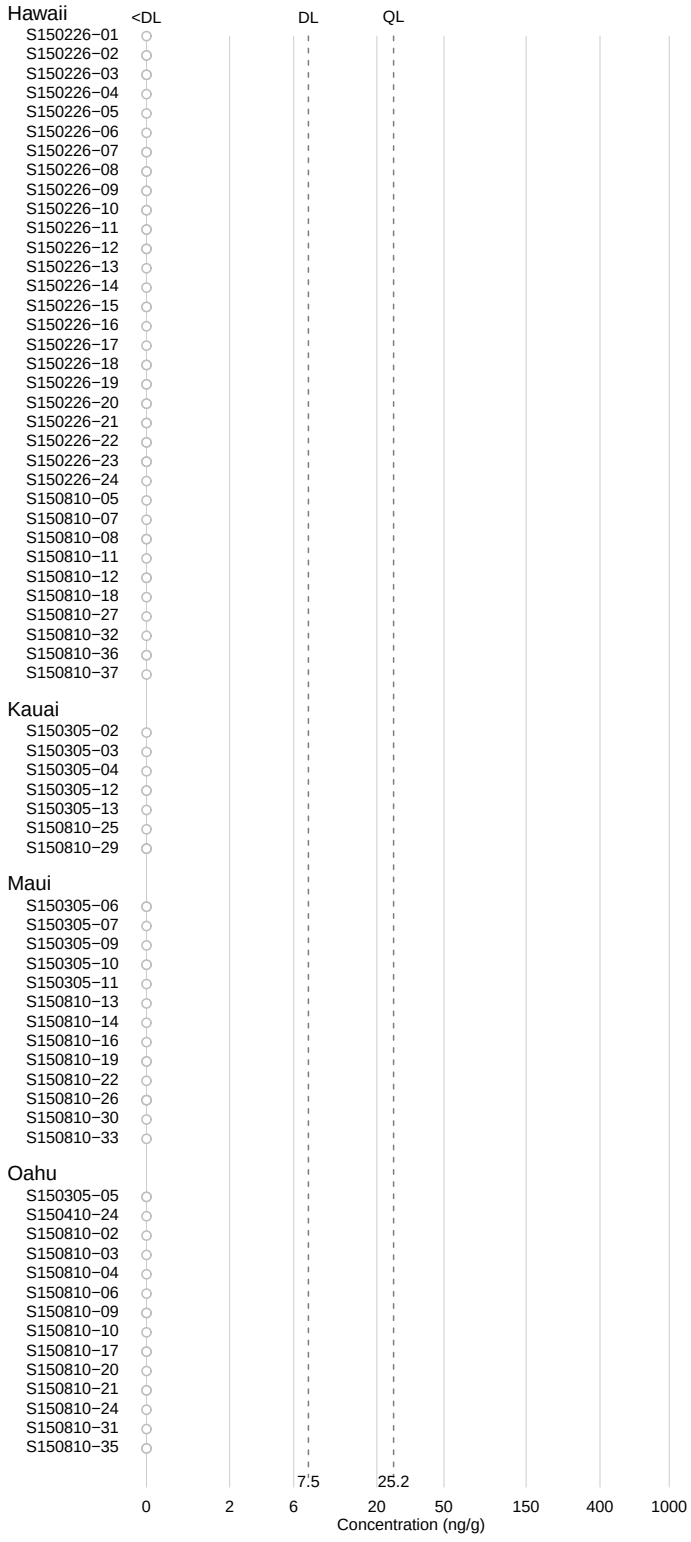

Figure 8: Diphacinone detections in liver tissue of barn owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

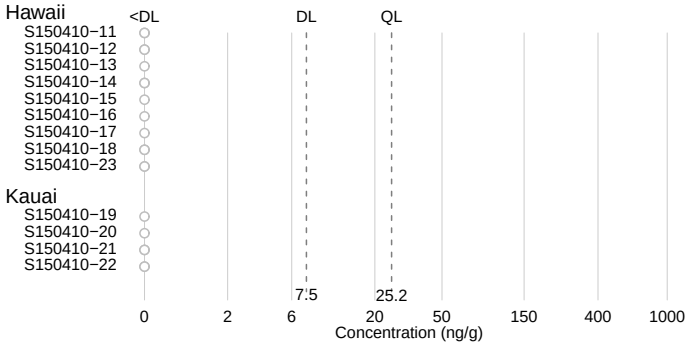

Figure 9: Diphacinone detections in liver tissue of Hawaiian goose by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

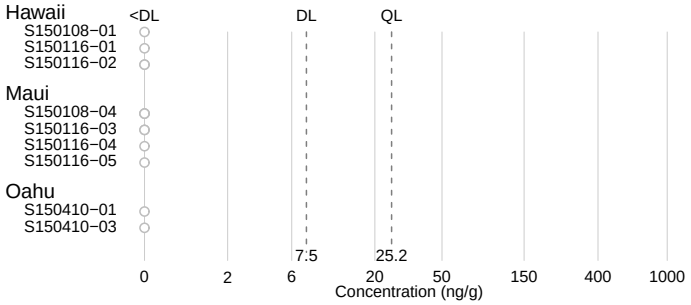

Figure 10: Diphacinone detections in liver tissue of Hawaiian hoary bats by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

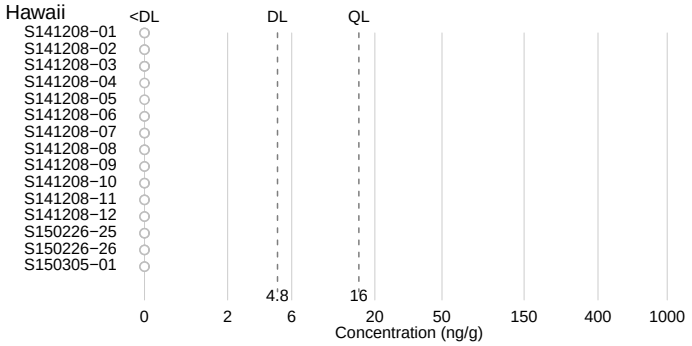

Figure 11: Chlorophacinone detections in liver tissue of Hawaiian hawks by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

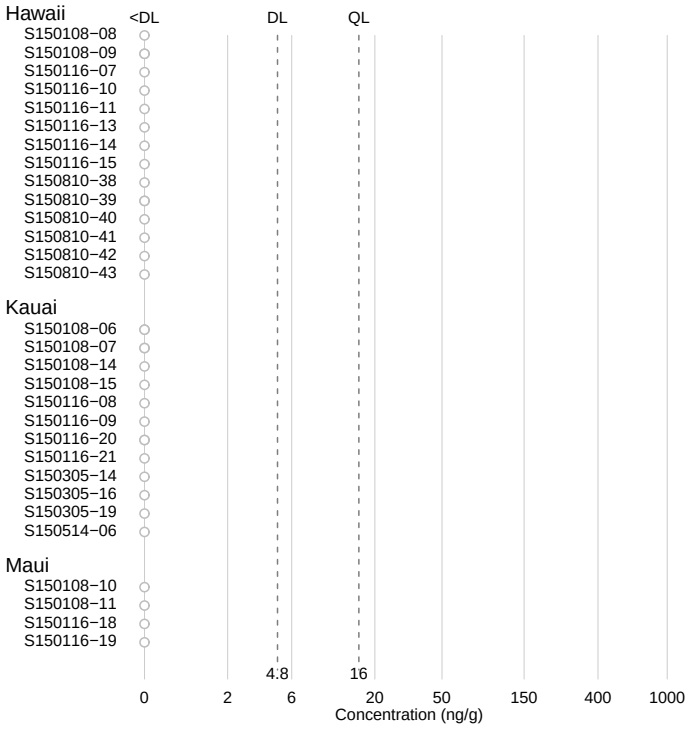

Figure 12: Chlorophacinone detections in liver tissue of Hawaiian short-eared owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

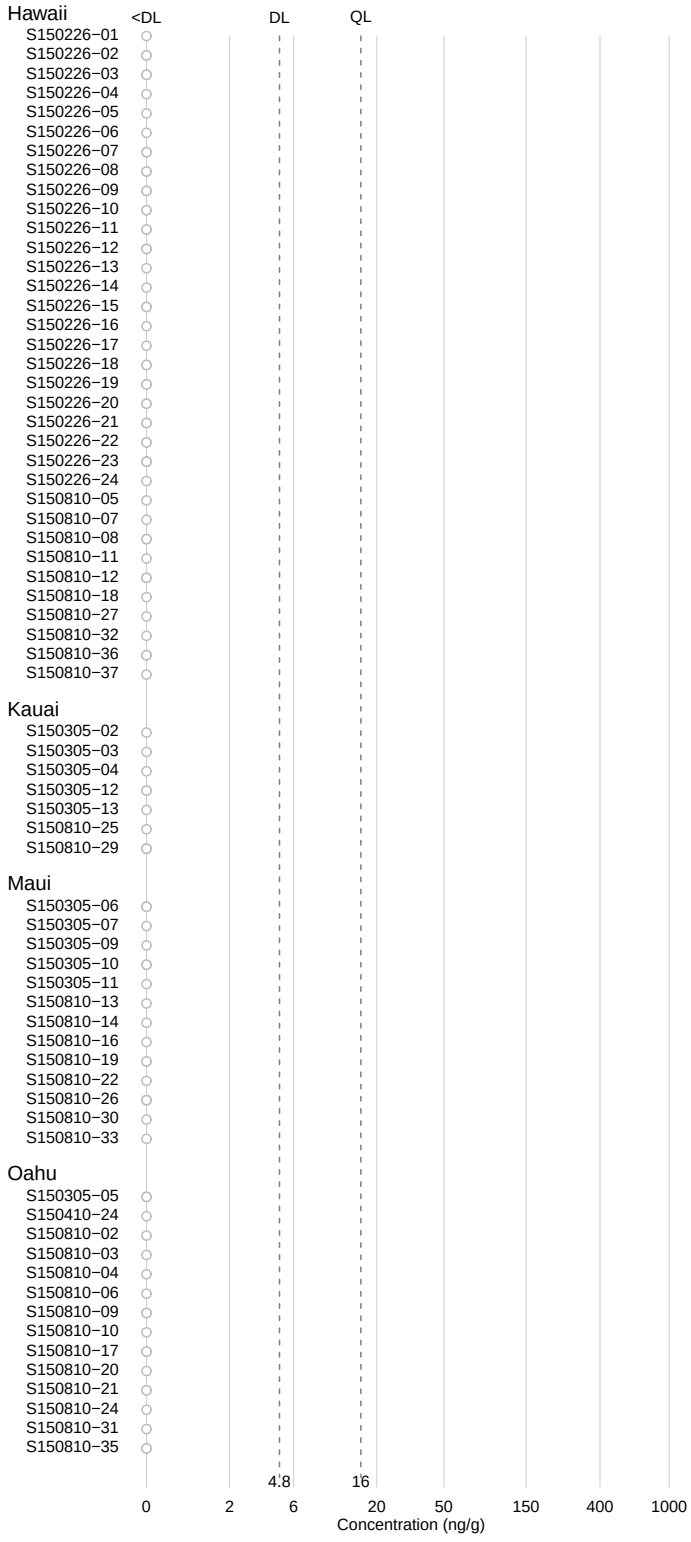

Figure 13: Chlorophacinone detections in liver tissue of barn owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

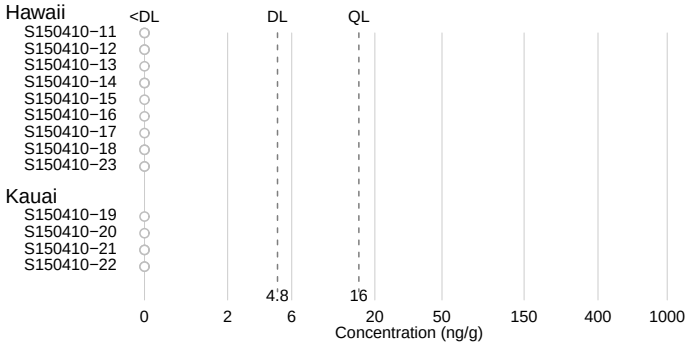

Figure 14: Chlorophacinone detections in liver tissue of Hawaiian goose by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

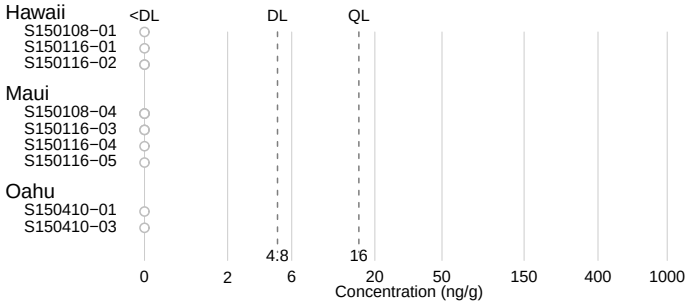

Figure 15: Chlorophacinone detections in liver tissue of Hawaiian hoary bats by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

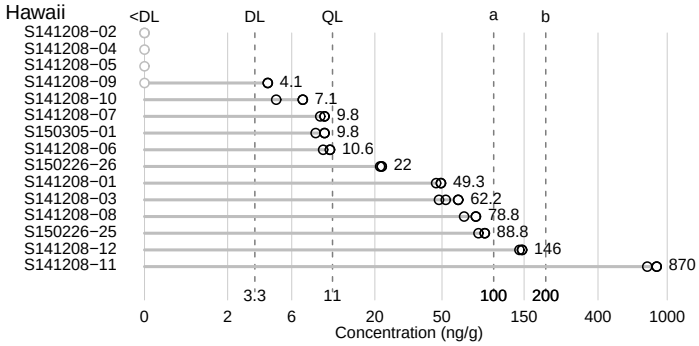

Figure 16: Brodifacoum detections in liver tissue of Hawaiian hawks by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit; a-b = "potentially lethal range" of brodifacoum in liver tissue for barn owls (Newton et al. 1999).

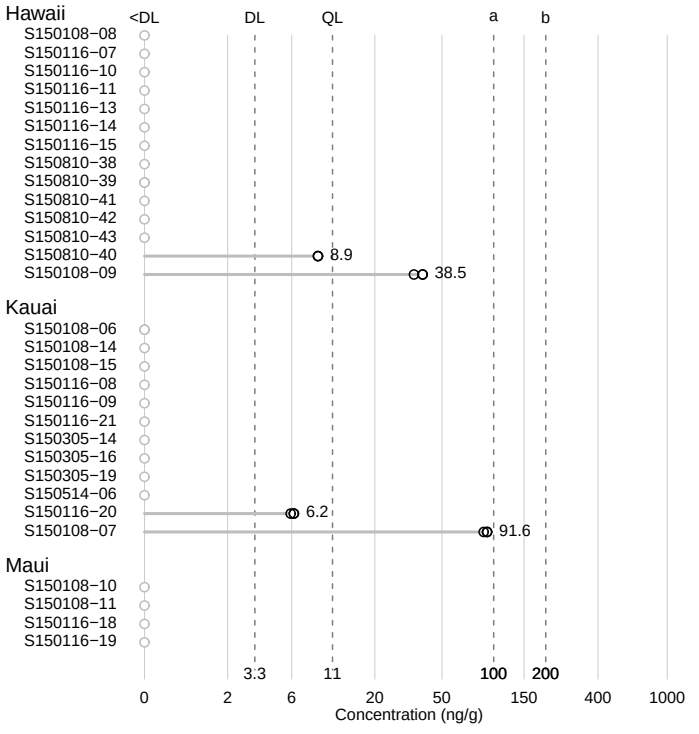

Figure 17: Brodifacoum detections in liver tissue of Hawaiian short-eared owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit; a-b = "potentially lethal range" of brodifacoum in liver tissue for barn owls (Newton et al. 1999).

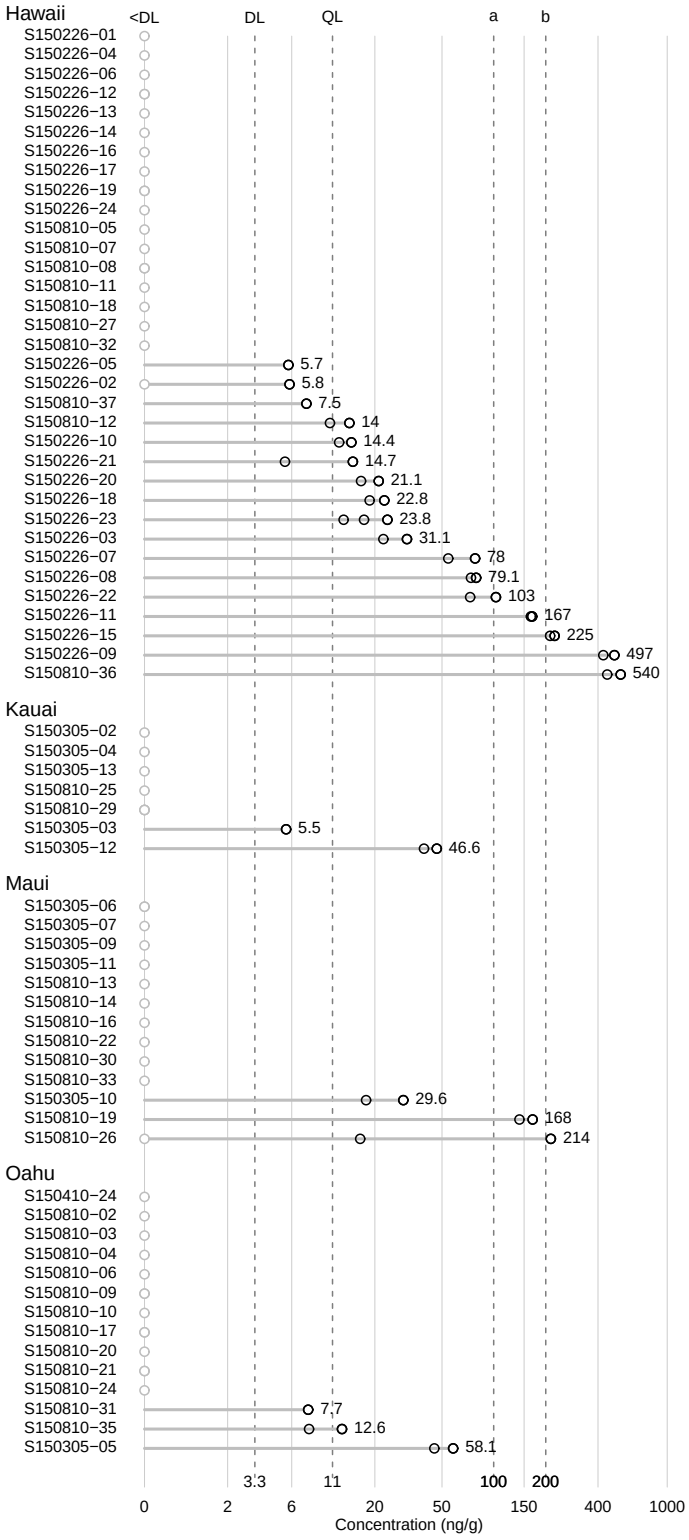

Figure 18: Brodifacoum detections in liver tissue of barn owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit; a-b = "potentially lethal range" of brodifacoum in liver tissue for barn owls (Newton et al. 1999).

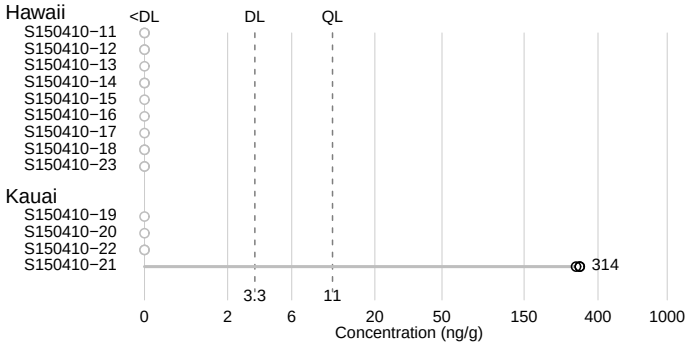

Figure 19: Brodifacoum detections in liver tissue of Hawaiian goose by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit; a-b = "potentially lethal range" of brodifacoum in liver tissue for raptors (Netwon et al. 1999).

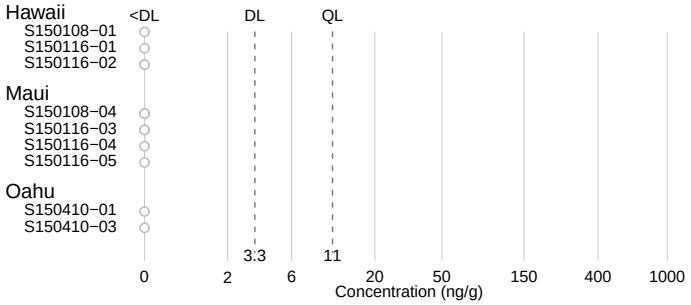

Figure 20: Brodifacoum detections in liver tissue of Hawaiian hoary bats by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit; a-b = "potentially lethal range" of brodifacoum in liver tissue for raptors (Netwon et al. 1999).

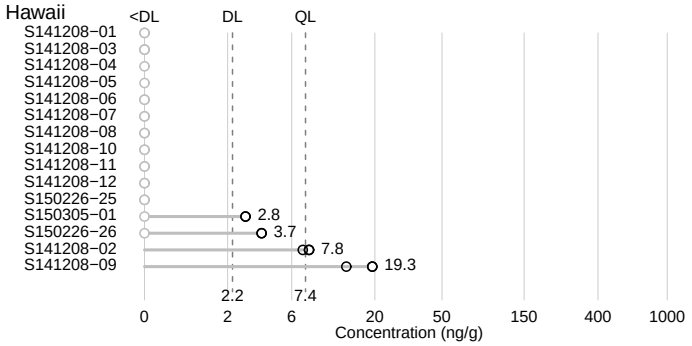

Figure 21: Bromadiolone detections in liver tissue of Hawaiian hawks by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

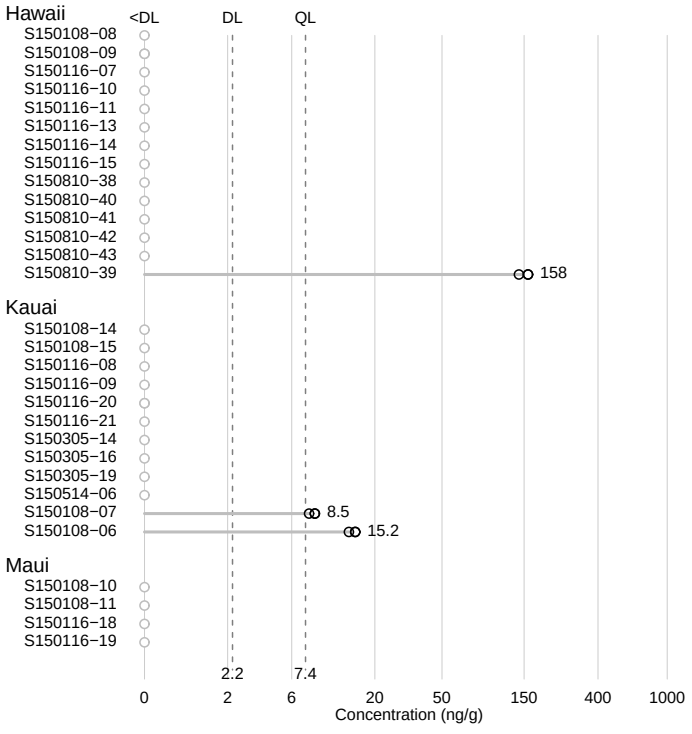

Figure 22: Bromadiolone detections in liver tissue of Hawaiian short-eared owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

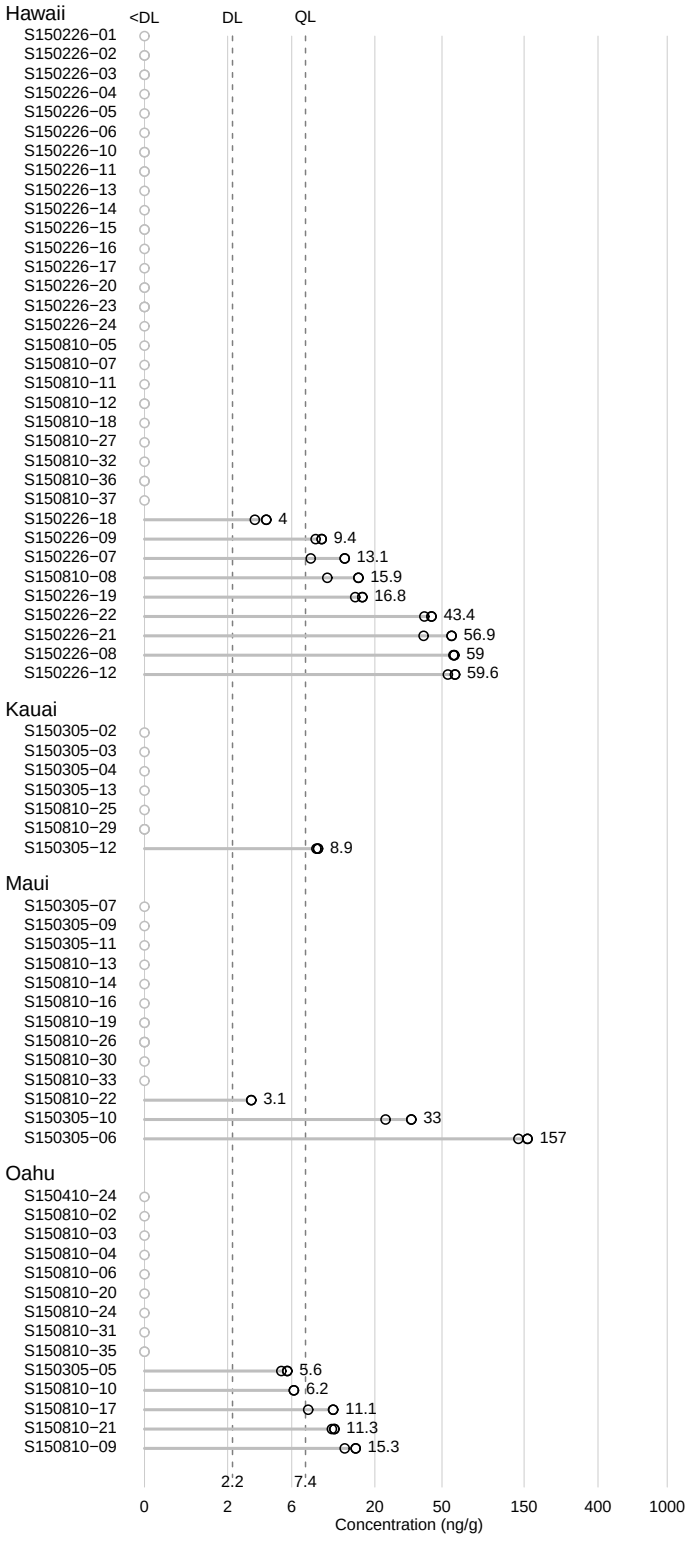

Figure 23: Bromadiolone detections in liver tissue of barn owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

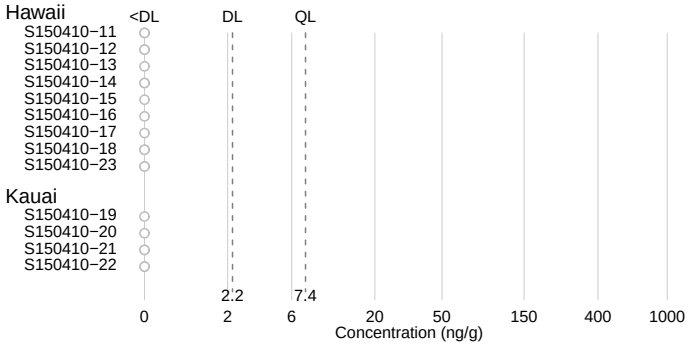

Figure 24: Bromadiolone detections in liver tissue of Hawaiian goose by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

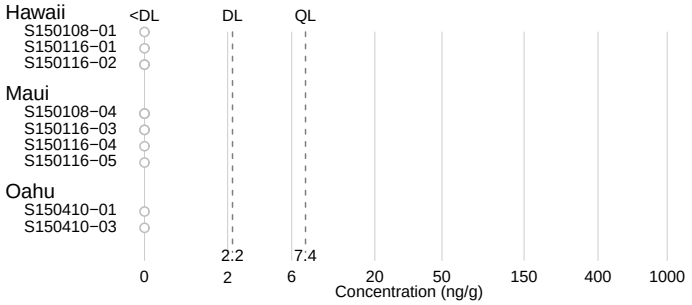

Figure 25: Bromadiolone detections in liver tissue of Hawaiian hoary bats by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

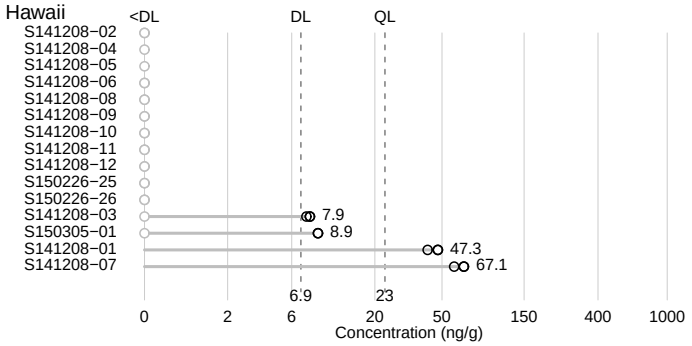

Figure 26: Difethialone detections in liver tissue of Hawaiian hawks by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

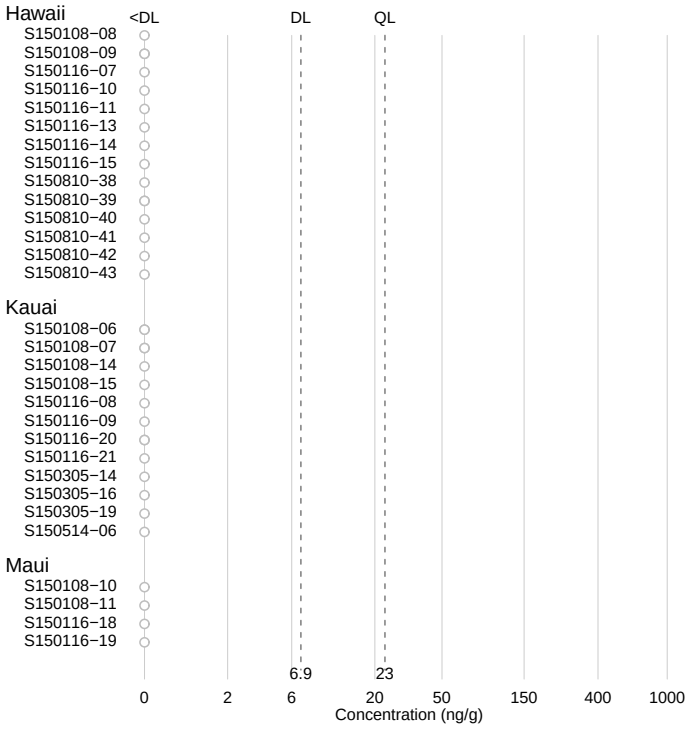

Figure 27: Difethialone detections in liver tissue of Hawaiian short-eared owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

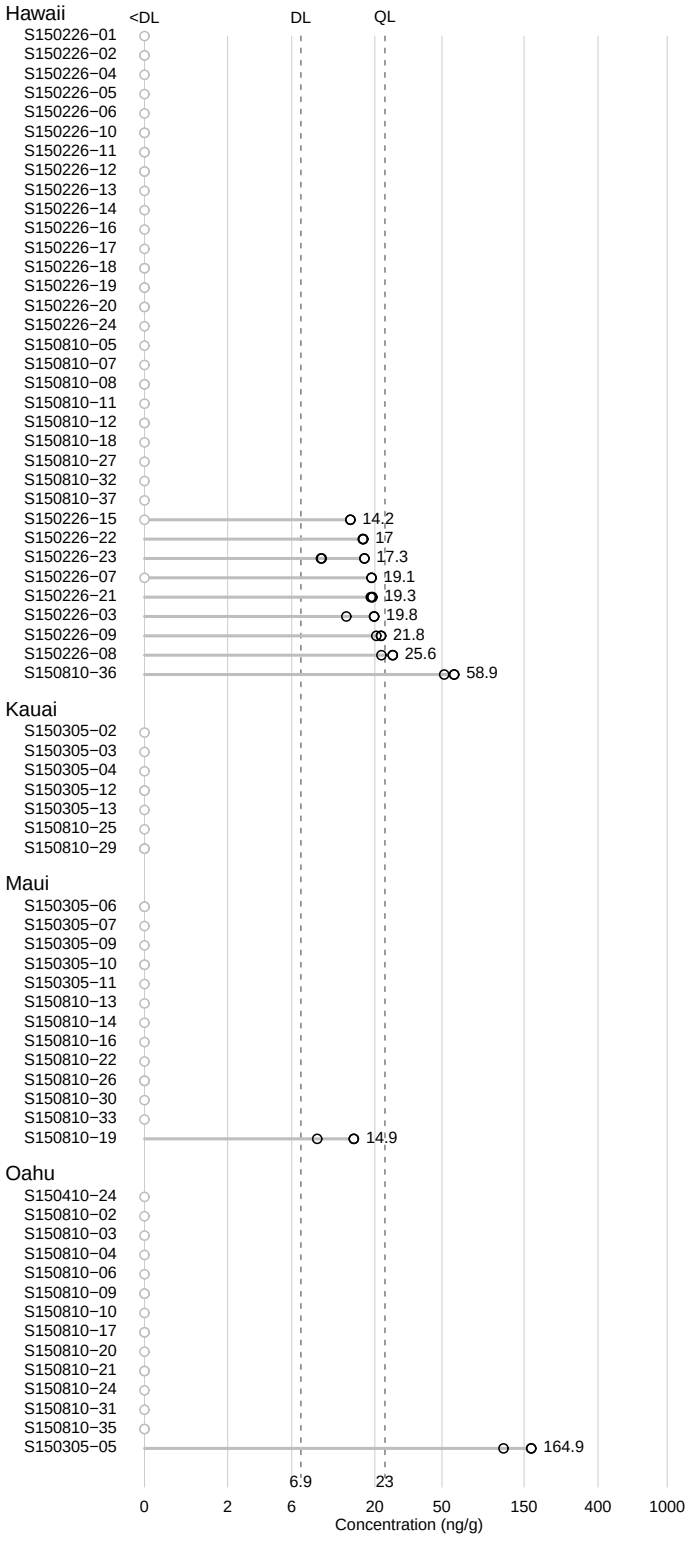

Figure 28: Difethialone detections in liver tissue of barn owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

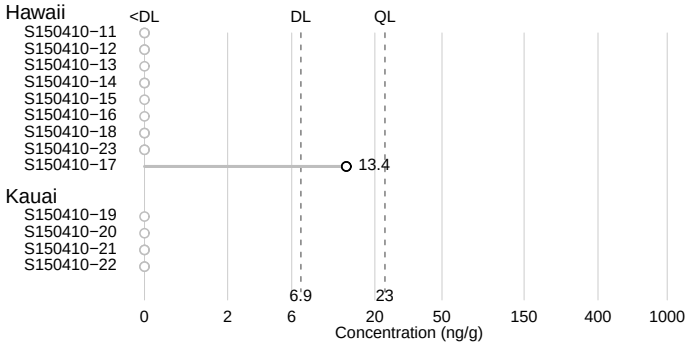

Figure 29: Difethialone detections in liver tissue of Hawaiian goose by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

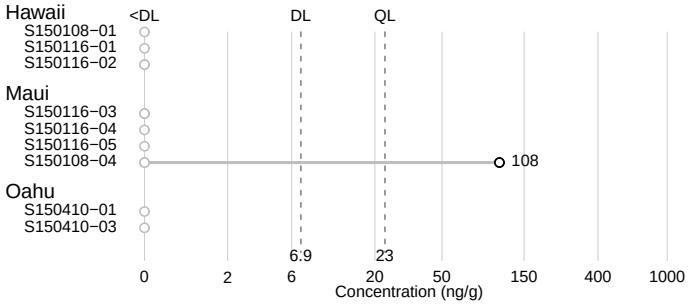

Figure 30: Difethialone detections in liver tissue of Hawaiian hoary bats by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

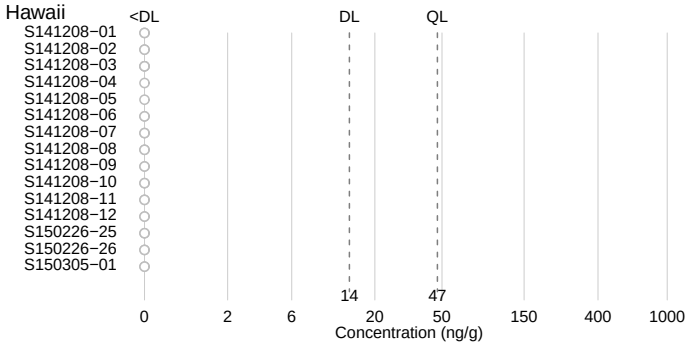

Figure 31: Desmethyl bromethalin detections in liver tissue of Hawaiian hawks by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

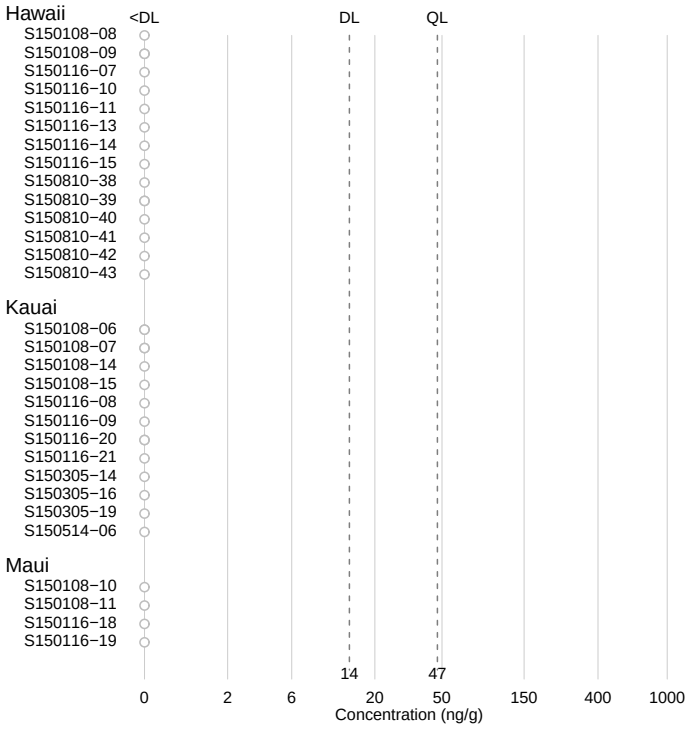

Figure 32: Desmethyl bromethalin detections in liver tissue of Hawaiian short-eared owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

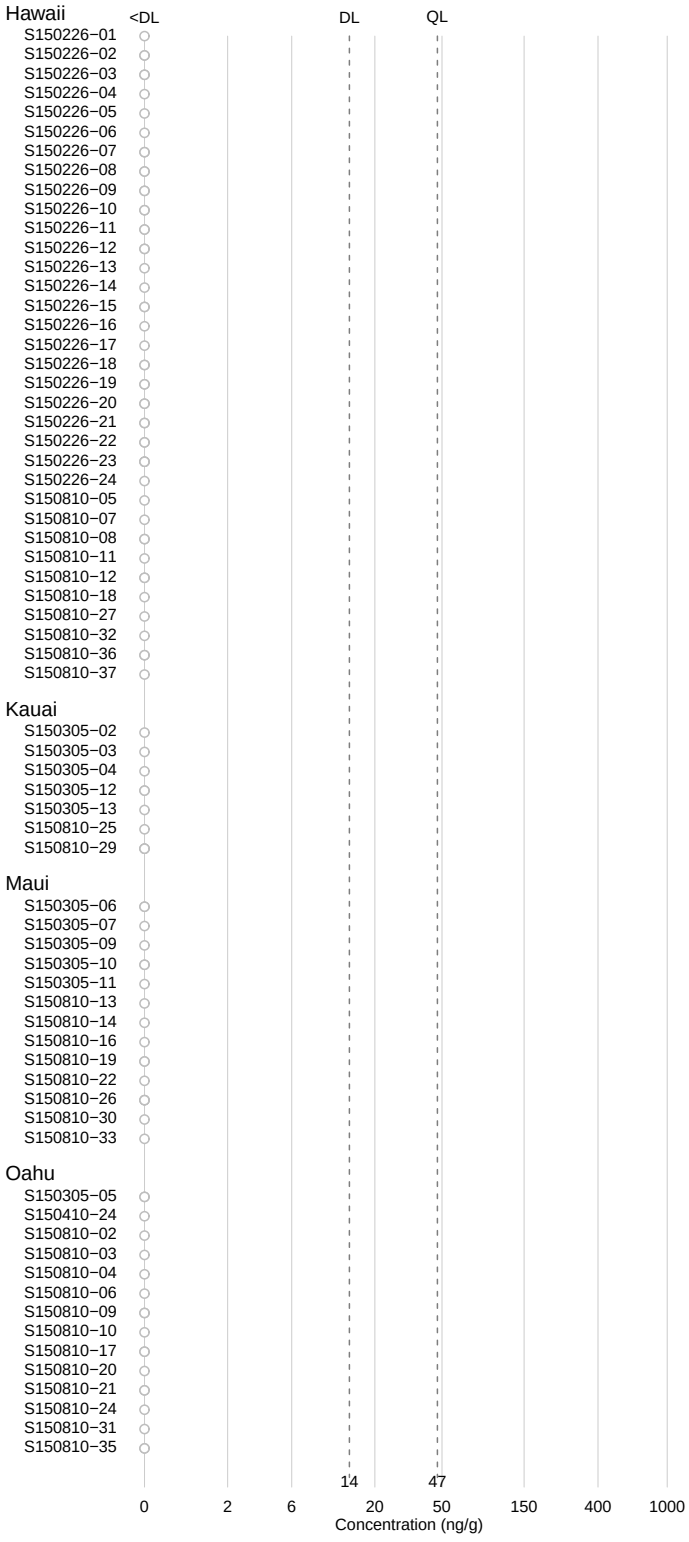

Figure 33: Desmethyl bromethalin detections in liver tissue of barn owls by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

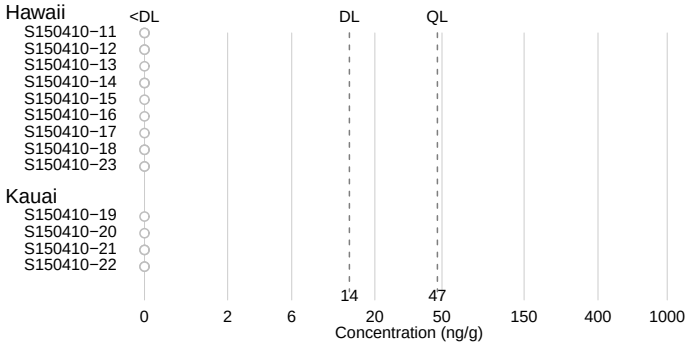

Figure 34: Desmethyl bromethalin detections in liver tissue of Hawaiian goose by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

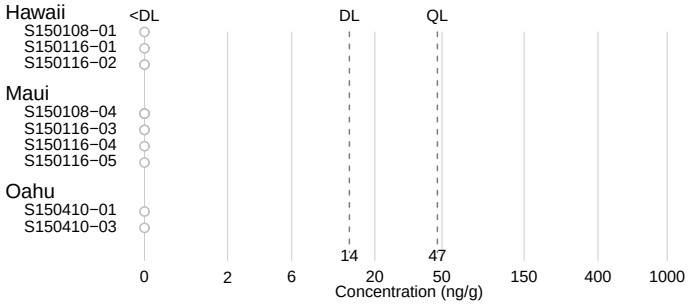

Figure 35: Desmethyl bromethalin detections in liver tissue of Hawaiian hoary bats by island. X-axis on natural log scale. <DL = not detected; DL = detection limit; QL = quantitation limit.

APPENDIX 1:

Analytical method for the determination of seven rodenticides in avian tissues using dispersive solid phase extraction and HPLC-APCI-MS/MS detection

ANALYTICAL METHOD FOR THE DETERMINATION OF SEVEN RODENTICIDES IN AVIAN TISSUES USING DISPERSIVE SOLID PHASE EXTRACTION AND HPLC-APCI-MS/MS DETECTION

I. CHEMICAL DATA

Analyte	CAS	Molecular Wt.	Molecular Formula
Warfarin	81-81-2	308.33	$C_{19}H_{16}O_4$
Diphacinone	82-66-6	340.37	$C_{23}H_{16}O_3$
Chlorophacinone	3691-35-8	374.82	$C_{23}H_{15}ClO_3$
Bromadiolone	28772-56-7	527.41	$C_{30}H_{23}BrO_4$
Brodifacoum	56073-10-0	523.42	$C_{31}H_{23}BrO_3$
Difethialone	104653-34-1	539.48	$C_{31}H_{23}BrO_2S$
Desmethyl bromethalin	57729-86-9	563.90	$C_{13}H_5Br_3F_3N_3O_4$
D_5-warfarin [a]	791013-22-4	313.36	$C_{19}H_{11}D_5O_4$
D_4-diphacione [a]	1219802-15-9	344.40	$C_{23}H_{12}D_4O_3$
D_4-chlorophacinone [a]	1219805-75-0	378.85	$C_{23}H_{11}D_4ClO_3$
D_5-bromadiolone [a]	28772-56-7	532.44	$C_{30}H_{18}D_5BrO_4$
Flocoumafen [a]	90035-08-8	542.54	$C_{33}H_{25}F_3O_4$

[a] Surrogate analyte

II. MATRICES TESTED

This method was developed and validated for the determination of seven rodenticides in quail liver, kidney and carcass tissues.

III. GENERAL METHOD

Homogenized avian liver (0.5g), kidney (0.25g) or carcass (0.5g) is weighed into a disposable 15-mL tube, fortified with five surrogates, and cleaned-up using dispersive solid phase extraction (dSPE). Water and acetonitrile (ACN) are added, and the sample is dispersed by shaking for 30 minutes. NaCl is added in excess to force a water:ACN phase boundary and the sample is again shaken for 30 minutes to extract the analytes into the ACN phase. The sample is centrifuge and an aliquot of the ACN phase is transferred to a dSPE tube containing magnesium sulfate

6/1/15 Developed By Date	Approved By Date
Validated By Date	QA/QC Specialist Date

($MgSO_4$), C18 sorbent, and primary-secondary amine (PSA) sorbent. The extract is exposed to the sorbents and $MgSO_4$ by vortex mixing followed by centrifugation to clarify the supernatant. Hydrophobic and anionic chemical species from the tissue are adsorbed onto the C18 and PSA sorbents, and excess water is removed by the $MgSO_4$. An aliquot of the supernatant is transferred to a microcentrifuge tube and the solvent removed in a 60°C N-Evap with a gentle flow of nitrogen. The analytes are reconstituted in mobile phase and analyzed by high-performance liquid chromatography combined with atmospheric pressure chemical ionization (APCI) and tandem mass spectrometry (HPLC-APCI-MS/MS).

IV. REAGENTS

	Name	CAS #
1.	Sodium chloride	7647-15-5
2.	Acetonitrile (ACN)	75-05-8
3.	Ultrapure water, 18.2MΩ	7732-18-5
4.	Acetic acid, glacial	64-19-7
5.	Ammonium hydroxide, 50%	1336-21-6
6.	Ethyl acetate (EtOAc)	141-78-6

V. SPECIAL EQUIPMENT/SUPPLIES

1. 15-mL disposable conical-bottom polypropylene tubes.
2. 1.5-mL polypropylene microcentrifuge tubes.
3. 2-mL dispersive solid-phase extraction (dSPE) tubes containing 25 mg end-capped C18 (C18EC) sorbent, 25mg primary secondary amine (PSA) sorbent, and 150 mg $MgSO_4$.
4. N-Evap
5. Centrifuge capable of holding 15-mL tubes (17mm outside diameter) and 2150 RCF.
6. Centrifuge capable of holding 1.5-mL microcentrifuge tubes and 16,000 RCF.
7. 10-mL screw-top glass tubes PTFE-lined caps.
8. 5-mL and 10-mL class A volumetric flasks.

VI. SOLUTIONS

200-mM Acetic acid: Transfer 250 mL ultrapure water to a 250-mL glass bottle . Add 2.85 mL glacial acetic acid. Cap and mix thoroughly. Store tightly closed at room temperature for no more than 3 months.

200-mM Ammonium hydroxide: Transfer 485 mL ultrapure water to a 500-mL glass bottle. Add 14.5 mL ammonium hydroxide (50% v/v). Cap and mix thoroughly. Store tightly closed for no more than 3 months.

pH 9.5 200-mM Ammonium acetate: Add approximately 300 mL of 200-mM ammonium hydroxide solution to a 500-mL glass bottle and add 200-mM acetic acid solution to achieve pH 9.5 (~150mL). Store at room temperature for no more than 2 months.

pH 9.5 20-mM Ammonium acetate diluent: Add 180 mL ultrapure water to a 200-mL glass bottle. Add 20 mL pH 9.5 200-mM ammonium acetate solution. Cap and mix thoroughly. Store at room temperature for no more than 2 months.

Mobile Phase A: 10%(ACN)/90%(pH 9.5 20-mM ammonium acetate): Combine 100 mL ACN with 900 mL pH 9.5 20-mM ammonium acetate in a 1-L glass bottle. Cap and mix thoroughly. Store at room temperature for no more than 2 months.

VII. STANDARDS PREPARATION

Surrogate stock solutions in ethyl acetate.: Accurately weigh about 5 mg each of D5-warfarin, D4-diphacinone, D4-chlorophacinone, D5-bromadiolone, and flocoumafen and quantitatively transfer to separate 5-mL Class A volumetric flasks. Record the masses to ±0.001 mg. Dilute each to approximately 4 mL with ethyl acetate, cap and sonicate 2 minutes or until all solids are dissolved, cool to room temperature, and bring to volume with ethyl acetate. Cap and mix thoroughly. Transfer each stock to a 10-mL screw-top glass tube with PTFE-lined cap. The concentration of each will be approximately 1000 µg/mL. Store at room temperature for no more than 6 months.

Combined surrogate stock in ACN: Add the indicated volume of each surrogate stock to a 5-mL Class A volumetric flask. Place the flask in a 60°C N-Evap and remove the ethyl acetate with a gentle flow of nitrogen. Reconstitute with ~4 mL ACN, sonicate 2 minutes, cool to room temperature, and bring to volume with ACN. Cap and mix thoroughly. Transfer to a 10-mL screw-top glass tube with PTFE-lined cap. Store at room temperature for no more than 3 months

Surrogate	Aliquot (mL)	Approximate Concentration in ACN (µg/mL)
D5-warfarin Stock	0.750	150
D4-diphacione Stock	0.750	150
D4-chlorophacinone Stock	1.000	200
D5-bromadiolone Stock	1.000	200
Flocoumafen Stock	0.250	50

Analyte stock solutions in ethyl acetate.: Accurately weigh about 10 mg each of warfarin, diphacinone, chlorophacinone, bromadiolone, brodifacoum, difethialone, and desmethyl bromethalin and quantitatively transfer to separate 10-mL Class A volumetric flasks. Record the masses to ±0.001 mg. Dilute each to approximately 8 mL with ethyl acetate, cap and sonicate 2 minutes or until all solids are dissolved, cool to room temperature, and bring to volume with ethyl acetate. Cap and mix thoroughly. Transfer each stock to a 10-mL screw-top glass tube with PTFE-lined cap. The concentration of each will be approximately 1000 µg/mL. Store at room temperature for no more than 6 months.

High-level combined analyte stock in ACN: "Stock 7": Add the indicated volume of each analyte stock to a 10-mL Class A volumetric flask. Place the flask in a 60°C N-Evap and remove the ethyl acetate with a gentle flow of nitrogen. Reconstitute with ~8 mL ACN, sonicate 2 minutes, cool to room temperature, and bring to volume with ACN. Cap and mix thoroughly. Transfer to a 10-mL screw-top glass tube with PTFE-lined cap. This solution will be "Stock 7" in the following section. Store at room temperature for no more than 3 months.

Analyte	Aliquot (mL)	Approximate Concentration in 10mL ACN (µg/mL)
Warfarin	0.600	60
Diphacinone	1.00	100
Chlorophacinone	0.400	40
Bromadiolone	0.600	60
Brodifacoum	0.700	70
Difethialone	1.700	170
Desmethyl bromethalin	3.500	350

7-Level combined analyte stocks in ACN: Prepare six serially diluted stocks from the high-level combined analyte stock (Stock 7) by combining 2.00 mL of each previous stock with 3.00 mL ACN. The following table presents the approximate concentrations at each of the seven levels. Prepare in 10-mL screw-top glass tubes with PTFE-lined caps. Store at room temperature for no more than 2 months.

Approximate Conc. in ACN (µg/mL)

Level :	7	6	5	4	3	2	1
Warfarin	60	20	6.7	2.2	0.74	0.25	0.082
Diphacinone	100	33	11	3.7	1.2	0.41	0.14
Chlorophacinone	40	13	4.4	1.5	0.49	0.16	0.055
Bromadiolone	60	20	6.7	2.2	0.74	0.25	0.082
Brodifacoum	70	23	7.8	2.6	0.9	0.29	0.096
Difethialone	170	57	19	6.3	2.1	0.70	0.23
Desmethyl bromethalin	350	117	39	13	4.3	1.4	0.48

7-Level combined analyte stocks with surrogates in ACN: For each of the seven levels prepared in the previous section, combine 0.100 mL with 0.100 mL of combined surrogate stock and 1.300 mL ACN in a screw-top 2-mL autosampler vial. The following table present the approximate concentrations at each of the seven levels. Note that concentrations have been converted to ng/mL. Store at room temperature for no more than 1 month.

Approximate Conc. in ACN (ng/mL)

Level :	7	6	5	4	3	2	1
Warfarin	4000	1333	444	148	49.4	16.5	5.49
Diphacinone	6667	2222	741	247	82.3	27.4	9.14
Chlorophacinone	2667	889	296	98.8	32.9	11.0	3.66
Bromadiolone	4000	1333	444	148	49.4	16.5	5.49
Brodifacoum	4667	1556	519	173	57.6	19.2	6.40
Difethialone	11333	3778	1259	420	140	46.6	15.5
Desmethyl bromethalin	23333	7778	2593	864	288	96.0	32.0
D5-warfarin	10000	10000	10000	10000	10000	10000	10000
D4-diphacione	10000	10000	10000	10000	10000	10000	10000
D4-chlorophacinone	13333	13333	13333	13333	13333	13333	13333
D5-bromadiolone	13333	13333	13333	13333	13333	13333	13333
Flocoumafen	3333	3333	3333	3333	3333	3333	3333

7-Level Standard Curve: For each of the seven levels prepared in the previous section, combine 0.300 mL with 1.200 mL pH 9.5 20-mM ammonium acetate buffer in an autosampler vial. This will result in a diluent composition of 20%ACN/80% buffer. The following table present the approximate concentration at each of the seven levels. Standards may be stored at room temperature for no more than 1 month.

Approximate Conc. in 20% ACN/80% Buffer (ng/mL)

Level :	7	6	5	4	3	2	1
Warfarin	800	267	88.9	29.6	9.88	3.29	1.10
Diphacinone	1333	444	148	49.4	16.5	5.49	1.83
Chlorophacinone	533	178	59.3	19.8	6.58	2.19	0.732
Bromadiolone	800	267	88.9	29.6	9.88	3.29	1.10
Brodifacoum	933	311	104	34.6	11.5	3.84	1.28
Difethialone	2267	756	252	84.0	28.0	9.33	3.11
Desmethyl bromethalin	4667	1556	519	173	57.6	19.2	6.40
D5-warfarin	2000	2000	2000	2000	2000	2000	2000
D4-diphacione	2000	2000	2000	2000	2000	2000	2000
D4-chlorophacinone	2667	2667	2667	2667	2667	2667	2667
D5-bromadiolone	2667	2667	2667	2667	2667	2667	2667
Flocoumafen	667	667	667	667	667	667	667

VIII. SAMPLE PREPARATION

Dissection and homogenization of avian tissues: Remove the wings and claws from avian whole body carcasses. Remove the skin and all feathers. Remove the liver and kidneys. Homogenize separately the liver, kidneys, and remaining carcass using a SPEX CertiPrep 6850 Freezer Mill liquid nitrogen automated homogenizer. Small samples (<5g) may be homogenized using liquid nitrogen and a mortar and pestle.

Sample Extraction:

1. Accurately weigh 0.19-0.21g homogenized liver, carcass or kidney into a 15-mL polypropylene tube. Record the mass to ±0.0001g. If necessary, centrifuge samples briefly at low RPM to collect tissues at the bottom of the tube.
2. Add 0.020 mL combined surrogate stock in ACN and 0.040 mL ultrapure water. Vortex mix for 8-10 seconds to disperse the sample.
3. Add 3.0 mL ACN and shake on a horizontal shaker for 30 minutes.
4. Add 240-260mg NaCl and shake on a horizontal shaker for 30 minuts.
5. Centrifuge for 2 minutes at 3800 RPM (2150 RCF) to clarify the sample.
6. Transfer 1.5 mL of supernatant (ACN phase) to a 2-mL dSPE tube . Cap and vortex mix for 2-3 seconds.
7. Centrifuge the dSPE tube at 4000 RPM (1300 RCF) to clarify the sample.
8. Transfer 1.0 mL of supernatant to a 1.5-mL capacity microcentrifuge tube and evaporate to dryness in a 60°C N-Evap with a gentle flow of nitrogen (~30 minutes).

9. Add 0.100 mL ACN, cap securely and vortex mix for 2-3 seconds. Before opening the tube, centrifuge for 2-3 seconds to collect the sample in the bottom of the tube.
10. Add 0.400 mL pH 9.5 20-mM ammonium acetate buffer, cap securely and vortex mix for 2-3 seconds. Centrifuge the sample for 1 minute at 14,000 RPM (16,000 RCF) to clarify the sample. Note that it is normal for carcass samples to remain slightly cloudy.
11. Transfer 0.400 mL of supernatant to an autosampler vial fitted with a 500-µL capacity insert. Cap securely and analyze by HPLC-APCI-MS/MS.

IX. ANALYSIS PROCEDURE

Repeatedly inject 10 µL of Standard 7 to determine suitability for analysis. Inject 10 µL of each standard and sample and record the calculated concentration of each analyte.

X. SYSTEM SUITABILITY

System suitability is demonstrated when the relative standard deviation of the peak area response for each of the seven analytes is $\leq 2.0\%$ for five consecutive injections of Standard 7.

XI. TYPICAL HPLC-APCI-MS/MS CONDITIONS

Configure the HPLC-APCI-MS/MS with the following method conditions. Time segments require minor adjustment from batch-to-batch variability in mobile phase and columns, but all other parameters typically do not require adjustment. Refer to Figure 1 for example integration and time-segment spacing.

HPLC	**Agilent 1200 Series Liquid Chromatograph**
Column	Xbridge C18, 2.5µm, 2.1 X 50mm, Waters P/N 186003085
Column Temp	60°C
Mobile Phase A	10%(ACN)/90%(pH 9.5 20-mM ammonium acetate)
Mobile Phase B	ACN
Flow Rate	0.800 mL/min *
Injection Volume	10µL
Run Time	7.25 min

Time (min)	% A	% B
0.00	100%	0%
0.50	100%	0%
5.00	35%	65%
5.01	0%	100%
6.00	0%	100%
6.01	100%	0%
7.25	100%	0%

* Heat column to 60°C prior to initiating flow to prevent column overpressure (400 bar)

Detector	**Agilent 6410A-2K Triple Quadrupole Mass Spectrometer (QQQ)**		
Ion Source	APCI	Capillary	±4500 V
Gas Temp	350°C	Cell Accelerator	7 V
Vaporizer	400°C	Corona Current	10 µA Neg; 4µA Pos
Gas Flow	4 L/min	MS1/MS2 Heater	100°C
Nebulizer	20 psi		

Time Segment *	Start Time (min)	End Time (min)	Scan Type	Diverter Valve	Delta EMV +	Delta EMV -	Polarity	Data Stored
1	0.00	0.50	MS2 Scan	to waste	0	0	Neg	No
2	0.50	1.00	MRM	to MS	0	100	Neg	No
3	1.00	2.30	MRM	to MS	0	100	Neg	Yes
4	2.30	2.90	MRM	to MS	0	100	Neg	Yes
5	2.90	3.28	MRM	to MS	0	100	Neg	Yes
6	3.28	3.72	MRM	to MS	0	100	Neg	Yes
7	3.72	4.30	MRM	to MS	0	100	Neg	Yes
8	4.30	5.00	MRM	to MS	0	100	Neg	Yes
9	5.00	7.25	MS2 Scan	to waste	0	0	Pos	No

* Time segment 1 prevents unretained species from contaminating the source. Segment 2 helps stabilize the source under flow conditions prior to data collection. Segment 9 is operated in reverse polarity to mitigate ion suppression of the APCI source.

MRM Transitions:

Analyte	Precursor Ion (m/z)	Product Ion (m/z) *	Frag (V)	CE (V)	Dwell (ms)	Time Seg	~t_R (min)
D5-warfarin	312.0	**160.9**	92	15	40	3	1.30
Warfarin	307.1	**161.0**	100	11	40	3	1.33
		250.1		18	40	3	
D4-diphacinone	343.1	**167.1**	120	23	35	4	2.62
Diphacinone	339.1	**167.1**	100	23	35	4	2.63
		145.0		18	35	4	
D4-chlorophacinone	377.0	**201.1**	110	26	35	5	3.01
Chlorophacinone	373.1	**201.1**	110	23	35	5	3.02
		145.1		20	35	5	
D5-bromadiolone A	529.9	**254.9**	212	40	20	6	3.41
D5-bromadiolone B	529.9	**254.9**	212	40	20	6	3.53
Bromadiolone A	524.9	**250.0**	168	37	20	6	3.42
		181.0		27	20	6	
Bromadiolone B	524.9	**250.0**	168	37	20	6	3.54
		181.0		27	20	6	
Brodifacoum	522.9	**80.9**	165	50	20	7	3.86
		135.0		44	20	7	
Flocoumafen	541.0	**382.1**	157	23	20	7	3.89
Difethialone	536.9	**151.0**	180	37	20	7	4.04
		371.1		42	20	7	
Desmethyl bromethalin	561.6	**277.8**	140	35	50	8	4.52
		452.9		30	50	8	

* Quantifier transitions are **bolded.**

XII. DATA ANALYSIS AND CALCULATIONS

Configure the data analysis software to calculate the analyte concentration for each of the seven analytes from the peak area ratios as described in the table below. Note that bromadiolone exists as diastereomers and that the two surrogate peaks are paired with the corresponding analyte peaks.

Analyte	Surrogate
Warfarin	D5-warfarin
Diphacinone	D4-diphacione
Chlorophacinone	D4-chlorophacinone
Bromadiolone A	D5-bromadiolone A
Bromadiolone B	D5-bromadiolone B
Brodifacoum	Flocoumafen
Difethialone	Flocoumafen
Desmethyl bromethalin	Flocoumafen

Example Calculation:

A quail liver sample weighing 0.5014g produced a diphacinone peak area response of 228 units for the 339.1 → 167.1 transition and a D4-diphacinone peak are a response of 106160 units for the 343.1 → 167.1 transition. The analytical concentration of D4-diphacinone was 1919 ng/mL. Diphacinone concentration in the sample was determined by the Agilent Masshunter ™ software from the response ratios and concentration ratios determined for the standard curve. A second-order quadratic equation was used ignoring the origin and weighted $1/x^2$.

$$\text{Response Ratio} = a\left(\frac{\text{Concentration}_{\text{Diph}}}{\text{Concentration}_{\text{D4-Diph}}}\right)^2 + b\left(\frac{\text{Concentration}_{\text{Diph}}}{\text{Concenctration}_{\text{D4-Diph}}}\right) + c$$

The calibration curve determined by the software for the 7-point diphacinone curve was:

$$y = 0.054099x^2 + 0.943450x + 0.0001299180$$

The response ratio for the sample was calculated as follows:

$$\text{Response Ration} = \left(\frac{\text{Response}_{\text{Diph}}}{\text{Response}_{\text{D4-Diph}}}\right) = \left(\frac{228\ \text{cts} * \text{s}}{106160\ \text{cts} * \text{s}}\right) = 0.002148$$

The concentration ratio (x) was determined from the quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4a(c - \text{Response Ratio})}}{2a}$$

$$x = \frac{-0.943450 \pm \sqrt{0.943450^2 - (4)(0.054099)(0.0001299180 - 0.002148)}}{(2)(0.054099)}$$

$$x = 0.002139 = \left(\frac{\text{Concentration}_{\text{Diph}}}{\text{Concentration}_{\text{D4-Diph}}}\right) = \left(\frac{\text{Concentration}_{\text{Diph}}}{1919\ \text{ng/mL}_{\text{D4-Diph}}}\right)$$

$$\text{Concentration}_{\text{Diph}} = (0.002139)(1919\ \text{ng/mL}) = 4.10\ \text{ng/mL Diph}$$

The analytical diphacinone concentration in units of ng/mL was then converted to ng/g by multiplying the final volume of the extract and dividing by the sample weight:

$$\text{Diph Conc.}_{\text{ng/g}} = \left(\frac{(\text{Conc.Diph}_{\text{ng/mL}})(\text{Dilution Vol.}_{\text{mL}})}{\text{Sample Wt.}_{\text{g}}}\right) = \left(\frac{(4.10\ \text{ng/mL})(0.500\ \text{mL})(7.5\text{mL})}{0.5014\ \text{g}}\right) = 30.7\ \text{ng/g Diph}$$

The quail liver used in this example therefore contains 30.7 ng/g diphacinone. The other six analytes are quantified in the same manner from their respective standard curves, if a second-order quadratic equation is also used. However, the Masshunter ™ software allows for other curve fitting equations (linear, power,) and weightings (1/x, 1/y, 1/y2, etc.). Various curve fitting equations should be evaluated for each analyte and chosen based on the highest accuracy over standard curve concentration range.

XIII. METHOD VALIDATION

QC Working Standard: Prepare the analyte solutions as described under the "Analyte stock solutions in ethyl acetate" and "High-level combined analyte stock in ACN" sections according to the method. QC acceptance will be evaluated for each of the seven analytes.

7-Rodenticide Spiking Solutions: Prepare the seven stock solutions as described in the "7-Level combined analyte stocks in ACN" section.

Fortification of quail liver, carcass and kidney: Accurately weigh 0.49-0.51g homogenized liver, 0.49-0.51g homogenized carcass, or 0.24-0.26g homogenized kidney into a 15-mL polypropylene tube. The table below indicates the volumes of each 7-rodendicide spiking solution to be added.

Rodenticide Fortification Level	7-Rodenticide Stock in ACN 2	4	6
Control	-	-	-
Low	0.040 mL	-	-
Mid	-	0.050 mL	
High	-	-	0.075 mL

Response Linearity:

A 7-point standard curve was injected at the beginning and end of each analysis over two days. The Masshunter ™ curve-fit assistant was used to choose the best cure fitting equation (type, origin, and weight).

Analyte	Surrogate	Levels	n	Type	Origin	Weight
Warfarin	D5-warfarin	7	14	Quadratic	Ignore	$1/x^2$
Diphacinone	D4-diphacione	7	14	Quadratic	Ignore	$1/x^2$
Chlorophacinone	D4-chlorophacinone	7	14	Linear	Ignore	$1/x^2$
Bromadiolone A	D5-bromadiolone A	7	14	Linear	Ignore	$1/y^2$
Bromadiolone B	D5-bromadiolone B	7	14	Quadratic	Ignore	$1/y^2$
Brodifacoum	Flocoumafen	7	14	Quadratic	Include	$1/x^2$
Difethialone	Flocoumafen	7	14	2nd Order ln	Ignore	$1/y^2$
Desmethyl bromethalin	Flocoumafen	7	14	Linear	Ignore	$1/y^2$

		Day 1		Day 2	
Analyte	Range (ng/mL)	Accuracy (%)	R^2	Accuracy (%)	R^2
Warfarin	1.06 - 773	97.0 - 102	0.9996	87.7 - 102	0.9955
Diphacinone	1.72 - 1256	94.9 - 104	0.9991	87.3 - 104	0.9962
Chlorophacinone	0.741 - 540	89.8 - 108	0.9968	90.2 - 108	0.9973
Bromadiolone A	0.723 - 527	95.0 - 111	0.9970	92.0 - 111	0.9963
Bromadiolone B	0.269 - 196	86.2 - 113	0.9902	89.1 - 113	0.9940
Brodifacoum	1.20 - 873	95.4 - 110	0.9980	90.4 - 110	0.9956
Difethialone	3.10 - 2263	95.8 - 103	0.9990	69.4 - 103	0.9623
Desmethyl bromethalin	6.49 - 4732	92.8 - 111	0.9961	89.2 - 111	0.9894

Matrix Interference:

Four control samples each of quail liver, carcass, and kidney were prepared according to the method. No quantifiable level of any of the seven rodenticides was observed.

Detection and Quantitation Limits:

The detection limit (DL) is defined as the concentration of analyte needed to generate a response equal to or greater than three times baseline noise. The peak-to-peak noise for each extracted control tissue was determined for each analyte within their respective time segments. The average peak height ratio for each analyte divided by the peak height of its corresponding surrogate was determined for each tissue fortified with seven rodenticides at both the low and mid fortification levels. The detection limits determined for each of the two sequences was then averaged to calculate the DL. By definition, the quantitation limit (QL) is 10*DL/3. Results for each of the three quail tissues are presented below, in terms of the analytical concentration (ng/mL) and the sample concentration (ng/g).

Analytical Detection and Quantitation Limits in Quail Tissues:

	DL (ng/mL)			QL (ng/mL)		
Analyte	Liver	Carcass	Kidney	Liver	Carcass	Kidney
Warfarin	0.64	1.3	1.2	2.1	4.2	3.9
Diphacinone	1.0	0.96	1.1	3.4	3.2	3.6
Chlorophacinone	0.64	0.58	0.64	2.1	1.9	2.1
Bromadiolone A	0.35	0.82	0.36	1.2	2.7	1.2
Bromadiolone B	0.24	0.46	0.26	0.80	1.5	0.86
Brodifacoum	0.44	0.44	0.54	1.5	1.5	1.8
Difethialone	0.92	0.92	0.90	3.1	3.1	3.0
Desmethyl bromethalin	1.9	5.0	1.2	6.3	17	4.0

Sample Detection and Quantitation Limits in Quail Tissues:

	DL (ng/g)			QL (ng/g)		
Analyte	Liver	Carcass	Kidney	Liver	Carcass	Kidney
Warfarin	4.8	9.4	8.6	16	31	29
Diphacinone	7.5	7.2	7.9	25	24	26
Chlorophacinone	4.8	4.3	4.7	16	14	16
Bromadiolone A	2.6	6.2	2.7	8.8	21	8.9
Bromadiolone B	1.8	3.5	1.9	6.0	12	6.3
Brodifacoum	3.3	3.3	4.0	11	11	13
Difethialone	6.9	6.9	6.7	23	23	22
Desmethyl bromethalin	14	37	8.8	47	120	29

Bias and Repeatability:

The following three tables present the accuracy and precision of the method for the seven rodenticides in quail liver, carcass, and kidney tissues.

Rodenticide Recoveries for Quail Liver (0.50g)

Analyte	n	Fortification Range (ng/g)	Accuracy Range (%)	Mean (%)	Std Dev (%)	CV (%)
Warfarin	18	18.9 – 2870	91.6 – 114	103	5.4	5.2
Diphacinone	18	30.8 – 4660	89.5 – 107	99.5	4.6	4.6
Chlorophacinone	18	13.2 – 2010	86.9 – 102	96.3	5.0	5.2
Bromadiolone A	18	12.9 – 1960	92.2 – 118	98.7	6.7	6.7
Bromadiolone B	18	4.80 – 730	88.6 – 123	98.9	7.7	7.8
Brodifacoum	18	21.4 – 3240	70.7 – 102	87.0	6.3	7.2
Difethialone	18	55.4 – 8400	78.8 – 108	94.4	7.4	7.9
Desmethyl bromethalin	18	116 – 17570	116 – 149	131	10	7.8

Rodenticide Recoveries for Quail Carcass (0.50g)

Analyte	n	Fortification Range (ng/g)	Accuracy Range (%)	Mean (%)	Std Dev (%)	CV (%)
Warfarin	18	18.2 – 2910	95.1 – 114	103	4.9	4.7
Diphacinone	18	29.6 – 4730	95.3 – 109	99.3	3.1	3.1
Chlorophacinone	18	12.8 – 2040	89.6 – 109	98.7	5.1	5.2
Bromadiolone A	18	12.4 – 1990	90.1 – 115	100	6.9	6.9
Bromadiolone B	18	4.62 – 738	81.3 – 116	103	8.0	7.8
Brodifacoum	18	20.6 – 3290	81.6 – 106	91.7	6.6	7.2
Difethialone	18	53.4 – 8520	81.1 – 117	96.2	8.9	9.2
Desmethyl bromethalin	18	112 – 17830	103 – 158	132	14	10

Rodenticide Recoveries for Quail Kidney (0.25g)

Analyte	n	Fortification Range (ng/g)	Accuracy Range (%)	Mean (%)	Std Dev (%)	CV (%)
Warfarin	12	36.6 – 5730	95.7 – 120	104	7.7	7.4
Diphacinone	12	59.4 – 9310	90.9 – 105	101	4.3	4.3
Chlorophacinone	12	25.6 – 4010	91.2 – 109	98.7	5.6	5.7
Bromadiolone A	12	24.9 – 3910	74.1 – 106	95.3	8.0	8.4
Bromadiolone B	12	9.27 – 1450	49.4 – 141	92.5	22	24
Brodifacoum	12	41.3 – 6470	72.6 – 88.7	82.2	4.9	6.0
Difethialone	12	107 – 16780	85.4 – 121	93.5	10	11
Desmethyl bromethalin	12	224 – 35080	149 – 211	177	19	11

XIV. STANDARD OPERATING PROCEDURES (SOPs)

The following SOPs were applicable at the time of method validation:

XV. REFERENCES

Analytical Chemistry Section Notebook: RD-149, pp. 45-80
Invoice: 15-004

XVI. CHROMATOGRAMS

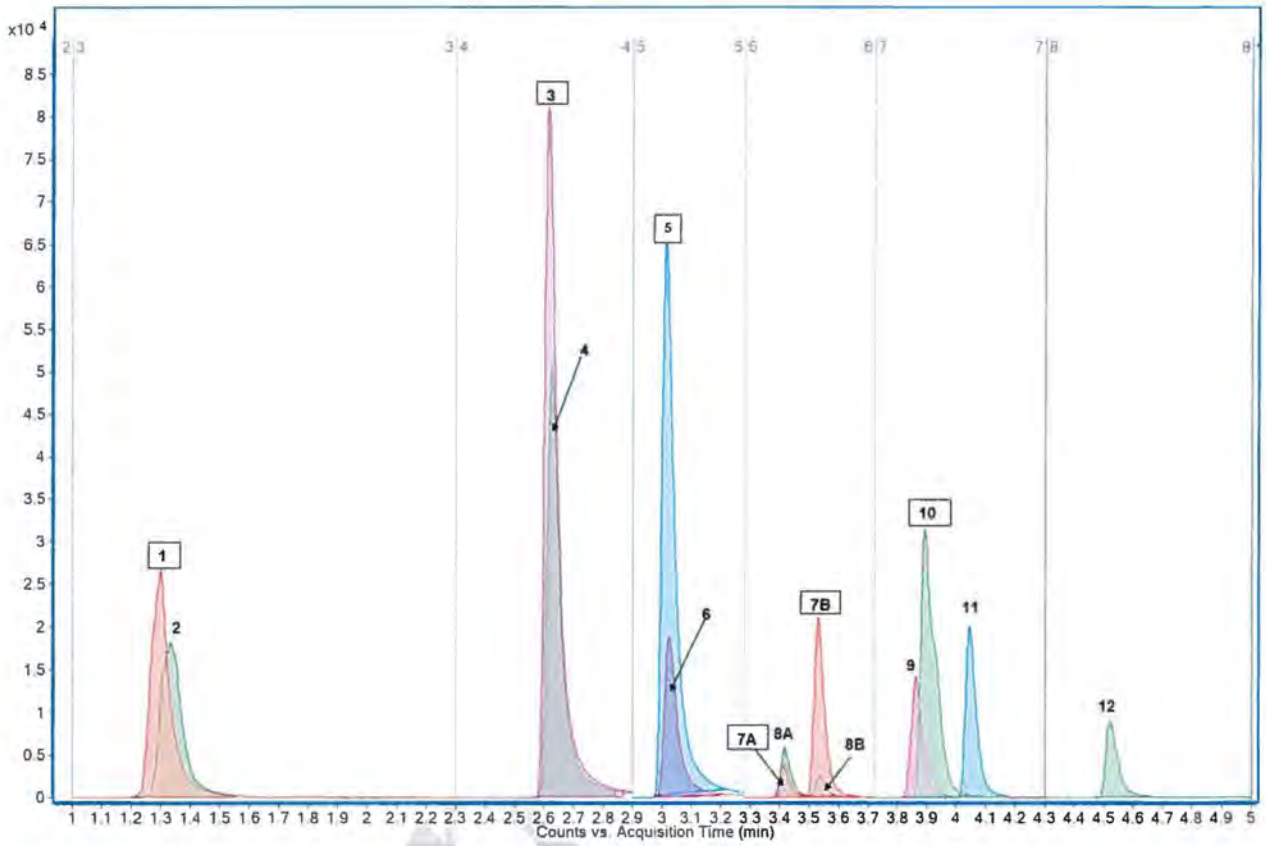

Figure 1. Standard 6: (1) D5-warfarin, (2) Warfarin, (3) D4-diphacinone, (4) Diphacinone, (5) D4-chlorophacinone, (6) Chlorophacinone, (7A&7B) D5-bromadiolone, (8A&8B) Bromadiolone, (9) Brodifacoum, (10) Flocoumafen, (11) Difethialone, (12) Desmethyl bromethalin. Surrogate analytes are identified by boxed labels.

APPENDIX 2:

Analytical Services Report #15-004/4: Multiple Rodenticides in Hawaiian Avian and Bat Tissues using Dispersive Solid Phase Extraction and HPLC-APCI-MS/MS Detection (QA-2240)

Wildlife Services NWRC National Wildlife Research Center Analytical Services Report	United States Department of Agriculture Animal Plant Health Inspection Service Wildlife Services National Wildlife Research Center Analytical Chemistry Project	Invoice #: 15-004/4 Date: February 8, 2016 Page: 1 of 32

To: Robert Sugihara
Wildlife Biologist
Hawaii Field Station

Subject: Multiple Rodenticides in Hawaiian Avian and Bat Tissues Using Dispersive Solid Phase Extraction and HPLC-APCI-MS/MS Detection (QA-2240)

Method: Method QA2240M.03, Non-GLP

Analysis Dates: 3/12/15, 3/20/15, 4/8/15, 4/24/15, 5/14/15, 8/11/15, 8/25/15, 9/10/15, 9/16/15, 9/18/15, 10/23/15, 10/28/15, 10/29/15, 1/4/16, 1/7/16, and 1/14/16

Notebook Reference: RD-149, pp. 78-129, 131-132, 153-160

QC Notebook Reference: QC-32, pp. 149 and 192

Analyst: Steve Volker

Sample Description:

Thirty-nine barn owls, 15 Hawaiian hawks, 21 Hawaiian hoary bats, 13 nene and 35 pueo obtained from Hawaii (Big Island), Kauai, Maui and Oahu were received by NWRC in seven shipments between 12/8/2014 and 5/14/2015. An additional 37 barn owls and 6 pueo were received on 8/10/2015. All samples were received frozen and stored at -20°C. A method was developed for quantifying the following rodenticides in liver, carcass, and kidneys: warfarin, diphacinone, chlorophacinone, bromadiolone, brodifacoum, difethialone and desmethyl bromethalin. A priority list was received 4/8/2015 ranking the samples from highest priority (1) to lowest (7). This final report presents results for all 166 samples. Results from the three preliminary reports should be discarded as a more scientifically robust approach was used to evaluate the detection limit of the method. The new approach significantly reduces the reporting of false postitives below the quantitation limit.

Each carcass was thawed and the skin (including feathers or fur), claws, talons and wings were removed. A portion of pectoral muscle and 3-4 large feathers (or a piece of skin and fur) were removed and returned to -20°C storage for additional testing by a separate laboratory. The liver and kidneys were removed, except for carcasses that were too decayed or when the organs were too small for a sufficient sample size. Each sample was homogenized using a Spex Certi-Prep liquid nitrogen freezer mill. Control tissues from quail (ID S130606-01) were used for the non-GLP method validation and to prepare quality control samples until November, 2015. Control tissues from nene (ID S150410-16) were used for the remaining analyses in January 2016.

Method Information:

Homogenized liver, carcass or kidney (0.2g) is weighed into a disposable 15-mL tube and fortified with five surrogate rodenticides. Water and acetonitrile (ACN) are added, and the sample is extracted by shaking for 30 minutes. NaCl is added in excess to force a water:ACN phase boundary and the sample is again shaken for 30 minutes to extract the analytes into the ACN phase. The sample is centrifuged and an aliquot of the ACN phase is transferred to a dispersive solid-phase extraction (dSPE) tube containing magnesium sulfate ($MgSO_4$), C18 sorbent, and primary-secondary amine (PSA) sorbent. The extract is exposed to the sorbents and $MgSO_4$ by vortex mixing followed by centrifugation to clarify the supernatant. Hydrophobic and anionic chemical species from the tissue are adsorbed onto the C18 and PSA sorbents, and excess water is removed by $MgSO_4$. An aliquot of the supernatant is transferred to a microcentrifuge tube and the solvent removed in a 60°C N-Evap with a gentle flow of nitrogen. The analytes are reconstituted in mobile phase and analyzed by high-performance liquid chromatography (HPLC) combined with atmospheric pressure chemical

Analyst	Date	QC Specialist	Date	Reviewer	Date
	2/8/16		2/8/16		2/8/16

ionization (APCI) and tandem mass spectrometry (HPLC-APCI-MS/MS). Control quail liver, carcass and kidneys were used to demonstrate the performance of the method in a non-GLP validation on 2/27/15 (Non-GLP Method QA2240M.03, "Analytical Method for the Determination of Seven Rodenticides in Avian Tissues Using Dispersive Solid Phase Extraction and HPLC-APCI-MS/MS Detection"). Refer to QA2240M.03 for detailed procedures and a summary of method performance. The two diastereomers of bromadiolone elute as separate peaks and were quantified separately. Bromadiolone results presented in this report are a sum of the diastereomers. Attempts to quantify bromethalin were unsuccessful. The method quantifies the metabolite desmethyl bromethalin [1].

Results:

Results are presented for liver, carcass, and kidney for each sample. The liver and/or kidneys were not removed from carcasses that were too decayed or when the organs were too small for a sufficient sample size. A gray box in the results tables indicates that the tissue was not available and was not tested.

If no analyte response was recorded by the data acquisition software or if the observed concentration was less than the Detection Limit determined during method validation, an entry of "ND" is reported to indicate that the analyte was not detected. The previous three preliminary reports used detection limits based on the 95% confidence interval derived from the baseline noise observed in control tissues. As sample testing progressed throughout 2015 it became apparent that the use of the 95% confidence interval method resulted in detection limits that were significantly lower than the detection limits determined during method validation in which detection limits were calculated from three times the signal-to-noise (3 x S/N) observed in six replicate controls for each tissue. The 95% confidence interval method resulted in numerous results near the detection limit that were often not observed when the sample was retested. This was particularly obvious for warfarin, diphacinone, and difethialone. For this reason the entire data set was reevaluated using the detection limits determined during method validation that were derived from 3 x S/N. The Detection Limits (DL) and Quantitation Limits (QL) are shown in the tables below.

Sample results that are greater than the DL, but less than QL are identified by an asterisk " * ". Care should be taken when evaluating results below the QL as the variability will be significantly greater than the variability observed in quality control (QC) samples.

When a rodenticide residue was observed above the QL in a particular tissue, a second preparation of that tissue was analyzed to confirm the result and is shown in parentheses.

Detection Limit (DL) – ng/g

Rodenticide	Liver	Carcass	Kidney
Warfarin	4.8	9.4	8.6
Diphacinone	7.5	7.2	7.9
Chlorophacinone	4.8	4.3	4.7
Bromadiolone	2.2	4.9	2.3
Brodifacoum	3.3	3.3	4.0
Difethialone	6.9	6.9	6.7
Desmethyl bromethalin	14	37	8.8

Quantitation Limits (QL) – ng/g

Rodenticide	Liver	Carcass	Kidney
Warfarin	15.9	31.4	28.6
Diphacinone	25.2	24.0	26.4
Chlorophacinone	16.0	14.4	15.7
Bromadiolone	7.4	16.1	7.6
Brodifacoum	11.0	11.0	13.3
Difethialone	23.0	23.0	22.2
Desmethyl bromethalin	46.8	125	29.4

[1] Bautista, Adrienne C., et al. "Bromethalin poisoning in a raccoon (Procyon lotor): diagnostic considerations and relevance to nontarget wildlife." Journal of Veterinary Diagnostic Investigation 26.1 (2014): 154-157.

Warfarin						
				Observed Warfarin Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S141208-01	2240-07	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-02	2240-09	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-03	2240-17	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-04	2240-18	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-05	2240-19	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-06	2240-20	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-07	2240-22	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-08	2240-52	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-09	2240-53	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-10	2240-54	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-11	2240-55	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-12	2240-56	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-25	2240-50	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-26	2240-08	Big Island	Hawaiian Hawk	ND	ND	ND
S150305-01	2240-125	Big Island	Hawaiian Hawk	ND	ND	ND
S150108-01	2240-02	Big Island	Hawaiian Hoary Bat	ND†	ND	ND
S150108-02	2240-59	Maui	Hawaiian Hoary Bat		ND	ND†
S150108-03	2240-60	Maui	Hawaiian Hoary Bat		ND	
S150108-04	2240-61	Maui	Hawaiian Hoary Bat	ND†	ND	
S150108-05	2240-65	Maui	Hawaiian Hoary Bat		ND	
S150116-01	2240-01	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-02	2240-57	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-03	2240-62	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-04	2240-63	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-05	2240-64	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-06	2240-66	Maui	Hawaiian Hoary Bat		ND	
S150410-01	2240-128	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-02	2240-129	Oahu	Hawaiian Hoary Bat		ND	
S150410-03	2240-130	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-04	2240-131	Oahu	Hawaiian Hoary Bat		ND	
S150410-05	2240-132	Oahu	Hawaiian Hoary Bat	No Tissue Available		
S150410-06	2240-133	Oahu	Hawaiian Hoary Bat		ND	
S150410-07	2240-134	Oahu	Hawaiian Hoary Bat		ND	
S150410-08	2240-135	Oahu	Hawaiian Hoary Bat		ND	
S150410-09	2240-136	Oahu	Hawaiian Hoary Bat		ND	
S150410-10	2240-137	Oahu	Hawaiian Hoary Bat		ND	
S150305-05	2240-58	Oahu	Barn Owl	ND	ND	ND
S150410-24	2240-139	Oahu	Barn Owl Tissue	ND	ND	ND†
S150108-06	2240-35	Kauai	Pueo	ND	ND	16.7*
S150108-07	2240-36	Kauai	Pueo	16.2 (ND)	ND	ND
S150108-08	2240-69	Big Island	Pueo	ND	ND	ND
S150108-09	2240-71	Big Island	Pueo	ND	ND	ND
S150108-10	2240-75	Maui	Pueo	ND	ND	ND
S150108-11	2240-76	Maui	Pueo	ND	ND	ND
S150108-12	2240-78	Maui	Pueo		ND	
S150108-13	2240-97	Kauai	Pueo		ND	
S150108-14	2240-98	Kauai	Pueo	ND	ND	ND
S150116-07	2240-12	Big Island	Pueo	ND†	ND	ND†
S150116-08	2240-32	Kauai	Pueo	ND	ND	ND
S150116-09	2240-34	Kauai	Pueo	ND	ND	ND
S150116-10	2240-67	Big Island	Pueo	ND	ND	ND
S150116-11	2240-68	Big Island	Pueo	ND	ND	ND
S150116-12	2240-70	Big Island	Pueo		ND	
S150116-13	2240-72	Big Island	Pueo	ND	ND	ND
S150116-14	2240-73	Big Island	Pueo	ND	ND	
S150116-16	2240-77	Maui	Pueo		ND	
S150116-17	2240-79	Maui	Pueo	No Tissue Available		
S150116-18	2240-80	Maui	Pueo	ND	ND	ND
S150116-19	2240-81	Maui	Pueo	ND	ND	ND
S150305-14	2240-33	Kauai	Pueo	ND	ND	ND†
S150305-15	2240-37	Kauai	Pueo		ND	

				Observed Warfarin Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150226-01	2240-04	Big Island	Barn Owl	ND	ND	ND
S150226-02	2240-05	Big Island	Barn Owl	ND	ND	ND
S150226-03	2240-06	Big Island	Barn Owl	ND	ND	ND
S150226-11	2240-112	Big Island	Barn Owl	ND	ND	ND
S150226-12	2240-113	Big Island	Barn Owl	ND	ND	ND
S150226-13	2240-114	Big Island	Barn Owl	ND	ND	ND
S150226-14	2240-115	Big Island	Barn Owl	ND	ND	ND
S150226-23	2240-03	Big Island	Barn Owl	56.1 (8.8*) (ND) [b]	ND	ND
S150305-02	2240-40	Kauai	Barn Owl	ND	ND	ND†
S150305-03	2240-41	Kauai	Barn Owl	ND	ND	ND
S150305-04	2240-42	Kauai	Barn Owl	ND	ND	ND
S150305-06	2240-83	Maui	Barn Owl	ND	ND	ND
S150305-07	2240-86	Maui	Barn Owl	ND	ND	ND
S150305-08	2240-89	Maui	Barn Owl		ND	
S150305-09	2240-93	Maui	Barn Owl	ND	ND	ND
S150305-10	2240-94	Maui	Barn Owl	ND	ND	ND
S150305-11	2240-96	Maui	Barn Owl	ND	ND	ND
S150305-12	2240-107	Kauai	Barn Owl	ND	ND	ND
S150305-13	2240-109	Kauai	Barn Owl	ND	ND	ND
S150305-20	2240-108	Kauai	Barn Owl (Pueo?)		ND	
S150410-11	2240-23	Big Island	Nene	ND	ND	ND
S150410-12	2240-25	Big Island	Nene	99.8 (ND) [b]	ND	ND
S150410-13	2240-26	Big Island	Nene	ND	ND	ND
S150410-14	2240-27	Big Island	Nene	ND	ND	ND
S150410-15	2240-28	Big Island	Nene	ND	ND	ND
S150410-16	2240-29	Big Island	Nene	ND	ND	ND
S150410-17	2240-30	Big Island	Nene	ND	ND	ND
S150410-18	2240-31	Big Island	Nene	ND	ND	ND
S150410-19	2240-38	Kauai	Nene	ND	ND	ND
S150410-20	2240-39	Kauai	Nene - Gosling	ND	ND	ND
S150410-21	2240-43	Kauai	Nene	ND	ND	ND
S150410-22	2240-44	Kauai	Nene	ND	ND	ND
S150410-23	2240-124	Big Island	Nene	ND	ND	ND
S150108-15	2240-100	-	Pueo	ND	ND	ND
S150108-16	2240-103	-	Pueo	No Tissue Available		
S150116-15	2240-74	-	Pueo	ND	ND	ND
S150116-20	2240-99	-	Pueo	ND	ND	
S150116-21	2240-102	-	Pueo	ND	ND	ND
S150226-04	2240-10	-	Barn Owl	ND	ND	ND
S150226-05	2240-11	-	Barn Owl	ND	ND	ND
S150226-06	2240-13	-	Barn Owl	ND	ND	ND
S150226-07	2240-15	-	Barn Owl	ND	ND	ND
S150226-08	2240-16	-	Barn Owl	ND	ND	ND
S150226-09	2240-21	-	Barn Owl	ND	ND	ND
S150226-10	2240-24	-	Barn Owl	ND	ND	ND†
S150226-15	2240-116	-	Barn Owl	ND	ND	ND
S150226-16	2240-117	-	Barn Owl	ND	ND	ND
S150226-17	2240-118	-	Barn Owl	ND	ND	
S150226-18	2240-119	-	Barn Owl	ND	ND	
S150226-19	2240-120	-	Barn Owl	ND	ND	ND
S150226-20	2240-121	-	Barn Owl	ND	ND	ND
S150226-21	2240-122	-	Barn Owl	ND	ND	ND
S150226-22	2240-123	-	Barn Owl	ND	ND	ND
S150226-24	2240-14	-	Barn Owl	ND	ND	
S150305-16	2240-101	-	Pueo	ND	ND	ND
S150305-17	2240-104	-	Pueo		ND	ND
S150305-18	2240-105	-	Pueo		ND	ND
S150305-19	2240-106	-	Pueo	ND	ND	ND
S150514-03	2240-161	-	Barn Owl		ND	
S150514-04	2240-160	-	Pueo		ND	
S150514-05	2240-162	-	Pueo		ND	
S150514-06	2240-163	-	Pueo	ND	ND	ND

				Observed Warfarin Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150810-01	2240-168	Hawaii	Barn Owl		ND†	
S150810-02	2240-151	Oahu	Barn Owl	ND	ND	ND
S150810-03	2240-152	Oahu	Barn Owl	ND	ND	ND
S150810-04	2240-153	Oahu	Barn Owl	ND	ND	ND
S150810-05	2240-169	Hawaii	Barn Owl	ND	ND	ND
S150810-06	2240-154	Oahu	Barn Owl	ND	ND	ND
S150810-07	2240-164	Hawaii	Barn Owl	ND	ND	ND
S150810-08	2240-165	Hawaii	Barn Owl	ND	ND	ND
S150810-09	2240-155	Oahu	Barn Owl	ND	ND	ND
S150810-10	2240-149	Oahu	Barn Owl	ND	ND	ND
S150810-11	2240-171	Hawaii	Barn Owl	ND	ND	ND
S150810-12	2240-172	Hawaii	Barn Owl	ND	ND	ND
S150810-13	2240-82	Maui	Barn Owl	ND	ND	ND
S150810-14	2240-84	Maui	Barn Owl	ND	ND	ND
S150810-15	2240-88	Maui	Barn Owl		ND	
S150810-16	2240-87	Maui	Barn Owl	ND	ND	ND
S150810-17	2240-148	Oahu	Barn Owl	ND	ND	ND
S150810-18	2240-166	Hawaii	Barn Owl	ND	ND	ND
S150810-19	2240-92	Maui	Barn Owl	ND	ND	ND
S150810-20	2240-156	Oahu	Barn Owl	ND	ND	ND
S150810-21	2240-150	Oahu	Barn Owl	ND	ND	ND
S150810-22	2240-85	Maui	Barn Owl	ND	ND	ND
S150810-23	2240-158	Kauai	Barn Owl		ND	
S150810-24	2240-147	Oahu	Barn Owl	ND	ND	ND
S150810-25	2240-110	Kauai	Barn Owl	ND	ND	ND†
S150810-26	2240-90	Maui	Barn Owl	7.0* (ND) (ND)	ND	ND
S150810-27	2240-170	Hawaii	Barn Owl	ND	ND	ND
S150810-28	2240-111	Kauai	Barn Owl		ND[a]	
S150810-29	2240-159	Kauai	Barn Owl	35.4 (ND) (ND)[b]	ND	ND
S150810-30	2240-91	Maui	Barn Owl	ND	ND	ND
S150810-31	2240-127	Oahu	Barn Owl	ND	ND	ND
S150810-32	2240-126	Hawaii	Barn Owl	ND	ND	
S150810-33	2240-95	Maui	Barn Owl	ND	ND	ND
S150810-34	2240-157	Kauai	Barn Owl		ND	
S150810-35	2240-138	Oahu	Barn Owl	ND	ND	ND
S150810-36	2240-146	Hawaii	Barn Owl	ND	12.8*	ND
S150810-37	2240-145	Hawaii	Barn Owl	ND	ND	ND
S150810-38	2240-143	Hawaii	Pueo	5.0*	ND	ND
S150810-39	2240-167	Hawaii	Pueo	ND	ND	ND
S150810-40	2240-144	Hawaii	Pueo	ND	ND	ND
S150810-41	2240-142	Hawaii	Pueo	ND	ND	ND
S150810-42	2240-140	Hawaii	Pueo	ND	ND	ND
S150810-43	2240-141	Hawaii	Pueo	ND	ND	ND
			DL (ng/g) =	4.8	9.4	8.6
			QL (ng/g) =	15.9	31.4	28.6

	No sample available for analysis.
ND	Not Detected. This is reported when no analyte is detected or when the result was < DL.
*	Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).
( )	Concentrations shown in parentheses indicate the result from retesting to confirm the initial result.
†	Sample weight significantly below nominal due to small organ size. QL will be significantly higher.
a	No warfarin was detected in the carcass of S150810-28, but a significant peak was observed at a later retention time and shared one of the mass transitions for warfarin (312.0 → 160.9 m/z). This may indicate a metabolite or a chemically similar compound.
b	The initial results for samples S150226-23, S150410-11, and S150810-29 that were > QL were NOT confirmed when retested.

Diphacinone						
				Observed Diphacinone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S141208-01	2240-07	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-02	2240-09	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-03	2240-17	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-04	2240-18	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-05	2240-19	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-06	2240-20	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-07	2240-22	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-08	2240-52	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-09	2240-53	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-10	2240-54	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-11	2240-55	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-12	2240-56	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-25	2240-50	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-26	2240-08	Big Island	Hawaiian Hawk	ND	ND	ND
S150305-01	2240-125	Big Island	Hawaiian Hawk	ND	ND	ND
S150108-01	2240-02	Big Island	Hawaiian Hoary Bat	ND†	ND	ND
S150108-02	2240-59	Maui	Hawaiian Hoary Bat		ND	ND†
S150108-03	2240-60	Maui	Hawaiian Hoary Bat		ND	
S150108-04	2240-61	Maui	Hawaiian Hoary Bat	ND†	ND	
S150108-05	2240-65	Maui	Hawaiian Hoary Bat		ND	
S150116-01	2240-01	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-02	2240-57	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-03	2240-62	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-04	2240-63	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-05	2240-64	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-06	2240-66	Maui	Hawaiian Hoary Bat		ND	
S150410-01	2240-128	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-02	2240-129	Oahu	Hawaiian Hoary Bat		ND	
S150410-03	2240-130	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-04	2240-131	Oahu	Hawaiian Hoary Bat		ND	
S150410-05	2240-132	Oahu	Hawaiian Hoary Bat	No Tissue Available		
S150410-06	2240-133	Oahu	Hawaiian Hoary Bat		ND	
S150410-07	2240-134	Oahu	Hawaiian Hoary Bat		ND	
S150410-08	2240-135	Oahu	Hawaiian Hoary Bat		8.8*	
S150410-09	2240-136	Oahu	Hawaiian Hoary Bat		ND	
S150410-10	2240-137	Oahu	Hawaiian Hoary Bat		ND	
S150305-05	2240-58	Oahu	Barn Owl	ND	ND	ND
S150410-24	2240-139	Oahu	Barn Owl Tissue	ND	ND	ND†
S150108-06	2240-35	Kauai	Pueo	ND	ND	ND
S150108-07	2240-36	Kauai	Pueo	ND	ND	ND
S150108-08	2240-69	Big Island	Pueo	ND	ND	ND
S150108-09	2240-71	Big Island	Pueo	ND	ND	ND
S150108-10	2240-75	Maui	Pueo	ND	ND	ND
S150108-11	2240-76	Maui	Pueo	ND	ND	ND
S150108-12	2240-78	Maui	Pueo		ND	
S150108-13	2240-97	Kauai	Pueo		ND	
S150108-14	2240-98	Kauai	Pueo	ND	ND	ND
S150116-07	2240-12	Big Island	Pueo	ND†	ND	ND†
S150116-08	2240-32	Kauai	Pueo	ND	ND	ND
S150116-09	2240-34	Kauai	Pueo	ND	ND	ND
S150116-10	2240-67	Big Island	Pueo	ND	ND	ND
S150116-11	2240-68	Big Island	Pueo	ND	ND	ND
S150116-12	2240-70	Big Island	Pueo		ND	
S150116-13	2240-72	Big Island	Pueo	ND	ND	ND
S150116-14	2240-73	Big Island	Pueo	ND	ND	
S150116-16	2240-77	Maui	Pueo		ND	
S150116-17	2240-79	Maui	Pueo	No Tissue Available		
S150116-18	2240-80	Maui	Pueo	ND	ND	ND
S150116-19	2240-81	Maui	Pueo	ND	ND	ND
S150305-14	2240-33	Kauai	Pueo	ND	ND	ND†
S150305-15	2240-37	Kauai	Pueo		ND	

				Observed Diphacinone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150226-01	2240-04	Big Island	Barn Owl	ND	ND	ND
S150226-02	2240-05	Big Island	Barn Owl	ND	ND	ND
S150226-03	2240-06	Big Island	Barn Owl	ND	ND	ND
S150226-11	2240-112	Big Island	Barn Owl	ND	ND	ND
S150226-12	2240-113	Big Island	Barn Owl	ND	ND	ND
S150226-13	2240-114	Big Island	Barn Owl	ND	ND	ND
S150226-14	2240-115	Big Island	Barn Owl	ND	ND	ND
S150226-23	2240-03	Big Island	Barn Owl	ND	ND	ND
S150305-02	2240-40	Kauai	Barn Owl	ND	ND	ND†
S150305-03	2240-41	Kauai	Barn Owl	ND	ND	ND
S150305-04	2240-42	Kauai	Barn Owl	ND	ND	ND
S150305-06	2240-83	Maui	Barn Owl	ND	ND	ND
S150305-07	2240-86	Maui	Barn Owl	ND	ND	ND
S150305-08	2240-89	Maui	Barn Owl		ND	
S150305-09	2240-93	Maui	Barn Owl	ND	ND	ND
S150305-10	2240-94	Maui	Barn Owl	ND	ND	ND
S150305-11	2240-96	Maui	Barn Owl	ND	ND	ND
S150305-12	2240-107	Kauai	Barn Owl	ND	ND	ND
S150305-13	2240-109	Kauai	Barn Owl	ND	ND	ND
S150305-20	2240-108	Kauai	Barn Owl (Pueo?)		ND	
S150410-11	2240-23	Big Island	Nene	ND	ND	ND
S150410-12	2240-25	Big Island	Nene	ND	ND	ND
S150410-13	2240-26	Big Island	Nene	ND	ND	ND
S150410-14	2240-27	Big Island	Nene	ND	ND	ND
S150410-15	2240-28	Big Island	Nene	ND	ND	ND
S150410-16	2240-29	Big Island	Nene	ND	ND	ND
S150410-17	2240-30	Big Island	Nene	ND	ND	ND
S150410-18	2240-31	Big Island	Nene	ND	ND	ND
S150410-19	2240-38	Kauai	Nene	ND	ND	ND
S150410-20	2240-39	Kauai	Nene - Gosling	ND	ND	ND
S150410-21	2240-43	Kauai	Nene	ND	ND	ND
S150410-22	2240-44	Kauai	Nene	ND	ND	ND
S150410-23	2240-124	Big Island	Nene	ND	ND	ND
S150108-15	2240-100	-	Pueo	ND	ND	ND
S150108-16	2240-103	-	Pueo	No Tissue Available		
S150116-15	2240-74	-	Pueo	ND	ND	ND
S150116-20	2240-99	-	Pueo	ND	ND	
S150116-21	2240-102	-	Pueo	ND	ND	ND
S150226-04	2240-10	-	Barn Owl	ND	ND	ND
S150226-05	2240-11	-	Barn Owl	ND	ND	ND
S150226-06	2240-13	-	Barn Owl	ND	ND	ND
S150226-07	2240-15	-	Barn Owl	ND	ND	ND
S150226-08	2240-16	-	Barn Owl	ND	ND	ND
S150226-09	2240-21	-	Barn Owl	ND	ND	ND
S150226-10	2240-24	-	Barn Owl	ND	ND	ND†
S150226-15	2240-116	-	Barn Owl	ND	ND	ND
S150226-16	2240-117	-	Barn Owl	ND	ND	ND
S150226-17	2240-118	-	Barn Owl	ND	ND	
S150226-18	2240-119	-	Barn Owl	ND	ND	
S150226-19	2240-120	-	Barn Owl	ND	ND	ND
S150226-20	2240-121	-	Barn Owl	ND	ND	ND
S150226-21	2240-122	-	Barn Owl	ND	ND	ND
S150226-22	2240-123	-	Barn Owl	ND	ND	ND
S150226-24	2240-14	-	Barn Owl	ND	ND	
S150305-16	2240-101	-	Pueo	ND	ND	ND
S150305-17	2240-104	-	Pueo		ND	ND
S150305-18	2240-105	-	Pueo		ND	ND
S150305-19	2240-106	-	Pueo	ND	ND	ND
S150514-03	2240-161	-	Barn Owl		ND	
S150514-04	2240-160	-	Pueo		ND	
S150514-05	2240-162	-	Pueo		ND	
S150514-06	2240-163	-	Pueo	ND	ND	ND

				Observed Diphacinone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150810-01	2240-168	Hawaii	Barn Owl		ND†	
S150810-02	2240-151	Oahu	Barn Owl	ND	ND	ND
S150810-03	2240-152	Oahu	Barn Owl	ND	ND	ND
S150810-04	2240-153	Oahu	Barn Owl	ND	ND	ND
S150810-05	2240-169	Hawaii	Barn Owl	ND	ND	ND
S150810-06	2240-154	Oahu	Barn Owl	ND	ND	ND
S150810-07	2240-164	Hawaii	Barn Owl	ND	ND	ND
S150810-08	2240-165	Hawaii	Barn Owl	ND	ND	ND
S150810-09	2240-155	Oahu	Barn Owl	ND	ND	ND
S150810-10	2240-149	Oahu	Barn Owl	ND	ND	ND
S150810-11	2240-171	Hawaii	Barn Owl	ND	ND	ND
S150810-12	2240-172	Hawaii	Barn Owl	ND	ND	ND
S150810-13	2240-82	Maui	Barn Owl	ND	ND	ND
S150810-14	2240-84	Maui	Barn Owl	ND	ND	ND
S150810-15	2240-88	Maui	Barn Owl		ND	
S150810-16	2240-87	Maui	Barn Owl	ND	ND	ND
S150810-17	2240-148	Oahu	Barn Owl	ND	ND	ND
S150810-18	2240-166	Hawaii	Barn Owl	ND	ND	ND
S150810-19	2240-92	Maui	Barn Owl	ND	ND	ND
S150810-20	2240-156	Oahu	Barn Owl	ND	ND	ND
S150810-21	2240-150	Oahu	Barn Owl	ND	ND	ND
S150810-22	2240-85	Maui	Barn Owl	ND	ND	ND
S150810-23	2240-158	Kauai	Barn Owl		ND	
S150810-24	2240-147	Oahu	Barn Owl	ND	ND	ND
S150810-25	2240-110	Kauai	Barn Owl	ND	ND	ND†
S150810-26	2240-90	Maui	Barn Owl	ND	ND	ND
S150810-27	2240-170	Hawaii	Barn Owl	ND	ND	ND
S150810-28	2240-111	Kauai	Barn Owl		ND	
S150810-29	2240-159	Kauai	Barn Owl	ND	ND	ND
S150810-30	2240-91	Maui	Barn Owl	ND	ND	ND
S150810-31	2240-127	Oahu	Barn Owl	ND	ND	ND
S150810-32	2240-126	Hawaii	Barn Owl	ND	ND	
S150810-33	2240-95	Maui	Barn Owl	ND	ND	ND
S150810-34	2240-157	Kauai	Barn Owl		ND	
S150810-35	2240-138	Oahu	Barn Owl	ND	ND	ND
S150810-36	2240-146	Hawaii	Barn Owl	ND	ND	ND
S150810-37	2240-145	Hawaii	Barn Owl	ND	ND	ND
S150810-38	2240-143	Hawaii	Pueo	ND	ND	ND
S150810-39	2240-167	Hawaii	Pueo	ND	ND	ND
S150810-40	2240-144	Hawaii	Pueo	ND	ND	ND
S150810-41	2240-142	Hawaii	Pueo	ND	ND	ND
S150810-42	2240-140	Hawaii	Pueo	ND	ND	ND
S150810-43	2240-141	Hawaii	Pueo	ND	ND	ND
			DL (ng/g) =	7.5	7.2	7.9
			QL (ng/g) =	25.2	24.0	26.4

No sample available for analysis.

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

( ) Concentrations shown in parentheses indicate the result from retesting to confirm the initial result.

† Sample weight significantly below nominal due to small organ size. QL will be significantly higher.

Chlorophacinone

				Observed Chlorophacinone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S141208-01	2240-07	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-02	2240-09	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-03	2240-17	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-04	2240-18	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-05	2240-19	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-06	2240-20	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-07	2240-22	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-08	2240-52	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-09	2240-53	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-10	2240-54	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-11	2240-55	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-12	2240-56	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-25	2240-50	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-26	2240-08	Big Island	Hawaiian Hawk	ND	ND	ND
S150305-01	2240-125	Big Island	Hawaiian Hawk	ND	ND	ND
S150108-01	2240-02	Big Island	Hawaiian Hoary Bat	ND†	ND	ND
S150108-02	2240-59	Maui	Hawaiian Hoary Bat		ND	ND†
S150108-03	2240-60	Maui	Hawaiian Hoary Bat			
S150108-04	2240-61	Maui	Hawaiian Hoary Bat	ND†	ND	
S150108-05	2240-65	Maui	Hawaiian Hoary Bat		ND	
S150116-01	2240-01	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-02	2240-57	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-03	2240-62	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-04	2240-63	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-05	2240-64	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-06	2240-66	Maui	Hawaiian Hoary Bat		ND	
S150410-01	2240-128	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-02	2240-129	Oahu	Hawaiian Hoary Bat		ND	
S150410-03	2240-130	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-04	2240-131	Oahu	Hawaiian Hoary Bat		ND	
S150410-05	2240-132	Oahu	Hawaiian Hoary Bat	No Tissue Available		
S150410-06	2240-133	Oahu	Hawaiian Hoary Bat		ND	
S150410-07	2240-134	Oahu	Hawaiian Hoary Bat		ND	
S150410-08	2240-135	Oahu	Hawaiian Hoary Bat		ND	
S150410-09	2240-136	Oahu	Hawaiian Hoary Bat		ND	
S150410-10	2240-137	Oahu	Hawaiian Hoary Bat		ND	
S150305-05	2240-58	Oahu	Barn Owl	ND	ND	ND
S150410-24	2240-139	Oahu	Barn Owl Tissue	ND	ND	ND†
S150108-06	2240-35	Kauai	Pueo	ND	ND	ND
S150108-07	2240-36	Kauai	Pueo	ND	ND	ND
S150108-08	2240-69	Big Island	Pueo	ND	ND	ND
S150108-09	2240-71	Big Island	Pueo	ND	ND	ND
S150108-10	2240-75	Maui	Pueo	ND	ND	ND
S150108-11	2240-76	Maui	Pueo	ND	ND	ND
S150108-12	2240-78	Maui	Pueo		ND	
S150108-13	2240-97	Kauai	Pueo		ND	
S150108-14	2240-98	Kauai	Pueo	ND	ND	ND
S150116-07	2240-12	Big Island	Pueo	ND†	ND	ND†
S150116-08	2240-32	Kauai	Pueo	ND	ND	ND
S150116-09	2240-34	Kauai	Pueo	ND	ND	ND
S150116-10	2240-67	Big Island	Pueo	ND	ND	ND
S150116-11	2240-68	Big Island	Pueo	ND	ND	ND
S150116-12	2240-70	Big Island	Pueo		ND	
S150116-13	2240-72	Big Island	Pueo	ND	ND	ND
S150116-14	2240-73	Big Island	Pueo	ND	ND	
S150116-16	2240-77	Maui	Pueo		ND	
S150116-17	2240-79	Maui	Pueo	No Tissue Available		
S150116-18	2240-80	Maui	Pueo	ND	ND	ND
S150116-19	2240-81	Maui	Pueo	ND	ND	ND
S150305-14	2240-33	Kauai	Pueo	ND	ND	ND†
S150305-15	2240-37	Kauai	Pueo		ND	

				Observed Chlorophacinone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150226-01	2240-04	Big Island	Barn Owl	ND	ND	ND
S150226-02	2240-05	Big Island	Barn Owl	ND	ND	ND
S150226-03	2240-06	Big Island	Barn Owl	ND	ND	ND
S150226-11	2240-112	Big Island	Barn Owl	ND	ND	ND
S150226-12	2240-113	Big Island	Barn Owl	ND	ND	ND
S150226-13	2240-114	Big Island	Barn Owl	ND	ND	ND
S150226-14	2240-115	Big Island	Barn Owl	ND	ND	ND
S150226-23	2240-03	Big Island	Barn Owl	ND	ND	ND
S150305-02	2240-40	Kauai	Barn Owl	ND	ND	ND†
S150305-03	2240-41	Kauai	Barn Owl	ND	ND	ND
S150305-04	2240-42	Kauai	Barn Owl	ND	ND	ND
S150305-06	2240-83	Maui	Barn Owl	ND	ND	ND
S150305-07	2240-86	Maui	Barn Owl	ND	ND	ND
S150305-08	2240-89	Maui	Barn Owl		ND	
S150305-09	2240-93	Maui	Barn Owl	ND	ND	ND
S150305-10	2240-94	Maui	Barn Owl	ND	ND	ND
S150305-11	2240-96	Maui	Barn Owl	ND	ND	ND
S150305-12	2240-107	Kauai	Barn Owl	ND	ND	ND
S150305-13	2240-109	Kauai	Barn Owl	ND	ND	ND
S150305-20	2240-108	Kauai	Barn Owl (Pueo?)		ND	
S150410-11	2240-23	Big Island	Nene	ND	ND	ND
S150410-12	2240-25	Big Island	Nene	ND	ND	ND
S150410-13	2240-26	Big Island	Nene	ND	ND	ND
S150410-14	2240-27	Big Island	Nene	ND	ND	ND
S150410-15	2240-28	Big Island	Nene	ND	ND	ND
S150410-16	2240-29	Big Island	Nene	ND	ND	ND
S150410-17	2240-30	Big Island	Nene	ND	ND	ND
S150410-18	2240-31	Big Island	Nene	ND	ND	ND
S150410-19	2240-38	Kauai	Nene	ND	ND	ND
S150410-20	2240-39	Kauai	Nene - Gosling	ND	ND	ND
S150410-21	2240-43	Kauai	Nene	ND	ND	ND
S150410-22	2240-44	Kauai	Nene	ND	ND	ND
S150410-23	2240-124	Big Island	Nene	ND	ND	ND
S150108-15	2240-100	-	Pueo	ND	ND	ND
S150108-16	2240-103	-	Pueo	No Tissue Available		
S150116-15	2240-74	-	Pueo	ND	ND	ND
S150116-20	2240-99	-	Pueo	ND	ND	
S150116-21	2240-102	-	Pueo	ND	ND	ND
S150226-04	2240-10	-	Barn Owl	ND	ND	ND
S150226-05	2240-11	-	Barn Owl	ND	ND	ND
S150226-06	2240-13	-	Barn Owl	ND	ND	ND
S150226-07	2240-15	-	Barn Owl	ND	ND	ND
S150226-08	2240-16	-	Barn Owl	ND	ND	ND
S150226-09	2240-21	-	Barn Owl	ND	ND	ND
S150226-10	2240-24	-	Barn Owl	ND	ND	ND†
S150226-15	2240-116	-	Barn Owl	ND	ND	ND (5.1*)
S150226-16	2240-117	-	Barn Owl	ND	ND	ND
S150226-17	2240-118	-	Barn Owl	ND	ND	
S150226-18	2240-119	-	Barn Owl	ND	ND	
S150226-19	2240-120	-	Barn Owl	ND	ND	ND
S150226-20	2240-121	-	Barn Owl	ND	ND	ND
S150226-21	2240-122	-	Barn Owl	ND	ND	ND
S150226-22	2240-123	-	Barn Owl	ND	ND	ND
S150226-24	2240-14	-	Barn Owl	ND	ND	
S150305-16	2240-101	-	Pueo	ND	ND	ND
S150305-17	2240-104	-	Pueo		ND	ND
S150305-18	2240-105	-	Pueo		ND	ND
S150305-19	2240-106	-	Pueo	ND	ND	ND
S150514-03	2240-161	-	Barn Owl		ND	
S150514-04	2240-160	-	Pueo		ND	
S150514-05	2240-162	-	Pueo		ND	
S150514-06	2240-163	-	Pueo	ND	ND	ND

				Observed Chlorophacinone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150810-01	2240-168	Hawaii	Barn Owl		ND†	
S150810-02	2240-151	Oahu	Barn Owl	ND	ND	ND
S150810-03	2240-152	Oahu	Barn Owl	ND	ND	ND
S150810-04	2240-153	Oahu	Barn Owl	ND	ND	ND
S150810-05	2240-169	Hawaii	Barn Owl	ND	ND	ND
S150810-06	2240-154	Oahu	Barn Owl	ND	ND	ND
S150810-07	2240-164	Hawaii	Barn Owl	ND	ND	ND
S150810-08	2240-165	Hawaii	Barn Owl	ND	ND	ND
S150810-09	2240-155	Oahu	Barn Owl	ND	ND	ND
S150810-10	2240-149	Oahu	Barn Owl	ND	ND	ND
S150810-11	2240-171	Hawaii	Barn Owl	ND	ND	ND
S150810-12	2240-172	Hawaii	Barn Owl	ND	ND	ND
S150810-13	2240-82	Maui	Barn Owl	ND	ND	ND
S150810-14	2240-84	Maui	Barn Owl	ND	ND	ND
S150810-15	2240-88	Maui	Barn Owl		ND	
S150810-16	2240-87	Maui	Barn Owl	ND	ND	ND
S150810-17	2240-148	Oahu	Barn Owl	ND	ND	ND
S150810-18	2240-166	Hawaii	Barn Owl	ND	ND	ND
S150810-19	2240-92	Maui	Barn Owl	ND	ND	ND
S150810-20	2240-156	Oahu	Barn Owl	ND	ND	ND
S150810-21	2240-150	Oahu	Barn Owl	ND	ND	ND
S150810-22	2240-85	Maui	Barn Owl	ND	ND	ND
S150810-23	2240-158	Kauai	Barn Owl		ND	
S150810-24	2240-147	Oahu	Barn Owl	ND	ND	ND
S150810-25	2240-110	Kauai	Barn Owl	ND	ND	ND†
S150810-26	2240-90	Maui	Barn Owl	ND	ND	ND
S150810-27	2240-170	Hawaii	Barn Owl	ND	ND	ND
S150810-28	2240-111	Kauai	Barn Owl		ND	
S150810-29	2240-159	Kauai	Barn Owl	ND	ND	ND
S150810-30	2240-91	Maui	Barn Owl	ND	ND	ND
S150810-31	2240-127	Oahu	Barn Owl	ND	ND	ND
S150810-32	2240-126	Hawaii	Barn Owl	ND	ND	
S150810-33	2240-95	Maui	Barn Owl	ND	ND	ND
S150810-34	2240-157	Kauai	Barn Owl		ND	
S150810-35	2240-138	Oahu	Barn Owl	ND	ND	ND
S150810-36	2240-146	Hawaii	Barn Owl	ND	ND	ND
S150810-37	2240-145	Hawaii	Barn Owl	ND	ND	ND
S150810-38	2240-143	Hawaii	Pueo	ND	ND	ND
S150810-39	2240-167	Hawaii	Pueo	ND	ND	ND
S150810-40	2240-144	Hawaii	Pueo	ND	ND	ND
S150810-41	2240-142	Hawaii	Pueo	ND	ND	ND
S150810-42	2240-140	Hawaii	Pueo	ND	ND	ND
S150810-43	2240-141	Hawaii	Pueo	ND	ND	ND
			DL (ng/g) =	4.8	4.3	4.7
			QL (ng/g) =	16.0	14.4	15.7

No sample available for analysis.

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

( ) Concentrations shown in parentheses indicate the result from retesting to confirm the initial result.

† Sample weight significantly below nominal due to small organ size. QL will be significantly higher.

Bromadiolone						
				Observed Bromadiolone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S141208-01	2240-07	Big Island	Hawaiian Hawk	ND	ND	ND (7.8)
S141208-02	2240-09	Big Island	Hawaiian Hawk	7.1* (7.8)	ND	ND
S141208-03	2240-17	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-04	2240-18	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-05	2240-19	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-06	2240-20	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-07	2240-22	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-08	2240-52	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-09	2240-53	Big Island	Hawaiian Hawk	13.4 (19.3)	ND	17.5 (25.3)
S141208-10	2240-54	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-11	2240-55	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-12	2240-56	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-25	2240-50	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-26	2240-08	Big Island	Hawaiian Hawk	3.7* (ND)	ND	3.2* (4.1*)
S150305-01	2240-125	Big Island	Hawaiian Hawk	ND (2.8*)	ND	ND
S150108-01	2240-02	Big Island	Hawaiian Hoary Bat	ND†	ND	ND
S150108-02	2240-59	Maui	Hawaiian Hoary Bat		ND	ND†
S150108-03	2240-60	Maui	Hawaiian Hoary Bat		ND	
S150108-04	2240-61	Maui	Hawaiian Hoary Bat	ND†	ND	
S150108-05	2240-65	Maui	Hawaiian Hoary Bat		ND	
S150116-01	2240-01	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-02	2240-57	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-03	2240-62	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-04	2240-63	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-05	2240-64	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-06	2240-66	Maui	Hawaiian Hoary Bat		ND	
S150410-01	2240-128	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-02	2240-129	Oahu	Hawaiian Hoary Bat		ND	
S150410-03	2240-130	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-04	2240-131	Oahu	Hawaiian Hoary Bat		ND	
S150410-05	2240-132	Oahu	Hawaiian Hoary Bat	No Tissue Available		
S150410-06	2240-133	Oahu	Hawaiian Hoary Bat		ND	
S150410-07	2240-134	Oahu	Hawaiian Hoary Bat		ND	
S150410-08	2240-135	Oahu	Hawaiian Hoary Bat		ND	
S150410-09	2240-136	Oahu	Hawaiian Hoary Bat		ND	
S150410-10	2240-137	Oahu	Hawaiian Hoary Bat		ND	
S150305-05	2240-58	Oahu	Barn Owl	5.6* (5.1*)	ND	5.8* (6.3*)
S150410-24	2240-139	Oahu	Barn Owl Tissue	ND	ND	ND†
S150108-06	2240-35	Kauai	Pueo	13.9 (15.2)	ND	4.7* (3.6*)
S150108-07	2240-36	Kauai	Pueo	7.8 (8.5)	ND	3.6* (4.4*)
S150108-08	2240-69	Big Island	Pueo	ND	ND	ND
S150108-09	2240-71	Big Island	Pueo	ND	ND	ND
S150108-10	2240-75	Maui	Pueo	ND	ND	ND
S150108-11	2240-76	Maui	Pueo	ND	ND	ND
S150108-12	2240-78	Maui	Pueo		ND	
S150108-13	2240-97	Kauai	Pueo		ND	
S150108-14	2240-98	Kauai	Pueo	ND	ND	ND
S150116-07	2240-12	Big Island	Pueo	ND†	ND	ND†
S150116-08	2240-32	Kauai	Pueo	ND	ND	ND
S150116-09	2240-34	Kauai	Pueo	ND	ND	ND
S150116-10	2240-67	Big Island	Pueo	ND	ND	ND
S150116-11	2240-68	Big Island	Pueo	ND	ND	ND
S150116-12	2240-70	Big Island	Pueo		ND	
S150116-13	2240-72	Big Island	Pueo	ND	ND	ND
S150116-14	2240-73	Big Island	Pueo	ND	ND	
S150116-16	2240-77	Maui	Pueo		ND	
S150116-17	2240-79	Maui	Pueo	No Tissue Available		
S150116-18	2240-80	Maui	Pueo	ND	ND	ND
S150116-19	2240-81	Maui	Pueo	ND	ND	ND
S150305-14	2240-33	Kauai	Pueo	ND	ND	ND†
S150305-15	2240-37	Kauai	Pueo		ND	

				Observed Bromadiolone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150226-01	2240-04	Big Island	Barn Owl	ND	ND	ND
S150226-02	2240-05	Big Island	Barn Owl	ND	ND	ND
S150226-03	2240-06	Big Island	Barn Owl	ND	ND	ND
S150226-11	2240-112	Big Island	Barn Owl	ND	ND	ND
S150226-12	2240-113	Big Island	Barn Owl	59.6 (54.1)	ND	38.0 (52.9)
S150226-13	2240-114	Big Island	Barn Owl	ND	ND	ND
S150226-14	2240-115	Big Island	Barn Owl	ND	ND	ND
S150226-23	2240-03	Big Island	Barn Owl	ND	ND	ND
S150305-02	2240-40	Kauai	Barn Owl	ND	ND	ND†
S150305-03	2240-41	Kauai	Barn Owl	ND	ND	ND
S150305-04	2240-42	Kauai	Barn Owl	ND	ND	ND
S150305-06	2240-83	Maui	Barn Owl	139 (157)	ND	108 (146)
S150305-07	2240-86	Maui	Barn Owl	ND	ND	ND
S150305-08	2240-89	Maui	Barn Owl		6.4* (ND)	
S150305-09	2240-93	Maui	Barn Owl	ND	ND	ND
S150305-10	2240-94	Maui	Barn Owl	33.0 (23.2)	ND	13.8 (15.8)
S150305-11	2240-96	Maui	Barn Owl	ND	ND	ND
S150305-12	2240-107	Kauai	Barn Owl	8.7 (8.9)	ND	6.3*
S150305-13	2240-109	Kauai	Barn Owl	ND	ND	ND
S150305-20	2240-108	Kauai	Barn Owl (Pueo?)		ND	
S150410-11	2240-23	Big Island	Nene	ND	ND	ND
S150410-12	2240-25	Big Island	Nene	ND	ND	ND
S150410-13	2240-26	Big Island	Nene	ND	ND	ND
S150410-14	2240-27	Big Island	Nene	ND	ND	ND
S150410-15	2240-28	Big Island	Nene	ND	ND	ND
S150410-16	2240-29	Big Island	Nene	ND	ND	ND
S150410-17	2240-30	Big Island	Nene	ND	ND	ND
S150410-18	2240-31	Big Island	Nene	ND	ND	ND
S150410-19	2240-38	Kauai	Nene	ND	ND	ND
S150410-20	2240-39	Kauai	Nene - Gosling	ND	ND	ND
S150410-21	2240-43	Kauai	Nene	ND	ND	ND
S150410-22	2240-44	Kauai	Nene	ND	ND	ND
S150410-23	2240-124	Big Island	Nene	ND	ND	ND
S150108-15	2240-100	-	Pueo	ND	ND	ND
S150108-16	2240-103	-	Pueo	No Tissue Available		
S150116-15	2240-74	-	Pueo	ND	ND	ND
S150116-20	2240-99	-	Pueo	ND	ND	
S150116-21	2240-102	-	Pueo	ND	ND	ND
S150226-04	2240-10	-	Barn Owl	ND	ND	ND
S150226-05	2240-11	-	Barn Owl	ND	ND	ND
S150226-06	2240-13	-	Barn Owl	ND	ND	ND
S150226-07	2240-15	-	Barn Owl	13.1 (8.0)	ND	7.2* (ND)
S150226-08	2240-16	-	Barn Owl	59.0 (58.3)	ND	35.0 (29.5)
S150226-09	2240-21	-	Barn Owl	9.4 (8.6)	ND	6.9* (ND)
S150226-10	2240-24	-	Barn Owl	ND	ND	ND†
S150226-15	2240-116	-	Barn Owl	ND	ND	ND
S150226-16	2240-117	-	Barn Owl	ND	ND	ND
S150226-17	2240-118	-	Barn Owl	ND	ND	
S150226-18	2240-119	-	Barn Owl	3.3* (4.0*)	ND	
S150226-19	2240-120	-	Barn Owl	15.2 (16.8)	ND	9.5
S150226-20	2240-121	-	Barn Owl	ND	ND	ND
S150226-21	2240-122	-	Barn Owl	39.0 (56.9)	ND	43.8 (44.6)
S150226-22	2240-123	-	Barn Owl	43.4 (39.4)	ND	37.7 (36.2)
S150226-24	2240-14	-	Barn Owl	ND	ND	
S150305-16	2240-101	-	Pueo	ND	ND	ND
S150305-17	2240-104	-	Pueo		ND	ND
S150305-18	2240-105	-	Pueo		9.7*	2.5*
S150305-19	2240-106	-	Pueo	ND	ND	ND
S150514-03	2240-161	-	Barn Owl		ND	
S150514-04	2240-160	-	Pueo		ND	
S150514-05	2240-162	-	Pueo		ND	
S150514-06	2240-163	-	Pueo	ND	ND	ND

				Observed Bromadiolone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150810-01	2240-168	Hawaii	Barn Owl		ND†	
S150810-02	2240-151	Oahu	Barn Owl	ND	ND	ND
S150810-03	2240-152	Oahu	Barn Owl	ND	ND	ND
S150810-04	2240-153	Oahu	Barn Owl	ND	ND	ND
S150810-05	2240-169	Hawaii	Barn Owl	ND	ND	ND
S150810-06	2240-154	Oahu	Barn Owl	ND	ND	ND
S150810-07	2240-164	Hawaii	Barn Owl	ND	ND	ND
S150810-08	2240-165	Hawaii	Barn Owl	15.9 (10.2)	ND	7.0*
S150810-09	2240-155	Oahu	Barn Owl	15.3 (13.1)	ND	8.7
S150810-10	2240-149	Oahu	Barn Owl	6.2*	ND	4.3*
S150810-11	2240-171	Hawaii	Barn Owl	ND	ND	ND
S150810-12	2240-172	Hawaii	Barn Owl	ND	ND	ND
S150810-13	2240-82	Maui	Barn Owl	ND	ND	ND
S150810-14	2240-84	Maui	Barn Owl	ND	ND	ND
S150810-15	2240-88	Maui	Barn Owl		ND	
S150810-16	2240-87	Maui	Barn Owl	ND	ND	ND
S150810-17	2240-148	Oahu	Barn Owl	11.1 (7.7)	ND	7.0*
S150810-18	2240-166	Hawaii	Barn Owl	ND	ND	ND
S150810-19	2240-92	Maui	Barn Owl	ND	ND	3.1* (3.2*)
S150810-20	2240-156	Oahu	Barn Owl	ND	ND	ND
S150810-21	2240-150	Oahu	Barn Owl	11.3 (10.9)	ND	11.9 (10.4)
S150810-22	2240-85	Maui	Barn Owl	3.1*	ND	2.8*
S150810-23	2240-158	Kauai	Barn Owl		ND	
S150810-24	2240-147	Oahu	Barn Owl	ND	ND	ND
S150810-25	2240-110	Kauai	Barn Owl	ND	ND	ND†
S150810-26	2240-90	Maui	Barn Owl	ND	ND	ND
S150810-27	2240-170	Hawaii	Barn Owl	ND	ND	ND
S150810-28	2240-111	Kauai	Barn Owl		ND	
S150810-29	2240-159	Kauai	Barn Owl	ND	ND	ND
S150810-30	2240-91	Maui	Barn Owl	ND	ND	ND
S150810-31	2240-127	Oahu	Barn Owl	ND	ND	ND
S150810-32	2240-126	Hawaii	Barn Owl	ND	ND	
S150810-33	2240-95	Maui	Barn Owl	ND	ND	ND
S150810-34	2240-157	Kauai	Barn Owl		ND	
S150810-35	2240-138	Oahu	Barn Owl	ND	ND	ND
S150810-36	2240-146	Hawaii	Barn Owl	ND	ND	ND
S150810-37	2240-145	Hawaii	Barn Owl	ND	ND	ND
S150810-38	2240-143	Hawaii	Pueo	ND	ND	ND
S150810-39	2240-167	Hawaii	Pueo	158 (140)	15.6* (13.1*)	47.7 (52.3)
S150810-40	2240-144	Hawaii	Pueo	ND	ND	ND
S150810-41	2240-142	Hawaii	Pueo	ND	ND	ND
S150810-42	2240-140	Hawaii	Pueo	ND	ND	ND
S150810-43	2240-141	Hawaii	Pueo	ND	ND	ND
			DL (ng/g) =	2.2	4.9	2.3
			QL (ng/g) =	7.4	16.1	7.6

	No sample available for analysis.
ND	Not Detected. This is reported when no analyte is detected or when the result was < DL.
*	Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).
( )	Concentrations shown in parentheses indicate the result from retesting to confirm the initial result.
†	Sample weight significantly below nominal due to small organ size. QL will be significantly higher.

Brodifacoum

				Observed Brodifacoum Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S141208-01	2240-07	Big Island	Hawaiian Hawk	46.2 (49.3)	13.0 (9.8*)	39.2 (86.3)
S141208-02	2240-09	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-03	2240-17	Big Island	Hawaiian Hawk	48.0 (62.2) (52.6)	5.9* (4.7*) (5.5*)	ND (22.0) (12.7*)
S141208-04	2240-18	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-05	2240-19	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-06	2240-20	Big Island	Hawaiian Hawk	10.6* (9.6*)	ND	ND
S141208-07	2240-22	Big Island	Hawaiian Hawk	9.8* (9.2*)	ND	ND (5.6*)
S141208-08	2240-52	Big Island	Hawaiian Hawk	67.3 (78.8)	8.2* (9.7*)	24.3* (28.6)[c]
S141208-09	2240-53	Big Island	Hawaiian Hawk	ND (4.1*)	ND	ND
S141208-10	2240-54	Big Island	Hawaiian Hawk	4.7* (7.1*)	ND	ND
S141208-11	2240-55	Big Island	Hawaiian Hawk	768 (870)	87.7 (66.4)	209 (324)
S141208-12	2240-56	Big Island	Hawaiian Hawk	141 (146)	18.0 (19.3)	60.0 (97.4)
S150226-25	2240-50	Big Island	Hawaiian Hawk	81.6 (88.8)	11.5 (12.0)	37.7 (33.6)
S150226-26	2240-08	Big Island	Hawaiian Hawk	21.5 (22.0)	ND	10.2* (12.3*)
S150305-01	2240-125	Big Island	Hawaiian Hawk	8.6* (9.8*)	ND	ND
S150108-01	2240-02	Big Island	Hawaiian Hoary Bat	ND†	ND	ND
S150108-02	2240-59	Maui	Hawaiian Hoary Bat		ND	ND†
S150108-03	2240-60	Maui	Hawaiian Hoary Bat		ND	
S150108-04	2240-61	Maui	Hawaiian Hoary Bat	ND†	ND	
S150108-05	2240-65	Maui	Hawaiian Hoary Bat		ND	
S150116-01	2240-01	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-02	2240-57	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-03	2240-62	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-04	2240-63	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-05	2240-64	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-06	2240-66	Maui	Hawaiian Hoary Bat		ND	
S150410-01	2240-128	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-02	2240-129	Oahu	Hawaiian Hoary Bat		ND	
S150410-03	2240-130	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-04	2240-131	Oahu	Hawaiian Hoary Bat		ND	
S150410-05	2240-132	Oahu	Hawaiian Hoary Bat	No Tissue Available		
S150410-06	2240-133	Oahu	Hawaiian Hoary Bat		ND	
S150410-07	2240-134	Oahu	Hawaiian Hoary Bat		ND	
S150410-08	2240-135	Oahu	Hawaiian Hoary Bat		ND	
S150410-09	2240-136	Oahu	Hawaiian Hoary Bat		ND	
S150410-10	2240-137	Oahu	Hawaiian Hoary Bat		ND	
S150305-05	2240-58	Oahu	Barn Owl	58.1 (45.1)	ND	33.1 (30.5)
S150410-24	2240-139	Oahu	Barn Owl Tissue	ND	ND	ND†
S150108-06	2240-35	Kauai	Pueo	ND	ND	ND
S150108-07	2240-36	Kauai	Pueo	87.5 (91.6)	9.1* (11.1)	19.0 (17.7)
S150108-08	2240-69	Big Island	Pueo	ND	ND	ND
S150108-09	2240-71	Big Island	Pueo	38.5 (34.2)	ND	4.6* (4.1*)
S150108-10	2240-75	Maui	Pueo	ND	ND	ND
S150108-11	2240-76	Maui	Pueo	ND	ND	ND
S150108-12	2240-78	Maui	Pueo		ND	
S150108-13	2240-97	Kauai	Pueo		ND	
S150108-14	2240-98	Kauai	Pueo	ND	ND	ND
S150116-07	2240-12	Big Island	Pueo	ND†	ND	ND†
S150116-08	2240-32	Kauai	Pueo	ND	ND	ND
S150116-09	2240-34	Kauai	Pueo	ND	ND	ND
S150116-10	2240-67	Big Island	Pueo	ND	ND	ND
S150116-11	2240-68	Big Island	Pueo	ND	ND	ND
S150116-12	2240-70	Big Island	Pueo		ND	
S150116-13	2240-72	Big Island	Pueo	ND	ND	ND
S150116-14	2240-73	Big Island	Pueo	ND	ND	
S150116-16	2240-77	Maui	Pueo		ND	
S150116-17	2240-79	Maui	Pueo	No Tissue Available		
S150116-18	2240-80	Maui	Pueo	ND	ND	ND
S150116-19	2240-81	Maui	Pueo	ND	ND	ND
S150305-14	2240-33	Kauai	Pueo	ND	ND	ND†
S150305-15	2240-37	Kauai	Pueo		ND	

				Observed Brodifacoum Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150226-01	2240-04	Big Island	Barn Owl	ND	ND	ND
S150226-02	2240-05	Big Island	Barn Owl	5.8* (ND)	ND	ND
S150226-03	2240-06	Big Island	Barn Owl	31.1 (22.5)	ND	15.2 (18.2)
S150226-11	2240-112	Big Island	Barn Owl	167 (164)	4.5*	38.4 [d]
S150226-12	2240-113	Big Island	Barn Owl	ND	ND	ND
S150226-13	2240-114	Big Island	Barn Owl	ND	ND	ND
S150226-14	2240-115	Big Island	Barn Owl	ND	ND	ND
S150226-23	2240-03	Big Island	Barn Owl	17.2 (12.9) (23.8)	ND	5.4*
S150305-02	2240-40	Kauai	Barn Owl	ND	ND	ND†
S150305-03	2240-41	Kauai	Barn Owl	5.5*	ND	ND
S150305-04	2240-42	Kauai	Barn Owl	ND	ND	ND
S150305-06	2240-83	Maui	Barn Owl	ND	ND	ND
S150305-07	2240-86	Maui	Barn Owl	ND	ND	ND
S150305-08	2240-89	Maui	Barn Owl		14.4 (ND)	
S150305-09	2240-93	Maui	Barn Owl	ND	ND	ND
S150305-10	2240-94	Maui	Barn Owl	29.6 (17.7)	ND	7.7* (9.8*)
S150305-11	2240-96	Maui	Barn Owl	ND	ND	ND
S150305-12	2240-107	Kauai	Barn Owl	39.2 (46.6)	ND	12.5*
S150305-13	2240-109	Kauai	Barn Owl	ND	ND	ND
S150305-20	2240-108	Kauai	Barn Owl (Pueo?)		ND	
S150410-11	2240-23	Big Island	Nene	ND	ND	ND
S150410-12	2240-25	Big Island	Nene	ND	ND	ND
S150410-13	2240-26	Big Island	Nene	ND	ND	ND
S150410-14	2240-27	Big Island	Nene	ND	ND	ND
S150410-15	2240-28	Big Island	Nene	ND	ND	ND
S150410-16	2240-29	Big Island	Nene	ND	ND	ND
S150410-17	2240-30	Big Island	Nene	ND	ND	ND
S150410-18	2240-31	Big Island	Nene	ND	ND	ND
S150410-19	2240-38	Kauai	Nene	ND	ND	ND
S150410-20	2240-39	Kauai	Nene - Gosling	ND	ND	ND
S150410-21	2240-43	Kauai	Nene	314 (299)	7.7*	20.9 (24.1)
S150410-22	2240-44	Kauai	Nene	ND	ND	ND
S150410-23	2240-124	Big Island	Nene	ND	ND	ND
S150108-15	2240-100	-	Pueo	ND	ND	ND
S150108-16	2240-103	-	Pueo	No Tissue Available		
S150116-15	2240-74	-	Pueo	ND	ND	ND
S150116-20	2240-99	-	Pueo	5.9* (6.2*)	ND	
S150116-21	2240-102	-	Pueo	ND	ND	ND
S150226-04	2240-10	-	Barn Owl	ND	ND	ND
S150226-05	2240-11	-	Barn Owl	5.7*	ND	ND
S150226-06	2240-13	-	Barn Owl	ND	ND	ND
S150226-07	2240-15	-	Barn Owl	78.0 (54.4)	5.0*	14.6 (11.8*)
S150226-08	2240-16	-	Barn Owl	73.8 (79.1)	8.9*	28.0 (27.7)
S150226-09	2240-21	-	Barn Owl	429 (497)	15.1 (18.1)	165 (145)
S150226-10	2240-24	-	Barn Owl	14.4 (12.1)	ND	ND†
S150226-15	2240-116	-	Barn Owl	212 (225)	9.0*	78.7 (87.6)
S150226-16	2240-117	-	Barn Owl	ND	ND	ND
S150226-17	2240-118	-	Barn Owl	ND	ND	
S150226-18	2240-119	-	Barn Owl	22.8 (18.6)	ND	
S150226-19	2240-120	-	Barn Owl	ND	ND	ND
S150226-20	2240-121	-	Barn Owl	21.1 (16.5)	ND	7.7*
S150226-21	2240-122	-	Barn Owl	14.7 (5.4*)	ND	4.9* (ND)
S150226-22	2240-123	-	Barn Owl	103 (73.0)	10.4*	49.8 (52.5)
S150226-24	2240-14	-	Barn Owl	ND	ND	
S150305-16	2240-101	-	Pueo	ND	ND	ND
S150305-17	2240-104	-	Pueo		ND	ND
S150305-18	2240-105	-	Pueo		ND	10.4*
S150305-19	2240-106	-	Pueo	ND	ND	ND
S150514-03	2240-161	-	Barn Owl		ND	
S150514-04	2240-160	-	Pueo		9.3*	
S150514-05	2240-162	-	Pueo		ND	
S150514-06	2240-163	-	Pueo	ND	ND	ND

				Observed Brodifacoum Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150810-01	2240-168	Hawaii	Barn Owl		ND†	
S150810-02	2240-151	Oahu	Barn Owl	ND	ND	ND
S150810-03	2240-152	Oahu	Barn Owl	ND	ND	ND
S150810-04	2240-153	Oahu	Barn Owl	ND	ND	ND
S150810-05	2240-169	Hawaii	Barn Owl	ND	ND	ND
S150810-06	2240-154	Oahu	Barn Owl	ND	ND	ND
S150810-07	2240-164	Hawaii	Barn Owl	ND	ND	ND
S150810-08	2240-165	Hawaii	Barn Owl	ND	ND	ND
S150810-09	2240-155	Oahu	Barn Owl	ND	ND	ND
S150810-10	2240-149	Oahu	Barn Owl	ND	ND	ND
S150810-11	2240-171	Hawaii	Barn Owl	ND	ND	ND
S150810-12	2240-172	Hawaii	Barn Owl	14.0 (10.6*)	ND	5.8*
S150810-13	2240-82	Maui	Barn Owl	ND	ND	ND
S150810-14	2240-84	Maui	Barn Owl	ND	ND	ND
S150810-15	2240-88	Maui	Barn Owl		ND	
S150810-16	2240-87	Maui	Barn Owl	ND	ND	ND
S150810-17	2240-148	Oahu	Barn Owl	ND	ND	ND
S150810-18	2240-166	Hawaii	Barn Owl	ND	ND	ND
S150810-19	2240-92	Maui	Barn Owl	168 (141)	11.9	110 (116)
S150810-20	2240-156	Oahu	Barn Owl	ND	ND	ND
S150810-21	2240-150	Oahu	Barn Owl	ND	ND	ND
S150810-22	2240-85	Maui	Barn Owl	ND	ND	ND
S150810-23	2240-158	Kauai	Barn Owl		ND	
S150810-24	2240-147	Oahu	Barn Owl	ND	ND	ND
S150810-25	2240-110	Kauai	Barn Owl	ND	ND	ND†
S150810-26	2240-90	Maui	Barn Owl	214 (16.3) (ND) [e]	ND	ND
S150810-27	2240-170	Hawaii	Barn Owl	ND	ND	ND
S150810-28	2240-111	Kauai	Barn Owl		ND	
S150810-29	2240-159	Kauai	Barn Owl	ND	ND	ND
S150810-30	2240-91	Maui	Barn Owl	ND	ND	ND
S150810-31	2240-127	Oahu	Barn Owl	7.7*	ND	ND
S150810-32	2240-126	Hawaii	Barn Owl	ND	ND	
S150810-33	2240-95	Maui	Barn Owl	ND	ND	ND
S150810-34	2240-157	Kauai	Barn Owl		ND	
S150810-35	2240-138	Oahu	Barn Owl	12.6 (7.8*)	ND	6.1*
S150810-36	2240-146	Hawaii	Barn Owl	452 (540)	45.3 (51.6)	305 (314)
S150810-37	2240-145	Hawaii	Barn Owl	7.5*	ND	ND
S150810-38	2240-143	Hawaii	Pueo	ND	ND	ND
S150810-39	2240-167	Hawaii	Pueo	ND	ND	ND
S150810-40	2240-144	Hawaii	Pueo	8.9*	ND	ND
S150810-41	2240-142	Hawaii	Pueo	ND	ND	ND
S150810-42	2240-140	Hawaii	Pueo	ND	ND	ND
S150810-43	2240-141	Hawaii	Pueo	ND	ND	ND
			DL (ng/g) =	3.3	3.3	4.0
			QL (ng/g) =	11.0	11.0	13.3

No sample available for analysis.

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

( ) Concentrations shown in parentheses indicate the result from retesting to confirm the initial result.

† Sample weight significantly below nominal due to small organ size. QL will be significantly higher.

[c] The first result for sample S141208-08 kidney was tested with an earlier version of the method that had a 2X higher QL.

[d] No tissue was available to retest the kidney of S150226-11 to confirm the initial result.

[e] The initial result for sample S150810-26 that was > QL was NOT confirmed when retested.

Difethialone

				Observed Difethialone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S141208-01	2240-07	Big Island	Hawaiian Hawk	47.3 (41.2)	7.7* (9.5*)	37.8* (49.8)[f]
S141208-02	2240-09	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-03	2240-17	Big Island	Hawaiian Hawk	ND (7.9*) (7.5*)	ND	ND
S141208-04	2240-18	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-05	2240-19	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-06	2240-20	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-07	2240-22	Big Island	Hawaiian Hawk	58.9 (67.1)	12.6* (7.0*)	48.8 (34.8)
S141208-08	2240-52	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-09	2240-53	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-10	2240-54	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-11	2240-55	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-12	2240-56	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-25	2240-50	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-26	2240-08	Big Island	Hawaiian Hawk	ND	ND	ND
S150305-01	2240-125	Big Island	Hawaiian Hawk	8.9* (ND)	ND	ND
S150108-01	2240-02	Big Island	Hawaiian Hoary Bat	ND†	ND	ND
S150108-02	2240-59	Maui	Hawaiian Hoary Bat		ND	ND†
S150108-03	2240-60	Maui	Hawaiian Hoary Bat		ND	
S150108-04	2240-61	Maui	Hawaiian Hoary Bat	108 (ND) (ND)[g]†	ND	
S150108-05	2240-65	Maui	Hawaiian Hoary Bat		ND	
S150116-01	2240-01	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-02	2240-57	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-03	2240-62	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-04	2240-63	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-05	2240-64	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-06	2240-66	Maui	Hawaiian Hoary Bat		ND	
S150410-01	2240-128	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-02	2240-129	Oahu	Hawaiian Hoary Bat		ND	
S150410-03	2240-130	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-04	2240-131	Oahu	Hawaiian Hoary Bat		ND	
S150410-05	2240-132	Oahu	Hawaiian Hoary Bat	No Tissue Available		
S150410-06	2240-133	Oahu	Hawaiian Hoary Bat		ND	
S150410-07	2240-134	Oahu	Hawaiian Hoary Bat		ND	
S150410-08	2240-135	Oahu	Hawaiian Hoary Bat		ND	
S150410-09	2240-136	Oahu	Hawaiian Hoary Bat		ND	
S150410-10	2240-137	Oahu	Hawaiian Hoary Bat		ND	
S150305-05	2240-58	Oahu	Barn Owl	165 (114)	11.4* (8.6*)	74.6 (73.0)
S150410-24	2240-139	Oahu	Barn Owl Tissue	ND	ND	ND†
S150108-06	2240-35	Kauai	Pueo	ND	ND	ND
S150108-07	2240-36	Kauai	Pueo	ND	ND	ND
S150108-08	2240-69	Big Island	Pueo	ND	ND	ND
S150108-09	2240-71	Big Island	Pueo	ND	ND	ND
S150108-10	2240-75	Maui	Pueo	ND	ND	ND
S150108-11	2240-76	Maui	Pueo	ND	ND	ND
S150108-12	2240-78	Maui	Pueo		ND	
S150108-13	2240-97	Kauai	Pueo		ND	
S150108-14	2240-98	Kauai	Pueo	ND	ND	ND
S150116-07	2240-12	Big Island	Pueo	ND†	ND	ND†
S150116-08	2240-32	Kauai	Pueo	ND	ND	ND
S150116-09	2240-34	Kauai	Pueo	ND	ND	ND
S150116-10	2240-67	Big Island	Pueo	ND	ND	ND
S150116-11	2240-68	Big Island	Pueo	ND	ND	ND
S150116-12	2240-70	Big Island	Pueo		ND	
S150116-13	2240-72	Big Island	Pueo	ND	ND	ND
S150116-14	2240-73	Big Island	Pueo	ND	ND	
S150116-16	2240-77	Maui	Pueo		ND	
S150116-17	2240-79	Maui	Pueo	No Tissue Available		
S150116-18	2240-80	Maui	Pueo	ND	ND	ND
S150116-19	2240-81	Maui	Pueo	ND	ND	ND
S150305-14	2240-33	Kauai	Pueo	ND	ND	ND†
S150305-15	2240-37	Kauai	Pueo		ND	

				Observed Difethialone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150226-01	2240-04	Big Island	Barn Owl	ND	ND	ND
S150226-02	2240-05	Big Island	Barn Owl	ND	ND	ND
S150226-03	2240-06	Big Island	Barn Owl	19.8 (13.4*)	ND	14.9* (13.3*)
S150226-11	2240-112	Big Island	Barn Owl	ND	ND	ND
S150226-12	2240-113	Big Island	Barn Owl	ND	ND	ND
S150226-13	2240-114	Big Island	Barn Owl	ND	ND	ND
S150226-14	2240-115	Big Island	Barn Owl	ND	ND	ND
S150226-23	2240-03	Big Island	Barn Owl	9.4* (9.3*) (17.3*)	ND	ND
S150305-02	2240-40	Kauai	Barn Owl	ND	ND	ND†
S150305-03	2240-41	Kauai	Barn Owl	ND	ND	ND
S150305-04	2240-42	Kauai	Barn Owl	ND	ND	ND
S150305-06	2240-83	Maui	Barn Owl	ND	ND	ND
S150305-07	2240-86	Maui	Barn Owl	ND	ND	ND
S150305-08	2240-89	Maui	Barn Owl		27.8 (25.3)	
S150305-09	2240-93	Maui	Barn Owl	ND	ND	ND
S150305-10	2240-94	Maui	Barn Owl	ND	ND	ND
S150305-11	2240-96	Maui	Barn Owl	ND	ND	ND
S150305-12	2240-107	Kauai	Barn Owl	ND	ND	ND
S150305-13	2240-109	Kauai	Barn Owl	ND	ND	ND
S150305-20	2240-108	Kauai	Barn Owl (Pueo?)		ND	
S150410-11	2240-23	Big Island	Nene	ND	ND	ND
S150410-12	2240-25	Big Island	Nene	ND	ND	ND
S150410-13	2240-26	Big Island	Nene	ND	ND	ND
S150410-14	2240-27	Big Island	Nene	ND	ND	ND
S150410-15	2240-28	Big Island	Nene	ND	ND	ND
S150410-16	2240-29	Big Island	Nene	ND	ND	ND
S150410-17	2240-30	Big Island	Nene	13.4*	ND	ND
S150410-18	2240-31	Big Island	Nene	ND	ND	ND
S150410-19	2240-38	Kauai	Nene	ND	ND	ND
S150410-20	2240-39	Kauai	Nene - Gosling	ND	ND	ND
S150410-21	2240-43	Kauai	Nene	ND	ND	ND
S150410-22	2240-44	Kauai	Nene	ND	ND	ND
S150410-23	2240-124	Big Island	Nene	ND	ND	ND
S150108-15	2240-100	-	Pueo	ND	ND	ND
S150108-16	2240-103	-	Pueo	No Tissue Available		
S150116-15	2240-74	-	Pueo	ND	ND	ND
S150116-20	2240-99	-	Pueo	ND	ND	
S150116-21	2240-102	-	Pueo	ND	ND	ND
S150226-04	2240-10	-	Barn Owl	ND	ND	ND
S150226-05	2240-11	-	Barn Owl	ND	ND	ND
S150226-06	2240-13	-	Barn Owl	ND	ND	ND
S150226-07	2240-15	-	Barn Owl	19.1* (ND)	ND	ND
S150226-08	2240-16	-	Barn Owl	25.6 (21.9*)	ND	18.9* (14.4*)
S150226-09	2240-21	-	Barn Owl	21.8* (20.4*)	ND	ND
S150226-10	2240-24	-	Barn Owl	ND	ND	ND†
S150226-15	2240-116	-	Barn Owl	14.2* (ND)	ND	ND
S150226-16	2240-117	-	Barn Owl	ND	ND	ND
S150226-17	2240-118	-	Barn Owl	ND	ND	
S150226-18	2240-119	-	Barn Owl	ND	ND	
S150226-19	2240-120	-	Barn Owl	ND	ND	ND
S150226-20	2240-121	-	Barn Owl	ND	ND	ND
S150226-21	2240-122	-	Barn Owl	19.3* (18.9*)	ND	13.3* (ND)
S150226-22	2240-123	-	Barn Owl	17.0* (16.9*)	ND	17.3* (ND)
S150226-24	2240-14	-	Barn Owl	ND	ND	
S150305-16	2240-101	-	Pueo	ND	ND	ND
S150305-17	2240-104	-	Pueo		ND	ND
S150305-18	2240-105	-	Pueo		ND	ND
S150305-19	2240-106	-	Pueo	ND	ND	ND
S150514-03	2240-161	-	Barn Owl		ND	
S150514-04	2240-160	-	Pueo		ND	
S150514-05	2240-162	-	Pueo		ND	
S150514-06	2240-163	-	Pueo	ND	ND	ND

				Observed Difethialone Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150810-01	2240-168	Hawaii	Barn Owl		ND†	
S150810-02	2240-151	Oahu	Barn Owl	ND	ND	ND
S150810-03	2240-152	Oahu	Barn Owl	ND	ND	ND
S150810-04	2240-153	Oahu	Barn Owl	ND	ND	ND
S150810-05	2240-169	Hawaii	Barn Owl	ND	ND	ND
S150810-06	2240-154	Oahu	Barn Owl	ND	ND	ND
S150810-07	2240-164	Hawaii	Barn Owl	ND	ND	ND
S150810-08	2240-165	Hawaii	Barn Owl	ND	ND	ND
S150810-09	2240-155	Oahu	Barn Owl	ND	ND	ND
S150810-10	2240-149	Oahu	Barn Owl	ND	ND	ND
S150810-11	2240-171	Hawaii	Barn Owl	ND	ND	ND
S150810-12	2240-172	Hawaii	Barn Owl	ND	ND	ND
S150810-13	2240-82	Maui	Barn Owl	ND	ND	ND
S150810-14	2240-84	Maui	Barn Owl	ND	ND	ND
S150810-15	2240-88	Maui	Barn Owl		ND	
S150810-16	2240-87	Maui	Barn Owl	ND	ND	ND
S150810-17	2240-148	Oahu	Barn Owl	ND	ND	ND
S150810-18	2240-166	Hawaii	Barn Owl	ND	ND	ND
S150810-19	2240-92	Maui	Barn Owl	14.9* (8.8*)	ND	10.1* (11.2*)
S150810-20	2240-156	Oahu	Barn Owl	ND	ND	ND
S150810-21	2240-150	Oahu	Barn Owl	ND	ND	ND
S150810-22	2240-85	Maui	Barn Owl	ND	ND	ND
S150810-23	2240-158	Kauai	Barn Owl		ND	
S150810-24	2240-147	Oahu	Barn Owl	ND	ND	ND
S150810-25	2240-110	Kauai	Barn Owl	ND	ND	ND†
S150810-26	2240-90	Maui	Barn Owl	ND	ND	ND
S150810-27	2240-170	Hawaii	Barn Owl	ND	ND	ND
S150810-28	2240-111	Kauai	Barn Owl		ND	
S150810-29	2240-159	Kauai	Barn Owl	ND	ND	ND
S150810-30	2240-91	Maui	Barn Owl	ND	ND	ND
S150810-31	2240-127	Oahu	Barn Owl	ND	ND	ND
S150810-32	2240-126	Hawaii	Barn Owl	ND	ND	
S150810-33	2240-95	Maui	Barn Owl	ND	ND	ND
S150810-34	2240-157	Kauai	Barn Owl		ND	
S150810-35	2240-138	Oahu	Barn Owl	ND	ND	ND
S150810-36	2240-146	Hawaii	Barn Owl	51.5 (58.9)	17.2* (ND)	27.4 (31.8)
S150810-37	2240-145	Hawaii	Barn Owl	ND	ND	ND
S150810-38	2240-143	Hawaii	Pueo	ND	ND	ND
S150810-39	2240-167	Hawaii	Pueo	ND	ND	ND
S150810-40	2240-144	Hawaii	Pueo	ND	ND	ND
S150810-41	2240-142	Hawaii	Pueo	ND	ND	ND
S150810-42	2240-140	Hawaii	Pueo	ND	ND	ND
S150810-43	2240-141	Hawaii	Pueo	ND	ND	ND
			DL (ng/g) =	6.9	6.9	6.7
			QL (ng/g) =	23.0	23.0	22.2

No sample available for analysis.

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

( ) Concentrations shown in parentheses indicate the result from retesting to confirm the initial result.

† Sample weight significantly below nominal due to small organ size. QL will be significantly higher.

f The first result for sample S141208-01 kidney was tested with an earlier version of the method that had a 2X higher QL.

g The initial result for sample S150108-04 that was > QL was NOT confirmed when retested.

Desmethyl Bromethalin						
				Observed Desmethyl Bromethalin Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S141208-01	2240-07	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-02	2240-09	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-03	2240-17	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-04	2240-18	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-05	2240-19	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-06	2240-20	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-07	2240-22	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-08	2240-52	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-09	2240-53	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-10	2240-54	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-11	2240-55	Big Island	Hawaiian Hawk	ND	ND	ND
S141208-12	2240-56	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-25	2240-50	Big Island	Hawaiian Hawk	ND	ND	ND
S150226-26	2240-08	Big Island	Hawaiian Hawk	ND	ND	ND
S150305-01	2240-125	Big Island	Hawaiian Hawk	ND	ND	ND
S150108-01	2240-02	Big Island	Hawaiian Hoary Bat	ND†	ND	ND
S150108-02	2240-59	Maui	Hawaiian Hoary Bat		ND	ND†
S150108-03	2240-60	Maui	Hawaiian Hoary Bat		ND	
S150108-04	2240-61	Maui	Hawaiian Hoary Bat	ND†	ND	
S150108-05	2240-65	Maui	Hawaiian Hoary Bat		ND	
S150116-01	2240-01	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-02	2240-57	Big Island	Hawaiian Hoary Bat	ND†	ND	
S150116-03	2240-62	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-04	2240-63	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-05	2240-64	Maui	Hawaiian Hoary Bat	ND†	ND	ND†
S150116-06	2240-66	Maui	Hawaiian Hoary Bat		ND	
S150410-01	2240-128	Oahu	Hawaiian Hoary Bat	ND†	46.1*	
S150410-02	2240-129	Oahu	Hawaiian Hoary Bat		ND	
S150410-03	2240-130	Oahu	Hawaiian Hoary Bat	ND†	ND	
S150410-04	2240-131	Oahu	Hawaiian Hoary Bat		ND	
S150410-05	2240-132	Oahu	Hawaiian Hoary Bat	No Tissue Available		
S150410-06	2240-133	Oahu	Hawaiian Hoary Bat		ND	
S150410-07	2240-134	Oahu	Hawaiian Hoary Bat		ND	
S150410-08	2240-135	Oahu	Hawaiian Hoary Bat		ND	
S150410-09	2240-136	Oahu	Hawaiian Hoary Bat		ND	
S150410-10	2240-137	Oahu	Hawaiian Hoary Bat		ND	
S150305-05	2240-58	Oahu	Barn Owl	ND	ND	ND
S150410-24	2240-139	Oahu	Barn Owl Tissue	ND	ND	ND†
S150108-06	2240-35	Kauai	Pueo	ND	ND	ND
S150108-07	2240-36	Kauai	Pueo	ND	ND	ND
S150108-08	2240-69	Big Island	Pueo	ND	ND	ND
S150108-09	2240-71	Big Island	Pueo	ND	ND	ND
S150108-10	2240-75	Maui	Pueo	ND	ND	ND
S150108-11	2240-76	Maui	Pueo	ND	ND	ND
S150108-12	2240-78	Maui	Pueo		ND	
S150108-13	2240-97	Kauai	Pueo		ND	
S150108-14	2240-98	Kauai	Pueo	ND	ND	ND
S150116-07	2240-12	Big Island	Pueo	ND†	ND	ND†
S150116-08	2240-32	Kauai	Pueo	ND	ND	ND
S150116-09	2240-34	Kauai	Pueo	ND	ND	ND
S150116-10	2240-67	Big Island	Pueo	ND	ND	ND
S150116-11	2240-68	Big Island	Pueo	ND	ND	ND
S150116-12	2240-70	Big Island	Pueo		ND	
S150116-13	2240-72	Big Island	Pueo	ND	ND	ND
S150116-14	2240-73	Big Island	Pueo	ND	ND	
S150116-16	2240-77	Maui	Pueo		ND	
S150116-17	2240-79	Maui	Pueo	No Tissue Available		
S150116-18	2240-80	Maui	Pueo	ND	ND	ND
S150116-19	2240-81	Maui	Pueo	ND	ND	ND
S150305-14	2240-33	Kauai	Pueo	ND	ND	ND†
S150305-15	2240-37	Kauai	Pueo		ND	

				Observed Desmethyl Bromethalin Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150226-01	2240-04	Big Island	Barn Owl	ND	ND	ND
S150226-02	2240-05	Big Island	Barn Owl	ND	ND	ND
S150226-03	2240-06	Big Island	Barn Owl	ND	ND	ND
S150226-11	2240-112	Big Island	Barn Owl	ND	ND	ND
S150226-12	2240-113	Big Island	Barn Owl	ND	ND	ND
S150226-13	2240-114	Big Island	Barn Owl	ND	ND	ND
S150226-14	2240-115	Big Island	Barn Owl	ND	ND	ND
S150226-23	2240-03	Big Island	Barn Owl	ND	ND	ND
S150305-02	2240-40	Kauai	Barn Owl	ND	ND	ND†
S150305-03	2240-41	Kauai	Barn Owl	ND	ND	ND
S150305-04	2240-42	Kauai	Barn Owl	ND	ND	ND
S150305-06	2240-83	Maui	Barn Owl	ND	ND	23.5* (ND)
S150305-07	2240-86	Maui	Barn Owl	ND	ND	ND
S150305-08	2240-89	Maui	Barn Owl		ND	
S150305-09	2240-93	Maui	Barn Owl	ND	ND	ND
S150305-10	2240-94	Maui	Barn Owl	ND	ND	ND
S150305-11	2240-96	Maui	Barn Owl	ND	ND	ND
S150305-12	2240-107	Kauai	Barn Owl	ND	ND	ND
S150305-13	2240-109	Kauai	Barn Owl	ND	ND	ND
S150305-20	2240-108	Kauai	Barn Owl (Pueo?)		ND	
S150410-11	2240-23	Big Island	Nene	ND	ND	ND
S150410-12	2240-25	Big Island	Nene	ND	ND	ND
S150410-13	2240-26	Big Island	Nene	ND	ND	ND
S150410-14	2240-27	Big Island	Nene	ND	ND	ND
S150410-15	2240-28	Big Island	Nene	ND	ND	ND
S150410-16	2240-29	Big Island	Nene	ND	ND	ND
S150410-17	2240-30	Big Island	Nene	ND	ND	ND
S150410-18	2240-31	Big Island	Nene	ND	ND	ND
S150410-19	2240-38	Kauai	Nene	ND	ND	ND
S150410-20	2240-39	Kauai	Nene - Gosling	ND	ND	ND
S150410-21	2240-43	Kauai	Nene	ND	ND	ND
S150410-22	2240-44	Kauai	Nene	ND	ND	ND
S150410-23	2240-124	Big Island	Nene	ND	ND	ND
S150108-15	2240-100	-	Pueo	ND	ND	ND
S150108-16	2240-103	-	Pueo	No Tissue Available		
S150116-15	2240-74	-	Pueo	ND	ND	ND
S150116-20	2240-99	-	Pueo	ND	ND	
S150116-21	2240-102	-	Pueo	ND	ND	ND
S150226-04	2240-10	-	Barn Owl	ND	ND	ND
S150226-05	2240-11	-	Barn Owl	ND	ND	ND
S150226-06	2240-13	-	Barn Owl	ND	ND	ND
S150226-07	2240-15	-	Barn Owl	ND	ND	ND
S150226-08	2240-16	-	Barn Owl	ND	ND	ND
S150226-09	2240-21	-	Barn Owl	ND	ND	ND
S150226-10	2240-24	-	Barn Owl	ND	ND	ND†
S150226-15	2240-116	-	Barn Owl	ND	ND	ND
S150226-16	2240-117	-	Barn Owl	ND	ND	ND
S150226-17	2240-118	-	Barn Owl	ND	ND	
S150226-18	2240-119	-	Barn Owl	ND	ND	
S150226-19	2240-120	-	Barn Owl	ND	ND	ND
S150226-20	2240-121	-	Barn Owl	ND	ND	ND
S150226-21	2240-122	-	Barn Owl	ND	ND	ND
S150226-22	2240-123	-	Barn Owl	ND	ND	ND
S150226-24	2240-14	-	Barn Owl	ND	ND	
S150305-16	2240-101	-	Pueo	ND	ND	ND
S150305-17	2240-104	-	Pueo		ND	ND
S150305-18	2240-105	-	Pueo		ND	ND
S150305-19	2240-106	-	Pueo	ND	ND	ND
S150514-03	2240-161	-	Barn Owl		ND	
S150514-04	2240-160	-	Pueo		ND	
S150514-05	2240-162	-	Pueo		ND	
S150514-06	2240-163	-	Pueo	ND	ND	ND

				Observed Desmethyl Bromethalin Conc. (ng/g)		
NWRC ID	Client ID	Location	Description	Liver	Carcass	Kidney
S150810-01	2240-168	Hawaii	Barn Owl		ND†	
S150810-02	2240-151	Oahu	Barn Owl	ND	ND	ND
S150810-03	2240-152	Oahu	Barn Owl	ND	ND	ND
S150810-04	2240-153	Oahu	Barn Owl	ND	ND	ND
S150810-05	2240-169	Hawaii	Barn Owl	ND	ND	ND
S150810-06	2240-154	Oahu	Barn Owl	ND	ND	ND
S150810-07	2240-164	Hawaii	Barn Owl	ND	ND	ND
S150810-08	2240-165	Hawaii	Barn Owl	ND	ND	ND
S150810-09	2240-155	Oahu	Barn Owl	ND	ND	ND
S150810-10	2240-149	Oahu	Barn Owl	ND	ND	ND
S150810-11	2240-171	Hawaii	Barn Owl	ND	ND	ND
S150810-12	2240-172	Hawaii	Barn Owl	ND	ND	ND
S150810-13	2240-82	Maui	Barn Owl	ND	ND	ND
S150810-14	2240-84	Maui	Barn Owl	ND	ND	ND
S150810-15	2240-88	Maui	Barn Owl		ND	
S150810-16	2240-87	Maui	Barn Owl	ND	ND	ND
S150810-17	2240-148	Oahu	Barn Owl	ND	ND	ND
S150810-18	2240-166	Hawaii	Barn Owl	ND	ND	ND
S150810-19	2240-92	Maui	Barn Owl	ND	ND	ND
S150810-20	2240-156	Oahu	Barn Owl	ND	ND	ND
S150810-21	2240-150	Oahu	Barn Owl	ND	ND	ND
S150810-22	2240-85	Maui	Barn Owl	ND	ND	ND
S150810-23	2240-158	Kauai	Barn Owl		ND	
S150810-24	2240-147	Oahu	Barn Owl	ND	ND	ND
S150810-25	2240-110	Kauai	Barn Owl	ND	ND	ND†
S150810-26	2240-90	Maui	Barn Owl	ND	ND	ND
S150810-27	2240-170	Hawaii	Barn Owl	ND	ND	ND
S150810-28	2240-111	Kauai	Barn Owl		ND	
S150810-29	2240-159	Kauai	Barn Owl	ND	ND	ND
S150810-30	2240-91	Maui	Barn Owl	ND	ND	ND
S150810-31	2240-127	Oahu	Barn Owl	ND	ND	ND
S150810-32	2240-126	Hawaii	Barn Owl	ND	ND	
S150810-33	2240-95	Maui	Barn Owl	ND	ND	ND
S150810-34	2240-157	Kauai	Barn Owl		ND	
S150810-35	2240-138	Oahu	Barn Owl	ND	ND	ND
S150810-36	2240-146	Hawaii	Barn Owl	ND	ND	ND
S150810-37	2240-145	Hawaii	Barn Owl	ND	ND	ND
S150810-38	2240-143	Hawaii	Pueo	ND	ND	ND
S150810-39	2240-167	Hawaii	Pueo	ND	ND	ND
S150810-40	2240-144	Hawaii	Pueo	ND	ND	ND
S150810-41	2240-142	Hawaii	Pueo	ND	ND	ND
S150810-42	2240-140	Hawaii	Pueo	ND	ND	ND
S150810-43	2240-141	Hawaii	Pueo	ND	ND	ND
			DL (ng/g) =	14	37	8.8
			QL (ng/g) =	46.8	125	29.4

No sample available for analysis.

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

( ) Concentrations shown in parentheses indicate the result from retesting to confirm the initial result.

† Sample weight significantly below nominal due to small organ size. QL will be significantly higher.

QC Recoveries - Liver

			Warfarin			Diphacinone			Chlorophacinone		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 1	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 2	Quail	3/12/2015	19.7	20.4	104%	31.6	31.4	99.4%	13.0	13.7 *	105%
QC 3	Quail	3/12/2015	235	239	102%	375	372	99.2%	155	153	98.7%
QC 4	Quail	3/12/2015	3060	3010	98.4%	4890	4920	101%	2010	2130	106%
QC 13	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 14	Quail	3/20/2015	25.9	26.0	100%	41.3	40.6	98.3%	17.0	18.1	106%
QC 15	Quail	3/20/2015	225	223	99.1%	360	370	103%	148	153	103%
QC 16	Quail	3/20/2015	3050	3060	100%	4870	5000	103%	2010	2160	107%
QC 23	Quail	4/8/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 24	Quail	4/8/2015	24.0	24.3	101%	38.3	38.9	102%	15.8	16.5	104%
QC 25	Quail	4/8/2015	234	242	103%	374	383	102%	154	154	100%
QC 26	Quail	4/8/2015	3230	3300	102%	5160	5260	102%	2130	2140	100%
QC 29	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 30	Quail	4/24/2015	25.2	24.8	98.4%	40.2	44.0	109%	16.6	19.7	119%
QC 31	Quail	4/24/2015	221	233	105%	353	367	104%	145	143	98.6%
QC 32	Quail	4/24/2015	2890	2990	103%	4610	4610	100%	1900	1960	103%
QC 39	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 40	Quail	5/14/2015	25.0	22.9	91.6%	40.0	46.2	116%	16.5	18.0	109%
QC 41	Quail	5/14/2015	232	231	99.6%	371	371	100%	153	154	101%
QC 42	Quail	5/14/2015	2620	2440	93.1%	4180	4200	100%	1720	1660	96.5%
QC 63	Quail	9/10/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 64	Quail	9/10/2015	24.8	25.0	101%	38.8	38.7	99.7%	17.1	16.5	96.5%
QC 65	Quail	9/10/2015	225	219	97.3%	351	354	101%	155	157	101%
QC 66	Quail	9/10/2015	3000	2970	99.0%	4690	4640	98.9%	2070	2080	100%
QC 67	Quail	9/16/2015	0.0	2.4 *	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 68	Quail	9/16/2015	25.5	24.2	105%	39.8	37.6	106%	17.5	20.1	87.1%
QC 69	Quail	9/16/2015	217	203	107%	339	329	103%	149	153	97.4%
QC 70	Quail	9/16/2015	3150	3070	103%	4930	4820	102%	2170	2130	102%
QC 71	Quail	9/18/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 72	Quail	9/18/2015	24.4	24.2	99.2%	38.1	36.0	94.5%	16.8	14.0 *	83.3%
QC 73	Quail	9/18/2015	226	223	98.7%	353	334	94.6%	156	151	96.8%
QC 74	Quail	9/18/2015	2960	2880	97.3%	4620	4490	97.2%	2040	2080	102%
QC 87	Quail	10/28/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 88	Quail	10/28/2015	24.3	23.3	95.9%	37.9	39.8	105%	16.7	18.1	108%
QC 89	Quail	10/28/2015	215	203	94.4%	335	318	94.9%	148	155	105%
QC 90	Quail	10/28/2015	3100	3110	100%	4850	4720	97.3%	2140	2250	105%
QC 99	Quail	11/4/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 100	Quail	11/4/2015	24.5	25.1	102%	38.3	34.2	89.3%	16.9	16.0	94.7%
QC 101	Quail	11/4/2015	222	215	96.8%	346	357	103%	152	165	109%
QC 102	Quail	11/4/2015	3310	3230	97.6%	5170	5140	99.4%	2280	2410	106%
QC 103	Nene	1/4/2016	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 104	Nene	1/4/2016	23.4	26.4	113%	36.6	40.7	111%	16.1	18.5	115%
QC 105	Nene	1/4/2016	202	220	109%	316	311	98.4%	139	152	109%
QC 106	Nene	1/4/2016	2640	2720	103%	4130	4270	103%	1820	1890	104%
QC 115	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 116	Nene	1/14/2016	22.3	21.8	97.8%	34.8	34.6	99.4%	15.3	16.4	107%
QC 117	Nene	1/14/2016	207	199	96.1%	324	318	98.1%	143	159	111%
QC 118	Nene	1/14/2016	2670	2600	97.4%	4170	4100	98.3%	1840	1880	102%
		DL (ng/g) =		4.8			7.5			4.8	
		QL (ng/g) =		15.9			25.2			16.0	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Liver

			Bromadiolone			Brodifacoum		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 1	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A
QC 2	Quail	3/12/2015	20.4	18.2	89.2%	22.0	22.2	101%
QC 3	Quail	3/12/2015	241	235	97.5%	262	245	93.5%
QC 4	Quail	3/12/2015	3150	3280	104%	3410	3220	94.4%
QC 13	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A
QC 14	Quail	3/20/2015	26.6	24.4	91.7%	28.8	31.1	108%
QC 15	Quail	3/20/2015	231	232	100%	251	241	96.0%
QC 16	Quail	3/20/2015	3130	3240	104%	3400	3110	91.5%
QC 23	Quail	4/8/2015	0.0	ND	N/A	0.0	ND	N/A
QC 24	Quail	4/8/2015	24.7	21.0	85.0%	26.7	24.3	91.0%
QC 25	Quail	4/8/2015	241	253	105%	261	250	95.8%
QC 26	Quail	4/8/2015	3330	3310	99.4%	3600	3310	91.9%
QC 29	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A
QC 30	Quail	4/24/2015	25.9	22.4	86.5%	28.1	26.3	93.6%
QC 31	Quail	4/24/2015	228	229	100%	246	230	93.5%
QC 32	Quail	4/24/2015	2960	3020	102%	3220	2890	89.8%
QC 39	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A
QC 40	Quail	5/14/2015	25.8	17.8	69.0%	27.9	27.6	98.9%
QC 41	Quail	5/14/2015	239	238	99.6%	259	236	91.1%
QC 42	Quail	5/14/2015	2690	2600	96.7%	2920	2460	84.2%
QC 63	Quail	9/10/2015	0.0	ND	N/A	0.0	ND	N/A
QC 64	Quail	9/10/2015	25.3	22.5	88.9%	30.3	28.7	94.7%
QC 65	Quail	9/10/2015	229	235	103%	274	251	91.6%
QC 66	Quail	9/10/2015	3070	3220	105%	3660	3210	87.7%
QC 67	Quail	9/16/2015	0.0	ND	N/A	0.0	ND	N/A
QC 68	Quail	9/16/2015	26.0	27.3	105%	31.0	26.9	115%
QC 69	Quail	9/16/2015	222	234	105%	265	235	113%
QC 70	Quail	9/16/2015	3220	3530	110%	3840	3380	114%
QC 71	Quail	9/18/2015	0.0	ND	N/A	0.0	ND	N/A
QC 72	Quail	9/18/2015	24.9	18.6	74.7%	29.7	23.1	77.8%
QC 73	Quail	9/18/2015	230	213	92.6%	275	229	83.3%
QC 74	Quail	9/18/2015	3030	2770	91.4%	3610	3090	85.6%
QC 87	Quail	10/28/2015	0.0	ND	N/A	0.0	ND	N/A
QC 88	Quail	10/28/2015	24.8	28.9	117%	29.6	26.9	90.9%
QC 89	Quail	10/28/2015	219	230	105%	261	210	80.5%
QC 90	Quail	10/28/2015	3170	3300	104%	3780	3630	96.0%
QC 99	Quail	11/4/2015	0.0	ND	N/A	0.0	ND	N/A
QC 100	Quail	11/4/2015	25.1	25.4	101%	29.8	24.2	81.2%
QC 101	Quail	11/4/2015	226	223	98.7%	270	220	81.5%
QC 102	Quail	11/4/2015	3380	3100	91.7%	4030	3640	90.3%
QC 103	Nene	1/4/2016	0.0	ND	N/A	0.0	ND	N/A
QC 104	Nene	1/4/2016	24.0	12.8	53.3%	28.5	24.3	85.3%
QC 105	Nene	1/4/2016	207	219	106%	246	223	90.7%
QC 106	Nene	1/4/2016	2700	2780	103%	3220	3080	95.7%
QC 115	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 116	Nene	1/14/2016	22.7	8.7	38.3%	27.1	22.6	83.4%
QC 117	Nene	1/14/2016	212	202	95.3%	253	223	88.1%
QC 118	Nene	1/14/2016	2730	2670	97.8%	3250	2950	90.8%
		DL (ng/g) =		2.2			3.3	
		QL (ng/g) =		7.4			11.0	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Liver

			Difethialone			Desmethyl Bromethalin		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 1	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A
QC 2	Quail	3/12/2015	58.4	60.4	103%	111	137	123%
QC 3	Quail	3/12/2015	695	666	95.8%	1320	1490	113%
QC 4	Quail	3/12/2015	9050	8970	99.1%	17100	20000	117%
QC 13	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A
QC 14	Quail	3/20/2015	76.5	75.7	99.0%	145	168	116%
QC 15	Quail	3/20/2015	666	696	105%	1260	1460	116%
QC 16	Quail	3/20/2015	9020	10400	115%	17100	17700	104%
QC 23	Quail	4/8/2015	0.0	ND	N/A	0.0	ND	N/A
QC 24	Quail	4/8/2015	70.9	71.9	101%	134	156	116%
QC 25	Quail	4/8/2015	692	632	91.3%	1310	1750	134%
QC 26	Quail	4/8/2015	9550	10300	108%	18100	23000	127%
QC 29	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A
QC 30	Quail	4/24/2015	74.5	76.5	103%	141	160	113%
QC 31	Quail	4/24/2015	654	675	103%	1240	1100	88.7%
QC 32	Quail	4/24/2015	8530	8840	104%	16200	14200	87.7%
QC 39	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A
QC 40	Quail	5/14/2015	74.1	77.7	105%	140	202	144%
QC 41	Quail	5/14/2015	687	695	101%	1300	1880	145%
QC 42	Quail	5/14/2015	7740	7060	91.2%	14700	19500	133%
QC 63	Quail	9/10/2015	0.0	ND	N/A	0.0	ND	N/A
QC 64	Quail	9/10/2015	76.4	69.6	91.1%	163	101	62.0%
QC 65	Quail	9/10/2015	690	655	94.9%	1480	835	56.4%
QC 66	Quail	9/10/2015	9230	8290	89.8%	19700	15200	77.2%
QC 67	Quail	9/16/2015	0.0	ND	N/A	0.0	ND	N/A
QC 68	Quail	9/16/2015	78.3	73.4	107%	167	134	125%
QC 69	Quail	9/16/2015	668	617	108%	1430	1240	115%
QC 70	Quail	9/16/2015	9700	9450	103%	20700	24000	86.3%
QC 71	Quail	9/18/2015	0.0	ND	N/A	0.0	ND	N/A
QC 72	Quail	9/18/2015	75.0	73.4	97.9%	160	48.6	30.4%
QC 73	Quail	9/18/2015	695	642	92.4%	1490	438	29.4%
QC 74	Quail	9/18/2015	9100	7380	81.1%	19500	1150	5.9%
QC 87	Quail	10/28/2015	0.0	ND	N/A	0.0	ND	N/A
QC 88	Quail	10/28/2015	74.6	66.7	89.4%	159	181	114%
QC 89	Quail	10/28/2015	660	544	82.4%	1410	1490	106%
QC 90	Quail	10/28/2015	9540	8350	87.5%	20400	21700	106%
QC 99	Quail	11/4/2015	0.0	ND	N/A	0.0	ND	N/A
QC 100	Quail	11/4/2015	75.3	71.5	95.0%	161	199	124%
QC 101	Quail	11/4/2015	681	549	80.6%	1460	1530	105%
QC 102	Quail	11/4/2015	10170	8160	80.2%	21800	23100	106%
QC 103	Nene	1/4/2016	0.0	ND	N/A	0.0	ND	N/A
QC 104	Nene	1/4/2016	72.0	62.8	87.2%	170	294	173%
QC 105	Nene	1/4/2016	621	592	95.3%	1460	2340	160%
QC 106	Nene	1/4/2016	8130	7750	95.3%	19200	24700	129%
QC 115	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 116	Nene	1/14/2016	68.5	43.4	63.4%	162	190	117%
QC 117	Nene	1/14/2016	638	610	95.6%	1500	1810	121%
QC 118	Nene	1/14/2016	8210	7570	92.2%	19400	15200	78.4%
		DL (ng/g) =		6.9			14	
		QL (ng/g) =		23.0			46.8	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Carcass

			Warfarin			Diphacinone			Chlorophacinone		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 5	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 6	Quail	3/12/2015	20.6	24.2 *	117%	32.9	32.3	98.2%	13.5	12.7 *	94.1%
QC 7	Quail	3/12/2015	230	240	104%	367	360	98.1%	151	148	98.0%
QC 8	Quail	3/12/2015	2980	3050	102%	4760	4930	104%	1960	1970	101%
QC 17	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 18	Quail	3/20/2015	25.5	27.2 *	107%	40.8	41.6	102%	16.8	17.7	105%
QC 19	Quail	3/20/2015	230	228	99.1%	368	370	101%	151	148	98.0%
QC 20	Quail	3/20/2015	3080	3110	101%	4930	4870	98.8%	2030	2090	103%
QC 33	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 34	Quail	4/24/2015	23.8	23.3 *	97.9%	38.0	39.0	103%	15.7	14.1 *	89.8%
QC 35	Quail	4/24/2015	224	221	98.7%	358	363	101%	148	143	96.6%
QC 36	Quail	4/24/2015	3060	3080	101%	4890	4840	99.0%	2020	2020	100%
QC 43	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 44	Quail	5/14/2015	22.5	23.0 *	102%	36.0	31.6	87.8%	14.8	11.4 *	77.0%
QC 45	Quail	5/14/2015	230	223	97.0%	368	355	96.5%	152	150	98.7%
QC 46	Quail	5/14/2015	2710	2540	93.7%	4330	4000	92.4%	1780	1830	103%
QC 49	Quail	8/11/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 50	Quail	8/11/2015	23.2	23.8 *	103%	36.3	37.0	102%	16.0	16.8	105%
QC 51	Quail	8/11/2015	218	208	95.4%	341	360	106%	150	148	98.7%
QC 52	Quail	8/11/2015	2990	2990	100%	4670	4580	98.1%	2060	2090	101%
QC 59	Quail	9/10/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 60	Quail	9/10/2015	25.7	25.5 *	99.2%	40.2	39.2	97.5%	17.7	18.7	106%
QC 61	Quail	9/10/2015	218	217	99.5%	341	345	101%	150	149	99.3%
QC 62	Quail	9/10/2015	3030	3200	106%	4740	4630	97.7%	2090	2160	103%
QC 83	Quail	10/23/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 84	Quail	10/23/2015	23.2	22.0 *	94.8%	36.3	36.7	101%	16.0	16.4	103%
QC 85	Quail	10/23/2015	206	205	99.5%	322	328	102%	142	152	107%
QC 86	Quail	10/23/2015	2970	2980	100%	4640	4750	102%	2040	1880	92.2%
QC 95	Quail	11/4/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 96	Quail	11/4/2015	22.2	21.7 *	97.7%	34.7	36.3	105%	15.3	14.7	96.1%
QC 97	Quail	11/4/2015	213	218	102%	333	316	94.9%	146	145	99.3%
QC 98	Quail	11/4/2015	2740	2640	96.4%	4280	4090	95.6%	1880	1890	101%
QC 111	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 112	Nene	1/14/2016	25.3	25.8 *	102 %	39.6	39.4	99.5%	17.4	22.6	130%
QC 113	Nene	1/14/2016	224	214	95.5%	350	353	101%	154	174	113%
QC 114	Nene	1/14/2016	2810	2840	101%	4400	3980	90.5%	1940	1960	101%
QC 123	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 124	Nene	1/14/2016	22.1	21.5 *	97.3%	34.5	34.8	101%	15.2	16.3	107%
QC 125	Nene	1/14/2016	198	196	99.0%	310	304	98.1%	136	135	99.3%
QC 126	Nene	1/14/2016	2870	2860	99.7%	4490	4290	95.5%	1980	1810	91.4%
		DL (ng/g) =		9.4			7.2			4.3	
		QL (ng/g) =		31.4			24.0			14.4	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Carcass

			Bromadiolone			Brodifacoum		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 5	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A
QC 6	Quail	3/12/2015	21.2	19.3	91.0%	22.9	19.6	85.6%
QC 7	Quail	3/12/2015	236	221	93.6%	256	191	74.6%
QC 8	Quail	3/12/2015	3060	2970	97.1%	3320	2550	76.8%
QC 17	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A
QC 18	Quail	3/20/2015	26.3	30.0	114%	28.5	25.7	90.2%
QC 19	Quail	3/20/2015	236	234	99.2%	257	208	80.9%
QC 20	Quail	3/20/2015	3170	3200	101%	3440	2980	86.6%
QC 33	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A
QC 34	Quail	4/24/2015	24.5	18.9	77.1%	26.5	19.4	73.2%
QC 35	Quail	4/24/2015	230	193	83.9%	250	181	72.4%
QC 36	Quail	4/24/2015	3150	2990	94.9%	3420	2620	76.6%
QC 43	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A
QC 44	Quail	5/14/2015	23.1	14.6	63.2%	25.1	20.3	80.9%
QC 45	Quail	5/14/2015	237	219	92.4%	257	208	80.9%
QC 46	Quail	5/14/2015	2780	2680	96.4%	3020	2300	76.2%
QC 49	Quail	8/11/2015	0.0	ND	N/A	0.0	ND	N/A
QC 50	Quail	8/11/2015	23.7	20.9	88.2%	28.3	22.9	80.9%
QC 51	Quail	8/11/2015	223	230	103%	266	212	79.7%
QC 52	Quail	8/11/2015	3050	3220	106%	3640	2990	82.1%
QC 59	Quail	9/10/2015	0.0	ND	N/A	0.0	ND	N/A
QC 60	Quail	9/10/2015	26.3	28.5	108%	31.3	28.0	89.5%
QC 61	Quail	9/10/2015	223	223	100%	266	223	83.8%
QC 62	Quail	9/10/2015	3100	3210	104%	3700	3300	89.2%
QC 83	Quail	10/23/2015	0.0	ND	N/A	0.0	ND	N/A
QC 84	Quail	10/23/2015	23.7	26.5	112%	28.3	24.7	87.3%
QC 85	Quail	10/23/2015	211	231	109%	251	210	83.7%
QC 86	Quail	10/23/2015	3030	2990	98.7%	3610	3160	87.5%
QC 95	Quail	11/4/2015	0.0	ND	N/A	0.0	ND	N/A
QC 96	Quail	11/4/2015	22.6	18.6	82.3%	27.0	25.1	93.0%
QC 97	Quail	11/4/2015	218	216	99.1%	259	244	94.2%
QC 98	Quail	11/4/2015	2800	2540	90.7%	3340	3090	92.5%
QC 111	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 112	Nene	1/14/2016	25.9	10.9	42.1%	30.8	23.3	75.6%
QC 113	Nene	1/14/2016	229	226	98.7%	273	253	92.7%
QC 114	Nene	1/14/2016	2880	2710	94.1%	3430	3110	90.7%
QC 123	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 124	Nene	1/14/2016	22.6	6.6	29.2%	26.9	22.0	81.8%
QC 125	Nene	1/14/2016	203	195	96.1%	241	214	88.8%
QC 126	Nene	1/14/2016	2930	2870	98.0%	3500	3070	87.7%
		DL (ng/g) =		4.9			3.3	
		QL (ng/g) =		16.1			11.0	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Carcass

			Difethialone			Desmethyl Bromethalin		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 5	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A
QC 6	Quail	3/12/2015	60.8	75.3	124%	115	150	130%
QC 7	Quail	3/12/2015	679	548	80.7%	1290	1620	126%
QC 8	Quail	3/12/2015	8810	7750	88.0%	16700	24000	144%
QC 17	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A
QC 18	Quail	3/20/2015	75.5	67.2	89.0%	143	184	129%
QC 19	Quail	3/20/2015	681	675	99.1%	1290	1590	123%
QC 20	Quail	3/20/2015	9120	9830	108%	17300	21000	121%
QC 33	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A
QC 34	Quail	4/24/2015	70.4	52.7	74.9%	133	162	122%
QC 35	Quail	4/24/2015	663	442	66.7%	1260	1490	118%
QC 36	Quail	4/24/2015	9060	8330	91.9%	17200	19900	116%
QC 43	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A
QC 44	Quail	5/14/2015	66.6	53.2	79.9%	126	185	147%
QC 45	Quail	5/14/2015	681	625	91.8%	1290	1860	144%
QC 46	Quail	5/14/2015	8020	7910	98.6%	15200	22200	146%
QC 49	Quail	8/11/2015	0.0	ND	N/A	0.0	ND	N/A
QC 50	Quail	8/11/2015	71.4	66.4	93.0%	153	158	103%
QC 51	Quail	8/11/2015	672	519	77.2%	1440	1550	108%
QC 52	Quail	8/11/2015	9190	8230	89.6%	19600	18800	95.9%
QC 59	Quail	9/10/2015	0.0	ND	N/A	0.0	ND	N/A
QC 60	Quail	9/10/2015	79.0	74.2	93.9%	169	211	125%
QC 61	Quail	9/10/2015	672	556	82.7%	1440	1590	110%
QC 62	Quail	9/10/2015	9330	8820	94.5%	19900	23800	120%
QC 83	Quail	10/23/2015	0.0	ND	N/A	0.0	ND	N/A
QC 84	Quail	10/23/2015	71.3	71.7	101%	153	177	116%
QC 85	Quail	10/23/2015	634	602	95.0%	1350	1850	137%
QC 86	Quail	10/23/2015	9120	8060	88.4%	19500	25700	132%
QC 95	Quail	11/4/2015	0.0	ND	N/A	0.0	ND	N/A
QC 96	Quail	11/4/2015	68.2	62.8	92.1%	146	168	115%
QC 97	Quail	11/4/2015	654	667	102%	1400	1560	111%
QC 98	Quail	11/4/2015	8420	7250	86.1%	18000	21300	118%
QC 111	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 112	Nene	1/14/2016	77.8	54.1	69.5%	184	337	183%
QC 113	Nene	1/14/2016	688	566	82.3%	1620	3030	187%
QC 114	Nene	1/14/2016	8650	7240	83.7%	20500	43300	211%
QC 123	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 124	Nene	1/14/2016	67.9	39.5	58.2%	161	243	151%
QC 125	Nene	1/14/2016	609	513	84.2%	1430	2020	141%
QC 126	Nene	1/14/2016	8830	7400	83.8%	20900	25400	122%
		DL (ng/g) =		6.9			37	
		QL (ng/g) =		23.0			125	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Kidney

			Warfarin			Diphacinone			Chlorophacinone		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 9	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 11	Quail	3/12/2015	464	468	101%	742	758	102%	306	283	92.5%
QC 21	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 22	Quail	3/20/2015	298	300	101%	476	464	97.5%	196	189	96.4%
QC 27	Quail	4/8/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 28	Quail	4/8/2015	227	234	103%	362	351	97.0%	149	141	94.6%
QC 37	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 38	Quail	4/24/2015	208	209	100%	333	334	100%	137	133	97.1%
QC 47	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 48	Quail	5/14/2015	226	219	96.9%	360	343	95.3%	148	141	95.3%
QC 53	Quail	8/25/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 54	Quail	8/25/2015	231	248	107%	361	369	102%	159	162	102%
QC 91	Quail	10/29/2015	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 92	Quail	10/29/2015	23.4	24.2 *	103%	36.5	36.2	99.2%	16.1	18.8	117%
QC 93	Quail	10/29/2015	207	196	94.7%	324	333	103%	143	142	99.3%
QC 94	Quail	10/29/2015	2910	2910	100%	4550	4560	100%	2000	2170	109%
QC 107	Nene	1/7/2016	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 108	Nene	1/7/2016	21.9	22.5 *	103%	34.2	35.1	103%	15.1	15.5 *	103%
QC 109	Nene	1/7/2016	198	178	89.9%	309	298	96.4%	136	143	105%
QC 110	Nene	1/7/2016	2670	2720	102%	4170	4020	96.4%	1840	1730	94.0%
QC 119	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A	0.0	ND	N/A
QC 120	Nene	1/14/2016	21.6	21.0 *	97.2%	33.7	32.3	95.8%	14.9	14.5 *	97.3%
QC 121	Nene	1/14/2016	215	214	99.5%	336	336	100%	148	153	103%
QC 122	Nene	1/14/2016	2800	2680	95.7%	4370	4370	100%	1930	1750	90.7%
		DL (ng/g) =		8.6			7.9			4.7	
		QL (ng/g) =		28.6			26.4			15.7	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Kidney

			Bromadiolone			Brodifacoum		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 9	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A
QC 11	Quail	3/12/2015	477	445	93.3%	518	377	72.8%
QC 21	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A
QC 22	Quail	3/20/2015	306	300	98.0%	332	296	89.2%
QC 27	Quail	4/8/2015	0.0	ND	N/A	0.0	ND	N/A
QC 28	Quail	4/8/2015	234	226	96.6%	253	235	92.9%
QC 37	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A
QC 38	Quail	4/24/2015	214	206	96.3%	233	200	85.8%
QC 47	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A
QC 48	Quail	5/14/2015	231	221	95.7%	252	217	86.1%
QC 53	Quail	8/25/2015	0.0	ND	N/A	0.0	ND	N/A
QC 54	Quail	8/25/2015	236	245	104%	282	264	93.6%
QC 91	Quail	10/29/2015	0.0	ND	N/A	0.0	ND	N/A
QC 92	Quail	10/29/2015	23.9	24.6	103%	28.5	24.7	86.7%
QC 93	Quail	10/29/2015	211	202	95.7%	252	204	81.0%
QC 94	Quail	10/29/2015	2970	2880	97.0%	3550	3090	87.0%
QC 107	Nene	1/7/2016	0.0	ND	N/A	0.0	ND	N/A
QC 108	Nene	1/7/2016	22.3	9.0	40.4%	26.7	22.9	85.8%
QC 109	Nene	1/7/2016	202	199	98.5%	241	214	88.8%
QC 110	Nene	1/7/2016	2730	2690	98.5%	3250	2840	87.4%
QC 119	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 120	Nene	1/14/2016	22.1	5.4	24.4%	26.3	26.8	102%
QC 121	Nene	1/14/2016	219	212	96.8%	262	261	99.6%
QC 122	Nene	1/14/2016	2860	2810	98.3%	3410	3130	91.8%
		DL (ng/g) =		2.3			4.0	
		QL (ng/g) =		7.6			13.3	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).

QC Recoveries - Kidney

			Difethialone			Desmethyl Bromethalin		
ID		Analysis Date	Theor. (ng/g)	Obser. (ng/g)	% Recov.	Theor. (ng/g)	Obser. (ng/g)	% Recov.
QC 9	Quail	3/12/2015	0.0	ND	N/A	0.0	ND	N/A
QC 11	Quail	3/12/2015	1370	1330	97.1%	2600	4820	185%
QC 21	Quail	3/20/2015	0.0	ND	N/A	0.0	ND	N/A
QC 22	Quail	3/20/2015	881	851	96.6%	1670	2260	135%
QC 27	Quail	4/8/2015	0.0	ND	N/A	0.0	ND	N/A
QC 28	Quail	4/8/2015	671	652	97.2%	1270	1590	125%
QC 37	Quail	4/24/2015	0.0	ND	N/A	0.0	ND	N/A
QC 38	Quail	4/24/2015	617	581	94.2%	1170	1040	88.9%
QC 47	Quail	5/14/2015	0.0	ND	N/A	0.0	ND	N/A
QC 48	Quail	5/14/2015	667	582	87.3%	1260	1670	133%
QC 53	Quail	8/25/2015	0.0	ND	N/A	0.0	ND	N/A
QC 54	Quail	8/25/2015	711	682	95.9%	1520	1700	112%
QC 91	Quail	10/29/2015	0.0	ND	N/A	0.0	ND	N/A
QC 92	Quail	10/29/2015	71.9	71.5	99.4%	154	190	123%
QC 93	Quail	10/29/2015	637	582	91.4%	1360	1490	110%
QC 94	Quail	10/29/2015	8950	7920	88.5%	19100	23000	120%
QC 107	Nene	1/7/2016	0.0	ND	N/A	0.0	ND	N/A
QC 108	Nene	1/7/2016	67.3	51.5	76.5%	159	190	119%
QC 109	Nene	1/7/2016	608	558	91.8%	1430	1380	96.5%
QC 110	Nene	1/7/2016	8210	8170	99.5%	19400	21500	111%
QC 119	Nene	1/14/2016	0.0	ND	N/A	0.0	ND	N/A
QC 120	Nene	1/14/2016	66.4	45.9	69.1%	157	285	182%
QC 121	Nene	1/14/2016	662	604	91.2%	1560	2550	163%
QC 122	Nene	1/14/2016	8600	5120	59.5%	20400	23700	116%
		DL (ng/g) =		6.7			8.8	
		QL (ng/g) =		22.2			29.4	

ND Not Detected. This is reported when no analyte is detected or when the result was < DL.

* Results reported with an asterisk denote concentrations below the Quantitation Limit (QL).