

Direct and Indirect Effects of Environmental Contaminants on Wildlife Health

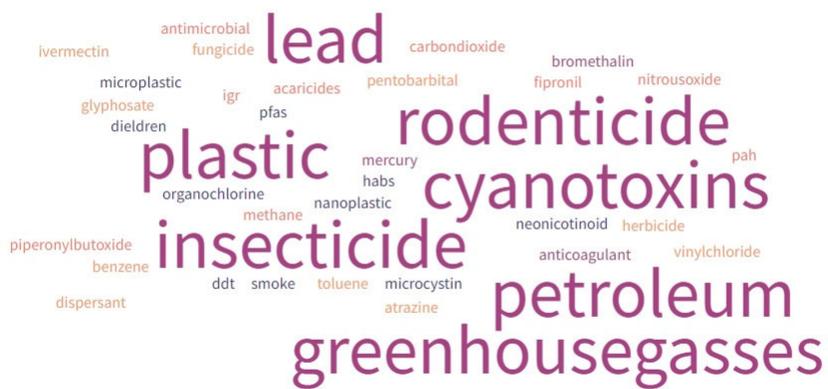
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College of Veterinary Medicine

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a few contaminants impacting wildlife health

- **Lead Poisoning**
- Rodenticides
- Mixed exposures: Pollinators

- Case study: Sam the adult male bald eagle
 - Found on the ground
 - Unable to stand, fly
 - Abnormal vocalization
 - Radiographs: metal object



Courtesy NYS Wildlife Health Program &
Avian Haven Wild Bird Rehabilitation Center

Test Results

Necropsy

Wing chord: 550 mm. Bill depth: 32.5 mm. Right hallux: 42.2 mm. Left hallux: 41.4 mm. No leg bands. Adult plumage. Bile stained plumage around vent. Bile-colored fluid from mouth. No sign of trauma. Fair flesh at best. Pectoral mass is down. Cardiac fat and small thoracoabdominal cavity fat stores present. Skeletal muscle slightly pale. Lungs and airsacs clear. Liver is unremarkable. Gall bladder distended with bile (staining surrounding liver). Heart pale, trace of serous fluid under pericardium. Kidneys pale, white uric acid visible on cut section. **Ventriculus contains one large lead bullet fragment (15x9x3.4 mm, 1.67 g) and a trace of deer hair fragments** (confirmed microscopically by KH). Ventriculus lining coated with bile colored mucoid material. Intestines contain bile/mucous. Crop contains bile-colored fluid and a few deer hair fragments.

Toxicology

Director Karyn Bischoff - 607-253-3900

Test	Result	Reference Interval
1 ██████████ Aves - Falconiformes Bald Eagle Male		
Liver		
Lead, tissue/feed/other	Moisture: 72.40 % Dry Matter: 27.60 % Lead: 132.6 ppm	

Comments: This liver lead concentration is remarkably elevated, consistent with the finding of lead foreign material in the gizzard, and most likely contributed to the death of this individual.

This Lead result is given on a dry matter basis. Liver lead concentrations greater than 20 ppm dry matter have been associated with clinical lead poisoning in wild birds (USGS Field Guide to Wildlife Diseases). Lead concentrations from livers of 10 bald eagles dead from various causes in Oregon and California ranged from approximately 1.28 to 108 ppm dry matter (Frenzel and Anthony, 1989).

	Lead (ug/dL)	Weight (g)	Sex	Sample Group	Lead (ug/dL)	Weight (g)	Sex	Sample Group
Whole blood lead concentrations in Virginia opossums presented to the Wildlife Medical Clinic and free-roaming opossums trapped at field locations from Illinois. Data is listed in order of lowest blood lead concentration to highest.	3.25	3242	Female	WMC	5.65	2750	Female	Field
	6.27	3270	Male	WMC	5.66	4100	Male	Field
	6.54	2260	Male	WMC	5.96	700	Male	Field
	9.95	2560	Female	WMC	5.96	3400	Female	Field
	16.3	2000	Female	WMC	6.52	32.85	Male	Field
	16.38	1340	Female	WMC	7.31	805	Male	Field
	17.23	1020	Female	WMC	7.72	740	Male	Field
	31.14	2075	Female	WMC	9.09	675	Female	Field
	33.2	3270	Female	WMC	10.43	2080	Female	Field
	34.03	1080	Male	WMC	13.17	3400	Male	Field
	43.86	2410	Male	WMC	14.12	1650	Female	Field
	47.06	2640	Male	WMC	17.12	3670	Female	Field
	47.52	1680	Male	WMC	18.85	3900	Male	Field
	61.42	1061	Female	WMC	20.75	2985	Female	Field
	70.82	2240	Male	WMC	25.83	1040	Male	Field
135	2765	Female	WMC	37.82	4400	Male	Field	

McDaniel, Sander, Sander, Mateus-Pinilla, Bischoff, Accepted by *J Wildlife Diseases*

- Common sources of lead:
 - Legacy lead
 - Paint from pre-1978 housing
 - Gasoline for pre-1975 cars
 - Some outdoor paints
 - Current
 - Gasoline for: marine, aircraft, racing, and farm equipment
 - Sporting goods: fishing sinkers, lures, ammunition
 - Battery plates
 - Lead objects

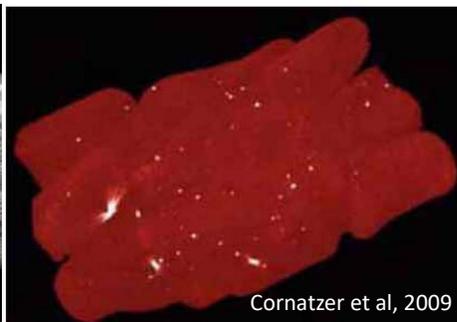


Table 1. Summary of lead content analysis in Wisconsin hunter-killed deer.

Sample group	Number of samples*	Mean lead conc., lead-positive samples mg/kg \pm std. dev.	Mean lead conc., all samples mg/kg \pm std. dev.	Prevalence of lead-positive samples
Commercial processor	199	15.9 \pm 32.5	2.4 mg/kg \pm 13.8	15%
Hunter processed	98	21.8 \pm 67.1	1.8 mg/kg \pm 19.8	8%

*Each sample represents a nominal 1 pound package.

Thiboldeaux 2008

- Lead Poisoning
- **Rodenticides**
- Mixed exposures: Pollinators

- Rodenticides
 - Anticoagulant
 - Short-acting
 - Warfarin
 - Diphacinone?
 - Chlorophacinone?
 - Long-acting
 - Brodifacoum
 - Bromadiolone
 - Difethialone
 - Death in 3-7 days
 - Rodenticides
 - Bromethalin
 - Cholecalciferol
 - Strychnine
 - Rapidly lethal
 - Zinc phosphide
 - Rapidly lethal

- Anticoagulant rodenticide contamination

- New York

- Stone et al, 2003
 - 49% of all raptors
 - 81% GHOs
 - 58% RTHs
 - 45% Screeches



Courtesy David Lei, AP

- California

- Serieys et al, 2015
 - 80+% of mammals
 - Coyote
 - Bobcat
 - Kit fox
 - Mountain lion
- Herring et al 2022
 - Condors (42%)
 - Vultures (93%)



Courtesy Don Vickers



Courtesy Lincoln Karim

- Anticoagulants rodenticide contamination

- Predatory birds

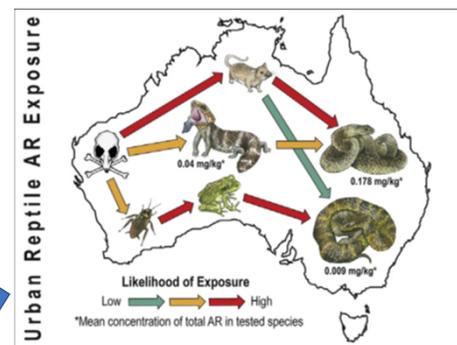
- Australia (Cooke 2023)
- Spain (Oliva-Vidal 2022)
- France (Lestrade 2021)

- Mammals

- Germany (Regnery 2024)
- France (Lestrade 2021)

- Reptiles

- Australia (Lettoof 2020)



- Bromethalin
 - Detected in hawks and owls in NE US
 - Murray & Cox 2023
 - Poisonings in feral conures in CA
 - Seguel et al 2022
 - Death in black bear in Guelph
 - Cox et al 2023

@UGAResearch

UGA ANNUAL HEALTH | MARCH 16, 2023
Bromethalin is poisoning the parrots of Telegraph Hill
By Kat Gilmore



- Lead Poisoning
- Rodenticides
- **Mixed Exposures: Pollinators**



- Honey bees (*Apis mellifera*)
 - USDA Honey Production Report 2023
 - 2.67M domestic honey bee colonies in US
 - 125M pounds of raw honey/year in US
 - \$370M US



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- Honey bees (*Apis mellifera*)
 - USDA Honey Production Report 2023
 - 2.67M domestic honey bee colonies in US
 - 125M pounds of raw honey/year in US
 - \$370M US
 - Food Security: pollination service
 - Up to \$577B worldwide (Khalifa 2023)
 - \$11.7B in US +\$3.4B for native bees



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1881.	THE AMERICAN BEE JOURNAL.	85
	<p>not discouraged. If I had to make a living from bees it would be slim. I can learn more in 1 week about taking care of bees from the BEE JOURNAL, than I could in 1 year without it.</p> <p style="text-align: right;">EDMUND DELAIR.</p>	<p>very late spring, I prepared 148 colonies for winter, (123 in chaff hives and 25 in the common box hive.) I have lost but one in chaff hive yet, and 10 in the box hive already, and doubt if one-half of what are left will see the middle of next year.</p> <p>Bees in Prime Condition.—I have 110 colonies in the cellar in prime condition. Nearly all bees out doors are dead.</p> <p style="text-align: right;">C. H. DRIBBEN.</p> <p>Milan, Ill. Mar. 9, 1881.</p>

- Honey bee physiology: Xenobiotic metabolism
 - Phase I: cytochrome P450s & carboxylesterases
 - Relatively deficient in bees
 - Symbiosis with plants
 - Variable with age, cast, season
 - Inhibited by some pesticides
 - Bischoff & Moiseff 2023 (review)



Paris Green.—It is not very good for bees, as I had an opportunity last spring to find out. I have in my garden a 10 year old plum tree that never perfected any fruit and knowing that Paris green would kill bugs I thought it might also kill the "little turk," or Curculio. Acting upon the suggestion I mixed some Paris green in a watering can and put up through the branches of the tree a long ladder, from the top of which I sprinkled the whole top of the tree just before dark, and a day or 2 before the bloom went off. Next day afternoon as I was passing through my bee yard I was very much surprised to see on the ground a good many bees in a dying condition which I could not account for. I came at last, however, to the conclusion that they had gone to the plum tree in the morning before it was dry and partaken of the poison. I lost a good many bees but I have learned this lesson, "never to put Paris green on trees when in bloom;" still I am satisfied that by sprinkling or syringing 2 or 3 times, when the plum is in its incipient state, it will insure a crop. Who will try this spring and report?

GEO. THOMPSON.

Geneva, Ill.

- Honey bee physiology: Xenobiotic metabolism
 - Phase I: cytochrome P450s & carboxylesterases
 - Location:
 - Fat bodies (liver)
 - Malpighian tubules (kidney)
 - Midgut
 - Mitochondria
 - Cuticle
 - Brain

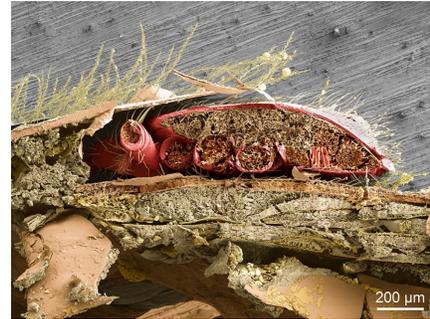


Photo credit: USDA-ARS, Electron and Confocal Microscopy Unit, Beltsville, Maryland)

Table 2.

Pesticides found 50%, New York, USA, 2021

Pesticide	% positive, <i>n</i> = 72	\bar{x} , $\mu\text{g}/\text{kg}$
Piperonyl butoxide	98.6	13.5
Metolachlor	95.8	1.32
Fenpyroximate	94.4	1.89
Difenoconazole	93.1	5.54
2,4-DMPF	83.3	1810
Atrazine	75.0	0.58
Diuron	73.6	6.63
Pyraclostrobin	68.1	7.17
Azoxystrobin	66.7	6.16
Trifloxystrobin	66.7	1.52
Propiconazole	55.6	9.53
Tebuthiuron	54.2	0.696
Cyprodinil	52.8	0.556
Carbaryl	50.0	0.76
Fluopyram	50.0	0.134

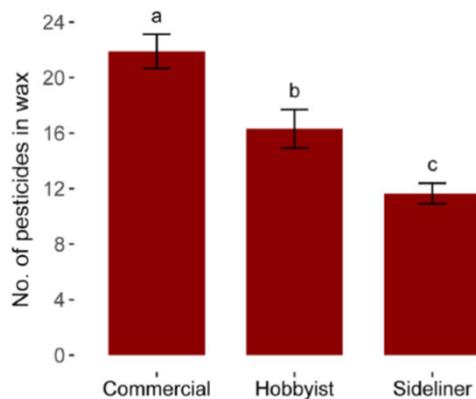


Figure 1. Number of pesticide residues in beeswax sampled from commercial beekeepers (> 300 colonies), sideliners (50–299 colonies), and hobbyists (< 50 colonies). Different letters indicate significance ($p < 0.05$) via emmeans post-hoc contrasts. $\bar{x} \pm \text{SE}$ shown.

Bischoff et al 2023

• References: Lead

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• References: Rodenticides

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• References: Pollinators

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