Monitoring Pesticide Use and Wildlife Exposure in Scotland

Jacqueline Hughes, Elizabeth Sharp, Laura Melton & Michael Taylor. Science and Advice for Scottish Agriculture (SASA), Scottish Government

Introduction

Scottish wildlife is exposed to a range of environmental contaminants, including rodenticides and plant protection products (PPPs). Potential exposure routes include consumption of rodenticide bait, ingestion of contaminated food or water and, for PPPs, dermal absorption and inhalation.

Methods

SASA surveys Scottish agricultural use of PPPs and rodenticides and also operates the Scottish Wildlife Incident Investigation Scheme (WIIS). In addition to investigating accidental and deliberate poisoning, WIIS has analysed wildlife carcasses, using LC-MS/MS, for sub-lethal residues of anticoagulant rodenticides since 2003 and for 70 currently approved PPPs since 2010. These surveillance schemes are operated to provide post-approval feedback to the pesticide regulation process.

Results

Approximately 1,400 tonnes of PPP compounds are applied to Scottish arable crops annually (Figure 1). In contrast, anticoagulant rodenticide use on arable farms is less than 0.1 tonne per annum (Figure 2).

Figure 1 Estimated quantity of PPP active ingredient used on Scottish arable farms 2000-2010

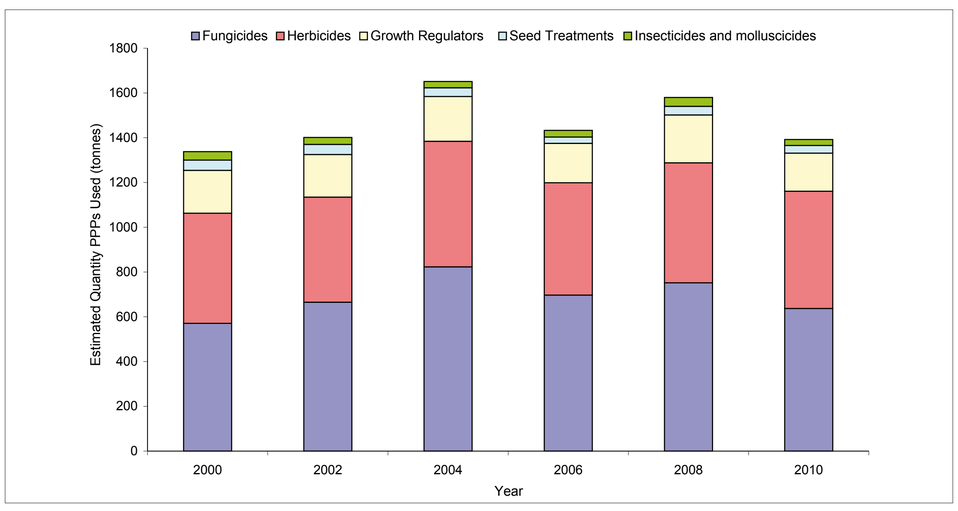
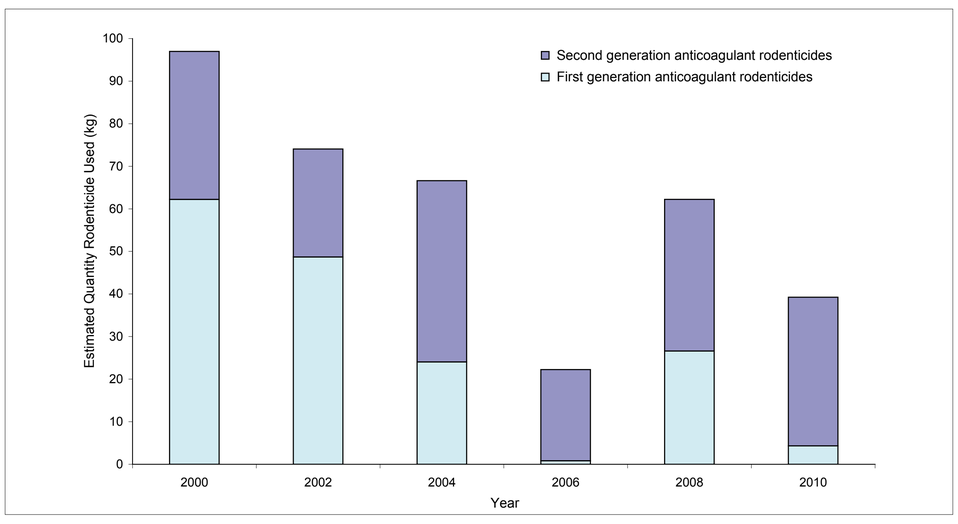


Figure 2 Estimated quantity of anticoagulant rodenticide compounds used on Scottish arable farms 2000-2010.



Use of first generation anticoagulants is decreasing over time; in 2010 the second generation compounds bromadiolone and difenacoum accounted for around 80% of all rodenticide use.

Of 335 carcasses tested for PPPs only two buzzards contained residues (Table 1). In contrast, rodenticide residues were found in nearly all species tested (Table 2). Unsurprisingly, rodenticide exposure and residue levels were greatest in raptors and carnivorous mammals which prey on rodents; with red kites and foxes displaying notably high rates. However, it should also be noted that species that do not regularly prey on rodents such as sparrowhawks and otters, also displayed around 50% exposure. Additionally, rodenticides were detected in 9% of herbivorous and insectivorous bird and mammal species, suggesting that predation of rodents is not the sole exposure route. The rodenticide residues detected in wildlife reflected reported agricultural use patterns, with the majority of use and detection being difenacoum and bromadiolone.

Table 1. PPP residues in tissue and stomach/crop content samples from non-target species (2010-2013)[a]

Species	n	% sample containing residues
Birds	303	0.66
Buzzard (*Buteo buteo*)	130	1.5 [b]
Red Kite (*Milvus milvus*)	37	0
Barn Owl (*Tyto alba*)	4	0
Tawny Owl (*Strix aluco*)	7	0
Peregrine Falcon (*Falco peregrinus*)	11	0
Kestrel (*Falco tinnunculus*)	4	0
Sparrowhawk (*Accipiter nisus*)	21	0
Golden Eagle (*Aquila chrysaetos*)	22	0
White Tailed Eagle (*Haliaeetus albicilla*)	10	0
Osprey (*Pandion haliaetus*)	1	0
Corvids	23	0
Insectivorous and granivorous birds	19	0
Wildfowl and water birds	14	0
Mammals	32	0
Fox (*Vulpes vulpes*)	11	0
Badger (*Meles meles*)	6	0
Red Squirrel (*Sciurus vulgaris*)	5	0
Mole (*Talpa europaea*)	1	0
Otter (*Lutra lutra*)	5	0
Pine Marten (*Martes martes*)	2	0
Scottish Wildcat (*Felis silvestris grampia*)	2	0

[a] Analysis by LC-MSMS (LOD 0.025 - 0.05 mg/kg)
[b] 2 buzzard liver samples contained PPP residues;
1) 0.1 mg/kg isoproturon (fungicide)
2) 0.2 mg/kg methiocarb (slug pellet)

Table 2. Anticoagulant rodenticide residues in liver tissues of non-target species (2003-2013)[a]

Species	n	% sample containing residues	% mortality by secondary poisoning[b]	Median residue (mg/kg)
Raptors	874	48	1.6	0.028
Buzzard (*Buteo buteo*)	506	48	0.6	0.020
Red Kite (*Milvus milvus*)	112	72	8.9	0.082
Barn Owl (*Tyto alba*)	48	44	2.1	0.029
Tawny Owl (*Strix aluco*)	37	43	0	0.032
Peregrine Falcon (*Falco peregrinus*)	29	35	0	0.011
Kestrel (*Falco tinnunculus*)	27	37	0	0.062
Sparrowhawk (*Accipiter nisus*)	58	48	0	0.023
Golden Eagle (*Aquila chrysaetos*)	34	12	0	0.010
White Tailed Eagle (*Haliaeetus albicilla*)	20	25	0	0.011
Osprey Pandion haliaetus	3	33	0	0.004
Other Birds (Non-Raptor)	91	9	0	0.010
Corvids[c]	37	5	0	0.060
Insectiverous and granivorous birds[d]	30	7	0	0.009
Wildfowl and water birds[e]	24	17	0	0.015
Predatory/Carnivorous Mammals	147	64	0.7	0.025
Fox (*Vulpes vulpes*)	109	71	0.9	0.191
Badger (*Meles meles*)	14	29	0	0.045
Ferret (*Mustela putorius furo*)	2	50	0	0.325
Otter (*Lutra lutra*)	16	50	0	0.021
Pine Marten (*Martes martes*)	3	67	0	0.028
Scottish Wildcat (*Felis silvestris grampia*)	3	67	0	0.208
Herbivorous/Insectivorous mammals	32	9	0	0.090
Red Squirrel (*Sciurus vulgaris*)	18	0	0	NA
Grey Squirrel (*Sciurus carolinensis*)	5	20	0	NA
Hedgehog (*Erinaceus europaeus*)	6	33	0	0.047
Mole (*Talpa europaea*)	3	0	0	NA

[a] Analysis by LC-MSMS (LOD 0.005 mg/kg); [b] poisoning confirmed by post-mortem; [c] crows, magpies, ravens, rooks and jackdaws; [d] pigeons, doves, blackbirds, waxwings, chaffinches, greenfinches, sparrows, goldcrests, tree creeper; [e] swans, geese, ducks, herons

Discussion

Rodenticide residues are found in a range of Scottish wildlife, including many species which are subject to conservation and reintroduction schemes, such as Golden Eagles, White Tailed Eagles, Ospreys, Red Kites, Otters, Pine Martins and Scottish Wildcats. Despite application rates of PPPs being 10,000 fold greater than rodenticides, very few carcasses contained residues, highlighting the acknowledged difference in risk of exposure in relation to application rate. With the exception of red kites, very few cases of rodenticide related mortality were confirmed. However, lack of data about sub-lethal effects leads to concern about the potential impact on wildlife and questions whether the recommended risk management procedures are adequate to protect non-target species.

SASA
Science and Advice for Scottish Agriculture
Agriculture, Food and Rural Communities Directorate

WILD COMS

The Scottish Government