DOI: 10.7589/JWD-D-20-00191

Journal of Wildlife Diseases, 57(4), 2021, pp. 922–926

Persecution of Birds of Prey in Flanders: A Retrospective Study 2011–19

An Garmyn,[1,5] Lieze Rouffaer,[1] Tom Roggeman,[2] Marc Verlinden,[1] Katleen Hermans,[1] Marleen Cools,[1] Mark Van den Meersschaut,[3] Siska Croubels,[4] and An Martel[1] [1]Ghent University, Faculty of Veterinary Medicine, Department of Pathology, Bacteriology and Avian Diseases, Salisburylaan 133, 9820 Merelbeke, Belgium; [2]Ghent University, Faculty of Veterinary Medicine, Department of Small Animals, Salisburylaan 133, 9820 Merelbeke, Belgium; [3]Flemish Government, Agency for Nature and Forests, Nature Inspectorate, Havenlaan 88, 1000 Brussels, Belgium; [4]Ghent University, Faculty of Veterinary Medicine, Department of Pharmacology, Toxicology and Biochemistry, Salisburylaan 133, 9820 Merelbeke, Belgium; [5]Corresponding author (email: An.Garmyn@Ugent.be)

ABSTRACT: For decades birds of prey have been under the protection of European law, but deliberate or unintentional killing is still a large-scale problem in Europe. In an effort to monitor illegal practices, the Flemish government established several bird of prey hotlines in 2006. Since then, every suspicious death of a bird of prey has been investigated. This retrospective study reviews the necropsy results of every bird of prey submitted for investigation from January 2011 to December 2019, with a focus on illegal practices. In 36.7% (83/226) of all necropsy cases, an illegal cause of death was found, with poisoning being demonstrated in 88% (73/83) of these cases. Cholinesterase inhibitors were the most commonly used toxins, despite being prohibited in Europe. With a prevalence of 82.5% (260/315) of all cases, the Common Buzzard (*Buteo buteo*) was the species most submitted for necropsy.

Key words: Bird of prey, buzzard, illegal practices, intoxication, shooting.

Free-living birds of prey naturally occurring in the European territory of the member states are legally protected by Council Directive 2009/147/EC on the conservation of wild birds (Publications Office of the European Union 2009a), the Bern Convention on the conservation of European wildlife and natural habitats (European Treaty Series 1979), and the Convention on the Conservation of Migratory Species of Wild Animals (CMS 1979). Despite their protected status, unintentional killing and the deliberate persecution of birds of prey is still omnipresent (Brochet et al. 2019). Depending on the region, different reasons are invoked for the illegal killing of birds of prey, with predator or pest control and sports being the main reasons in central and northern European countries (Berny 2007; Brochet et al. 2019). Notwithstanding the strictly regulated use of pesticides in the European Union (Publications Office of the European Union 2009b), illegal poisoning of wildlife is still common in all European countries (Brochet et al. 2019). In Flanders, the Agency for Nature and Forests (ANF) is responsible for wildlife surveillance and the execution of environmental enforcement decisions. To monitor illegal practices, several bird of prey hotlines were established in 2006. Whenever a suspicious death (i.e., every mortality not clearly related to traumatic injuries due to collisions with windows or vehicles) of a bird of prey is encountered by the general public, foresters, and inspectors of the ANF through passive surveillance, the carcass is necropsied to assess whether the death is from an illegal cause. This retrospective study gives an overview of the necropsy results of birds of prey that have been submitted through the bird of prey hotlines (i.e., suspicious mortalities), with a specific focus on poisoning, shooting, or trapping events over the period 2011–19.

In total, 315 birds of prey were collected through the passive surveillance program between January 2011 and December 2019. Because the ANF occasionally collected more than one bird at the same location, these 315 birds were found in 226 suspicious mortality events. Necropsies were performed on 260 Common Buzzards (*Buteo buteo*), 20 Northern Goshawks (*Accipiter gentilis*), nine Red Kites (*Milvus milvus*), six Eurasian Marsh-harriers (*Circus aeruginosus*), five Eurasian Sparrowhawks (*Accipiter nisus*), four Eurasian Kestrels (*Falco tinnunculus*), two Peregrine Falcons (*Falco peregrinus*), two European

Honey-buzzards (*Pernis apivorus*), two Tawny Owls (*Strix aluco*), a Hen Harrier (*Circus cyaneus*), and a Eurasian Eagle-owl (*Bubo bubo*). Furthermore, two harriers (*Circus* sp.) and one falcon (*Falco* sp.), which could not be further identified, were also brought in for investigation (Fig. 1).

Most carcasses were cooled or frozen prior to the necropsy and presented in advanced states of postmortem decay, which impeded bacteriologic, virologic, and histopathologic analyses. If ballistic injury was suspected, carcasses were screened for fractures or the presence of metallic objects using lateral and dorsoventral radiographic images. Birds were then weighed and after external inspection, carcasses were plucked, skinned, and the sternum removed. A macroscopic investigation of all tissues and internal organs was performed.

If necropsy findings were indicative of poisoning (e.g., organ congestion, suspicious contents in the upper gastrointestinal tract or alongside the carcass, internal bleeding), or if the bird did not present with lesions that could explain the cause of death, samples were sent for further toxicologic investigation. Qualitative analyses for strychnine, carbamates, and organophosphates (aldicarb, benfuracarb, carbaryl, carbofuran, carbosulfan, diazinon, fenoxycarb, furathiocarb, indoxacarb, malathion, methiocarb, mevinfos, parathion, phoxim, pirimicarb, pirimiphos-methyl, propoxur, thiodicarb) were conducted on upper gastrointestinal contents using thin-layer chromatography. When the presence of carbamates or organophosphates was suspected, additional high-performance liquid chromatography with ultraviolet detection was performed. When necropsy revealed internal bleeding suggestive of the presence of anticoagulants (e.g., brodifacoum, bromadiolone, chlorophacinone, difenacoum, difethialone, flocoumafen, warfarin, coumatetralyl), liquid chromatography-tandem mass spectrometry was used to provide confirmation of these analytes in liver samples, based on Vandenbroucke et al. (2008).

In 36.7% (83/226) of the suspicious mortality events, mortality could be linked to illegal practices. In 4% (9/226) of all birds of prey (six Common Buzzards, one European Honey-buzzard, one Peregrine Falcon, and one Northern Goshawk), shooting projectiles, with accompanying lesions in seven independent cases, were detected radiographically and recovered during necropsy. Two Common Buzzards died due to entrapment, one being found with cachexia in a funnel trap and one in a spring trap. In 149 cases, necropsy findings were suspicious for poisoning and samples were sent for toxicologic investigation. In 32.3% (73/226) of the mortality events, involving 127 birds of prey, toxic substances were detected in the content of the upper gastrointestinal tract (oral cavity, esophagus, crop, proventriculus, or gizzard). Cholinesterase inhibitors were the most frequently detected toxic substances, being detected in 84.9% (62/73) of all toxicologic cases. Of these, carbofuran was detected in 43/62 cases, aldicarb in 13/62 cases, a combination of carbofuran and aldicarb in 4/62 cases, a combination of aldicarb and anthraquinone in 1/62 cases, and parathion in one. Strychnine was identified in 2.7% (2/73). Second-generation anticoagulants (i.e., brodifacoum, bromadiolone, difenacoum, difethialone, flocoumafen), used solely or in combination, were detected in 12.3% (9/73; Table 1). This is similar to other countries where malicious poisoning has mostly involved cholinesterase inhibitors and rodenticides (Berny 2007). As strychnine and the cholinesterase inhibitors detected in this study are forbidden substances in Belgium, detection of these substances suggests illegal importations or that illegal stocks are still present.

In 8.4% (19/226) of the mortality events, involving 36 birds of prey (34 Common Buzzards, one Northern Goshawk, and one Red Kite), no toxins could be detected within the gastrointestinal contents but the circumstances of death were highly suspicious (e.g., toxic substances sometimes presented in the form of bait were found next to the deceased birds, common incident location, anamnesis of peracute mortality).

In 55.3% (125/226) of the mortality events, no indications for illegal practices were

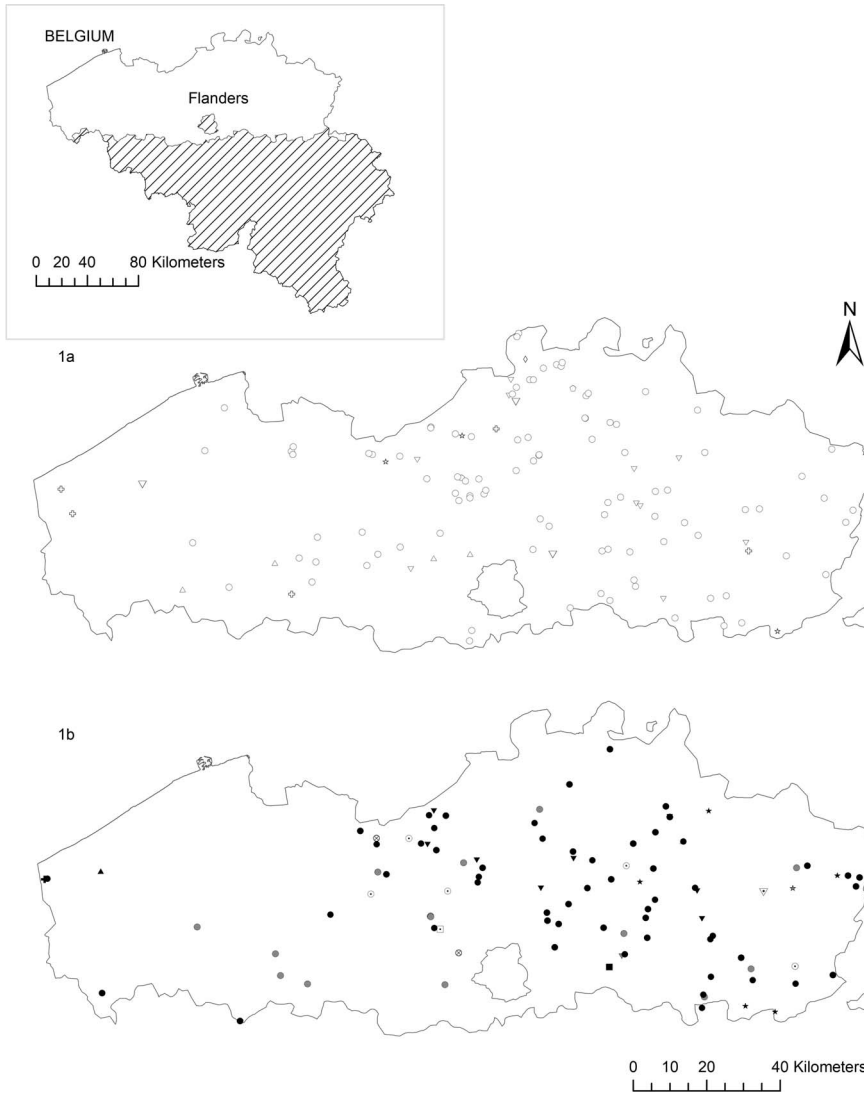

FIGURE 1. Birds of prey collected between 2011 and 2019 for necropsy in Flanders, Belgium. (A) No clear cause of death. (B) Illegal and suspicious causes of death. Common Buzzard (*Buteo buteo*; ●), falcon (*Falco* spp.; ▲), hawk (*Accipiter* spp.; ▼), harrier (*Circus* spp.; ✚), Red Kite (*Milvus milvus*; ★), Eurasian Honey Buzzard (*Pernis apivoris*; (■) Eurasian Eagle Owl (*Bubo bubo*; ◆), Tawny Owl (*Strix aluco* ⬟). Empty symbols (no clear cause of death), filled symbols (intoxication), dotted symbols (shooting), crossed symbols (entrapment), gray symbols (suspicious cause of death). Inset of Flanders, a region in the northern part of Belgium.

detected based on the necropsy and toxicologic findings. In many of these birds postmortem decay impeded further analysis. Some of these birds presented with lesions of traumatic origin, signs of infection, or cachexia, but in most cases the cause of death could not be determined.

Our study confirms and complements existing literature (Guitart et al. 2010; Brochet et al. 2019) showing that birds of prey still suffer from illegal activities in Flanders. However, only suspicious carcasses of birds of prey were submitted for necropsy, which may lead to a positive bias in the presented percentages; therefore, these results should be cautiously interpreted.

The Common Buzzard was the bird of prey most submitted through the passive

TABLE 1. Between January 2011 and December 2019, 315 birds of prey found in 226 suspicious mortality events were submitted for necropsy through a passive surveillance program in an effort to monitor illegal practices in Flanders, Belgium. In 32.2% (73/226) of the mortality events, involving 127 birds of prey (belonging to the following species: Common Buzzard [*Buteo buteo*], European Honey Buzzard [*Pernis apivorus*], Eurasian Kestrel [*Falco tinnunculus*], Eurasian Marsh Harrier [*Circus aeruginosus*], Eurasian Sparrowhawk [*Accipiter nisus*], Northern Goshawk [*Accipiter gentilis*], and Red Kite [*Milvus milvus*]), toxic substances could be detected in the content of the upper gastrointestinal tract. Per toxin, an overview is provided of the number of mortality events during which the birds of prey were found and the number of individuals per bird species. Because not all individuals found during a mortality event were necropsied, the additional number of birds found at the scene appears in parentheses.

Toxic substance	Common species name	No. mortality events	No. individuals
Aldicarb	Common Buzzard	6	10
	Northern Goshawk	4	6
	Red Kite	2	2
	Eurasian Kestrel	1	1
Carbofuran	Common Buzzard	38[a]	78 (4)
	Northern Goshawk	[b]	1
	Eurasian Marsh Harrier	1	2 (2)
	Red Kite	2	2
	Eurasian Sparrowhawk	1	1
	European Honey Buzzard	1	1
Aldicarb + carbofuran	Common Buzzard	3	4 (2)
	Northern Goshawk	1	1
Aldicarb + anthraquinone	Common Buzzard	1	2
Parathion	Common Buzzard	1	3
Strychnine	Red Kite	1	1
	Northern Goshawk	1	1
Anticoagulants	Common Buzzard	9	11 (1)

[a] During a mortality event in which Common Buzzards were intoxicated with carbofuran, one Northern Goshawk was also collected.
[b] To avoid duplication of the number of mortality events, no number is indicated in this column.

surveillance program (82.5%, 260/315 birds) and was the species in which illegal practices were identified most often (of 138 individuals in which illegal activities were identified, 116 were Common Buzzards). Whether the Common Buzzard in Flanders is persecuted intentionally or accesses poisons accidentally is unknown. One would expect that hunters, who may consider birds of prey as rivals (Brochet et al. 2019), would less actively target the Common Buzzards because they are more a scavenger compared to an active predators. Through their scavenging diet, Common Buzzards are more likely to access poisoned bait compared to other birds of prey (Austin 1992), potentially leading to higher numbers of poisoned birds.

Because the cause of death could not be determined in a large number of cases, an underestimation of the presence of illegal practices is possible. The advanced postmortem decay and insufficient gastrointestinal contents in many cases might have obscured macroscopic findings and reduced the detection of pesticides (Berny 2007). Because of cost limitations, only the most commonly used pesticides in Europe were analyzed using qualitative toxicologic analyses. A large array of toxins may therefore have passed unnoticed. Additionally, metabolic or environmental degradation of the pesticides might have occurred prior to the toxicologic analysis, leading to false-negative toxicologic results (Berny 2007). Besides the direct toxic effects of cholinesterase inhibitors and rodenticides, subacute and chronic intoxications have been described leading to behavioral and reproductive alterations. These alterations could have had an effect on the birds' survival (Hill 2003).

As shown in Figure 1, a higher number of suspicious bird of prey mortalities were detected in the northeastern part of Flanders. This could possibly be related to the higher number of birds of prey observed in these regions (Herremans 2007). In 2011, 100 birds of prey were submitted for necropsy through the passive surveillance program, compared with a mean number of 27 birds submitted per year between 2012–19, demonstrating a decline in the number of suspicious submissions. One of the reasons might be enhanced governmental attention and control and the heavy fines for violating the environmental legislation (Environmental Department of the Flemish Government 1995). However, because only passive surveillance is used to monitor illegal activities, and carcasses are preselected (i.e., no window or vehicle collisions) before submitting the birds for necropsy, it is very possible that many illegal practices remain unnoticed (Brochet et al. 2019). Rapid concealment of carcasses by the perpetrators or scavengers, or less obvious ways of illegal killing, might also have obscured our interpretations.

In conclusion, this retrospective study shows that birds of prey are still frequent victims of illegal practices, with the Common Buzzard having the highest number of individuals being killed through illegal practices. Cholinesterase inhibitors were the most commonly used toxins detected.

The technical assistance of Jelle Lambrecht (Department of Pharmacology, Toxicology and Biochemistry, Faculty of Veterinary Medicine, Ghent University), of Paul Tavernier for performing necropsies, and of anonymous reviewers for reviewing the earlier manuscript are greatly appreciated.

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Submitted for publication 5 November 2020.
Accepted 22 April 2021.