

## Population-level Effects of Lead Shot on European Terrestrial Birds

In the EU Voluntary Targeted Risk Assessment Report on use of lead in ammunition, three major literature review papers (Pain and Amiard-Triquet 1993, Kendall et al. 1996, Fisher et al. 2006) were assessed and collectively show that under some circumstances lead ammunition can adversely affect individual terrestrial birds, even large numbers in some isolated events. However, it is highly unlikely that terrestrial bird populations are exposed and impacted by lead shot at levels that would cause populations to significantly decline within the European Union (EU). A literature review of population trends of potentially exposed terrestrial bird species suggests that most species that have been reported to be potentially exposed to lead shot are not declining in Europe; and those that are, probably are declining due to other causes. Support for this conclusion is presented below.

Two guilds of species are most susceptible to lead shot: (1) granivorous birds which accidentally obtain lead shot while foraging and (2) carnivorous/scavenger birds which obtain lead shot mostly from tissue of hunted prey or carrion. Of five species of granivorous birds in Europe that have been found to ingest lead shot, only grey partridge (*Perdix perdix*) and willow ptarmigan (also known as red grouse, *Lagopus lagopus*) had declining trends during some period between 1970 and 2006 (Table 1); lead shot has not been implicated in the literature as the cause of these declines (Bird Life International 2004, PECBMS 2008). Moreover, an evaluation of grey partridge population trends in two EU countries where lead shot was banned in upland areas in the 1990s (Netherlands in 1993 and Denmark in 1996) shows no obvious positive effect of such bans on the population size (monitoring data at <http://www.sovon.nl/soorten.asp?euring=3670&lang=en> and Grell et al. 2007, updated by Michael Grell to 2009).

Of the 19 carnivorous bird species that feed primarily on non-aquatic organisms and appear to experience secondary lead poisoning, 9 had declining population trends during some period between 1970 and 2006 (Table 1). The reasons for the declines were reviewed in the literature (PECBMS 2008, del Hoyo et al. 1994, Duncan et al. 1997, Watson 1997, Meyburg et al. 2001, Mebs and Schmidt 2006, Vaerla Simó 2007, Bird Life International Species Fact Sheets, [europeanraptors.org](http://europeanraptors.org)). Only one of the 9 species, the Egyptian vulture (*Neophron percnopterus*), had lead shot listed as a potential reason for the decline (Bird Life International 2009), based on limited studies in the Canary Islands (Mateo 2009). As a group, trends in population sizes of raptors in Europe do not consistently follow trends in lead shot exposure because other factors such as habitat and illegal persecution more strongly affect population trends.

A second line of evidence for little to no effect of lead shot on bird population sizes in Europe is that the percent of granivorous and carnivorous birds in the EU exposed to at least one lead shot is no more than 4%, when available data for birds in the EU are pooled (Table 2). At that rate of exposure, the likelihood of extinction from lead shot is zero. Even if all of the exposed birds are conservatively assumed to die (4% mortality due to lead shot), a density-dependent bird population model of a representative granivore and carnivore in the EU likely would show decreases in population size are small and insignificant, especially relative to population size reductions caused by shooting. Wildlife managers often accept a 25% reduction below carrying capacity by hunters in managed populations as acceptable and desirable.

In summary, (1) little evidence exists in the literature that terrestrial bird population declines observed are from lead shot, and (2) very low percentages of terrestrial birds are exposed to lead shot. These two lines of evidence support that the current level of lead shot exposure in the EU does not threaten the sustainability of terrestrial bird populations in Europe.

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Table 1. Population status of bird species with documented lead shot exposure in the European Union (EU) of 25 countries (bolded text are reported population declines).

Species	2009 IUCN Red List Status (lead effect studied): LC - Least Concern; EN - Endangered; CR - Critically Endangered; V - Vulnerable; NT - Near Threatened	Country	References	EU25 Breeding Population Trend (1970-1990)	EU25 Breeding Population Size and Trend (1990-2000); BirdLife Threat (T) status <sup>1</sup> ; Conservation (C) status
<b>Granivorous Birds</b>					
Grey partridge ( <i>Perdix perdix</i> )	LC (Ingestion & Poisoning)	Denmark, UK	Clausen and Wolstrup (1979); Keymer and Stebbings (1987)	<b>Large Decline</b>	<b>720,000 - 1,700,000;</b> <b>Large Decline</b> <b>Declined by 56% from 1990 to 2006</b> <b>Vulnerable (T)</b> <b>Unfavourable - (C)</b>
Common pheasant ( <i>Phasianus colchicus</i> )	LC (Poisoning)	Denmark, UK	Calvert (1976); Elder (1955); Clausen and Wolstrup (1979); National Wildlife Health Laboratory (1985)	Moderate Increase	2,900,000 - 3,900,000 Unknown trend Secure (T) Favourable (C)
Willow ptarmigan ( <i>Lagopus lagopus</i> )	LC (Ingestion)	Scotland, UK	Thomas et al. (2009)	<b>Large Decline</b>	<b>310,000 - 680,000;</b> <b>Moderate Decline</b> <b>Declining (T)</b> <b>Unfavourable (C)</b>
Rock pigeon ( <i>Columba livia</i> )	LC (Ingestion)	Belgium	Tavernier et al. (2004)	Moderate Increase	4,200,000 - 6,300,000 Unknown status Secure (T) Favourable (C)
Common wood-pigeon ( <i>Columba palumbus</i> )	LC (Poisoning)	Denmark	Clausen and Wolstrup (1979)	Stable	7,500,000 - 13,000,000 Stable from 1990 to 2000 Increased by 21% from 1990 to 2006 Secure (T) Favourable (C)
<b>Carnivorous Birds</b>					
Red kite ( <i>Milvus milvus</i> )	NT (Ingestion or Poisoning)	Germany, Spain, UK	Mateo (1998); Mateo et al. (2001, 2003); Kenntner et al. (2005)	Stable	<b>18,000 - 23,000;</b> <b>Moderate Decline</b> <b>Declining (T)</b> <b>Unfavourable (C)</b>
Eurasian griffon vulture ( <i>Gyps fulvus</i> )	LC (Poisoning)	Spain	Mateo et al. (1997); Sultant (1998); Mateo et al. (2003)	Large Increase	18,000 - 19,000; Large Increase Secure (T) Favourable (C)
Bearded vulture ( <i>Gypaetus barbatus</i> )	LC (Poisoning)	Austria	Mateo (2009)	Large Increase	130; Large Increase Vulnerable (T) Unfavourable - (C)
Egyptian vulture ( <i>Neophron percnopterus</i> )	EN (Poisoning)	Spain	Donazar et al. (2002)	<b>Large Decline</b>	<b>1,500 - 1,800;</b> <b>Large Decline</b> <b>Endangered (T)</b> <b>Unfavourable - (C)</b>
Cinereous vulture ( <i>Aegypius monachus</i> )	NT (Poisoning)	Spain	Hernandez and Margalida (2008)	Large Increase	1,400; Large Increase Rare (T) Unfavourable - (C)
Common buzzard ( <i>Buteo buteo</i> )	LC (Poisoning or Ingestion)	France, Germany, UK, Captive, Poland, Italy, Spain, Netherlands, Denmark	Stehle (1980); MacDonald et al. (1983); Pain and Amiard-Triquet (1993); Pain et al. (1995); Kenntner et al. (2005); Komosa and Kitowski (2008); Battaglia et al. (2005); Perez-Lopez et al. (2008); Jager et al. (1996); Clausen and Wolstrup (1979)	Stable	<b>410,000 - 590,000;</b> <b>Moderate Increase from 1990 to 2000</b> <b>Declined by 17% from 1990 to 2006</b> <b>Secure (T)</b> <b>Favourable - (C)</b>
European honey-buzzard ( <i>Pernis ptilorhynchus</i> )	LC (Unknown; Ingestion or Shot)	Netherlands	Lumeij et al. (1985)	Stable	36,000 - 52,000; Stable Secure (T) Favourable (C)
Eurasian sparrowhawk ( <i>Accipiter nisus</i> )	LC (Ingestion)	France, Captive, Kimosa and Kitowski (2008)	MacDonald et al. (1983); Pain and Amiard-Triquet (1993)	Large Increase	150,000 - 220,000; Stable from 1990 to 2000 Increased by 13% from 1990 to 2006 Secure (T) Favourable (C)
Rough-legged hawk ( <i>Buteo lagopus</i> )	LC (Ingestion)	Poland	Komosa and Kitowski (2008)	Stable	2,500 - 9,000; Stable Secure (T) Favourable (C)
Northern goshawk ( <i>Accipiter gentilis</i> )	LC (Poisoning or Ingestion)	France, Germany, Captive, Canada, Poland	Stehle (1980); Pain and Amiard-Triquet (1993); Martin and Barrett (2001); Kenntner et al. (2003, 2005); Komosa and Kitowski (2008)	Large Increase	<b>46,000 - 70,000;</b> <b>Moderate Decline</b> <b>Secure (T)</b> <b>Favourable (C)</b>
Common kestrel ( <i>Falco tinnunculus</i> )	LC (Poisoning)	Spain	Garcia-Fernandez et al. (2005a)	<b>Moderate Decline</b>	<b>240,000 - 350,000;</b> <b>Moderate Decline from 1990 to 2000</b> <b>Decreased 32% from 1990 to 2006</b> <b>Declining (T)</b> <b>Unfavourable (C)</b>
Greater spotted eagle ( <i>Aquila clanga</i> )	V (Ingestion)	Poland	Komosa and Kitowski (2008)	<b>Large Decline</b>	30 - 50; Stable Endangered (T) Unfavourable (C)
Lesser spotted eagle ( <i>Aquila pomarina</i> )	LC (Ingestion)	Poland	Komosa and Kitowski (2008)	Stable	<b>7,000 - 10,000;</b> <b>Moderate Decline</b> <b>Declining (T)</b> <b>Unfavourable (C)</b>
Peregrine falcon ( <i>Falco peregrinus</i> )	LC (Poisoning)	UK, Captive	MacDonald et al. (1983); Pain et al. (1995)	Moderate Increase	7,400 - 8,800; Moderate Increase Secure (T) Favourable (C)
Tawny owl ( <i>Strix aluco</i> )	LC (Ingestion)	Poland	Komosa and Kitowski (2008)	Stable	320,000 - 680,000; Stable Secure (T) Favourable (C)
Golden eagle ( <i>Aquila chrysaetos</i> )	LC (Poisoning)	Sweden, Spain, Switzerland, Germany, Austria, Norway	Borg (1975); Cerradillo et al. (1992); Kenntner et al. (2007); Bezzel an Furfstuck (1995); Zechner et al. (2005); Pain and Amiard-Triquet (1993)	<b>Moderate Decline</b>	4,100 - 4,500; Stable Rare (T) Unfavourable (C)
Barn owl ( <i>Tyto alba</i> )	LC (Poisoning)	Spain	Gonzales et al. (1983)	<b>Moderate Decline</b>	<b>100,000 - 210,000;</b> <b>Moderate Decline</b> <b>Declining (T)</b> <b>Unfavourable (C)</b>
Eurasian eagle owl ( <i>Bubo bubo</i> )	LC (Poisoning)	Spain	Mateo et al. (2003)	Large Increase	9,100 - 20,000; Stable Secure (T) Favourable (C)
Long-eared owl ( <i>Asio otus</i> )	LC (Poisoning or Ingestion)	Spain, Poland	Brinzal (1996); Komosa and Kitowski (2008)	Stable	95,000 - 220,000; Stable Secure (T) Favourable (C)

<sup>1</sup>Bird Life International (2004) categorized species with a threat status and a long-term conservation status

<sup>2</sup>1990 to 2006 trend is from PECBMS (2008).

**Table 2. Studies and number of granivorous and carnivorous birds in Europe exposed to at least one lead shot in gizzard or with toxic levels of lead in tissue.**

Species	Country	Exposure Based on Gizzards with Shot*		Exposure Based on Tissue**		Collection Method	Years of collection	Mean shot density	Source	
		Number with Shot	Number of birds or regurgitated pellets examined	Elevated Lead	Number of birds examined					
<b>Granivorous Birds</b>										
Red-legged Partridge	Spain	3	76	2	64	Hunter shot wild birds	2004, 2006	73,600 shot/ha	Ferrandis et al. 2008 <sup>1</sup>	
Red-legged Partridge	Spain	1	7	1	7	Hunter shot	May 2000	NA	Soler-Rodriguez et al. 2004	
Grey Partridge	UK	6	222	NA	NA	Adults: found dead by gamekeepers/ Chicks: shot or auto accident	1970 - 1992	NA	Potts 2005	
Pheasant	UK	13	437	NA	NA	Hunter shot	Spring of 1996, 1997 and hunting seasons of 1999-2000, 2001-2002	NA	Butler et al. 2005	
Red-legged Partridge	UK	2	144	NA	NA	Hunter shot	2001 - 2002 hunting season	NA	Butler 2005	
Pheasant	Hungary	45	947	NA	NA	Hunter shot	Not available in English	4,600 shot/ ha	Imre 1997, as cited in Mateo 2009	
Pheasant	Denmark	0	199	NA	NA	Majority found dead or ill, supplemented with hunter shot birds	1971 - 1979	NA	Clausen and Wolstrup 1979	
Grey Partridge	Denmark	1	62	NA	NA	Majority found dead or ill, supplemented with hunter shot birds	1971 - 1979	NA	Clausen and Wolstrup 1979	
<b>Total</b>	Europe	<b>71 (3%)</b>	<b>2094</b>	<b>3 (4%)</b>	<b>71</b>	Various	1971 - 2006	NA		
<b>Carnivorous Birds</b>										
Buzzard	Italy	NA	NA	2	18	Injured/dead birds from wildlife rehabilitation center	1998 - 1999	NA	Battaglia et al. 2005	
Egyptian Vulture	Canary Islands, Spain	13	424	1 <sup>2</sup>	26	Pellets collected at roost sites during hunting season/ tissue from birds captured by baited cannon nets	1998 - 2001	NA	Donazar et al. 2002	
Egyptian Vulture	Canary Islands, Spain	NA	NA	1	137	Pellets collected from roost sites/ tissue from birds captured by cannon nets	1999 - 2005	NA	Gangoso et al. 2009	
Egyptian Vulture	Iberian Peninsula (Spain)	0	327	0	32	Hunter shot wild birds	2002 - 2004	NA	Gangoso et al. 2009	
Griffon Vulture	Spain	NA	NA	2	23	Collected using baited cannon nets in Caorla Natural Park, Spain	2003	NA	Garcia-Fernandez et al. 2005b	
Northern Goshawk	Germany	NA	NA	3	61	Adults: found dead by gamekeepers/ Chicks: shot or auto accident	1995 - 2001	NA	Kenntner et al. 2003	
Buzzard	France	NA	NA	3	90	Wild birds that died in animal care centers	Winters of 1988/1989 and 1989/1990	NA	Pain and Amiard-Triquet 1993	
Peregrine	France	NA	NA	0	2	Wild birds that died in animal care centers	Winters of 1988/1989 and 1989/1990	NA	Pain and Amiard-Triquet 1993	
Sparrowhawk	France	NA	NA	2	32	Wild birds that died in animal care centers	Winters of 1988/1989 and 1989/1990	NA	Pain and Amiard-Triquet 1993	
Buzzard	UK	NA	NA	4 <sup>2</sup>	56	Majority found dead or ill, supplemented with huntershot birds	Early 1980s - early 1990s	NA	Pain et al. 1995	
Peregrine	UK	NA	NA	4 <sup>2</sup>	26	Majority found dead or ill, supplemented with huntershot birds	Early 1980s - early 1990s	NA	Pain et al. 1995	
Sparrowhawk	UK	NA	NA	1 <sup>2</sup>	150	Birds obtained from requests in bird journals	Early 1980s - early 1990s	NA	Pain et al. 1995	
Red Kite	UK	NA	NA	0 <sup>2</sup>	6	Birds obtained from requests in bird journals	Early 1980s - early 1990s	NA	Pain et al. 1995	
Goshawk	UK	NA	NA	0 <sup>2</sup>	6	Birds obtained from requests in bird journals	Early 1980s - early 1990s	NA	Pain et al. 1995	
Red Kite	UK	25	264	6	44	Regurgitated pellets collected from hunting grounds/ tissue from birds found dead or injured	1995 - 2003	NA	Pain et al. 2007	
Red Kite	Spain	13	1233	NA	NA	Not available in English	Not available in English	Not available in English	Garcia and Vinuela 1999 (as cited in Mateo 2009)	
Red Kite	Spain	21	962	NA	NA	Collected from roost sites during hunting season	1991 - 1996	NA	Mateo et al. 2001,2007 (as cited in Mateo 2009)	
Peregrine	Spain	1	117	NA	NA	Collected from roost sites during hunting season	1997 - 2002	NA	Mateo et al. 2007 (as cited in Mateo 2009)	
Raven	Spain	0	321	NA	NA	Collected from roost sites during hunting season	1998 - 2002	NA	Mateo et al. 2007 (as cited in Mateo 2009)	
<b>Total</b>	Europe	<b>73 (2%)</b>	<b>3648</b>	<b>29 (4%)</b>	<b>709</b>	Various	Early 1980s - 2005	NA		

<sup>1</sup>Assumes that one shot or more found in the gizzard is indicative of toxic exposure.

\*\* Uses toxic tissue concentrations described in toxicity table

<sup>1</sup>Ferrandis et al. incorrectly added percentage of birds with lead in gizzard to percentage of birds with toxic levels of lead in tissue to obtain an incorrect reported 7.8% of birds exposed to lead

<sup>2</sup>Threshold reported and used was below the chosen toxicity threshold, chosen to be: (1) Liver, >17.6 ppm dry weight (6 ppm wet weight) for granivores & >8.8 ppm dry weight (3 ppm wet weight) for carnivores; (2) Blood, >5 ppm for granivores & >1 ppm for carnivores.