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The contribution to wildlife conservation of an Italian Recovery Centre

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Abstract

Wildlife recovery centres are widespread worldwide and their goal is the rehabilitation of wildlife and the subsequent release of healthy animals to appropriate habitats in the wild. The activity of the Genoese Wildlife Recovery Centre (CRAS) from 2015 to 2020 was analysed to assess its contribution to the conservation of biodiversity and to determine the main factors affecting the survival rate of the most abundant species. In particular, the analyses focused upon the cause, provenance and species of hospitalised animals, the seasonal distribution of recoveries and the outcomes of hospitalisation in the different species. In addition, an in-depth analysis of the anthropogenic causes was conducted, with a particular focus on attempts of predation by domestic animals, especially cats. Significantly, 96.8% of animals hospitalised came from Liguria, the region in north-western Italy where CRAS is located, with 44.8% coming from the most populated and urbanised areas of Genoa, indicating a positive correlation between population density and the number of recoveries. A total of 5881 wild animals belonging to 162 species were transferred to CRAS during the six years study period. The presence of summer migratory bird species and the high reproductive rates of most animals in summer resulted in a corresponding seasonal peak of treated animals. Birds represented 80.9% of entries; mammals accounted for 18.6% of hospitalisations; and about 0.5% of the entries were represented by reptiles and amphibians. Species protected by CITES and/or in IUCN Red List amounted to 8% of the total number of individuals. Consistent with results recorded elsewhere from Italy and other European countries, 53.9% of the specimens treated were released in nature; 4.7% were euthanised and 41.4% died. There was a significant difference between taxa in the frequency of individuals that were released, died or euthanised due to the intrinsic characteristics of species (more resistant or more adaptable to captivity than others) and/or to the types of debilitative occurrences common to each species (e.g.

infections, wounds, traumas, fractures). A total of 14.2% of wildlife recovery was from injuries caused with certainty by people or domestic animals (human impact), with 54.3% of these hospitalised animals having been victims of predation attempts by domestic animals, mainly cats. The percentage of release in nature of animals hospitalised following human impact was significantly lower than overall cases (31.2% vs. 53.9%) due to the greater severity of the injuries. The percentage of animals released showed a further reduction to 27.1% amongst victims of predation attempts by pets. The work of Rehabilitation/Recovery Centres contributes to wildlife conservation. In particular, the CRAS in Genoa is a Centre with an increasing level of activity concerning the rehabilitation of species under CITES protection and/or included on the IUCN Red List. The contribution and experience of CRAS operators is critical for the success of 'information campaigns' aimed at limiting the number of stray dogs and cats because of their impact on wildlife. Therefore, the activity of a properly-managed CRAS can significantly contribute both directly and indirectly to wildlife conservation, resulting in important territorial safeguards for the protection of biodiversity.

Keywords
domestic animal-wildlife interactions, Liguria, release, wildlife mortality, wildlife rehabilitation

Introduction

Wildlife Recovery Centres are widespread worldwide (Tribe and Brown 2000; Burton and Doblar 2004; Rouffignac 2008; Rodriguez et al. 2010; Wimberger et al. 2010; Molina-López et al. 2011; Grogan and Kelly 2013). In Italy, they are managed by public or private entities that conduct their work in close contact with the local administrations (Table 1). The goal of each Recovery Centre is the rehabilitation of wildlife, defined as "the treatment and temporary care of injured, diseased and displaced indigenous animals and the subsequent release of healthy animals to appropriate habitats in the wild" (Miller 2012).

Wildlife "rehabilitation and relocation" is a traditional management practice, defined by Begg and Brown (1998) as "taking wild animals that are injured, sick or orphaned and providing basic veterinary support, with the aim of bringing them back in their natural state, in the habitat from which they come". Wildlife rescue, rehabilitation and relocation are arguably the most intimate, intense and costly interaction that most people can have with wildlife. Such activities naturally involve human intervention in the life of wild animals by raising important emotional, political and ethical issues (Tribe and Brown 2000). Moreover, they need to be based on a comprehensive approach that takes into account the needs of animal welfare, its eco-ethological basis and advances in veterinary science. Wild animals are in a sentinel position as biological indicators of environmental conditions in every habitat, even in urban and suburban areas. Some of their causes of debilitation and mortality can be described as "unnatural" and directly related to human activities. The activity of Wildlife Recovery Centres, therefore, can take on a triple importance: acting as a compensation system of anthropogenic impact, contributing to the conservation of animal biodiversity and guaranteeing a continuous monitoring of the general health status of wildlife (Burton and Doblar 2004).

Table 1. Number of Recovery Centres in the Italian Regions (updated to August 2019; from http://www.recuperoselvatici.it/principale.htm).

Region	Number of active CRAS
Aosta Valley	1
Piedmont	6
Trentino Alto Adige	4
Lombardy	8
Veneto	8
Friuli Venezia Giulia	9
Liguria	1
Emilia Romagna	14
Tuscany	8
Umbria	2
Marche	2
Latium	5
Abruzzo	1
Molise	0
Campania	3
Basilicata	5
Apulia	6
Calabria	3
Sicily	6
Sardinia	5
Total (Italy)	97

The Centre

In Genoa, CRAS has operated since 2015 and is the only organisation authorised to recover, rehabilitate and relocate injured wild animals throughout the Genoa hinterland and the whole Liguria Region. The Centre is managed by ENPA Onlus (National Animal Protection Agency), the oldest Italian animal rights association (established in 1871) that manages many Recovery Centres and other specialised structures throughout Italy (www.enpa.it).

The Genoese CRAS is located in the Municipality of Campomorone in the Polcevera Valley, in the Liguria Region (north-western Italy) and consists of a central office where the main activities are carried out and of a rehabilitation area located about two kilometres away. The main complex includes a veterinary clinic, an area for welcoming the public and a series of rooms where animals are housed with 'batteries' for small animals and 'housings' for larger animals, as well as a series of bags and coolers for food storage. The final rehabilitation area for animals before their release is located in an isolated woodland away from the public. It is a fenced area that includes six aviaries of different sizes, a small stable and two internal enclosures. Larger animals can also be accommodated here. The animal's release can only take place after clearance from a veterinarian. This internationally-accepted procedure helps maximise the success of re-introducing an injured wild animal back into its natural habitat (Kirkwood 1993; McDougall et al. 2006; Harrington et al. 2013; Mullineaux 2014).

The recovery of injured or displaced wild animals is often carried out by citizens, especially in the case of small to medium-sized animals. In other instances,

recoveries are carried out by CRAS staff and, if necessary, with the intervention of other competent authorities (e.g. Carabinieri Forestali – the Italian environment and wildlife police force).

When a debilitated animal arrives at the Centre, staff records its date of entry, species, age, provenance and assess its apparent injury or disability. The animal then receives appropriate first aid and housing, before undergoing a thorough examination by a veterinarian, the results of which do not always agree with the initial diagnosis. Following the examination, the veterinarian may recommend that the animal be euthanised when it cannot be saved or when the injuries would result in an animal living with severe pain and/or loss of independence. On the other hand, if the veterinarian's evaluation is positive, the animal will receive the necessary treatment(s) for its recovery from the veterinarian and other appropriately qualified staff at the Centre.

At Campomorone, the Centre has only three employees professionally trained in zoology; the remaining staff is made up of volunteers trained in the treatment of wild animals who primarily feed and clean the animals and their enclosures. When an animal's treatment regime has finished and the observations on its behaviour are positive, the veterinarian will approve its transfer to a designated rehabilitation area.

During the last stage of its rehabilitation at the Centre, the animal is visited only once a day to be fed, in order to minimise human contact. The final rehabilitation phase varies due to factors such as the species and age of the animal, the cause(s) of debilitation and the timing of its release due to the availability of suitable habitat and favourable climatic conditions.

All releases take place in accordance with the Italian law 157/1992 governing the management and protection of wildlife. The most common problem faced by the Centre is its inability to free some animals due to their overpopulation in the wild (e.g. in the case of Wild boar *Sus scrofa*) or because they belong to exotic species (e.g. the Rose-collared parakeet *Psittacula krameri* and the Greek tortoise *Testudo graeca*), which are often victims of neglect or object of seizures by the authorities, the latter being a common problem in other countries (Trendler 1995; Kirkwood and Sainsbury 1996; Kirkwood and Best 1998; Kirkwood 2000).

Materials and methods

The data recorded on the Centre's registers (2015–2020) were analysed in order to obtain information relevant to the management and conservation of wild animals.

An ordinary least square regression, followed by a Mann-Kendall Trend Test was performed on data about annual recoveries in order to verify the actual increase of the Centre's activity.

The geographic provenance of each specimen was attributed to the following areas: West and East Liguria, Genoa City and those external to Liguria.

The phenology of the entries was analysed for dominant species (at least 2% of the total individuals) or homogeneous groups of species, dividing the year into half-month

periods (marked with the numbers 1 and 2). The recoveries were examined focusing on those species that represented at least 1% of the total individuals, while the remaining species were grouped homogeneously with a focus on the causes of debilitation and the final outcomes. Overall, differences amongst frequencies of species' outcomes (adding together the numbers of animals that died in care or were euthanised) were analysed using the Chi-square Test. Additional in-depth analysis was undertaken on data concerning animals hospitalised for injuries resulting from "anthropogenic causes". The frequencies of release of such individuals and of those admitted to the Centre following predation attempts by domestic animals was compared with the frequency of releases on the total of hospitalisations using the Chi-square Test.

PAST Software (Paleontological Statistics version 4.02, Hammer et al. 2001) was used to perform the statistical analyses mentioned above.

Results

There was a total of 5881 wild animals transferred to the Recovery Centre between 2015 and 2020 with the majority coming from the Liguria Region (Table 2, Fig. 1). Only a small percentage of animals came from outside Liguria (Piedmont, Emilia-Romagna, Aosta Valley). Despite its relatively small territory and high population density, the Genoese urban area resulted in the highest percentage of wild animal recoveries (44.8% of the total). High numbers of wildlife animal recoveries were also associated with the Polcevera Valley (18.8%), where CRAS is located. The Polcevera Valley is rich in natural and semi-natural patches of vegetation that lie adjacent to the southern border of the Capanne di Marcarolo Natural Park, which has been a protected area since 1979 (Fig. 1).

A total of 162 species were housed in the Centre during the six-year study (Appendix 1) which recorded an associated increase in its level of activity over the same period (Fig. 2). The linear regression analysis performed on the annual number of recoveries confirmed a highly significant increasing trend ($a = 253.6 \pm 11.6$; $p << 0.01$; $r^2 = 0.97$), which was also evidenced by the Mann-Kendall Test ($p_{no\ trend} = 0.0014$) (box in Fig. 2).

The number of wildlife admissions to CRAS during the year (Fig. 3) showed a close relationship with the seasons, with a maximum peak occurring from early spring to early autumn and, upon close examination of the dominant species, patterns were evident in their hospitalisation. The Yellow-legged gull *Larus michahellis*, the Collared dove *Streptopelia decaocto* and the Blackbird *Turdus merula* are very common sedentary species, well adapted to the urban environment and their frequency of admission was almost constant throughout the year, with an increase during the breeding season. The Common swift *Apus apus*, is a widespread migratory species whose presence in Liguria occurs only during its breeding period, which correlated closely with its peak in admissions during spring and summer. European hedgehog *Erinaceus europaeus* and Roe deer *Capreolus capreolus* are common mammals whose admissions to CRAS are fairly frequent and evenly distributed throughout the year, except in the late spring-early summer when there is an increase in admissions due to births.

Table 2. Provenance (number and relative percentage) of hospitalised animals at the CRAS in Genoa from 2015 to 2020.

Area of provenance	Nr Individuals	% Individuals
Western Liguria	664	11.3
Eastern Liguria	2392 (1106 in Polcevera Valley)	40.7 (18.8 in Polcevera Valley)
Genoa	2634	44.8
Outside of Liguria	142	2.4
Unknown	49	0.8

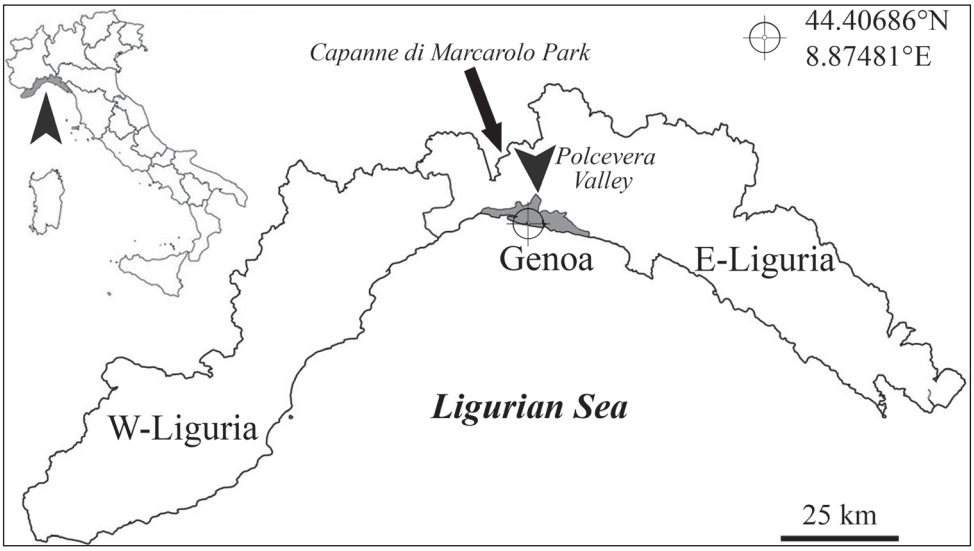

Figure 1. Liguria, NW-Italy: the Italian Region from which about 97% of the animals hospitalised at the CRAS in Genoa originate. The town of Genoa is shown in grey and the coordinates of the Centre on its coast are given. The border between Western (Imperia and Savona Provinces) and Eastern Liguria (Genoa and La Spezia Provinces) is shown. Capanne di Marcarolo Park and Polcevera Valley locations are also shown (see text).

Birds represented the 80.9% of the entries (31.1% non-passerines, 49.8% passerines), with the Common swift, Yellow-legged gull, Blackbird and Eurasian collared dove being the most common species. Mammals accounted for 18.6% of hospitalisations with the European hedgehog being the most common. Other mammals commonly hospitalised are ungulates, bats and some rodents, especially Roe deer, Wild boar, Kuhl's pipistrelle *Pipistrellus kuhlii*, Savi's pipistrelle *Hypsugo savii* and Dormouse *Glis glis*. Admission of carnivores are less numerous and were represented by Red fox *Vulpes vulpes*, European badger *Meles meles*, Beech marten *Martes foina*, Weasel *Mustela nivalis*, European polecat *Mustela putorius* and Italian wolf *Canis lupus italicus*. A minimal percentage (about 0.5% of the entries) was represented by reptiles and amphibians, with few wild specimens belonging to the local fauna (e.g. Barred grass snake *Natrix helvetica* and Green whip snake *Hierophis viridiflavus*). Despite this, the Centre

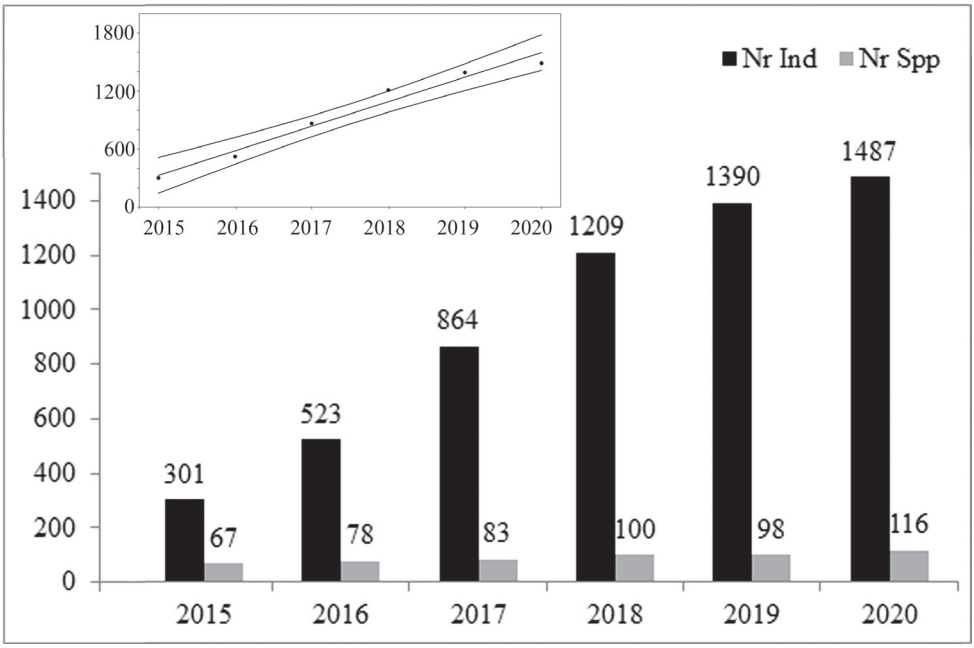

Figure 2. Number of individuals and species of wildlife hospitalised at the CRAS in Genoa between 2015 and 2020. The box shows the linear regression on the annual number of recoveries.

houses numerous tortoises and snakes resulting from abandonment or seizures by the Finance Police due to trade irregularities. Species protected by CITES (Convention on International Trade of Endangered Species) and/or included on the IUCN Red List (Rondinini et al. 2013), amounted to 8% of total admissions. Some of these species are very or quite common, such as the Little owl *Athene noctua*, Sparrowhawk *Accipiter nisus*, Buzzard *Buteo buteo* and Italian sparrow *Passer italiae*, while others represent rarer species, such as the Eagle owl *Bubo bubo*, Peregrine falcon *Falco peregrinus* and Italian wolf.

In Fig. 4, the percentages of the final outcomes of hospitalisation for the dominant species are shown. In general, 53.9% of the specimens treated were released back into nature; 4.7% of the animals were euthanised; and the remaining 41.4% died. The Chi-square Test evidenced a significant overall difference amongst dominant species/group of species in terms of frequencies of released and euthanised/died animals (χ^2 = 408.32, 21 d.f., Monte Carlo p = 0.0001). Focusing on the causes of debilitation, 14.2% of hospitalisations was attributable to man and domestic animals (human impact). It is very likely that this percentage is underestimated, since, for almost all the other hospitalisations, the specific cause of the injuries found in the animals is unknown. Fig. 5A shows the relative incidences of the various anthropogenic causes of hospitalisation. Based on reports of people who have rescued the animals or on the examination of injuries by the veterinarian, 54.3% of them were related to attempts of predation by domestic animals, mainly cats (*Felis catus*). The percentage of release back into nature

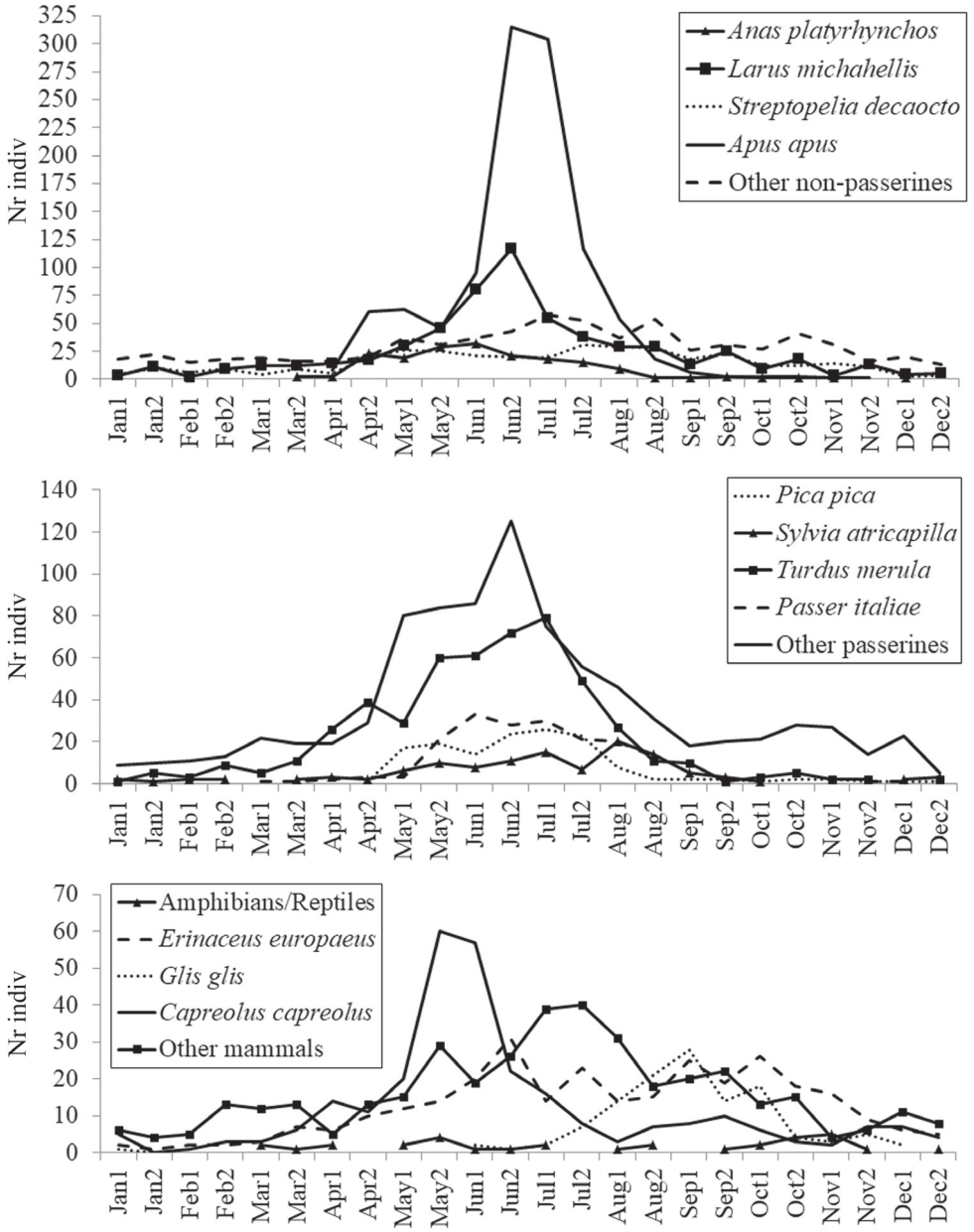

Figure 3. Annual phenology of animals hospitalised at the CRAS in Genoa. The year was divided into half-months. Trends of species amounting to at least 2% of the total (≥ 118 individuals) are shown. From the top: non-passerine birds, passerines, others (amphibians, reptiles and mammals).

of animals hospitalised following an anthropogenic impact (Fig. 5B) was 31.2%. This value, due to the greater severity of the injuries, is significantly lower than 53.9% recorded on the total of recoveries (χ^2 = 106.35, 1 d.f., Monte Carlo p = 0.0001 – Fisher's

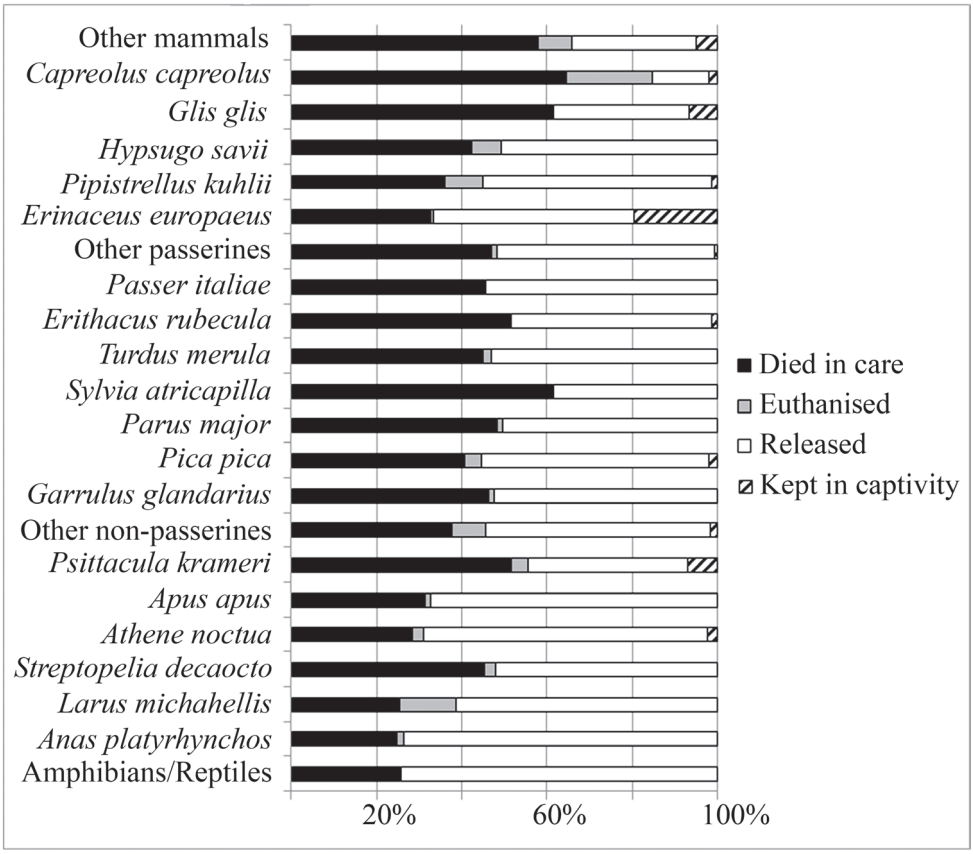

Figure 4. Percentages of the outcomes of hospitalisation at the CRAS in Genoa for the dominant species (at least 1% of the total; ≥ 59 individuals) and group of species. "Kept in captivity" indicates those animals which were still guests of the Centre at the end of 2020 (still under therapy, exotic or invasive species not releasable, no longer self-sufficient individuals).

Exact Test: $P_{(no\ assoc.)}$ <<0.01). From analysing data on the victims of predation attempts by domestic animals, the release rate resulted in 27.1%, which did not differ significantly from that of releases based on the total hospitalisations for anthropogenic causes (χ^2 = 1.7544, 1 d.f., Monte Carlo p = 0.1855 – Fisher's Exact Test: $P_{(no\ assoc.)}$ = 0.19191).

Discussion

The Genoese CRAS received annually some hundreds of debilitated wild animals that mainly came from the Liguria Region; a high percentage of admissions came from the relatively small and urbanised area of Genoa. This indicates the essential contribution of the general public to the recovery of wild animals and a positive correlation between density of the human population and the probability of wildlife recovery. The linear increase

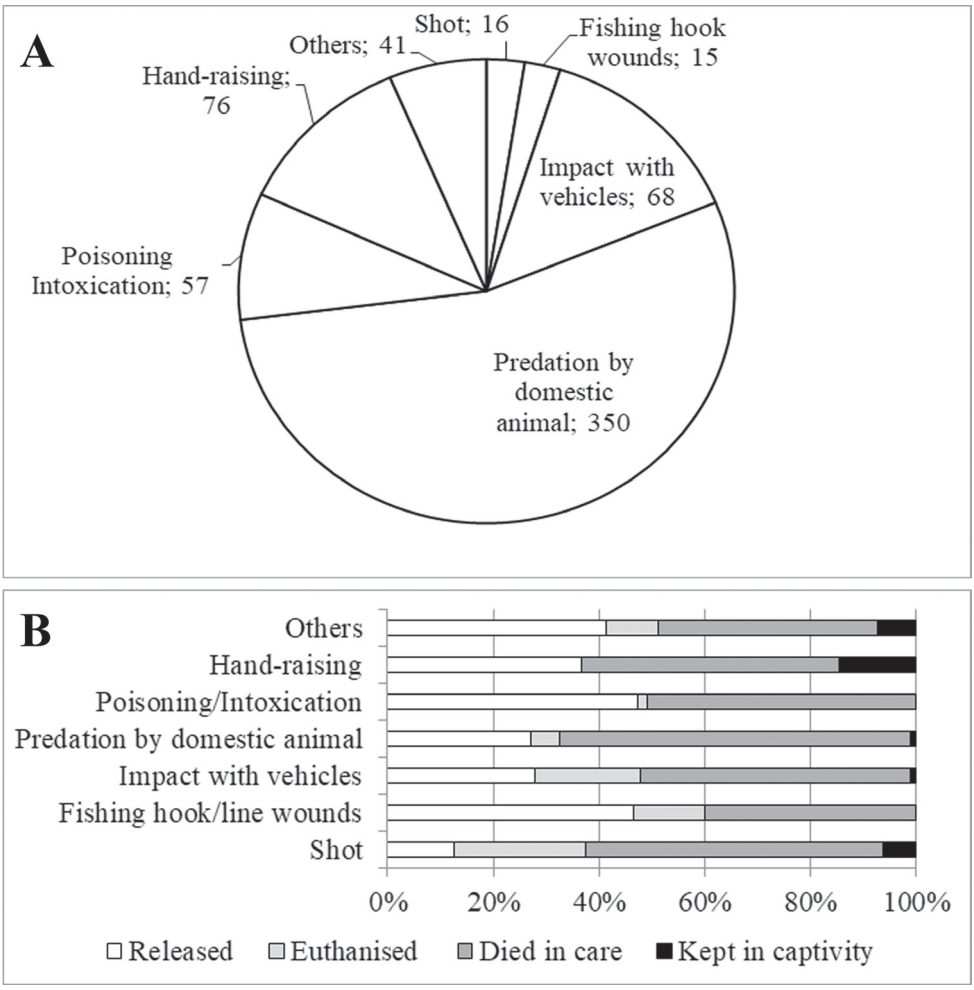

Figure 5. CRAS in Genoa. Causes of wildlife hospitalisation attributable to people and domestic animals (**A**). Outcomes of hospitalisation due to different forms of anthropogenic impact or to domestic animals (**B**).

of activity recorded over the years seems to indicate an increase in the degree of public awareness on the role of the Centre in the rehabilitation of wild animals and on the importance of wildlife conservation, but also a greater anthropogenic impact on nature.

The seasonal distribution of wildlife admissions recorded at CRAS is the result of two main factors: the presence of summer migrants (especially birds) and the reproduction of most animals during the hot season. Both these factors led not only to a numerical increase of individuals in the wild, but also to an increase in the percentage of juveniles (more than 70% of the entries during the hot season) that are at greater risk of capture than adults. For example, Roe deer fawns, according to the ethology of the species, are frequently found alone crouching in the woods by people who take them thinking they have been abandoned (Marsan and Spanò 1999). The return of

these animals by CRAS back into the wild can directly enhance the reproductive success of many wildlife species by increasing the survival rate of newborns and juveniles.

Birds accounted for 80.9% of entries; mammals 18.6%; and amphibians and reptiles 0.5%. This representation of animal type by percentage is quite common in recovery centres worldwide (Molina-López et al. 2017; Romero et al. 2019). The low number of recoveries of amphibians and reptiles is presumably the result of two concomitant factors: the difficulty of seeing them, especially when debilitated and the little empathy that these species arise in the community. Some of the species/group of species recovered in Genoa are so frequent amongst those hospitalised in European Recovery Centres that they are the subject of monographs or specific papers in the veterinary and conservation literature relating to recovery and rehabilitation. This is the case for the European hedgehog (Bunnell 2001; Bullen 2002; Martinez et al. 2014; Yarnell et al. 2019), Red fox (Matesic and Finegan 2016; Tolhurst et al. 2016), owls (Couper and Bexton 2012), Sparrow hawk (Kelly and Bland 2006) and birds of prey in general (Keran 1981; Molina-López et al. 2011). The latter species include those protected by CITES and included in IUCN Red List, which further highlights the important contribution of Recovery Centres in general and of the Genoese CRAS in particular, to wildlife conservation.

In Genoa, the percentage of released animals from CRAS was 53.9%, which can be considered as a successful outcome when compared with those known for other Italian CRAS Centres (http://www.recuperoselvatici.it/) that typically range between 35% and 65%. The lower percentages were recorded in the smaller Centres without veterinary assistance, while the highest percentage was recorded in the CRAS at Monte Adone (Bologna Province), a privately funded Centre. Similar results have been recorded in other countries. A study of four Royal Society for the Prevention of Cruelty to Animals (RSPCA) Recovery Centres, located in England, showed an overall release rate of about 40% of casualties (Grogan and Kelly 2013). The analysis of data from a long-term study (19 years), based on the activity of a Recovery Centre, located at Torreferrussa in the Spanish Region of Catalonia, achieved an overall percentage of released animals slightly over 50% (Molina-López et al. 2017). Tribe and Brown (2000), through an analysis of the outcomes in Australian Wildlife Rehabilitation Centres, showed an overall release rate ranging from 38 to 45%.

The significant differences recorded amongst different species' release rates can be attributed to the intrinsic characteristics of the species (animals more resistant or more adaptable to captivity than others) and to the types of debilitation suffered by the different species (e.g. infections, wounds, traumas, fractures) (Molina-López et al. 2017; Hanson et al. 2019).

In the Genoese CRAS, a significant percentage of hospitalisations (14.2%) were due to anthropogenic causes. Mortality of wildlife (especially birds) due to such causes has been previously analysed in depth both globally and locally (e.g. Galuppo and Borgo 2006; de Lucas et al. 2007; Loss et al. 2014, 2015; Janssen et al. 2020). These studies highlight that at least for birds, which are the most frequently hospitalised animals in the CRAS we studied, predation by cats alone accounts for a higher mortality

Table 3. Animals killed by cats housed in the collection of the Museum of Natural History in Genoa. In the first column, the date of collection is shown, except for some specimens indicated with [M] for which only the date of arrival in the Museum is known.

Date	Species	Provenance	Museum Code
Reptiles			
16.10.2012	*Coronella girondica*	Genoa Quinto, Via F. Filzi	
Birds			
08.04.1997	*Picus viridis*	Sori (Genoa Province), via Sant'Apollinare	MSNG 55021
21.03.1998	*Luscinia svecica cyanecula*	Genoa Quinto, via Bettolo	MSNG 54858
17.04.2002	*Cuculus canorus*	Lavagna (Genoa Province), strada panoramica	MSNG 54986
23.01.2007 [M]	*Garrulus glandarius*	Genoa, via Ruffini	
10.05.2010	*Sylvia atricapilla*	Genoa Apparizione, via Shelley	
01.11.2013	*Leiothrix lutea*	Ferriere di Lumarzo (Genoa Province), Fontanabuona Valley	MSNG 57837
12.02.2014	*Phylloscopus collybita*	Genoa, Piazza Manin	MSNG 57862
11.2014	*Troglodytes troglodytes*	Carasco (Genoa Province), loc. Terrarossa	
09.2015	*Sylvia borin*	Sestri Levante (Genoa Province)	
12.04.2017 [M]	*Melopsittacus undulatus*	Genoa Quarto	
28.11.2017 [M]	*Leiothrix lutea*	Alassio (Savona Province)	
29.11.2017 [M]	*Regulus regulus*	Lumarzo (Genoa Province), loc. Costa da Cà	
30.03.2019	*Prunella modularis*	Vado Ligure (Savona Province), Porto Vado, via Madonnetta	
01.11.2019	*Cyanistes caeruleus*	Stella (Savona Province), Mezzano	
Mammals			
12.05.2011	Shrew	Genoa Multedo, Villa Gavotti	
19.06.2012 [M]	*Glis glis*	Cremeno (Genoa Province)	
19.06.2012 [M]	*Glis glis*	Cremeno (Genoa Province)	
19.06.2012 [M]	*Sciurus vulgaris*	Cremeno (Genoa Province)	
19.06.2012	*Sciurus vulgaris*	Cremeno (Genoa Province)	
27.08.2014	*Glis glis*	Finale Ligure (Savona Province), Finalborgo, Aquila valley	
02.09.2014	*Glis glis*	Ceranesi (Genoa Province), Livellato	
22.06.2016 [M]	Shrew	Genoa Quinto al Mare	
20.09.2016	Shrew	Genoa Quinto al Mare	
20.09.2016	Shrew	Genoa Quinto al Mare	
26.10.2018	*Glis glis*	Pezzolo, Uzzone Valley (Cuneo Province)	
11.05.2019	Shrew	Rialto (Savona Province)	
23.11.2019	Shrew	Genoa Quinto al Mare	

than the other main anthropogenic causes of death combined (agricultural chemicals, electrocution and collisions against buildings, windows, vehicles, communication towers, power-lines and wind turbines). In our study, more than half (54.3%) of hospitalisations due to anthropogenic causes were due to predation attempts by domestic animals (mainly cats), with a release percentage significantly lower than the overall one (27.1%). Similar results were demonstrated by Loyd et al. (2017) who reviewed data from 82 North American wildlife Rehabilitation Centres. Domestic animals were found to be responsible for 14% of the hospitalisations and 78% of the attacked animals did not survive. Many papers have highlighted and quantified the impact on reptiles, small birds and mammals due to feral cats (Churcher and Lawton 1987; Woods et al. 2003; Kays and DeWan 2004; Baker et al. 2005; Dickman 2009; Legge et al. 2017; Trouwborst et al. 2020). In the collection of the Museum of Natural History of Genoa, for example, there are 14 birds, 13 mammals and one reptile from Liguria and Piedmont Regions that were killed by cats between 1997 and 2019 (Table 3). Furthermore, one of the authors (L. Galli, pers. comm.) saw an apparently docile dog killing

a roe deer fawn that was crouched on the ground in the woods. The impact of dogs on wild fauna is well known in literature: for example, Gompper (2013) emphasised how free-ranging dogs can influence wildlife conservation and management strategies of native species and Romero et al. (2019) observed that both dogs and cats were implicated in attacks to wildlife in Chile. These examples highlight a problem, often ignored or downplayed by people and invariably linked to the degree of settlement of the territory. Cats and dogs, left free to roam, significantly alter the natural balances that regulate wildlife, resulting in significant levels of mortality for many species, including endemic ones (Churcher and Lawton 1987; Woods et al. 2003; Kays and DeWan 2004; Baker et al. 2005; Ancillotto et al. 2013; Loss et al. 2013, 2015).

Conclusions

The work of rehabilitation/recovery centres contributes to wildlife conservation and the one in Genoa is growing in its activity concerning recovery and release of species under protection from CITES and/or the IUCN Red List, which now stands at 8% (Rondinini et al. 2013). The Genoese CRAS's level of efficiency is above average with 53.9% of animals released back into their natural habitats. However, this Centre needs the continuous support from the community (most of the funds come from private donations) and from the government authorities in order to continue and expand its work. Future projects of the Centre include the enlargement of facilities, hiring and training of new staff and the purchase of a radio-tracking system for monitoring the animals once released. These systems have been in use in some Centres for several years and allow staff to more accurately evaluate success rate of animals that manage to re-enter their natural ecosystem (Kenward 1993; Griffiths et al. 2010; Grogan and Kelly 2013; Mullineaux 2014; Musto et al. 2020).

The CRAS in Genoa recorded a certain percentage (14.2%) of cases hospitalised because of human direct or indirect impact. Moreover, animals which recovered from injuries due to predation attempts by domestic animals were those at highest risk of death. This result leads us to believe that, in addition to the Centre's activity, the adoption of preventative measures and a greater disclosure concerning the cause(s) of injury is fundamental. For example, the importance of animal over- and underpasses in enhancing connectivity between habitats of wild animals and in reducing the risk of animal-vehicles collisions is well known (Burton and Doblar 2004; Misłajek et al. 2020; Ważna et al. 2020). However, information campaigns designed to raise the level of awareness of politicians and the general public on the destructive impact of stray cats and dogs can also be effective in protecting wildlife populations (Loss et al. 2013; Mori et al. 2019; Trouwborst and Somsen 2020). It is critical that cat and dog owners prevent their pet animals from straying into wildlife habitats and the staff at CRAS can play a lead role in educating the general public on how best to curb the hunting of wildlife by cats and dogs and how pet owners can play a pivotal role in the protection and conservation of our wildlife, especially the conservation of our critically endangered species.

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Appendix 1

Number of individuals hospitalised for each species. Species are ordered according to decreasing number and to their systematics (following: Razzetti et al. 2005, Gippoliti 2013, Brichetti and Fracasso 2015). * Protected by CITES – appendix II; ** Protected by CITES – appendix I. CR = critically endangered, EN = endangered, VU = vulnerable according to the IUCN Italian Red List (Rondinini et al. 2013).

Species	N° ind.	Protection/Conservation status
Common swift / *Apus apus*	1093	
Yellow-legged gull / *Larus michahellis*	594	
Blackbird / *Turdus merula*	512	
Eurasian collared dove / *Streptopelia decaocto*	361	
European hedgehog / *Erinaceus europaeus*	300	
Roe deer / *Capreolus capreolus*	283	
Mallard / *Anas platyrhynchos*	179	
Italian sparrow / *Passer italiae*	178	VU
Eurasian magpie / *Pica pica*	150	
Dormouse / *Glis glis*	123	
Blackcap / *Sylvia atricapilla*	119	
Great tit / *Parus major*	101	
Rose-ringed parakeet / *Psittacula krameri*	99	
Little owl / *Athene noctua*	81	*
Eurasian jay / *Garrulus glandarius*	80	
Robin / *Erithacus rubecula*	67	
Kuhl's pipistrel / *Pipistrellus kuhlii*	66	
Savi's pipistrelle / *Hypsugo savii*	59	
Goldfinch / *Carduelis carduelis*	58	
Barn swallow / *Hirundo rustica*	57	
Common house martin / *Delichon urbicum*	54	
Hooded crow / *Corvus cornix*	49	
Chaffinch / *Fringilla coelebs*	49	
Sparrowhawk / *Accipiter nisus*	47	
Wild boar / *Sus scrofa*	46	
Common kestrel / *Falco tinnunculus*	43	*
Pallid swift / *Apus pallidus*	39	
Buzzard / *Buteo buteo*	38	*
Grey heron / *Ardea cinerea*	36	
Common redstart / *Phoenicurus phoenicurus*	34	
European serin / *Serinus serinus*	34	
European green woodpecker / *Picus viridis*	33	
Woodcock / *Scolopax rusticola*	29	
Song thrush / *Turdus philomelos*	29	
European quail / *Coturnix coturnix*	27	
White wagtail / *Motacilla alba*	27	
Red fox / *Vulpes vulpes*	27	
European starling / *Sturnus vulgaris*	26	
Tawny owl / *Strix aluco*	25	*
European badger / *Meles meles*	25	
Muskovy duck / *Cairina moschata*	24	
Common pipistrelle / *Pipistrellus pipistrellus*	23	
Eastern cottontail / *Sylvilagus floridanus*	22	
Pheasant / *Phasianus colchicus*	19	
Eurasian scops owl / *Otus scops*	19	*
Brown rat / *Rattus norvegicus*	19	
Goldcrest / *Regulus regulus*	18	
Black-headed gull / *Chroicocephalus ridibundus*	16	
Blue tit / *Cyanistes caeruleus*	15	

Species	N° ind.	Protection/Conservation status
Fallow deer / *Dama dama*	15	
Honey buzzard / *Pernis apivorus*	14	*
Red squirrel / *Sciurus vulgaris*	14	
Black rat / *Rattus rattus*	14	
Beech marten / *Martes foina*	14	
Eurasian jackdaw / *Corvus monedula*	12	
Peregrine falcon / *Falco peregrinus*	11	**
Water rail / *Rallus aquaticus*	10	
European free-tailed bat / *Tadarida teniotis*	10	
Red-legged partridge / *Alectoris rufa*	9	
Little bittern / *Ixobrychus minutus*	9	VU
European nightjar / *Caprimulgus europaeus*	9	
Eurasian reed warbler / *Acrocephalus scirpaceus*	9	
Common firecrest / *Regulus ignicapilla*	9	
Spotted flycatcher / *Muscicapa striata*	9	
Barred grass snake / *Natrix helvetica*	8	
Goshawk / *Accipiter gentilis*	8	*
Common kingfisher / *Alcedo atthis*	8	
Common woodpigeon / *Columba palumbus*	8	
European greenfinch / *Chloris chloris*	8	
House mouse / *Mus domesticus*	7	
Common chiffchaff / *Phylloscopus collybita*	7	
Turquoise-fronted amazon / *Amazona aestiva*	6	
Melodious warbler / *Hippolais polyglotta*	6	
Grey wagtail / *Motacilla cinerea*	6	
European hare / *Lepus europaeus*	6	
Crested porcupine / *Hystrix cristata*	6	
Green whip snake / *Hierophis viridiflavus*	5	
Common moorhen / *Gallinula chloropus*	5	
Eurasian hoopoe / *Upupa epops*	5	
Great-spotted woodpecker / *Dendrocopos major*	5	
Long-tailed tit / *Aegithalos caudatus*	5	
Common wall gecko / *Tarentola mauritanica*	4	
Aesculapian snake / *Zamenis longissimus*	4	
Common shag / *Phalacrocorax aristotelis*	4	
Barn owl / *Tyto alba*	4	*
Long-eared owl / *Asio otus*	4	*
Eurasian hobby / *Falco subbuteo*	4	*
Coal tit / *Periparus ater*	4	
Subalpine warbler / *Sylvia cantillans*	4	
Sardinian warbler / *Sylvia melanocephala*	4	
Wren / *Troglodytes troglodytes*	4	
Weasel / *Mustela nivalis*	4	
Fire salamander / *Salamandra salamandra*	3	
Little egret / *Egretta garzetta*	3	
Booted eagle / *Hieraaetus pennatus*	3	*
Short-toed eagle / *Circaetus gallicus*	3	* VU
Western marsh harrier / *Circus aeruginosus*	3	* VU
Nightingale / *Luscinia megarhynchos*	3	
Red-billed leiothrix / *Leiothrix lutea*	3	
Eurasian tree sparrow / *Passer montanus*	3	VU
Hawfinch / *Coccothraustes coccothraustes*	3	
White toothed pygmy shrew / *Suncus etruscus*	3	
Common toad / *Bufo bufo*	2	VU
Slow-worm / *Anguis fragilis*	2	
Eurasian teal / *Anas crecca*	2	EN
European storm petrel / *Hydrobates pelagicus*	2	

Species	N° ind.	Protection/Conservation status
Cattle egret / *Bubulcus ibis*	2	
Collared dove / *Streptopelia turtur*	2	
Common cuckoo / *Cuculus canorus*	2	
Eagle owl / *Bubo bubo*	2	*
Alpine swift / *Apus melba*	2	
Red-footed falcon / *Falco vespertinus*	2	*
European crested tit / *Lophophanes cristatus*	2	
Eurasian crag martin / *Ptyonoprogne rupestris*	2	
Wood warbler / *Phylloscopus sibilatrix*	2	
Whitethroat / *Sylvia communis*	2	
Black redstart / *Phoenicurus ochruros*	2	
European pied flycatcher / *Ficedula hypoleuca*	2	
Italian wolf / *Canis lupus italicus*	2	* VU
European polecat / *Mustela putorius*	2	
Strinati's cave salamander / *Speleomantes strinatii*	1	
Smooth snake / *Coronella austriaca*	1	
Riccioli's snake / *Coronella girondica*	1	
Viperine snake / *Natrix maura*	1	
Greylag goose / *Anser anser*	1	
Northern shoveler / *Anas clypeata*	1	VU
Grey partridge / *Perdix perdix*	1	
Sacred ibis / *Threskiornis aethiopicus*	1	
Black crowned night heron / *Nycticorax nycticorax*	1	VU
Northern gannet / *Morus bassanus*	1	
Great cormorant / *Phalacrocorax carbo*	1	
Black kite / *Milvus migrans*	1	*
Little crake / *Porzana parva*	1	
Spotted crake / *Porzana porzana*	1	
Coot / *Fulica atra*	1	
Common crane / *Grus grus*	1	*
Common sandpiper / *Actitis hypoleucos*	1	
Dunlin / *Calidris alpina*	1	
Sandwich tern / *Thalasseus sandvicensis*	1	
Whiskered tern / *Chlidonias hybrida*	1	
Stock pigeon / *Columba oenas*	1	
Short-eared owl / *Asio flammeus*	1	*
European bee-eater / *Merops apiaster*	1	
Yellow-crowned amazon / *Amazona ochrocephala*	1	
Golden oriole / *Oriolus oriolus*	1	
Marsh tit / *Poecile palustris*	1	
Sand martin / *Riparia riparia*	1	VU
Great reed warbler / *Acrocephalus arundinaceus*	1	
Sedge warbler / *Acrocephalus schoenobaenus*	1	CR
Garden warbler / *Sylvia borin*	1	
Lesser whitethroat / *Sylvia curruca*	1	
Western orphean warbler / *Sylvia hortensis*	1	EN
Redwing / *Turdus iliacus*	1	
Whinchat / *Saxicola rubetra*	1	
Dunnock / *Prunella modularis*	1	
Tree pipit / *Anthus trivialis*	1	VU
Water pipit / *Anthus spinoletta*	1	
Siskin / *Spinus spinus*	1	
Cirl bunting / *Emberiza cirlus*	1	
Common shrew / *Sorex araneus*	1	
Natterer's bat / *Myotis nattereri*	1	VU
Grey squirrel / *Sciurus carolinensis*	1	