

Digital trophies: using social media to assess wildlife crime in Lebanon

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Abstract Illegal hunting of migratory birds across the Mediterranean region is a serious international conservation issue with population-level impacts. We analysed photographs posted on social media platforms to assess the bird species illegally targeted in Lebanon. During 2011–2023 we reviewed 1,844 photographs publicly posted by poachers on Facebook and Instagram. In these images we identified 212 bird species, of which 94% are legally protected. Many are species of conservation concern, with 19 listed as threatened or Near Threatened on the IUCN Red List and 33% experiencing population declines in Europe. The five bird species with the most individuals illegally killed were the barn swallow *Hirundo rustica*, blackcap *Sylvia atricapilla*, European bee-eater *Merops apiaster*, Eurasian golden oriole *Oriolus oriolus* and ortolan bunting *Emberiza hortulana*. Raptors and other large soaring birds were particularly prevalent, with 35 species of raptor (particularly the European honey-buzzard *Pernis apivorus*, Eurasian sparrowhawk *Accipiter nisus*, common kestrel *Falco tinnunculus*, short-toed snake-eagle *Circaetus gallicus* and Levant sparrowhawk *Accipiter brevipes*) as well as storks, pelicans and cranes. Protected mammals were also posted as trophies, including the Near Threatened striped hyaena *Hyaena hyaena*. Poachers were present in 44% of photographs and were clearly identifiable 89% of the time, showing little concern about posting illegal activities on publicly accessible social media platforms. Our study is the first to use social media as a tool for assessing illegal hunting activities in Lebanon. We discuss both the use and limitations of this approach, as well as the ways in which social media can be utilized by law enforcement, to promote legal hunting or hunting alternatives and improve conservation education.

Keywords Conservation culturomics, hunting, Lebanon, poaching, raptor, social media, wildlife crime, wildlife trophies

Introduction

Illegal killing and trapping of migratory birds pose severe threats to wild bird populations and together are

considered the fourth biggest threat to birds globally (Lees et al., 2022). At the species level multiple studies have demonstrated that unregulated illegal hunting can compromise international conservation actions for certain species (Raine et al., 2016; Jiguet et al., 2019; Lormée et al., 2020; Perez-Garcia et al., 2024). At the regional scale a series of studies by Brochet et al. (2016) assessed illegal bird killing in 63 countries in Northern and Central Europe, the Mediterranean and the Middle East, and estimated 28 million birds are killed annually, with hundreds of species affected. Subsequently, the Mediterranean has emerged as a continental and global blackspot, with 11–36 million birds killed there illegally each year (Brochet et al., 2016).

Located along the eastern edge of the Mediterranean, Lebanon is situated on the Eastern African–Eurasian Flyway, one of the largest migratory bird flyways, and is particularly important for large soaring birds (Serhal & Khatib, 2014; Jobson et al., 2021). A total of 399 bird species have been recorded in Lebanon, of which 135 are confirmed breeders (53 resident and 82 summer breeders; Ramadan-Jaradi et al., 2020). In recognition of its importance, multiple agreements and memoranda pledging protection for birds utilizing the flyway have been created. These include the Agreement on the Conservation of African–Eurasian Migratory Waterbirds and the Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia, to both of which Lebanon is a signatory. Millions of migratory birds travel through Lebanon during biannual migrations, and observational and animal-tracking studies continue to highlight the importance of the country for large soaring birds that use the Lebanon Mountains as a thermal highway (Cameron et al., 1967; Meyburg et al., 2020). Geographical features and meteorological conditions prominent along this flyway form bottlenecks that concentrate birds into relatively small areas, where they are vulnerable to persecution by shooting (Meyburg et al., 2020; Oppel et al., 2021).

Records of bird migration over Lebanon emphasize the international importance of the country to multiple species (Nielsen & Christensen, 1970; Khairallah, 1991; Cameron et al., 2008; Ramadan-Jaradi et al., 2008, 2020; Ramadan-Jaradi & Ramadan-Jaradi, 2015; Jobson et al., 2021). For example, it is estimated that almost the entire global population of the lesser spotted eagle *Clanga pomarina* and Levant sparrowhawk *Accipiter brevipes* migrate through the country (Meyburg et al., 1995, 2020; Yosef et al., 2003; Meyburg & Meyburg, 2009). Similarly, the area is particularly

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important for many other large soaring species, including significant numbers of the European honey-buzzard *Pernis apivorus*, white stork *Ciconia ciconia*, black stork *Ciconia nigra* and great white pelican *Pelecanus onocrotalus* (Frumkin et al., 1995; Beale & Ramadan-Jaradi, 2001; Shirihai, 2002; Yosef et al., 2003; Leshem & Yom-Tov, 2008a,b; Krumenacker, 2013).

Widespread overhunting of migratory birds in Lebanon was first highlighted over 4 decades ago (Hatsofe, 1981; Leshem, 1985). Although there is some hunting of birds for food or for profit (the latter particularly in relation to songbirds), most hunting (especially that focused on raptors, storks and other large soaring birds) is carried out for sport, with the carcasses of these birds typically discarded in the countryside after shooting. More recently, Lebanon has been ranked as one of the five worst countries for bird poaching amongst Mediterranean and Middle Eastern countries, with an estimated 2.5 million birds illegally killed annually (Brochet et al., 2016). Recent studies have found that a quarter of the worst poaching hotspots in 26 Mediterranean and Middle Eastern countries occur within Lebanon (Brochet et al., 2016), with illegal bird killing considered one of the primary bird conservation issues in the country (El-Jisr, 2011; Serhal & Khatib, 2014). This is consistent with evidence collected by the NGO Committee Against Bird Slaughter together with local Lebanese partners from the Society for the Protection of Nature in Lebanon and the Middle Eastern Sustainable Hunting Centre and Anti-Poaching Unit. Since 2017, these organizations have documented widespread illegal hunting through field monitoring of active poaching incidents. Research using tracking and ring recoveries has revealed that birds killed in Lebanon originate from breeding populations across Eurasia (Meyburg et al., 2020; Oppel et al., 2021; Raine et al., 2021). Using the European ringing recovery database EURING, Raine et al. (2021) found that birds originating in 28 different countries were shot in Lebanon, with the top three countries of origin being Finland, Sweden and Germany. This included multiple species that are the focus of conservation throughout Europe, including the lesser spotted eagle, European honey-buzzard, white stork and black stork.

The legality of bird hunting in Lebanon has changed in recent decades. During 1995–2016 the shooting of all bird species and other wildlife was considered illegal. However, this was never effectively enforced. In 2017, Lebanese Law No. 580 was passed, designating hunting seasons and daily bag limits, prohibiting certain hunting methods and enforcing the requirement for a hunting licence. Under this law there are now 12 bird species that may be hunted, including three duck species (mallard *Anas platyrhynchos*, common teal *Anas crecca* and garganey *Spatula querquedula*), Eurasian woodcock *Scolopax rusticola*, wood pigeon *Columba palumbus*, stock dove *Columba oenas*, three thrush species (song thrush *Turdus philomelos*, mistle thrush *Turdus viscivorus* and fieldfare *Turdus pilaris*), common chaffinch *Fringilla*

coelebs, calandra lark *Melanocorypha calandra* and common quail *Coturnix coturnix*. The hunting of all other species is strictly prohibited. The official hunting season runs from September to the end of January and hunting in the spring is illegal. The Eurasian hare *Lepus europaeus* and wild boar *Sus scrofa* are the only two mammals that can be legally hunted. Despite hunting regulations, systematic monitoring and quantification of illegal bird killing remain key conservation challenges in Lebanon and across the Mediterranean and Middle East (Brochet et al., 2016). Even the legal taking of migratory birds is not well tracked or rigorously regulated across many hunting schemes (e.g. in Malta and Cyprus), affecting the conservation of a wide range of species at the flyway scale (Hirschfeld et al., 2019; Aubry et al., 2020; Raine et al., 2021), despite this being contrary to European Union law.

Social media are used globally, with an estimated 4.9 billion users in 2023 (Wong & Bottorff, 2023). Users publish millions of images, videos, text and other content daily, and there is growing recognition that this represents a large source of passively crowdsourced data that could be utilized to investigate a wide range of environmental and conservation topics (Ghermandi & Sinclair, 2019; Toivonen et al., 2019; Vaz et al., 2020). Dubbed conservation culturomics (Ladle et al., 2016), studies using such data have investigated the distribution of animals, illegal hunting and the illegal wildlife trade (Di Minin et al., 2019; Panter & White, 2020; Sardari et al., 2022; Haq et al., 2023; Bashyal & Roberts, 2024; Yeo et al., 2024). Hunters use social media to create and engage with online groups associated with hunting, network with other hunters, share and view hunting-related photographs, text and videos, and to advertise hunting-related merchandise and services (Eid & Handal, 2018). Hunters regularly publish photographs of hunted wildlife on Facebook (Meta, USA), Instagram (Meta, USA), TikTok (ByteDance, China) and private WhatsApp (Meta, USA) chats, possibly to gain a sense of achievement or satisfaction (Child & Darimont, 2015).

In recent years there has been increased recognition of the potential use of photographs of wildlife trophies posted on social media platforms in the Mediterranean and Arabian Peninsula as a tool for investigating illegal hunting (Brochet et al., 2019). Here we examine illegal hunting in Lebanon by analysing images posted on two popular social media platforms (Facebook and Instagram) to gain an understanding of the protected species that are favoured targets of Lebanese poachers. We discuss the benefits and limitations of social media as a tool for assessing illegal hunting, as well as their use in law enforcement, promoting legal hunting and adherence to hunting laws, education and conservation campaigns.

Methods

During 2011–2023 we reviewed posts on Facebook and Instagram that contained images of hunted birds and other wildlife in Lebanon. We specifically looked for images

of illegal activities, i.e. we did not include in our analysis images of species that appeared to have been shot within the legal daily hunting quotas. As all hunting was prohibited prior to 2017, we considered any photograph posted during 2011–2016 to be illegal. We discovered photographs by searching public Facebook and Instagram user profiles that were clearly associated with bird hunting in Lebanon or those of users who had joined Lebanese hunting groups on Facebook. We viewed activity in these groups by requesting access. Access to photographs on personal profiles was dependent on user-established privacy settings (i.e. we only viewed posts available to the public). In accordance with the privacy policy and terms of use of the social media platforms we did not collect personal information of users and did not interact with those posting photographs (i.e. we observed the posts passively). We determined whether a photograph was taken in Lebanon by looking for location data, examining the group and/or user profile and reading comments posted with the photograph.

We included 1,844 photographs in our analysis. For each image we first identified all pictured birds (and other wildlife) to species level wherever possible using field guides (e.g. Porter & Aspinall, 2010; Forsman, 2016; Svensson, 2022) and then counted the number of individuals for each species. It was not possible to identify all birds to species level because of factors such as low image resolution, poor lighting, the state of the bird (e.g. some were plucked or feathers or missing body parts that were necessary for identification) and visibility of the bird (e.g. some were partially covered by other carcasses). Where there was doubt regarding the species it was recorded as unidentified and not included in our analysis. Thus, some species that were difficult to differentiate (e.g. the common chiffchaff *Phylloscopus collybita*, willow warbler *Phylloscopus trochilus*, tree pipit *Anthus trivialis* and meadow pipit *Anthus pratensis*) could be under-represented.

For each photograph we also recorded the presence or absence of poachers (and whether they were identifiable), traps and electronic callers, and the specific law that had been broken. When considering whether daily hunting quotas had been breached we applied a conservative approach: where one hunter was visible in the photograph we divided the number of each pictured species by two (the hunter and the photographer). If no hunters were visible in the photograph, we recorded the number of hunters as one (the photographer).

Lastly, to determine whether there has been any change in the species composition of trophies over the study period, we compared data from two distinct time periods: 2011–2013 ($n = 598$) and 2020–2023 ($n = 139$), the beginning and end of our data collection period.

Results

We identified 29,542 individual birds of 212 species, with a mean of 19.1 ± 1.4 birds per photograph. This represents

53% of all bird species recorded in the country at the time of this study. Of these species, 199 (94%) are currently protected in Lebanon, and of these, 19 are categorized on the IUCN Red List as either Endangered (Egyptian vulture *Neophron percnopterus*, great bustard *Otis tarda* and steppe eagle *Aquila nipalensis*), Vulnerable (six) or Near Threatened (10; Table 1) globally. In Europe, one species is categorized as Critically Endangered (the steppe eagle), 13 as Vulnerable and nine as Near Threatened (Table 1). Thirty-three per cent of the species we recorded ($n = 70$) have decreasing population trends in Europe. One species (the eyebrowed thrush *Turdus obscurus*) is listed as a vagrant to Lebanon.

The species with the most individual birds shot and posted on social media by Lebanese poachers were the common quail ($n = 4,828$, 162 photographs), common chaffinch (4,478, 121), barn swallow *Hirundo rustica* (2,409, 122), song thrush (2,254, 95) and blackcap *Sylvia atricapilla* (1,940, 158). Although the common quail, common chaffinch and song thrush became legally huntable under Law No. 580 in 2017, in many of these instances they were either shot prior to 2017 (whilst protected) or in numbers far exceeding the daily bag limit, thus were shot illegally. After removing legally huntable species, the protected bird species that appeared most often in poachers' photographs were the barn swallow, blackcap, European bee-eater *Merops apiaster* ($n = 1,581$, 171 photographs), Eurasian golden oriole *Oriolus oriolus* (1,318, 141), Ortolan bunting *Emberiza hortulana* (1,080, 78), European honey-buzzard (890, 232), yellow wagtail *Motacilla flava* (677, 50), corncrake *Crex crex* (647, 64), European turtle-dove *Streptopelia turtur* (631, 90) and northern wheatear *Oenanthe oenanthe* (624, 83; Fig. 1). Raptors and other large soaring birds were particularly prevalent: 25% of all images posted by hunters included at least one raptor. We recorded 1,771 raptors of 35 species, with the most common being the European honey-buzzard ($n = 890$, 232 photographs), Eurasian sparrowhawk (327, 87), common kestrel *Falco tinnunculus* (81, 66), short-toed snake-eagle *Circaetus gallicus* (74, 52) and Levant sparrowhawk (60, 29). Other large soaring birds included the white stork (523, 159), black stork (15, 13), great white pelican (93, 61) and common crane (147, 39).

We also analysed the number of photographs containing at least one individual of each species, as we considered this a potential indication of whether the species itself was considered a trophy for poachers and thus specifically targeted (i.e. poachers often posted photographs of themselves holding a single raptor or stork rather than a single warbler or finch). This changed the species order and composition, with the five species featuring most frequently being the European honey-buzzard, European bee-eater, common quail, white stork and blackcap (Fig. 2).

We then considered the number of birds shown in a single photograph. For legally huntable species, photographs regularly showed piles of bird carcasses well above the current legal daily hunting bag limit of 20

TABLE 1 All protected species identified in social media photographs as hunted illegally in Lebanon during 2011–2023, with their status on the Global and European IUCN Red List (presented in order of global Red List status), and their population trend in Europe.

Species	Global IUCN Red List ¹	European IUCN Red List ¹	European population trend	Number of individuals	Total photographs
Steppe eagle <i>Aquila nipalensis</i>	EN	CR	Decreasing	7	7
Egyptian vulture <i>Neophron percnopterus</i>	EN	VU	Decreasing	4	4
Great bustard <i>Otis tarda</i>	EN	LC	Decreasing	4	3
Syrian serin <i>Serinus syriacus</i>	VU			4	3
Common pochard <i>Aythya ferina</i>	VU	VU	Decreasing	14	1
European turtle-dove <i>Streptopelia turtur</i>	VU	VU	Decreasing	631	90
Greater spotted eagle <i>Clanga clanga</i>	VU	VU	Decreasing	1	1
Lesser white-fronted goose <i>Anser erythropus</i>	VU	VU	Decreasing	3	2
Red-footed falcon <i>Falco vespertinus</i>	VU	VU	Decreasing	52	26
Bar-tailed godwit <i>Limosa lapponica</i>	NT	LC	Stable	3	1
Black-winged pratincole <i>Glareola nordmanni</i>	NT	LC	Stable	2	2
Cinereous vulture <i>Aegypius monachus</i>	NT	LC	Increasing	4	4
Ferruginous duck <i>Aythya nyroca</i>	NT	LC	Unknown	2	1
Pallid harrier <i>Circus macrourus</i>	NT	LC	Stable	9	8
Redwing <i>Turdus iliacus</i>	NT	LC	Decreasing	2	1
Eurasian curlew <i>Numenius arquata</i>	NT	NT	Decreasing	2	2
Woodchat shrike <i>Lanius senator</i>	NT	NT	Decreasing	11	7
Little bustard <i>Tetrax tetrax</i>	NT	VU	Decreasing	1	1
Northern lapwing <i>Vanellus vanellus</i>	NT	VU	Decreasing	153	22
Common redshank <i>Tringa totanus</i>	LC	VU	Decreasing	1	1
Common snipe <i>Gallinago gallinago</i>	LC	VU	Decreasing	2	2
Great spotted cuckoo <i>Clamator glandarius</i>	LC	VU	Decreasing	3	3
Northern pintail <i>Anas acuta</i>	LC	VU	Decreasing	1	1
White-breasted kingfisher <i>Halcyon smyrnensis</i>	LC	VU	Decreasing	4	4
Common coot <i>Fulica atra</i>	LC	NT	Decreasing	6	3
Common quail <i>Coturnix coturnix</i>	LC	NT	Decreasing	4,828	162
Common swift <i>Apus apus</i>	LC	NT	Decreasing	119	10
Cream-coloured courser <i>Cursorius cursor</i>	LC	NT	Unknown	22	7
Little swift <i>Apus affinis</i>	LC	NT	Decreasing	1	1
Red-breasted merganser <i>Mergus serrator</i>	LC	NT	Decreasing	1	1
Ruff <i>Calidris pugnax</i>	LC	NT	Decreasing	18	2

¹CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern.

individuals per species, therefore indicating illegal levels of hunting. For example, the mean number of common quail shot per hunter was 21.9 (maximum = 315 between three hunters), with 31% of photographs showing numbers exceeding the daily personal limit. The same was true for song thrush, with 19% (mean = 11.6, maximum = 83 by one hunter) of photographs presenting hunting bags over the daily limit. Photographs also often showed large piles of protected birds, such as the European bee-eater (mean = 9.6, maximum = 78) and barn swallow (mean = 20.3, maximum = 300). High numbers of raptors and other large soaring birds were also seen in individual photographs, for example the European honey-buzzard (maximum = 41 in one photograph), Eurasian sparrowhawk (31), white stork (26), common crane (19) and great white pelican (10).

Although most photographs showed dead birds, poachers also posted photographs of mammal and reptile carcasses. We recorded 15 mammal species in 56 photographs,

with the most common being Eurasian hare ($n = 235$, maximum = 48, 16 photographs), Eurasian badger *Meles meles* (25, 5, 12), Indian porcupine *Hystrix indica* (19, 3, 12) and the Near Threatened striped hyaena *Hyaena hyaena* (13, 3, 11). Almost half (47%) of the mammal carcasses pictured were carnivores, including the grey wolf *Canis lupus*, golden jackal *Canis aureus*, red fox *Vulpes vulpes*, African wildcat *Felis lybica* and beech marten *Martes foina*. We recorded six reptile species, including the Vulnerable Greek tortoise *Testudo graeca* ($n = 3$) and the Transcaucasian rat snake *Zamenis hohenackeri* ($n = 2$).

Lastly, we assessed photographs for evidence of other illegalities. Although the shooting of protected species was the most common illegal act ($n = 1,657$), we recorded eight other illegal activities (Table 2). These included hunting in the closed season (173), exceeding the hunting bag limit of legally shot species (88) and possession of live protected species (36). Poachers were present in 44% of all photographs,

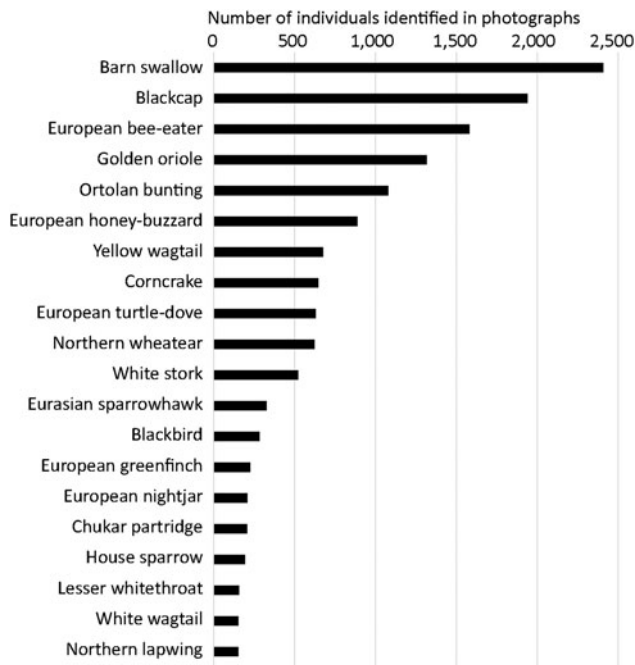


FIG. 1 The top 20 illegally hunted bird species, in terms of the number of individuals visible in photographs posted by Lebanese poachers on social media.

and were clearly identifiable (often with social media profiles, licence plates or phone numbers shown) in 89% of these.

Regarding temporal changes between the beginning (2011–2013, 128 species recorded) and end (2020–2023,

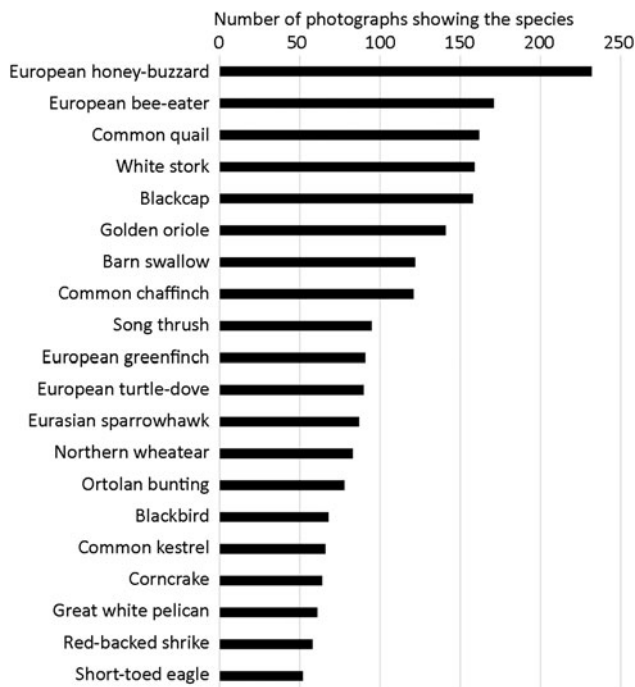


FIG. 2 The top 20 illegally hunted bird species, in terms of the number of photographs posted by Lebanese poachers on social media.

TABLE 2 Illegal hunting activities identified from photographs posted on social media by Lebanese poachers.

Violation of hunting law	Total
Hunting protected species	1,657
Hunting in closed season	173
Exceeding bag limit for legal species	88
Possession of live protected species	36
Minor with shotgun	10
Illegal hunting weapon	9
Electronic caller	8
Bird trapping	8
Selling protected species	6

86 species recorded) of our study period, four species (common chaffinch, common quail, song thrush and blackcap) were frequently hunted in both time periods, with the most common species being the common chaffinch and song thrush in 2011–2013 and the song thrush and common quail in 2020–2023. The European honey-buzzard remained the most commonly represented raptor in both time periods. The proportion of legally hunted to illegally hunted species appearing in photographs changed, with images towards the end of our study period containing a higher percentage of illegally shot species ($\chi^2 = 348.9$, $df = 1$, $P < 0.00001$). Conversely, there were significantly more raptors present in images at the beginning of the study ($\chi^2 = 57.4$, $df = 1$, $P < 0.00001$), and this was also true of all large soaring birds combined, with 36 species posted at the beginning of our study period ($\chi^2 = 77.6$, $df = 1$, $P < 0.00001$) compared to 16 species at the end.

Discussion

Conservation culturomics is becoming increasingly valuable for assessing a wide range of research topics (Ladle et al., 2016) and can be a viable way of assessing the impact of illegal hunting. As our results demonstrate, analysing public posts on social media platforms can be useful for assessing which protected species are targeted by poachers. By analysing images posted on Facebook and Instagram we found that Lebanese poachers kill a wide range of protected bird and mammal species. These include 212 bird, 15 mammal and 6 reptile species, of which 97% of bird species, 87% of mammals and 100% of reptiles were shot illegally. According to the IUCN Red List, 19 of these bird species are of conservation concern (i.e. categorized as threatened or Near Threatened) globally and 23 in Europe (including the most frequently shot species, the common quail, which is categorized as Near Threatened in Europe), and 33% have declining populations in Europe. Similar studies focused on hunting in Iran and Jordan also showed high percentages of illegally shot species, including those of conservation concern (Eid & Handal, 2018; Sardari et al., 2022).

As these examples and our analysis show, applying this technique in other illegal hunting blackspots worldwide is worthy of consideration.

One benefit of using social media posts to assess illegal hunting is highlighted by comparing our results with a previous study in which we investigated the international impact of illegal hunting in Lebanon by analysing bird rings recovered from hunted birds (Raine et al., 2021). There we found that most available data in the ringing database related to birds that are ringed systematically or are focal conservation species in Europe, resulting in those species being disproportionately represented. The absence of a species in our ringing analysis therefore did not necessarily mean that it was not heavily hunted in Lebanon. Although ringing recoveries were useful for highlighting the origin of birds and thus the international dimensions of illegal hunting in the region, they did not provide a comprehensive list of species targeted by Lebanese poachers. Our ringing analysis highlighted the European bee-eater as a species that is not present in the ringing database, but is known to be shot in large numbers in Lebanon based on our observations in the field. In the present study analysing hunters' social media posts, however, this species was the third most frequent bird seen in photographs. Social media posts therefore provide a particularly useful alternative method for assessing the species targeted by poachers.

Many of the species that appeared in social media posts were shot in large numbers, with multiple carcasses displayed in the photographs. This includes protected species (particularly raptors, swallows and bee-eaters) as well as species that can be hunted legally, such as the common quail and common chaffinch. Legally huntable species were often seen in piles well over the personal daily hunting limit of 20 birds, evidencing that hunters are regularly breaking the law even when it comes to species they are legally allowed to shoot. Furthermore, illegal methods such as the use of electronic callers or hunting at night are being employed to target these birds (authors, pers. obs., 2018–2023). Electronic callers are also used to attract protected species, such as the European nightjar *Caprimulgus europaeus*, barn swallow and blackcap (authors, pers. obs., 2018–2023).

Our study highlights that extensive work is needed to enforce legal hunting of birds and mammals in Lebanon. For migratory birds, Lebanon is an important bottleneck on the Eastern European–African Migratory Flyway (Beale & Ramadan-Jaradi, 2001; Serhal & Khatib, 2014), and significant numbers of raptors and other large soaring birds fly through the country each year, roosting overnight in some areas. Illegal hunting in Lebanon is particularly focused on these large species. For example, raptors appeared in 25% of the photographs we analysed, whereas in a similar analysis of illegal hunting in Jordan (Eid & Handal, 2018) raptors appeared in only 2% of social media posts. The global

populations of both the lesser spotted eagle and the Levant sparrowhawk migrate over Lebanon (Meyburg et al., 1995, 2020; Yosef et al., 2003; Meyburg & Meyburg, 2009) and both appeared regularly in our analysis (27 and 60, respectively), indicating that poachers preferentially target these species. Heavy poaching of these species is therefore likely to have global ramifications. The same is true for species of conservation concern such as the Vulnerable European turtle-dove, the ninth most commonly hunted species in our analysis. Furthermore, social media posts only represent a small proportion of the number of birds actually hunted in Lebanon, as the majority of hunters do not post images of their kills (or instead use private platforms, such as WhatsApp) and many bird carcasses are not retrieved after being shot.

Our results support evidence collected by the Committee Against Bird Slaughter and local Lebanese partners (the Middle Eastern Sustainable Hunting Centre, the Society for the Protection of Nature in Lebanon and the Association for Bird Conservation in Lebanon) suggesting that illegal hunting in the country is widespread. Many hunted birds originate from countries such as Germany, Sweden, Finland, Czechia and the UK (Raine et al., 2021), where millions of euros are spent annually on conservation projects, and several of the raptors and storks we saw on social media had coloured bands or wing tags from European projects. The fact that birds from these countries are being killed in large numbers in Lebanon represents a significant international issue, even more so when this is considered in the context of illegal hunting in adjacent countries and across the flyway (Eid & Handal, 2018; Brochet et al., 2019; Handal et al., 2021; Salih et al., 2022; Sardari et al., 2022). Controlling illegal hunting in Lebanon should be considered a conservation priority not only for the Lebanese authorities but also for the European countries in which these birds breed. Actions should include funding and capacity building for local and international NGOs, provision of technical expertise, education in schools and communities, support for local law enforcement, and diplomatic efforts. If illegal hunting continues in Lebanon at its current level, it could lead to localized extinctions of key species that breed across Europe.

Lebanese poachers appeared to be unconcerned about posting images and videos of their illegal hunting on public social media platforms and groups. They posed enthusiastically with their illegal trophies, often making no attempt to hide their identities. The culture of posting these photographs could be further driving illegal killing by motivating other poachers and establishing norms and an idea of impunity (Brochet et al., 2019). At the same time, this photographic evidence of poachers carrying out illegal hunting could be a useful tool for Lebanese law enforcement. In recent years (particularly from 2017 onwards when the Committee Against Bird Slaughter and the Middle Eastern

Sustainable Hunting Centre started annual bird protection camps in the country) Lebanese Internal Security Forces have apprehended and prosecuted poachers posing with illegally shot birds online, although this is still uncommon. Regularly reviewing social media posts could be an efficient way to catch poachers, and we recommend considering this as a tool in any attempts to bring illegal hunting in the country under control. Similarly, we recommend investigating other social media platforms, particularly TikTok, where videos of poachers shooting protected species in Lebanon are now becoming commonplace.

The use of social media to analyse illegal hunting in Lebanon also has its limitations. Low image resolution and difficulties identifying birds to species could lead to under-representation of some species. Moreover, although illegal shooting of birds was evident, other illegal activities were rarely evidenced in social media posts. For example, photographs of mist nets and limesticks, two prevalent forms of illegal trapping in certain areas in Lebanon (such as the Beqaa Valley), were rarely seen. This could be because poachers using these techniques are more interested in catching large numbers of birds to sell (blackcaps and other warblers are openly sold in supermarkets in Lebanon despite this being illegal) rather than as trophies to post on social media. Other illegalities, such as night hunting, are also difficult to assess through social media, as night photography presents technical challenges and photographs of wildlife trophies are normally taken in the day. We were able to infer night hunting from some photographs (because of the presence of spotlights on vehicles and images of species that typically migrate nocturnally), but there was no definitive evidence. However, we are aware of (and have witnessed) night hunting taking place in certain areas of Lebanon (such as Danniyeh) to target nightjars, rails, owls and quails, as well as the use of spotlights and decoys for thrushes in spring. One photograph we discovered showed poachers posing with a pile of 107 European nightjars on the front of their jeep, demonstrating the large number of individuals that can be killed in a single hunting outing in key migratory hotspots.

Another limitation of using social media to assess illegal hunting is that poachers may change their posting habits upon realizing that these photographs could be used to prosecute them. We identified a clear shift in species composition of trophy photographs between the beginning and end periods of our study. Although poachers were still sharing images of illegally shot species towards the end of our study (and the proportion of illegally shot birds increased), large soaring birds such as raptors, pelicans and storks appeared far less frequently. Although it could be suggested that this is because illegal hunting of large soaring birds has decreased in Lebanon, our collective field experience in the country suggests this is not the reality: in the last 4 years (2019–2023) we have found that illegal hunting is

still prolific, widespread and involves thousands of poachers. We suggest that the shift in species composition is instead because poachers are becoming more aware of the risks of posting illegal activities on social media (multiple arrests have been made during 2019–2023) and are therefore not posting photographs of larger species (which tend to draw the attention of authorities) as frequently or are posting them within closed and encrypted groups, for example on WhatsApp. Therefore, undertaking such analyses in countries where illegal hunting is prevalent requires consideration of the potential for behavioural changes.

We found two posts by users selling protected species (a juvenile Egyptian vulture and an adult black-winged kite *Elanus caeruleus*, both alive), but the small number of posts suggests this is not a primary reason that poachers in Lebanon use social media. The use of social media as a digital marketplace to sell wildlife illegally has been identified as a major emerging issue in a number of other countries, including China (Xiao et al., 2017), Indonesia (Nijman et al., 2021, 2022) and Pakistan (Haq et al., 2023). The sale of protected wildlife species, which violates the terms of use of both Facebook and Instagram, suggests there is little or no regulation of these posts in Lebanon. Additionally, some of the photographs we reviewed were extremely graphic, including dozens of photographs demonstrating acts of cruelty or torture to injured birds or desecration of dead birds (e.g. birds posed smoking cigarettes). One series of photographs showed a jackal being skinned, seemingly whilst still alive, and another was of a hyaena's throat being cut. Evidently, social media platforms have not invested sufficient resources to address the issue of wildlife crime (Xiao et al., 2017; Xu et al., 2020; Nijman et al., 2021, 2022), and our analysis demonstrates this is the case in Lebanon. Allowing users to continually post images of protected species that have been killed creates a cycle of rewarding illegal behaviour, often tempting hunters to compete for photographs with the rarest species or the most carcasses, thus perpetuating the issue. Facebook, Instagram and TikTok must be more proactive in screening and regulating posts relating to wildlife crime. We have reported multiple posts viewed during our analysis via the appropriate reporting portals. These reports should be assessed against Meta's community standards (which include sanctions against graphic violence and animal abuse), but as yet we have not seen any specific action being taken.

Previous studies have highlighted the benefits of social media for wildlife conservation, including increasing pro-conservation behaviour amongst the public, increasing conservation funding and inciting policy changes (Bergman et al., 2022). In the case of illegal hunting, in addition to their potential use in law enforcement and as a research tool, photographs published by hunters on social media can also motivate international discourse, environmental campaigns and diplomacy addressing the issue of bird

poaching. For example, images of numerous hunted white storks galvanized a Polish campaign to reduce illegal bird killing in Lebanon (Kronenberg et al., 2017). Seeing the level of cruelty or the scale of the problem on social media can also incite people to speak out against illegal hunting. Organizations such as the Committee Against Bird Slaughter have been utilizing social media as a tool to highlight the impact of illegal hunting in the country through photographs, videos and blogs. Lebanese groups such as the Middle Eastern Sustainable Hunting Centre have been using social media to promote legal hunting and to applaud hunters who are adhering to the hunting laws in Lebanon, using their platform to educate and to encourage hunters to attend workshops, and to suggest alternatives to hunting (such as photography). Similarly, multiple bird conservation groups such as the Society for the Protection of Nature in Lebanon and the Association for Bird Conservation in Lebanon regularly use social media posts to encourage the general population to bird watch and visit nature reserves, and provide education on bird conservation issues. When used appropriately, social media can therefore be an effective way to counter illegal hunting and promote change in public perceptions of wildlife conservation and nature appreciation.

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Conflicts of interest LS, AH and FB are affiliated with the Committee Against Bird Slaughter, Bonn, Germany.

Ethical standards This research abided by the *Oryx* guidelines on ethical standards and did not require specific approval from the institutions that the authors are affiliated with. As this research draws upon data sourced from photographs posted publicly on social media, it was carried out in a way that addressed potential privacy concerns (as outlined in Di Minin et al., 2021). We did not collect personal data or interact in any way with poachers posting photographs (we observed posts passively). We ensured that the images and data utilized in our analysis were anonymized so that the individuals engaged in illegal activity could not be identified through this analysis.

Data availability The raw data are not publicly available to maintain confidentiality.

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