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Clicks and comments: Representation of wildlife crime in Pakistan in social media posts

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ABSTRACT

To evaluate the online presence of wildlife crime and the public's reaction to these crimes, we collected data on species, locations, animal status, and motives of wildlife crime depicted on nine Pakistani Facebook pages and eight groups from January 2016 to May 2021. We categorized reactions to images depicting birds, mammals, and reptiles and applied generalized linear models to the total number of reactions on posts. In 594 relevant posts, we identified 10,644 animals of 138 species. Common Krait (*Bungarus caeruleus*) had the highest number of posts, followed by Grey Francolin (*Ortygornis pondicerianus*) and Black Francolin (*Francolinus francolinus*). The number of posts has generally increased, particularly after the Covid-19 lockdown in March 2020. Almost 66 % of the posts showed animals being killed, 27 % were captured with no visible signs of torture, and the rest showed visible signs of torture in captivity. The most common reason for wildlife crimes was illegal hunting, followed by fear and illegal trade. Most victims of illegal hunting were birds, while reptiles were predominantly killed for fear. However, illegal trade was affecting all three classes of animals. Killed or tortured animals received more reactions than non-tortured animals, as well as more comments both against and in favor of the crime. Crimes against reptiles received more pro-crime comments than birds and mammals. Our results reflect the importance of social media to monitor wildlife crimes. Urgent actions are necessary by the relevant authorities to improve management and strengthen the response of law enforcement to wildlife crime.

1. Introduction

Wildlife crime in general is the "unauthorized taking, trading (supplying, selling, or trafficking), importing, exporting, processing, obtaining and consumption of wild fauna and flora" (CITES, 2022; UNODC, 2020). However, the exact definition of wildlife crime varies among countries. In Pakistan, provincial governments (for example, the Punjab Wildlife Act, 1974 and the Sindh Wildlife Protection Act, 2020) and the administrative units of Azad Jammu and Kashmir and Gilgit-Baltistan have particular laws for the management of wildlife resources in areas under their jurisdiction (Government of Pakistan, 2017). Wildlife crimes can range from small-scale opportunity crimes to organized large-scale criminal operations (FATF, 2020). Globally, wildlife crimes include highly profitable transactional offenses, in all ranking fourth behind cocaine, weapons, and human trafficking (TRAFFIC, 2022), with an

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estimated annual financial gain of US$7–23 billion (UNEP, 2016).

Wildlife crime is driven by several factors, including economic profit and poverty (Akinsorotan et al., 2020; Duffy et al., 2016; Knapp et al., 2017), the survival of humans involved in the crime (Travers et al., 2019), possession or use of wildlife for cultural and religious purposes or values (Shao et al., 2021), bush meat (Rija et al., 2020), trophy hunting (Sollund, 2020), human-wildlife conflicts (Didarali et al., 2022; Viollaz et al., 2021), excitement and tradition (Forsyth and Forsyth, 2018). Wildlife crime has been posing a significant threat to animals worldwide (UNODC, 2020). For instance, it has contributed to an 80 % decrease in the overall population size of tropical mammals and a 40 % decrease in their distribution range globally (Rija et al., 2020). Wildlife crime is also recognized in the Sustainable Development Goals (SDGs) as a threat to the environment and Targets 15.7 and 15.C explicitly focus on wildlife crime and community participation (United Nations, 2015). Overexploitation of wildlife has accelerated adverse effects on national and local economies (FATF, 2020), public health (Zhou, 2020), governance, rule of law (INTERPOL-UN Environment, 2016), sustainable development, and on communities dependent on local wildlife for their livelihood (McFann and Pires, 2020).

In general, wildlife offenses are ranked as less serious, less harmful, and "less wrong" than offenses against persons and property, and also are taken less seriously than crimes against companion or farm animals (Wagner et al., 2019). The reactions of people not directly involved in the crime can reflect the culture and beliefs and can help to identify interventions to increase reporting of the crimes and social pressure to stop them (Feddema et al., 2020).

Due to its geographic position and high biodiversity, Pakistan has become a nexus for wildlife crime, including large-scale poaching (WWF, 2019). Poaching has contributed to wildlife declines in Pakistan (Ahmad et al., 2022; Din et al., 2022; Mahmood et al., 2012; Ullah et al., 2020). However, wildlife crime is still largely understudied and undocumented in the region (Masroor et al., 2020).

Since the early 2000s, the exponential growth of social media networks (e.g., Twitter, Facebook, and WeChat) has transformed regular networking resources in all facets of society. By mid-2022, the number of active social media users has reached 58.4 % of the world's human population, about 4.62 billion people worldwide (Kemp, 2022a). Social media data have been used in business, artificial intelligence, market analysis, and forecast (Fraccastoro et al., 2021). With the expansion of the digital world of social media, its use to tackle conservation challenges has also been increasing (Vaz et al., 2020). The organized social web of many-to-many has expanded the sources of wildlife-related data, as wildlife-trade information can travel easily through peer-to-peer networks (Sullivan et al., 2019). A wide range of wild vertebrate species, including mammals (Shivaprakash et al., 2021), birds (Nijman et al., 2022; Siriwat and Nijman, 2020), reptiles (Marshall et al., 2020), amphibians (Hughes et al., 2021) and fish (Borges et al., 2021) has become openly available and advertised on popular websites around the world. Among other examples, social media data have been used to evaluate illegal hunting in Iran (Sardari et al., 2022), and the illegal trade of raptors (Panter and White, 2020) and otters (Siriwat and Nijman, 2018) in Thailand. Besides data on affected species, successful conservation also relies on identifying and combating the reasons behind these crimes (St John et al., 2013).

In January 2022, the 71.7 million social media users in Pakistan represented 31.5 % of the total population (Kemp, 2022b). Among the six most popular social media websites (Facebook, Twitter, YouTube, Instagram, Pinterest, and Reddit) used in Pakistan, Facebook had the highest number of users (73.56 %) in May 2022 (Statcounter, 2022). In fact, approximately one in every three Pakistani citizens uses Facebook, which prompted us to focus on this platform.

Analyzing social media data, including comments on blogs and posts, can inform us about the magnitude of wildlife crime, hotspots, and apparent reasons. Evaluating responses from the public to these posts can help us design education campaigns and other awareness-raising actions (Bergman et al., 2022; Nekaris et al., 2013).

In this study, we aim to

- Quantify the number and type of wildlife crimes depicted in Facebook posts in Pakistan;
- Examine the temporal and spatial distribution of reported wildlife crimes;
- Identify the possible underlying reasons;
- Analyze the reactions and comments on the posts to understand the public's perception of wildlife crimes and conservation; and
- Highlight the potential of social media as a tool for biodiversity conservation.

2. Methods

Wildlife crime is any activity that goes against legislation protecting wild animals and plants. These actions cause pain and suffering to individual animals, push species closer to extinction, and can be linked to other serious crimes, such as firearms offenses and organized crime. Wildlife law is complicated, and it can be hard to know whether something is a crime and whether, or when, to involve the police. For this reason, in this study, we use the state of the animals (captured or killed) and the apparent reasons for the crime.

2.1. Data collection

We analyzed wildlife crimes in Pakistan that were posted or reported on Facebook between January 2016 and May 2021. We used the keywords "crime", "wildlife", and "wild animals" in English and Urdu in the search bar of Facebook. For our definition of wildlife crimes, we relied on the Provincial Wildlife Acts, which cover crimes and cruelty against all classes of animals. We also considered Society for the Prevention of Cruelty to Animals (SPCA), Punjab guidelines (The Prevention of Cruelty of Animals Act, 1890). We evaluated the resulting posts for evidence of wildlife crime. From this initial sample of posts, we used backward and forward snowball sampling to identify other posts, pages, and groups related to wildlife crime. Groups and pages that were identified were not explicitly

related to wildlife trade, but focused on awareness, posting, or sharing topics related to wildlife. Overall, we identified nine Facebook pages and eight Facebook groups relevant to wildlife of Pakistan, where such posts were common (Table 1.). All identified pages and four groups were public, i.e., even people with no Facebook account are able to see who is in the group and what they post. For the four private groups, our request to join was approved within 24 h. This was the only interaction we had with Facebook page group admins. These pages and groups mostly used Urdu language and some posts were written in Roman Urdu. All translations were completed prior to analysis by author RUH, who is a fluent speaker of Urdu.

We manually identified relevant posts and recorded and classified wildlife crimes. We collected data in May 2021, following the guidelines by Kosinski et al. (2015) and Martin et al. (2018). Our protocol had four conditions: we anonymized data (including the names of the poster, the commenters, and the names of the groups and the pages), avoided communication with users, did not publish identifying information, and checked for duplicates.

From each post, we identified animal species based on the picture(s) and description in the original post and comments. We noted common and scientific names, taxonomic class, global conservation status, and population trends of the species (IUCN, 2022). For the native status of the species in Pakistan, we followed Grimmett et al. (2009), Khan (2006), and Roberts (1997). We also identified species that were included in Appendix I, Appendix II, and Appendix III in CITES for international trade regulations from the Species+ database (UNEP, 2023).

We manually extracted the geographic location and the date of the crime from the description of the post or from the comments by the poster or other people who had that information. When the date of the crime was not included in the text caption or on the photograph, we recorded it as missing information. We obtained the number of animals from the comments or if this information was not provided, based on the photo. We also quantified public reactions by recording the number of likes and other emoji reactions, shares, and comments to each post.

Based on the photographs, the description of the post and if necessary, expert knowledge, we categorized the types of wildlife crime and the reason behind them. We considered the robustness of the coding by checking agreement among the four authors and an expert. They always agreed on class and the status of the animal. When there was disagreement about the reasons behind the crime, it was discussed until agreed on. We used three general categories for the type of wildlife crime based on the state of the animal: captured with no visible torture, captured and visibly tortured, or killed (Table 2).

We identified 10 reasons for the animals being captured or killed: baiting, fear, human-animal conflict, ignorance, illegal hunting, illegal trade, kept as a pet, medicine, performance, and to take photos/videos (Table 3). There was a single case of an animal sacrificed for Eid, which was an unidentified mammal species (most probably a female Urial (*Ovis vignei*). It is against the law to use a protected wild animal as an Eid sacrifice. The text describing the post states "*We sacrificed a jungli bakri (In English: wild goat) for Eid, therefore we will get more reward*". Because of their ignorance, they sacrificed a protected wild animal. Because there was only this one example, we decided not to treat it as a separate category and included this case under ignorance.

For each post, we recorded the number and types of the seven different emoji reactions (like, love, care, laugh, wow, sad, or angry)

Table 1
Summary statistics of the anonymized Facebook pages and groups with wildlife-crime posts in Pakistan, with the number of likes, followers, and members (for pages and groups, respectively) and relevant wildlife crime posts at the time of data collection. Please note that Facebook groups do not have likes (indicated by NA), only members.

Group/page ID	Number of posts	Number of page likes[1]	Number of followers[2] or members[3]
Group 1	129	NA	8360
Group 2	44	NA	15,338
Group 3	40	NA	9809
Group 4	23	NA	2210
Group 5	21	NA	51,900
Group 6	3	NA	10,655
Group 7	2	NA	13,667
Group 8	1	NA	254,700
Page 1	148	71,134	18,795
Page 2	133	8979	9636
Page 3	26	215,261	219,808
Page 4	6	8979	9636
Page 5	6	5103	5169
Page 6	5	21,099	21,965
Page 7	3	71,134	18,795
Page 8	3	3295	3399
Page 9	1	9534	9812

[1] A Like is a Facebook emoji reaction, in fact, the famous "Like" icon with the blue thumb is one of the most central images in the Facebook brand. A person can like anything on a site that they can comment on. A like usually represents "I like this", "I agree" or "I have seen it".

[2] Facebook followers are people who have opted-in to "follow" a profile or page, meaning that they will receive updates from this profile or page in their timeline. When people like a page, according to Facebook's default settings, they become followers as well.

[3] A Facebook Group is a place for group communication and for people to share their common interests and express their opinion. Groups let people (i.e., the members) come together around a common cause, issue, or activity to organize, express objectives, discuss issues, post photos, and share related content. Anybody can create and manage a Facebook group and a person can join up to 6000 Groups. Again, they will see activity of the groups they joined on their page."

Table 2
Status of the animals affected by wildlife crime in Pakistan as depicted in posts in nine Facebook pages and eight groups from January 2016 to May 2021 and the reason behind the crime. For detailed examples of the reasons for the wildlife crime, see Table 3.

Type of wildlife crime	Description	Most common reason
Captured (No visible Torture)	Wild-caught animals kept in captivity without visible signs of torture or stress	● illegal trade ● to be kept as pets
Captured (Tortured)	Severe pain and suffering inflicted on captured wild animals by humans	● illegal trade ● to be kept as pets ● to be kept as performance animals
Killed	Purposefully caused death in wild animals by humans	● illegal hunting ● fear

Table 3
Definitions of the reasons for wildlife crime from Pakistan with examples based on posts in nine Facebook pages and eight groups from January 2016 to May 2021. Representative screenshots are shown in Appendix Fig. 1, but please be warned that some of the images can be upsetting.

Reasons	Definition	Examples and further explanation
Baiting	Baiting is a blood sport, where a chained wild animal and one or more dogs are forced to fight one another. It may also involve pitting two wild animals against each other.	Wild Boar (*Sus scrofa*), Striped Hyena (*Hyaena hyaena*), and bears are most commonly used. Example: A Wild Boar is immobilized by having its legs tied with ropes and is attacked by two dogs for the amusement of onlookers (Appendix Fig. 1a).
Fear	Killing or hurting a wild animal as a result of an emotional reaction because people consider them a threat.	Different species of (venomous and non-venomous) snakes. Example: An Indian Cobra (*Naja naja*) was killed using a metal rod (Appendix Fig. 1b).
Human-animal conflict	Killing or hurting a wild animal as a result of negative interaction between wildlife and humans or livestock.	Leopards (*Panthera pardus*), Indian Rock Pythons (*Python molurus*), and Indian Crested Porcupines (*Hystrix indica*) are often victims of human-animal conflicts. Example: A Leopard killed by villagers for attacking a person (Appendix Fig. 1c).
Ignorance	Killing or hurting a wild animal as a result of ignorance. Given the lack of education, people cannot correctly identify wild animals and misidentify them as dangerous species.	Similar looking animals (particularly non-venomous snakes) are often mistaken for dangerous species. Example: A Fishing Cat (*Prionailurus viverrinus*) was tortured and killed for being misidentified as a Leopard by the villagers (Appendix Fig. 1d).
Illegal hunting	Illegal killing of an animal during sport hunting, which is traditional in Pakistan.	A variety of species are killed indiscriminately, particularly birds and ungulates. Example: An illegally shot Nilgai (*Boselaphus tragocamelus*) (Appendix Fig. 1e).
Illegal trade	Illegal trade of live wild animals, body parts, or derived products.	Birds, mammals, and reptiles are all traded illegally. Example: A person announcing having an Indian Pangolin (*Manis crassicaudata*) in their possession and selling it online (Appendix Fig. 1h).
Kept as pet	Wild animals captured and/or traded to be kept as pets.	Many animals (mainly parakeets, snakes, and small mammals) that were captured in the wild are kept as pets. Example: A Small Indian Civet (*Viverricula indica*) is tied up like a dog (Appendix Fig. 1f).
Medicine	Killing or hurting wild animals to use their products for the treatment of various diseases and disorders	In our sample, Indian Spiny-tailed Lizard (*Saara hardwickii*) was the only example for this category. The vendor often breaks the spinal cord of the lizards thereby paralyzing them to display alive (Appendix Fig. 1h).
Performance	A street performance, where an animal is forced to dance or perform in some other way in front of a live audience.	Mostly monkeys and bears are used in street performances by the *Qalandars*. Example: An Asiatic Black Bear (*Ursus thibetanus*) performing on the street (Appendix Fig. 1i).
Photos or videos	Wild animals used to take photos or videos of them or with them to get likes online or offline, for wedding photoshoots and political rallies.	Lions and tigers are often kept and photographed as status symbols. Example: A Lion (*Panthera leo*) used in a rally organized to campaign for a political party, whose political symbol is a tiger (Appendix Fig. 1j).

and categorized the comments (Obamiro et al., 2020; Pal et al., 2017) as positive, negative, sharing information, or irrelevant (Table 4). We calculated the frequency of the different reactions and comment types (Pal et al., 2017). We treated "likes" as a unique category, as this is a general and loosely used reaction and the other six reactions explain public sentiments more exclusively (Badiata, 2016; Eberl et al., 2020). For each post, we analyzed the number and type of reactions and comments as a function of the taxonomic class, the status of the species, and the reason for the crime.

2.2. Spatial and statistical analysis

Using the geographical location, where the crime was recorded, we created a heat map using ArcGIS version 10.5.1 (ESRI, 2017). To understand the effect of taxonomic class, type of crime, and reason for the crime on the (i) number of reactions (to observe public engagement), (ii) comments against the crime, and (iii) comments appreciating the crime on individual posts, we used generalized linear models (GLMs) with negative binomial distribution using the *mass* package (Venables and Ripley, 2002) in R version 1.4.1717 (R Core Team, 2019). We added the predictor variables to the models individually, two at a time, and all three together to obtain the

Table 4
Types of comments with example quotes on wildlife crime posts from Pakistan on nine Facebook pages and in eight groups from January 2016 to May 2021. NA indicates no subcategories.

Comment type	Subcategory of comment type	Description	Illustrative examples
Positive	Against wildlife crime	Condemning wildlife crime and encouraging the protection and conservation of wild animals.	*"This is horrible. These bears are already few. Punjab Wildlife and Parks Department must take action immediately."*
	Religious positive	Giving religious references and remarks on the protection, care, and benefits of wild animals.	*"This is not acceptable. Allah forbids us from hurting living beings"*
Negative	Encouraging wildlife crime	Encouraging wildlife crime and appreciating the brutal acts against wild animals.	*"Bravo, you did the right thing. A good snake is a dead snake"*
	Religious negative	Giving religious references and commands, which allow harming and committing other crimes against wild animals.	*"Man is "Ashraf-ul-Makhlooqat" (the highest form of creation), so he can kill and eat everything halal."*
Information sharing	NA	Providing scientific knowledge, for instance identifying the species in the post and describing its ecological importance, conservation status, conservation needs, occurrence, or habitat.	*"This crime against "redacted" species happened in "redacted" district, "redacted" province of Pakistan"*
Irrelevant	NA	Comments not related to the content of the post.	Another person is mentioned or tagged by the commenter.

influence of each variable. Using Akaike's information criterion (AIC) for model selection (Burnham and Anderson, 2004), we selected the model with the lowest score through the *wiqid* R package (Meredith, 2020). We used an 85 % confidence interval to recognize variables with a significant effect on the reaction of the public towards wildlife crimes to reduce model choice and to make parameter-assessment criteria more harmonious than the smaller confidence intervals, such as the widely used 95 % (Arnold, 2010). We also calculated the incidence rate ratio (IRR) to indicate the influence of the explanatory variable on the response variable compared to the model regression coefficient (Piza, 2012).

3. Results

3.1. The magnitude and dynamics of wildlife crime in Pakistan based on Facebook posts

We identified 594 posts depicting wildlife crime in Pakistan on nine Facebook pages and in eight Facebook groups that were posted between January 2016 and May 2021. These posts depicted 10,644 individual animals belonging to 138 species of birds, mammals, and reptiles. No amphibian, fish, or invertebrate species were represented in these posts. Birds had the most posts, species, and individuals (224 posts, 69 species, and 9480 individuals) followed by 195 posts of reptiles with 763 individuals of 30 species and 175 posts of 39 mammal species showing 401 individuals. We could not identify at the species level 16 cases (14 birds, a mammal, and a reptile).

The highest overall number of individuals depicted as victims of a wildlife crime event on posts was 1288 Rosy Starlings (*Pastor roseus*), followed by 1255 Grey Francolin (*Ortygornis pondicerianus*), and 1100 Bank Mynas (*Acridotheres ginginianus*). Among mammals, we identified 101 individuals of Siberian Ibex (*Capra sibirica*), followed by 49 Indian Desert Hare (*Lepus nigricollis*) and 44 Leopard (*Panthera pardus*). Considering reptiles, we recorded 537 Spiny-tail Lizard (*Saara hardwickii*), followed by two relatively less affected snakes, Common Krait (*Bungarus caeruleus*), and Chequered Keelback (*Fowlea piscator*) with 34 and 31 individuals, respectively. Common Krait was identified in 34 posts of one individual each ($n_p = 34$, $n_{ind} = 34$), which was the highest among all taxa,

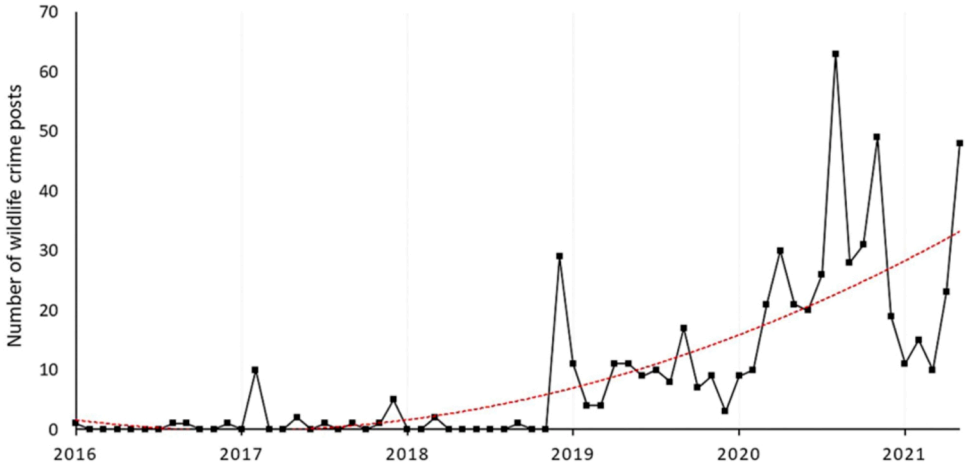

Fig. 1. The number of wildlife crime posts per month in Pakistan from January 2016 to May 2021 with January of each year marked.

followed by Grey Francolin ($n_p = 30$, $n_{ind} = 1255$), and Black Francolin (*Francolinus francolinus*) ($n_p = 24$, $n_{ind} = 341$). Bank Myna, Spiny-tailed Lizard, and Siberian Ibex had the highest number of individuals/post ratio in the three taxonomic classes with values of 550, 107.4, and 50.5, respectively.

The annual number of wildlife crime posts has increased between January 2016 and May 2021, reaching 327 in 2020. Considering monthly values, there was a clear increase in March 2020, when the Covid-19 lockdown began in Pakistan, and the highest number of posts was reported in August 2020 (Fig. 1).

3.2. Native-exotic status, global conservation status, and population trends of the animals

Regarding the native status of the species in Pakistan, 123 of 594 posts were of native birds belonging to 31 species ($n_{ind} = 5278$, $n_{sp} = 31$), 194 posts from native reptiles ($n_{ind} = 762$, $n_{sp} = 30$), and 161 posts from native mammals ($n_{ind} = 378$, $n_{sp} = 33$). The 10 posts depicting non-native animals included four species: Lion (*Panthera leo*), Tiger (*Panthera tigris*), Giraffe (*Giraffa camelopardalis*), and Sambar (*Rusa unicolor*).

We identified individuals of one globally Critically Endangered bird (Great Indian Bustard *Ardeotis nigriceps*), four bird and six mammal species that were Endangered, 16 Vulnerable species (six birds, eight mammals, and two reptiles), 16 Near Threatened species (five birds, six mammals, and five reptiles), and 96 Least Concern species (Appendix Table 1). Among the 43 threatened species, wildlife trade or illegal hunting were not mentioned by IUCN as threats for Afghan Tortoise (*Testudo horsfieldii*), which was identified as a pet in one post, one Kashmir Gray Langur (*Semnopithecus ajax*) and 14 individuals of Wild Goat (*Capra aegagrus*) as victims of illegal hunting, and a Woolly Flying Squirrel (*Eupetaurus cinereus*) tortured because of ignorance.

Overall, we identified 270 individuals of 24 species (seven birds, 14 mammals, and three reptiles) that were listed in Appendix I of CITES, 870 individuals of 37 species (22 birds, seven mammals, and eight reptiles) listed in Appendix II, and 196 individuals of 15 species (two birds and reptiles each and 11 mammals) listed in Appendix III (Appendix Table 1).

About half (64) of the species identified in Facebook posts were globally declining, 33 were stable, 23 increasing and 19 had unknown trends (Appendix Table 1). Most bird and mammal species in our dataset were globally declining, whereas most reptiles were stable, and none were increasing.

Among the 138 species in our dataset, 101 had hunting and trapping listed as a threat and 122 species were threatened due to illegal wildlife trade according to IUCN. Use and trade were identified as a threat for 68 bird species, 34 mammals, and 20 reptiles (Appendix Table 1).

3.3. Wildlife crimes and the underlying reasons

Most of the animals depicted in these posts were killed, followed by capture with no visible torture. Of 10,644 individuals, 7027 were killed (birds: $n_{ind} = 6529$, $n_{sp} = 53$, mammals: $n_{ind} = 303$, $n_{sp} = 29$, and reptiles: $n_{ind} = 195$, $n_{sp} = 27$), while 2878 were captured with no visible torture (birds: $n_{ind} = 2839$, $n_{sp} = 24$, mammals: $n_{ind} = 13$, $n_{sp} = 9$, and reptiles: $n_{ind} = 26$, $n_{sp} = 14$), whereas 739 were in captivity with visible signs of physical torture on them (birds: $n_{ind} = 112$, $n_{sp} = 11$, mammals: $n_{ind} = 85$, $n_{sp} = 19$, and reptiles: $n_{ind} = 542$, $n_{sp} = 6$).

The most common reason for wildlife crime was illegal hunting ($n_p = 220$, $n_{ind} = 5802$), followed by fear ($n_p = 154$, $n_{ind} = 182$), illegal trade ($n_p = 85$, $n_{ind} = 3964$), pet keeping ($n_p = 42$, $n_{ind} = 54$), ignorance ($n_p = 29$, $n_{ind} = 31$), performance ($n_p = 22$, $n_{ind} = 30$),

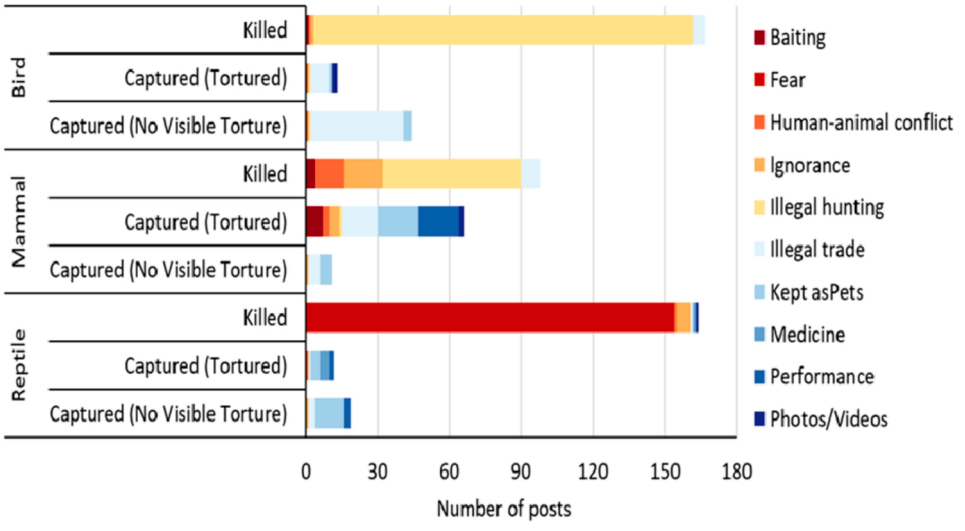

Fig. 2. The number of posts in function of the status of the animals and the reasons behind the wildlife crimes for birds, mammals, and reptiles identified in Pakistani Facebook posts from January 2016 and May 2021.

human-animal conflict ($n_p = 20$, $n_{ind} = 26$), baiting ($n_p = 12$, $n_{ind} = 13$), medicine ($n_p = 5$, $n_{ind} = 537$) and to be used in photos or videos ($n_p = 5$, $n_{ind} = 5$). The reasons were different for different classes of animals, for birds and mammals illegal hunting and illegal trade were the main reasons why they were victims of crime. However, for reptiles, fear was the main reason followed by the urge to keep them as pets (Fig. 2).

3.4. Geographical distribution of wildlife crimes in Pakistan according to Facebook posts

Location information was missing for 174 posts. Among the rest, locations up to the province level were available for 40 cases. Wildlife crimes were recorded in 98 districts of all seven administrative units of Pakistan (Fig. 3), most in Punjab ($n_p = 199$), followed by Khyber Pakhtunkhwa ($n_p = 110$) and Sindh ($n_p = 52$). Furthermore, for crimes with a known location, the number of animals affected was also highest in Punjab ($n_{ind} = 3406$) followed by Sindh ($n_{ind} = 1542$) and KPK ($n_{ind} = 1522$).

3.5. Sentiment analysis of the reactions to wildlife crime

The taxonomic class of the animal affected the numbers and types of the reactions. Birds received the most likes (23,344), followed by mammals (15,455) and reptiles (11,172), whereas the number of other emojis was highest for reptiles (40,917), followed by birds (34,139) and mammals (22,131). Posts with mammals were shared 36,861 times, followed by birds and reptiles, 22,032 and 12,963 times, respectively. People mostly reacted to posts using the "angry" emoji, followed by "sad". However, when reptiles were killed, there were more "laugh" reactions than for birds and mammals. Sentiments also varied based on the type of crime, in the case of killing birds, over 90 % of the reactions were "angry" and "sad", and only 4 % "laugh" emojis (Fig. 4).

Most comments were on posts depicting reptiles (5008 comments), followed by birds (4451), and mammals (3729). The proportion of different types of comments (against or supporting the crime, providing information, religious positive or religious negative, or irrelevant) varied based on the status of the animal and the type of crime (Fig. 5, Fig. 6).

3.6. Factors driving the number of reactions to wildlife crime posts

The number of comments varied based on the reason for the crime (from 9 to over 5000 total comments) and the class of the animal (Fig. 6). Posts depicting illegal hunting received over five times more comments appreciating the crime, than the ones criticizing it.

Results of the first model suggest that the status of the animal was the only significant factor in the number of reactions (likes and

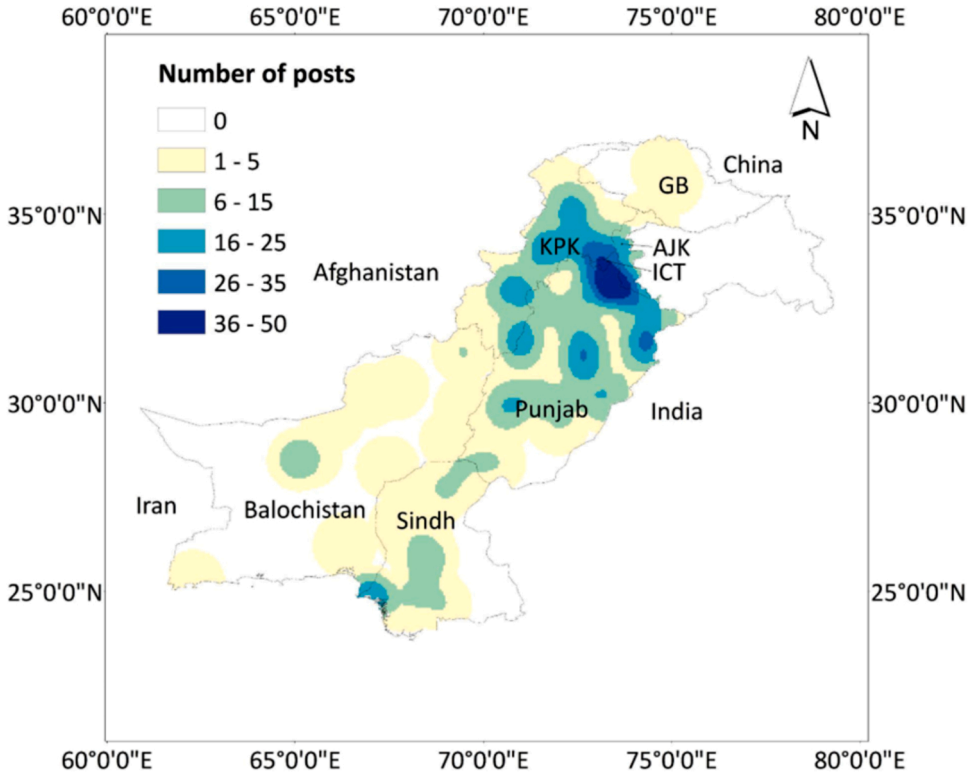

Fig. 3. The number of wildlife crime posts in different administrative units of Pakistan based on Facebook data in 2016–2021. KPK: Khyber Pakhtunkhwa, AJK: Azad Jammu and Kashmir, GB: Gilgit-Baltistan, and ICT: Islamabad Capital Territory.

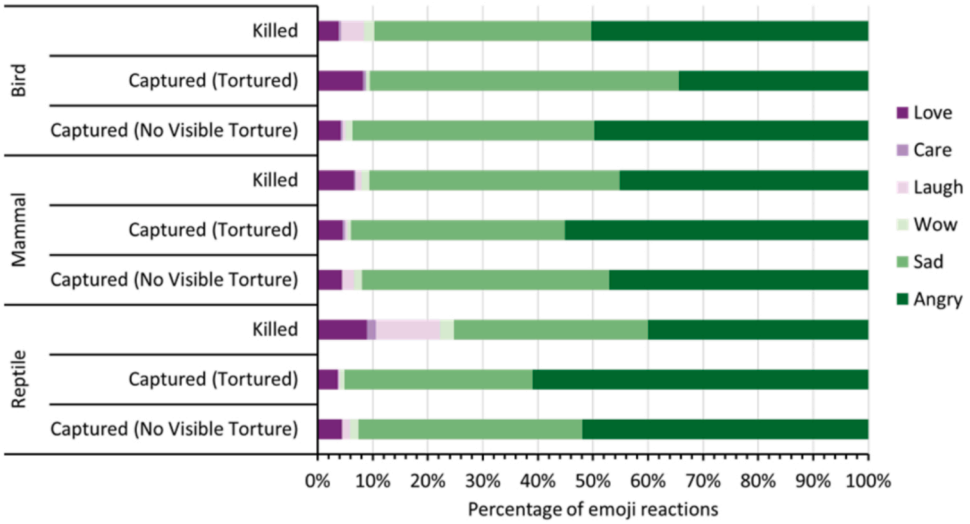

Fig. 4. The proportion of different emoji reactions as a function of the status of birds, mammals, and reptiles in posts depicting wildlife crime on Facebook in Pakistan.

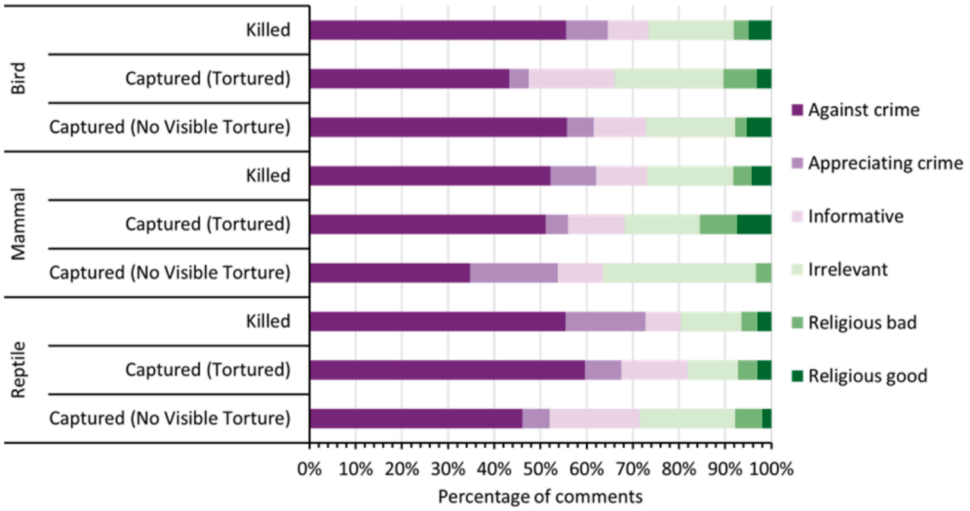

Fig. 5. The proportion of different comment types as a function of the status of birds, mammals, and reptiles in posts depicting wildlife crime on Facebook in Pakistan.

other emojis) on the post (Appendix Table 2; Table 5). Posts depicting a dead animal received significantly (1.62 times) more reactions than posts with captured animals that showed no visible signs of torture (Table 5). Animals that were captured with visible signs of torture, received fewer (0.62 times the amount of) reactions than those without.

3.7. Factors driving the number of comments against the crime

Based on the second model, the status of the animal was the only significant factor defining the number of comments against the crime (including both general and religious comments) on the post (Appendix Table 2; Table 5). Posts that depicted the killing of an animal received significantly (1.54 times) more comments compared to posts, where animals were captured with no visible signs of torture.

3.8. Factors driving the number of comments appreciating the crime

Results of the third model suggest that both the class and the status of the animal affected the number of comments appreciating the crime (including religious comments favoring crimes) on Facebook posts (Appendix Table 2; Table 5). Posts featuring reptiles received

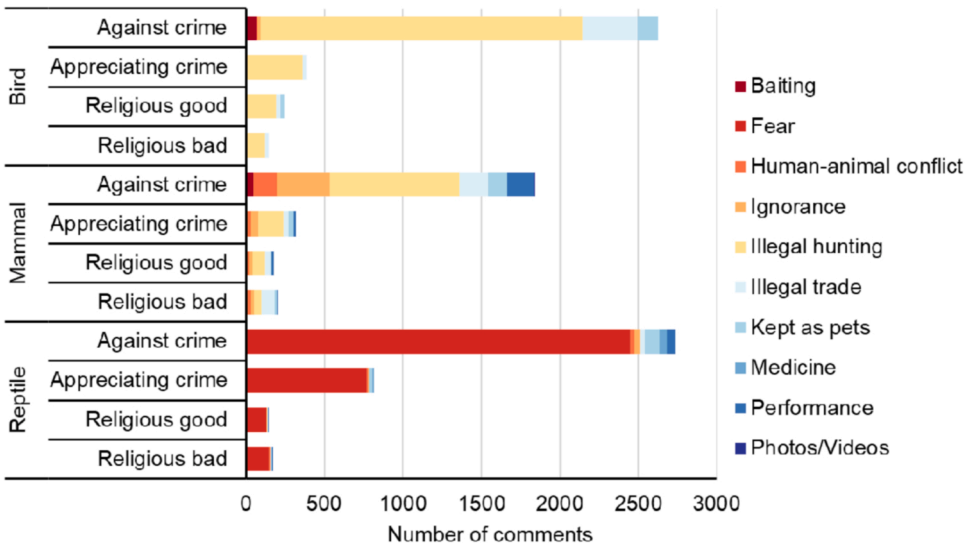

Fig. 6. The number of comments on Facebook posts depicting wildlife crime in Pakistan as a function of the class of the animal and the reason for the crime for birds, mammals, and reptiles.

Table 5
Average estimates of the coefficients with unconditional standard error (SE) and 85 % confidence intervals of the variables included in the best generalized linear models. SE is the unconditional standard error and IRR is incidence rate ratio. Bold numbers indicate estimate within the confidence interval.

Models and Predictors	Estimate	SE	IRR	Lower 85 %	Upper 85 %
All reactions					
Intercept	**4.77**	0.21	117.72	4.48	5.09
Status of the animal (Reference = Captured (No Visible Torture)					
Captured (Tortured)	**-0.51**	0.28	0.60	-0.92	-0.10
Killed	**0.49**	0.23	1.62	0.14	0.80
Comments against crime					
Intercept	**2.27**	0.25	9.66	1.93	2.65
Status of the animal (Reference = Captured (No Visible Torture)					
Captured (Tortured)	-0.30	0.34	0.74	-0.80	0.18
Killed	**0.43**	0.27	1.54	0.03	0.81
Comments appreciating crime					
Intercept	0.13	0.38	1.14	-0.38	0.71
Class (Reference = Birds)					
Mammal	0.40	0.33	1.49	-0.09	0.90
Reptile	**0.67**	0.30	1.96	0.24	1.11
Status of the animal (Reference = Captured (No Visible Torture)					
Captured (Tortured)	0.14	0.51	1.15	-0.62	0.89
Killed	**0.88**	0.39	2.41	0.28	1.42

nearly twice as many comments in favor of the crime than birds. Posts featuring an animal killed received 2.41 times more comments than posts with captured animal (with no visible signs of torture). Even though mammals received slightly more comments appreciating the crime than birds, it was not significant.

4. Discussion

To our knowledge, our study is the first to analyze the magnitude and apparent patterns of wildlife crime in Pakistan and to describe attitudes of the Pakistani public towards wildlife crime as depicted on social media. We have identified over 10,500 individuals of 138 bird, mammal, and reptile species in a relatively short time frame of five years, indicating the potentially large number of wildlife crimes occurring in Pakistan. The populations of a large number of species (66 out of 138) in our dataset are declining, and most of these declining species are threatened by hunting and trapping and are known to be used and traded (IUCN, 2022). In fact, the second major threat to biodiversity globally is direct overexploitation through hunting, poaching, harvesting, trade, and use (WWF, 2020). Many Asian species have been threatened by overexploitation raising conservation concerns (Nijman and Shepherd, 2015). While restrictive policies following the Covid-19 outbreak have reduced the magnitude of anthropogenic impacts (Forti et al., 2020), in Pakistan the number of wildlife crimes represented on Facebook has sharply increased. Similarly, wildlife crimes doubled during the

Covid-19 lockdown in 2020 in Bangladesh, and 28 % more animals were killed in 2020 than in the same period previously (Rahman et al., 2021). The wildlife-related criminal enterprise has been digitally expanding, reaching more consumers through social media (Xu et al., 2020). Nevertheless, the increased number of wildlife crime posts on Facebook could have also resulted from trade shifting from physical markets to online social media platforms (Morcatty et al., 2021). Facebook has been used to assess the magnitude of wildlife crime in Sweden to understand illegal hunting through informal Facebook conversations (Essen, 2016) and to study illegal hunting in Russia (Braden, 2014). While the scope of our study is limited, as we sampled a handful of Facebook posts in selected public groups and pages, we found that the general picture was similar to the findings of previous publications from neighboring India (Mendis et al., 2022) and Iran (Sardari et al., 2022). In fact, social media can be a double-edged sword when it comes to wildlife crime, i.e., used for illegal wildlife trade (Lenzi et al., 2020) and also to monitor wildlife crime (Shan et al., 2022).

4.1. The number of posts depicting a wildlife crime as a function of the class of the animal

In our dataset, birds were represented by more species and more individuals than mammals and reptiles, reflecting species diversity in the country in these three groups (658, 208, and 193 species of birds, mammals, and reptiles, respectively). This means that 10.8 % of bird species, 19.2 % of mammal species, and 16.1 % of reptile species were victims of wildlife crime as seen on Facebook.

In Pakistan, wildlife conservation is neglected, and species are under multiple threats, such as illegal wildlife trade, hunting, and habitat loss (Business Recorder, 2022). Our content analysis identified illegal hunting as the major reason (considering both the number of posts and the number of individual animals depicted) for wildlife crimes in Pakistan. We identified over 5000 individuals of 45 bird species and over 200 mammals of 17 species. There were no illegally hunted reptiles in our dataset. Previous studies also reported illegal hunting as a major concern in Pakistan (Awan, 2011; Hassan et al., 2020; Mahmood et al., 2012; Rehman et al., 2021). Sport hunting is very common with a long tradition in the country (Hussain, 2010). Nevertheless, hunting is not only seen as a sport, but also as a way of exhibiting wealth and power and elevating social status (Gurven and von Rueden, 2006; Tariq and Minhas, 2015). While most sport hunters often follow the rules and only hunt permitted species during hunting season, people who use hunting as a way to show off, often hunt illegally and indiscriminately (RU pers. obs.). Religious faith plays a significant role in hunting, as "*halal*" species that are "fit for consumption by Muslims" are more often hunted illegally than "*haram*" i.e., species "unfit for consumption by Muslims". For instance, all reptiles are *haram*, similar to the Wild Boars (*Sus scrofa*), which according to our dataset, were never hunted, but used in baiting and were tortured to death. On the other hand, among 17 hunted mammal species (with 5802 individuals), 11 were *halal* (with 5792 individuals). Considering threatened species, we identified two posts each of the Critically Endangered Great Indian Bustard and the Endangered Hog Deer (*Axis porcinus*), which are *halal*. However, we also found one record of the Endangered Kashmir Gray Langur, which is *haram* according to Muslim faith. The number of religious comments was highest for this type of crime, particularly considering birds. While there were 260 religious comments against the crime, 163 religious comments praised the crime. According to Muslim faith, humans are "*Ashraf-ul-Makhlooqat*" (the highest form of creation), so often Muslims wrongly interpret it that everything is created for them, and they can use every living creature for their needs (Tasgheer and Anwar, 2021).

Globally, wild birds are among the most hunted and most traded taxa (Sardari et al., 2022; Spee et al., 2019), as profit drives trade and culture drives hunting (Silva et al., 2022). Most posts and the highest numbers of birds depicted cases of illegal hunting. Birds are relatively easy to shoot or capture in large numbers, as they congregate in predictable areas (i.e., in crops, on fruiting trees, and at wintering or migratory stopover sites) and are easier to catch than other wildlife with readily available nets and can be killed using cheap air guns (Carvalho et al., 2015). In Pakistan, only a handful of game bird species are legal to hunt (depending on the administrative unit) during a determined season and pending a permit. Even when permitted species were shown in some posts, based on the numbers, location, or time of the year they were hunted illegally. Examples are the Grey Francolin (with the highest number of posts) and the Rosy Starling (highest number of individuals). In fact, we did not identify any cases of legal hunting for any animal.

Reptiles had the second highest number of individuals affected after birds, driven by several factors. Prominent motives for killing snakes for instance are fear and myths (M.S. Khan, 2014). Not surprisingly, fear was only associated with reptiles, especially snakes. The second highest number of comments were also received by this type of crime. While there were three times more comments against the crime, the number of religious comments appreciating the crime was higher than those condemning it. Snakes in particular are considered terrifying and threatening in many cultures (Polák et al., 2020). Both venomous and non-venomous species are considered "dangerous, death-causing evil creatures", therefore many people exhibit religious antipathy, superstitious fear, and repulsion towards them (Janovcová et al., 2019) and hence they are being killed without understanding their role in the ecosystem. For instance, in Bangladesh, males and followers of Islam and Christianity are more likely to kill snakes than members of Sonaton religion (Jaman et al., 2020).

4.2. Reasons for the crimes

Illegal trade of live wild animals, body parts, or derived products is also rampant in Pakistan (e.g., Ahmad et al., 2021; Faiz et al., 2022; Hassan et al., 2022; Mussarat et al., 2021). Although there were fewer posts than for animals captured or killed for fear, more individuals were affected by illegal trade from all classes, including the Critically Endangered Great Indian Bustard, and the Endangered Saker Falcon (*Falco cherrug*), Indian Pangolin (*Manis crassicaudata*), Green Turtle (*Chelonia mydas*), and Spotted Pond Turtle (*Geoclemys hamiltonii*). Capturing birds to be kept as pets is common in Pakistan, particularly parrots (Hussain and Khan, 2023), flamingos (U. Khan, 2014), and cranes (Rehman et al., 2021). In our results, the highest number of posts of birds kept as pets were of wild-caught Alexandrine Parakeet (*Palaeornis eupatria*), a highly demanded pet in Pakistan (Ilyas, 2013). Birds of prey (both diurnal and nocturnal) were also often captured, particularly for the pet market. A study from Thailand also found a large number of owls and

diurnal raptors traded online (Panter and White, 2020). Other species according to our dataset used as pets included such unusual species, as the Common Crane (*Grus grus*) and Demoiselle Crane (*Anthropoides virgo*). Small (e.g., the 10–15 kg Fishing Cat; *Prionailurus viverrinus*) to large cats (a 150–200 kg Lion) are also affected by illegal trade for the pet market, as they are kept as a status symbol.

Although most of the posts were about people intending to trade animals locally, Lahore and Karachi are considered hubs for exporting wild animals to China, Hong Kong, Korea, Singapore, and Vietnam (Noureen et al., 2012; Waseem et al., 2020). Additionally, The Belt and Road Initiative between Pakistan and China may create new routes and supplies for illegal wildlife trade in Pakistan (Farhadinia et al., 2019). The already-present obsession of keeping wild animals as pets might also further increase (Khan, 2019), as the Initiative will open up new routes for importing exotic animals. We identified a relatively high number of comments on posts depicting illegal trade, most against the crime (particularly for birds). Surprisingly, there were more religious comments praising the crime than against it.

We included spiritual release under wildlife trade. In our dataset, Bank Myna and House Sparrows (*Passer domesticus*) were represented by the highest numbers. These species are victims of a widespread religious practice of buying and releasing animals (mostly birds) for "*sawab*" i.e., "spiritual merit or reward" in Pakistan. Releasing captive wild animals for spiritual/religious purposes is common in many parts of Eastern and Southern Asia (Gilbert et al., 2012).

Ignorance is another important reason for wildlife crimes. For instance, Indian Pangolins are killed as they are believed to dig graves and eat the dead bodies (by 86 % of the 268 people surveyed by WWF-Pakistan in AJK (Faraz, 2022). We found a record of an Indus River Dolphin (*Platanista minor*) that was hunted believing it was a fish and a Fishing Cat killed for being mistaken for a Leopard. Animal rights are not taught in Pakistan (except for one subject in a single university) and the general attitude of the public toward animals is hostile (Ilyas and Qazilbash, 2021). For example, in a survey of public universities in Punjab, Pakistan studying the attitude of students in higher education towards animal rights, over half of the respondents had no concerns or objections to the abuse of animals and their use for economic and scientific purposes (Balouch et al., 2022).

Certain mammals and reptiles were often depicted in street performances, but we found no posts of birds used in this activity. The most commonly depicted species were the globally Vulnerable Asiatic Black Bear (*Ursus thibetanus*) and Rhesus Monkey (*Macaca mulatta*). Among reptiles, Near Threatened Indian Rock Python (*Python molurus*), Saw-scaled Viper (*Echis carinatus*), and the Indian Cobra (*Naja naja*), were used in snake charming performances, the last two being venomous. Using wildlife for street shows (bear dancing, mongoose and snake fights, and macaques performing) is illegal, albeit still common in Pakistan (Altaf et al., 2017). Snakes, including threatened species, are often collected for snake charming in Pakistan (Masroor et al., 2020). Surprisingly, both religious and non-religious comments were condemning this type of activity. To some degree, animals were also used as a prop online. We identified examples of the emerging trend of using animals in photos and videos to show one's wealth and status, and to get likes. Examples were persons posing with a Black Kite (*Milvus migrans*), torturing a Common Myna (*Acridotheres tristis*), and harassing a Chequered Keelback, i.e., a person was deliberately allowing the animal to bite him for getting likes and was saying "*if you like and share it, I will get another bite*". There was also an example of using a Lion in a political rally by a party, whose election symbol is the tiger. Using wildlife for getting likes and shares on social media has been documented to affect wildlife (Lenzi et al., 2020). People mostly share such pictures or videos on social media to get attention and also because they are copying celebrities (Datta, 2022).

Mammals are often affected by human-wildlife conflicts in Pakistan (Akrim et al., 2021; Ali et al., 2016; Dar et al., 2009; Hamid et al., 2019; Kabir et al., 2014; Khan et al., 2019). In our analysis, such conflicts involved Leopard, as they often prey on livestock (Shehzad et al., 2015), two species of eagle (Tawny Eagle; *Aquila rapax* and Steppe Eagle; *Aquila nipalensis*) and Eurasian Buzzard (*Buteo buteo*) by pigeon-keepers, Indian Crested Porcupine (*Hystrix indica*) for damaging crops (Safeer et al., 2018), Small Indian Civet (*Viverricula indica*) for potentially killing chickens, and Indian Rock Python as they can predate on goats (Goursi et al., 2019). Mammals received the most comments, and while there were five times more comments condemning the action than against it, religious comments were mostly supporting the person's actions against the animal, which can again be linked to the "*humans are a superior species*" argument.

While animal baiting is illegal according to the Punjab Wildlife Act and Prevention of Cruelty to Animals Act, it is still present in the country (Fakhar-i-Abbas et al., 2015; Kim, 2018), often accompanied by gambling (Osborne, 2022). We found four posts of Wild Boar, three of Golden Jackal (*Canis aureus*), two of Striped Hyena (*Hyaena hyaena*), and one each of Asiatic Black Bear and Small Indian Civet. Wild Boars were most commonly used for this activity, as they are considered "*najis*" or impure by Muslims. These animals were not killed for food, but were brutally tortured and killed for this blood sport. Some people believe that killing these animals will be rewarded by God. Wild Boars are hunted and killed in the most inhumane ways based on the spiritual and social belief that the Wild Boar is ugly and even uttering its name may cause rejection of one's prayers to God (Altaf et al., 2017). Two posts depicted Grey Francolins pitted against fighting cocks.

Animals and animal products, such as meat, excrement, fur, skin, horn, blood, trotters, feathers, hair, bile, claws, tongue, liver, eggs, gizzard, gallbladder, urine, teeth, eyes, tail, and musk are used in traditional medicine in different parts of Pakistan (Mussarat et al., 2021). Villagers have traditionally been using animal products for medicinal and therapeutic purposes due to the lack of available medical help (Altaf et al., 2020). However, we found five posts all depicting one species, the Indian Spiny-tailed Lizard with a large number (537) of individuals in total. There is a high demand for this species in traditional medicine (Khalil et al., 2022; Masroor et al., 2020; Valdez, 2021). This lizard is frequently collected illegally, individuals are tortured by breaking their backbone, and their fat and oil are sold for penis enlargement (Ehsan et al., 2018; Khalil et al., 2020).

4.3. Socioeconomic reasons for wildlife crime in Pakistan and public attitudes

Although the topic is outside the scope of this paper, based on the comments on some posts, we found evidence about the

prevalence of corruption in the public sector, as well as in economic, social, and political systems, minimal fines, along with weak wildlife laws and poor law enforcement. These factors further encourage hunters, poachers, sellers, and buyers (Aisha and Khan, 2016). For instance, The Wildlife Department of Rawalpindi division imposed a fine of PKR 680,350 (USD 3822 at the time of posting) on poachers after recovering three bears, eight monkeys, 2200 quails, 55 wild bird nestlings, and 7000 unidentified wild birds and other animals in 2021 (Express Tribune, 2022). This means that on average, the fine paid for an individual animal was PKR 73 (USD 0.41). In summary, different cultural, traditional, and mythological factors and biases contribute to the occurrence of wildlife crime in Pakistan, enabled by the shortcomings and loopholes in outdated wildlife protection laws and legislation. Therefore, it is important to understand the public reaction and attitudes towards the different types of crimes affecting different types of animals.

Over 66 % of all individuals depicted in the posts were killed (as the main reason for the crime was illegal hunting), followed by capture with no visible torture. Birds represented most individuals in all categories. Posts that depicted the killing of an animal received significantly more reactions and comments (both condemning and supporting the crime). However, tortured animals received more reactions and comments (including those supporting the crime) than posts of animals captured without torture.

Animal welfare and animal rights are basically ignored in Pakistan and the mistreatment of animals originates from inadequate education and a lack of compassion (Sarfaraz, 2020). Apathy toward animals is a concern in Pakistan (Ilyas and Qazilbash, 2021), particularly reptiles, as seen from the high number of comments and reactions supporting the killing and torture of these animals. On the other hand, there was some compassion for certain species of mammals, as they received more comments against the crimes, compared to other taxa. However, there is still a culture of enjoying violence against animals (Ilyas and Qazilbash, 2021), as seen in supporting comments on posts where the animal was killed.

By analyzing public reactions to Facebook posts about wildlife crimes, conservation organizations, and researchers can better understand public attitudes and use it to design public education and engagement programs. Changes in public interest and involvement in wildlife crime can be monitored by tracking the numbers and types of posts and the types of reactions over time, to evaluate the success of education and awareness-raising campaigns. Our results can also inform resource allocation to types of crimes, regions, and taxa most in need.

We covered five years of social media posts with regard to wildlife crimes in Pakistan. Large-scale monitoring of social media is time-consuming and difficult (Panter and White, 2020). We also acknowledge certain biases in our study. While we managed to identify most species, the low quality of some photographs and videos prevented us from identifying the species depicted in some of the posted images. As the number of likes, shares, and comments on a particular post is not static (Liberatore et al., 2018), these numbers represent the situation at the time of data collection. Therefore, recent posts often have fewer comments, shares, and reactions than older ones, creating a bias when analyzing the proportion of posts between different species, as the number of reactions changes through time in a non-random manner. In addition, some remote areas in Pakistan have poor or no internet availability, but this does not necessarily mean the lack of wildlife crimes. On the other hand, Punjab, the province with the highest population density (Nawab et al., 2023), showed the highest rate of wildlife crimes, which could be due to higher population densities, easy access to animals, and better internet access.

5. Conclusions

Our study emphasizes the importance of effective monitoring of social media websites for wildlife crimes and the use of this information by law enforcement agencies and wildlife management departments to curb wildlife crimes in Pakistan. With the expansion of social media, its use to tackle conservation challenges should also increase and it should be monitored for evidence of wildlife crimes. Social media websites can provide valuable information about the causes of wildlife crimes, hotspots, and apparent reasons. In response, law enforcement agencies should design their strategies according to the trends and information available on social media. Public policies should be adjusted accordingly to reduce the rate of wildlife crime. Awareness campaigns should be designed and conducted to educate the public about the condition and severity of these wildlife crimes and the role these “unattractive” species play in the ecosystem. Awareness raising and public education would also increase reporting of crimes by the general public and prevent them from getting involved in wildlife crime activities.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.gecco.2023.e02473.

References

Ahmad, K., Ahmad, M., Huber, F.K., Weckerle, C.S., 2021. Traditional medicinal knowledge and practices among the tribal communities of Thakht-e-Sulaiman Hills, Pakistan. BMC Complement. Med. Ther. 21, 1–21. https://doi.org/10.1186/S12906-021-03403-1.

Ahmad, S., Nabi, G., Hacker, C.E., Strelnikov, I.I., Luan, X., 2022. Increasing threats to snow leopard survival in Pakistan. Front. Ecol. Evol. 10, 818798 https://doi.org/10.3389/fevo.2022.818798.

Aisha, H., Khan, U., 2016. An assessment of the scale of illegal wildlife trade in Pakistan.

Akinsorotan, O., Olaniyi, O., Oguntuase, B.G., Raheem, T., 2020. Dynamics and socioeconomic drivers of illegal hunting of wildlife animal for consumption in Oba Hills Forest Reserve in Southwest Nigeria. J. Appl. Sci. Environ. Manag. 24, 287–298. https://doi.org/10.4314/jasem.v24i2.15.

Akrim, F., Mahmood, T., Belant, J.L., Nadeem, M.S., Qasim, S., Zangi, I.U.D., Asadi, M.A., 2021. Livestock depredations by leopards in Pir Lasura National Park, Pakistan: characteristics, control and costs. Wildl. Biol. 2021, 1–7. https://doi.org/10.2981/wlb.00782.

Ali, U., Minhas, R.A., Awan, M.S., Ahmed, K.B., Qamar, Z.Q., Dar, N.I., 2016. Human-grey wolf (*Canis lupus* linnaeus, 1758) conflict in Shounther valley, district Neelum, Azad Jammu and Kashmir, Pakistan. Pak. J. Zool. 48, 861–868.

Altaf, M., Javid, A., Umair, M., Iqbal, K.J., Rasheed, Z., Abbasi, A.M., 2017. Ethnomedicinal and cultural practices of mammals and birds in the vicinity of river Chenab, Punjab-Pakistan. J. Ethnobiol. Ethnomed. 13, 1–24. https://doi.org/10.1186/S13002-017-0168-5.

Altaf, M., Abbasi, A.M., Umair, M., Amjad, M.S., Irshad, K., Khan, A.M., 2020. The use of fish and herptiles in traditional folk therapies in three districts of Chenab riverine area in Punjab, Pakistan. J. Ethnobiol. Ethnomed. 16, 1–21. https://doi.org/10.1186/s13002-020-00379-z.

Arnold, T.W., 2010. Uninformative parameters and model selection using Akaike's information criterion. J. Wildl. Manag. 74, 1175–1178. https://doi.org/10.2193/2009-367.

Awan, M.N., 2011. Monitoring & conservation of cheer pheasant (*Catreus wallichii*) in Jhelum Catchments, Pakistan.

Badiata, F., 2016. Understanding facebook reactions using google sentiment analysis | by Florin Badita | Google Cloud - Community | Medium.

Balouch, S., Jamil, E., Khan, M.M., 2022. An assessment of knowledge and attitude regarding animal suffering and rights among university students in Punjab, Pakistan. J. Manag. Pract. Humanit. Soc. Sci. 6, 94–103. https://doi.org/10.33152/jmphss-6.3.8.

Bergman, J.N., Buxton, R.T., Lin, H.Y., Lenda, M., Attinello, K., Hajdasz, A.C., Rivest, S.A., Nguyen, T.T., Cooke, S.J., Bennett, J.R., 2022. Evaluating the benefits and risks of social media for wildlife conservation. Facets 7, 360–397. https://doi.org/10.1139/facets-2021-011.

Borges, A.K.M., Oliveira, T.P.R., Rosa, I.L., Braga-Pereira, F., Ramos, H.A.C., Rocha, L.A., Alves, R.R.N., 2021. Caught in the (inter)net: online trade of ornamental fish in Brazil. Biol. Conserv. 263, 109344 https://doi.org/10.1016/j.biocon.2021.109344.

Braden, K., 2014. Illegal recreational hunting in Russia: the role of social norms and elite violators. Eurasia Geogr. Econ. 55, 457–490. https://doi.org/10.1080/15387216.2015.1020320.

Burnham, K.P., Anderson, D.R., 2004. Multimodel inference: understanding AIC and BIC in model selection. Sociol. Methods Res. 33, 261–304. https://doi.org/10.1177/0049124104268644.

Business Recorder, 2022. Wildlife populations have seen 69pc decline since 1970: WWF - Pakistan - Business Recorder. https://www.brecorder.com/news/40203023 (Accessed 24 February 2023).

Carvalho, M., Palmeirim, J.M., Rego, F.C., Sole, N., Santana, A., Fa, J.E., 2015. What motivates hunters to target exotic or endemic species on the island of São Tomé, Gulf of Guinea. Oryx 49, 278–286. https://doi.org/10.1017/S0030605313000550.

CITES, 2022. Wildlife crime | CITES. ⟨https://cites.org/eng/prog/iccwc/crime.php⟩, (Accessed 26 June 2022).

Dar, N.I., Minhas, R.A., Zaman, Q., Linkie, M., 2009. Predicting the patterns, perceptions and causes of human-carnivore conflict in and around Machiara National Park, Pakistan. Biol. Conserv. 142, 2076–2082. https://doi.org/10.1016/j.biocon.2009.04.003.

Datta, C., 2022. Wildlife Selfie Craze: A Case from India. SSRN. doi: 10.2139/ssrn.4061470.

Didarali, Z., Kuiper, T., Brink, C.W., Buij, R., Virani, M.Z., Reson, E.O., Santangeli, A., 2022. Awareness of environmental legislation as a deterrent for wildlife crime: a case with Masaai pastoralists, poison use and the Kenya Wildlife Act. Ambio 51, 1632–1642. https://doi.org/10.1007/s13280-021-01695-8.

Din, J.U., Bari, F., Ali, H., Rehman, E., ur, Adli, D.S.H., Abdullah, N.A., Norma-Rashid, Y., Kabir, M., Hameed, S., Nawaz, D.A., Nawaz, M.A., 2022. Drivers of snow leopard poaching and trade in Pakistan and implications for management. Nat. Conserv. 46, 49–62.

Duffy St, R., John, F.A.V., Büscher, B., Brockington, D., 2016. Toward a new understanding of the links between poverty and illegal wildlife hunting. Conserv. Biol. 30, 14–22. https://doi.org/10.1111/COBI.12622.

Eberl, J.M., Tolochko, P., Jost, P., Heidenreich, T., Boomgaarden, H.G., 2020. What's in a post? How sentiment and issue salience affect users' emotional reactions on Facebook. J. Inf. Technol. Polit. 17, 48–65. https://doi.org/10.1080/19331681.2019.1710318.

Ehsan, M., Khalil, M.Z., Rasool, F., 2018. Sandy ka tail (*Saara Hardwickii* Oil) and footpath hakeems: a challenge to modern clinics. Asian J. Humanit. Art. Lit. 5, 81–88. https://doi.org/10.18034/AJHAL.V5I2.338.

ESRI, 2017. ArcGIS Desktop: Release 10.5.1.

Essen, E. von, 2016. In the Gap between Legality and Legitimacy. Department of Urban and Rural Development, Swedish University of Agricultural Sciences, Uppsala.

Express Tribune, 2022. 103 held for illegal hunting in 2021. ⟨https://tribune.com.pk/story/2340644/103-held-for-illegal-hunting-in-2021⟩, (Accessed 24 February 2023).

Faiz, M., Altaf, M., Umair, M., Almarry, K.S., Elbadawi, Y.B., Abbasi, A.M., 2022. Traditional uses of animals in the himalayan region of Azad Jammu and Kashmir. Front. Pharm. 13. https://doi.org/10.3389/fphar.2022.807831.

Fakhar-i-Abbas, Bhatti, Haider, Z.I., Mian, A, J., 2015. Bears in Pakistan: distribution, population biology and human conflicts. J. Bioresour. Manag 2, 1–13. https://doi.org/10.35691/jbm.5102.0015.

Faraz, S., 2022. Pakistan's pangolins need more than armour. ⟨https://tribune.com.pk/story/2377266/pakistans-pangolins-need-more-than-armour⟩, (Accessed 24 February 2023).

Farhadinia, M.S., Maheshwari, A., Nawaz, M.A., Ambarlı, H., Gritsina, M.A., Koshkin, M.A., Rosen, T., Hinsley, A., Macdonald, D.W., 2019. Belt and road initiative may create new supplies for illegal wildlife trade in large carnivores. Nat. Ecol. Evol. https://doi.org/10.1038/s41559-019-0963-6.

FATF, 2020. Money laundering and the illegal wildlife trade. Paris, France.

Feddema, K., Harrigan, P., Nekaris, K.A.I., Maghrifani, D., 2020. Consumer engagement behaviors in the online wildlife trade: implications for conservationists. Psychol. Mark. 37, 1755–1770. https://doi.org/10.1002/mar.21423.

Forsyth, Y.A., Forsyth, C.J., 2018. Ordinary folk transformed: poachers' accounts of cultural contests and history. In: Moreto, W. (Ed.), In Current Criminological and Criminal Justice Perspectives on Wildlife Crime. Temple University Press, Philadelphia, PA, pp. 135–149.

Forti, L.R., Japyassú, H.F., Bosch, J., Szabo, J.K., 2020. Ecological inheritance for a post COVID-19 world. Biodivers. Conserv. https://doi.org/10.1007/s10531-020-02036-z.
Fraccastoro, S., Gabrielsson, M., Pullins, E.B., 2021. The integrated use of social media, digital, and traditional communication tools in the B2B sales process of international SMEs. Int. Bus. Rev. 30, 101776 https://doi.org/10.1016/j.ibusrev.2020.101776.
Gilbert, M., Sokha, C., Joyner, P.H., Thomson, R.L., Poole, C., 2012. Characterizing the trade of wild birds for merit release in Phnom Penh, Cambodia and associated risks to health and ecology. Biol. Conserv. 153, 10–16. https://doi.org/10.1016/j.biocon.2012.04.024.
Goursi, U.H., Mehmood, A., Sajid, M., Kabir, M., 2019. New distribution records and challenges to the conservation of Indian rock python in azad Jammu and Kashmir, Pakistan. Int. J. Conserv. Sci. 10, 543–554.
Government of Pakistan, 2017. Pakistan national biodiversity strategy and action plan for achieving Aichi Biodiversity Targets and Sustainable Development Goals.
Grimmett, R., Roberts, T., Inskipp, T., Byers, C., 2009. Birds of Pakistan, A&C Black. ⟨https://doi.org/10.5860/choice.46-6803⟩.
Gurven, M., von Rueden, C., 2006. Hunting, social status and biological fitness. Soc. Biol. 53, 81–99. https://doi.org/10.1080/19485565.2006.9989118.
Hamid, A., Mahmood, T., Fatima, H., Hennelly, L.M., Akrim, F., Hussain, A., Waseem, M., 2019. Origin, ecology and human conflict of gray wolf (*Canis lupus*) in Suleman Range, South Waziristan, Pakistan. Mammalia 83, 539–551. https://doi.org/10.1515/mammalia-2018-0167.
Hassan, H.U., Ali, Q.M., Ahmad, N., Attaullah, M., Chatta, A.M., Farooq, U., Ali, A., 2020. Study of vertebrate diversity and associated threats in selected habitats of Sindh and Baluchistan, Pakistan. Int. J. Biol. Biotechnol. 17, 163–175.
Hassan, M., Haq, S.M., Ahmad, R., Majeed, M., Sahito, H.A., Shirani, M., Mubeen, I., Aziz, M.A., Pieroni, A., Bussmann, R.W., Alataway, A., Dewidar, A.Z., Al-Yafrsi, M., Elansary, H.O., Yessoufou, K., 2022. Traditional use of wild and domestic fauna among different ethnic groups in the Western Himalayas—a cross cultural analysis. Animals 12, 2276. https://doi.org/10.3390/ani12172276.
Hughes, A.C., Marshall, B.M., Strine, C.T., 2021. Gaps in global wildlife trade monitoring leave amphibians vulnerable. Elife 10. https://doi.org/10.7554/eLife.70086.
Hussain, A., Khan, A.A., 2023. Wild birds trade in Dera Ismael Khan and Bannu divisions of Khyber PakhtunKhwa (KPK) Province, Pakistan. Braz. J. Biol. 83. https://doi.org/10.1590/1519-6984.247915.
Hussain, S., 2010. Sports-hunting, fairness and colonial identity: collaboration and subversion in the northwestern frontier region of the British Indian Empire. Conserv. Soc. 8, 112–126. https://doi.org/10.4103/0972-4923.68911.
Ilyas, A., Qazilbash, M., 2021. Apathy Towards Animal Rights in Pakistan: What Needs to be Done: A Spotlight on the Laws in Pakistan, India, Sri Lanka, Indonesia & Turkey. Sustainable Development Policy Institute.
Ilyas, F., 2013. Parrots population declining fast in Sindh and Punjab: survey. ⟨https://www.dawn.com/news/791596/parrots-population-declining-fast-in-sindh-and-punjab-survey⟩, (Accessed 22 February 2023).
INTERPOL-UN Environment, 2016. Strategic report: environment, peace and security – a convergence of threats.
IUCN, 2022. IUCN Red List of Threatened Species. Version 2022-2. ⟨https://www.iucnredlist.org/⟩, (Accessed 2 February 2023).
Jaman, M.F., Rabbe, M.F., Alam, M.M., Shome, A.R., Hossain, M.A., Sarker, M.A.R., 2020. Students' perceptions on snake in Northwestern Bangladesh. Asian J. Ethnobiol. 3. https://doi.org/10.13057/asianjethnobiol/y030203.
Janovcová, M., Rádlová, S., Polák, J., Sedláčková, K., Peléšková, Š., Žampachová, B., Frynta, D., Landová, E., 2019. Human attitude toward reptiles: a relationship between fear, disgust, and aesthetic preferences. Animals 9, 238. https://doi.org/10.3390/ani9050238.
Kabir, M., Ghoddousi, A., Awan, M.S., Awan, M.N., 2014. Assessment of human-leopard conflict in Machiara National Park, Azad Jammu and Kashmir, Pakistan. Eur. J. Wildl. Res. 60, 291–296. https://doi.org/10.1007/s10344-013-0782-z.
Kemp, S., 2022a. Digital 2022: Global overview report — DataReportal – Global Digital Insights. ⟨https://datareportal.com/reports/digital-2022-global-overview-report⟩, (Accessed 7 July 2022).
Kemp, S., 2022b. Digital 2022: Pakistan — DataReportal – Global Digital Insights. ⟨https://datareportal.com/reports/digital-2022-pakistan⟩, (Accessed 26 February 2022).
Khalil, S., Nisar, A., Hussain, T., Hassan, A., 2020. Population ecology of spiny tailed lizard (*Saara hardwickii*) from lesser Cholistan desert, Bahawalpur, Punjab. Pesqui. Agropecu. Bras. 9, 1436–1441. https://doi.org/10.19045/bspab.2020.90149.
Khalil, S., Rana, A.H., Hussain, T., 2022. Morphometric analysis of spiny tailed lizard (*Saara hardwickii*) from Lesser Cholistan Desert, Bahawalpur, Punjab, Pakistan. J. Anim. Plant Sci. 32, 301–310. https://doi.org/10.36899/JAPS.2022.1.0425.
Khan, M.S., 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Malabar, Florida, USA.
Khan, M.S., 2014. Snake in Pakistani folklore. Bull. | Chicago Herpetol. Soc., vol. 49, pp. 137–41.
Khan, S.J., 2019. From the jungle to the cage: Pakistan's culture of keeping exotic animals as pets. Express Trib.
Khan, T.U., Xiaofeng, L., Ahmad, S., Mannan, A., Khan, W., Khan, A.A., Khan, B.U., Din, E.U., Bhattarai, S., Shah, S., Saeed, S., Amara, U., 2019. Status and magnitude of grey wolf conflict with pastoral communities in the foothills of the Hindu Kush Region of Pakistan. Animals 9, 787. https://doi.org/10.3390/ani9100787.
Khan, U., 2014. Flamingoes in Pakistan. ⟨https://tribune.com.pk/story/710055/flamingoes-in-pakistan⟩.
Kim, D.W., 2018. Colonial Transformation and Asian Religions in Modern History. Cambridge Scholars Publishing, Newcastle, UK.
Knapp, E.J., Peace, N., Bechtel, L., 2017. Poachers and poverty: assessing objective and subjective measures of poverty among illegal hunters outside Ruaha National Park, Tanzania. Conserv. Soc. 15, 24–32. https://doi.org/10.4103/0972-4923.201393.
Kosinski, M., Matz, S.C., Gosling, S.D., Popov, V., Stillwell, D., 2015. Facebook as a research tool for the social sciences: opportunities, challenges, ethical considerations, and practical guidelines. Am. Psychol. 70, 543–556. https://doi.org/10.1037/a0039210.
Lenzi, C., Speiran, S., Grasso, C., 2020. "Let me take a selfie": implications of social media for public perceptions of wild animals. Soc. Anim. 18, 1–20. https://doi.org/10.1163/15685306-BJA10023.
Liberatore, A., Bowkett, E., MacLeod, C.J., Spurr, E., Longnecker, N., 2018. Social media as a platform for a citizen science community of practice. Citiz. Sci. Theory Pract. 3, 3. https://doi.org/10.5334/cstp.108.
Mahmood, T., Hussain, R., Irshad, N., Akrim, F., Nadeem, M.S., 2012. Illegal mass killing of Indian pangolin (*Manis crassicaudata*) in Potohar region, Pakistan. Pak. J. Zool. 44, 1457–1461.
Marshall, B.M., Strine, C., Hughes, A.C., 2020. Thousands of reptile species threatened by under-regulated global trade. Nat. Commun. 11, 1–12. https://doi.org/10.1038/s41467-020-18523-4.
Martin, R.O., Senni, C., D'Cruze, N.C., 2018. Trade in wild-sourced African grey parrots: insights via social media. Glob. Ecol. Conserv. 15, e00429 https://doi.org/10.1016/j.gecco.2018.e00429.
Masroor, R., Khisroon, M., Jablonski, D., 2020. A case study on illegal reptile poaching from Balochistan, Pakistan. Herpetozoa 33, 67–75. https://doi.org/10.3897/HERPETOZOA.33.E51690.
McFann, S.C., Pires, S.F., 2020. Taking stock in wildlife crime research: trends and implications for future research. Deviant Behav. 41, 118–135. https://doi.org/10.1080/01639625.2018.1556851.
Mendis, A., Nikita, V., Ramya Roopa, S., Sultan, N., Shukla, S., Lewis, R., Deshpande, K., Balaji, K., Karve, A., Mendiratta, U., 2022. Media-reported Wildlife Poaching and Illegal Trade in India: 2020. Wildlife Conservation Society, Karnataka, India.
Meredith, M., 2020. Quick and dirty estimates for wildlife populations [R package wiqid version 0.3.0].
Morcatty, T.Q., Feddema, K., Nekaris, K.A.I., Nijman, V., 2021. Online trade in wildlife and the lack of response to COVID-19. Environ. Res. 193. https://doi.org/10.1016/j.envres.2020.110439.
Mussarat, S., Ali, R., Ali, S., Mothana, R.A., Ullah, R., Adnan, M., 2021. Medicinal animals and plants as alternative and complementary medicine in southern regions of Khyber Pakhtunkhwa, Pakistan. Front. Pharm. 12. https://doi.org/10.3389/fphar.2021.649046.
Nawab, T., Raza, S., Shabbir, M.S., Yahya Khan, G., Bashir, S., 2023. Multidimensional poverty index across districts in Punjab, Pakistan: estimation and rationale to consolidate with SDGs. Environ. Dev. Sustain 25, 1301–1325. https://doi.org/10.1007/s10668-021-02095-4.
Nekaris, B.K.A.I., Campbell, N., Coggins, T.G., Rode, E.J., Nijman, V., 2013. Tickled to death: analysing public perceptions of "cute" videos of threatened species (slow lorises - *nycticebus spp.*) on web 2.0 sites. PLoS One 8. https://doi.org/10.1371/journal.pone.0069215.

Nijman, V., Shepherd, C.R., 2015. Analysis of a decade of trade of tortoises and freshwater turtles in Bangkok, Thailand. Biodivers. Conserv. 24, 309–318. https://doi.org/10.1007/S10531-014-0809-0.
Nijman, V., Ardiansyah, A., Langgeng, A., Hendrik, R., Hedger, K., Foreman, G., Morcatty, T.Q., Siriwat, P., van Balen, S., (Bas), Eaton, J.A., Shepherd, C.R., Gomez, L., Imron, M.A., Nekaris, K.A.I., 2022. Illegal wildlife trade in traditional markets, on Instagram and Facebook: raptors as a case study. Birds 3, 99–116. https://doi.org/10.3390/birds3010008.
Noureen, U., Khan, A., Arshad, M., 2012. Exploring illegal trade in freshwater turtles in Pakistan. Rec. Zool. Surv. Pak. 21, 19–24.
Obamiro, K., West, S., Lee, S., 2020. Like, comment, tag, share: facebook interactions in health research. Int. J. Med. Inf. 137. https://doi.org/10.1016/j.ijmedinf.2020.104097.
Osborne, C., 2022. Bear-baiting is a national shame for Pakistan – AMUST. ⟨https://www.amust.com.au/2022/07/bear-baiting-is-a-national-shame-for-pakistan/⟩, (Accessed 24 February 2023).
Pal, A., Chua, A.Y.K., Goh, D.H.L., 2017. Analysis of Facebook comments in response to counter-rumors. In: Proceedings of the 21st Pacific Asia Conference on Information Systems: "Societal Transformation Through IS/IT". PACIS 2017.
Panter, C.T., White, R.L., 2020. Insights from social media into the illegal trade of wild raptors in Thailand. TRAFFIC Bull. 32, 5–12.
Piza, E.L., 2012. Using poisson and negative binomial regression models to measure the influence of risk on crime incident counts. Risk Terrain Modeling.
Polák, J., Rádlová, S., Janovcová, M., Flegr, J., Landová, E., Frynta, D., 2020. Scary and nasty beasts: self-reported fear and disgust of common phobic animals. Br. J. Psychol. 111, 297–321. https://doi.org/10.1111/bjop.12409.
R Core Team, 2019. R: A Language and Environment for Statistical Computing.
Rahman, Md. Saidur, Alam, M.A., Salekin, S., Belal, M.A.H., Rahman, Md. Saifur, 2021. The COVID-19 pandemic: a threat to forest and wildlife conservation in Bangladesh? Trees For. People 5, 100119. https://doi.org/10.1016/j.tfp.2021.100119.
Rehman, J.U., Alam, S., Khalil, S., Hussain, M., Iqbal, M., Khan, K.A., Sabir, M., Akhtar, A., Raza, G., Hussain, A., Habiba, U., 2021. Major threats and habitat use status of demoiselle crane (Anthropoides virgo), in district Bannu, Pakistan. Braz. J. Biol. 82. https://doi.org/10.1590/1519-6984.242636.
Rija, A.A., Critchlow, R., Thomas, C.D., Beale, C.M., 2020. Global extent and drivers of mammal population declines in protected areas under illegal hunting pressure. PLoS One 15, e0227163. https://doi.org/10.1371/journal.pone.0227163.
Roberts, T.J., 1997. The Mammals of Pakistan Revised Edition. Oxford University Press, Pakistan.
Safeer, B., Rasheed, Z., Altaf, M., Manzoor, I., Yasrub, S., 2018. Assessment of human-Indian crested porcupine (*Hystrix indica*) conflict in district Bagh, Azad Jammu and Kashmir. J. Wildl. Ecol. 2, 1–12.
Sardari, P., Felfelian, F., Mohammadi, A., Nayeri, D., Davis, E.O., 2022. Evidence on the role of social media in the illegal trade of Iranian wildlife. Conserv. Sci. Pr. 4, e12725 https://doi.org/10.1111/csp2.12725.
Sarfaraz, I., 2020. Let's learn to co-exist. The News. ⟨https://www.thenews.com.pk/magazine/you/672146-lets-learn-to-co-exist⟩, (Accessed 6 July 2022).
Shan, S., Ju, X., Wei, Y., Wen, X., 2022. Concerned or apathetic? Using social media platform (Twitter) to gauge the public awareness about wildlife conservation: a case study of the illegal rhino trade. Int. J. Environ. Res. Public Health 19, 6869. https://doi.org/10.3390/ijerph19116869.
Shao, M.L., Newman, C., Buesching, C.D., Macdonald, D.W., Zhou, Z.M., 2021. Understanding wildlife crime in China: socio-demographic profiling and motivation of offenders. PLoS One 16, e0246081. https://doi.org/10.1371/journal.pone.0246081.
Shehzad, W., Nawaz, M.A., Pompanon, F., Coissac, E., Riaz, T., Shah, S.A., Taberlet, P., 2015. Forest without prey: livestock sustain a leopard *Panthera pardus* population in Pakistan. ORYX 49, 248–253. https://doi.org/10.1017/S0030605313001026.
Shivaprakash, K.N., Sen, S., Paul, S., Kiesecker, J.M., Bawa, K.S., 2021. Mammals, wildlife trade, and the next global pandemic. Curr. Biol. 31, 3671–3677. https://doi.org/10.1016/j.cub.2021.06.006.
Silva, S., Braga, B., Brasil, L., Baía-Júnior, P., Guimarães, D., 2022. The use of passeriformes in the eastern Amazonia of Brazil: culture encourages hunting and profit encourages trade. ORYX 56, 218–227. https://doi.org/10.1017/S0030605320000551.
Siriwat, P., Nijman, V., 2018. Illegal pet trade on social media as an emerging impediment to the conservation of Asian otters species. J. Asia-Pac. Biodivers. 11, 469–475. https://doi.org/10.1016/j.japb.2018.09.004.
Siriwat, P., Nijman, V., 2020. Wildlife trade shifts from brick-and-mortar markets to virtual marketplaces: a case study of birds of prey trade in Thailand. J. Asia-Pac. Biodivers. 13, 454–461. https://doi.org/10.1016/j.japb.2020.03.012.
Sollund, R., 2020. Wildlife crime: a crime of hegemonic masculinity? Soc. Sci. 9. https://doi.org/10.3390/SOCSCI9060093.
Spee, L.B., Hazel, S.J., Dal Grande, E., Boardman, W.S.J., Chaber, A.L., 2019. Endangered exotic pets on social media in the Middle East: presence and impact. Animals 9. https://doi.org/10.3390/ani9080480.
St John, F.A.V., Keane, A.M., Milner-Gulland, E.J., 2013. Effective conservation depends upon understanding human behaviour. In: Key Topics in Conservation Biology 2. John Wiley & Sons, Ltd., pp. 344–361. https://doi.org/10.1002/9781118520178.ch19
Statcounter, 2022. Social media stats in Pakistan | Statcounter Global Stats. ⟨https://gs.statcounter.com/social-media-stats/all/pakistan⟩, (Accessed 26 June 2022).
Sullivan, M., Robinson, S., Littnan, C., 2019. Social media as a data resource for #monkseal conservation. PLoS One 14, e0222627. https://doi.org/10.1371/journal.pone.0222627.
Tariq, M., Minhas, R., 2015. Threats and hunting methods of crane species in district Karak of Khyber Pakhtunkhwa, Pakistan. J. Environ. Earth Sci. 5, 11–15.
Tasgheer, A., Anwar, M.J., 2021. An islamic perspective of animals'. AL-ILM 5, 44–59.
The Prevention of Cruelty of Animals Act, 1890. The Prevention of Cruelty of Animals Act.
TRAFFIC, 2022. Wildlife Crime. ⟨https://www.traffic.org/what-we-do/thematic-issues/wildlife-crime/⟩, (Accessed 8 July 2022).
Travers, H., Archer, L.J., Mwedde, G., Roe, D., Baker, J., Plumptre, A.J., Rwetsiba, A., Milner-Gulland, E.J., 2019. Understanding complex drivers of wildlife crime to design effective conservation interventions. Conserv. Biol. 33, 1296–1306. https://doi.org/10.1111/COBI.13330.
Ullah, Z., Ullah, Inayat, Ullah, Ikram, Mahmood, S., Iqbal, Z., 2020. Poaching of Asiatic black bear: evidence from Siran and Kaghan valleys, Pakistan. Glob. Ecol. Conserv. 24. https://doi.org/10.1016/j.gecco.2020.e01351.
UNEP, 2016. The Rise of Environmental Crime: A Growing Threat to Natural Resources, Peace, Development and Security. United Nations Environment Programme.
UNEP, 2023. The Species+ Website. Nairobi, Kenya. Compil. by UNEP-WCMC, Cambridge, UK. ⟨https://speciesplus.net/⟩, (Accessed 8 February 2023).
United Nations, 2015. Transforming our world: the 2030 agenda for sustainable development.
UNODC, 2020. World Wildlife Crime Report 2020: Trafficking in Protected Species.
Valdez, J.W., 2021. Using google trends to determine current, past, and future trends in the reptile pet trade. Animals 11, 1–18. https://doi.org/10.3390/ani11030676.
Vaz, A.S., Moreno-Llorca, R.A., Gonçalves, J.F., Vicente, J.R., Méndez, P.F., Revilla, E., Santamaria, L., Bonet-García, F.J., Honrado, J.P., Alcaraz-Segura, D., 2020. Digital conservation in biosphere reserves: Earth observations, social media, and nature's cultural contributions to people. Conserv. Lett. https://doi.org/10.1111/conl.12704.
Venables, B., Ripley, B., 2002. Modern Applied Statistics with S, 4th ed. Springer, New York.
Viollaz, J.S., Thompson, S.T., Petrossian, G.A., 2021. When human–wildlife conflict turns deadly: comparing the situational factors that drive retaliatory leopard killings in South Africa. Animals 11. https://doi.org/10.3390/ani11113281.
Wagner, K., Owen, S., Burke, T.W., 2019. Not wild about wildlife protection the perceived harmfulness, wrongfulness, and seriousness of wildlife crimes. Soc. Anim. 27, 383–402. https://doi.org/10.1163/15685306-12341589.
Waseem, M., Khan, B., Mahmood, T., Hussain, H.S., Aziz, R., Akrim, F., Ahmad, T., Nazir, R., Hameed, S., Awan, M.N., 2020. Occupancy, habitat suitability and habitat preference of endangered Indian pangolin (*Manis crassicaudata*) in Potohar Plateau and Azad Jammu and Kashmir, Pakistan. Glob. Ecol. Conserv. 23. https://doi.org/10.1016/j.gecco.2020.e01135.
WWF, 2019. Speakers call for stringent measures to tackle wildlife crime | WWF. ⟨https://www.wwfpak.org/?354751/Speakers-call-for-stringent-measures-to-tackle-wildlife-crime⟩, (Accessed 26 June 2022).

WWF, 2020. Living Planet Report 2020 – Bending the Curve of Biodiversity Loss. Gland, Switzerland.
Xu, Q., Cai, M., MacKey, T.K., 2020. The illegal wildlife digital market: an analysis of Chinese wildlife marketing and sale on Facebook. Environ. Conserv. 47, 206–212. https://doi.org/10.1017/S0376892920000235.
Zhou, X., 2020. Thoughts on convergence science of high-risk animals responsible for zoonotic epidemics. Chin. Sci. Bull. 65, 2303–2313. https://doi.org/10.1360/TB-2020-0372.