



A questionnaire-based investigation to explore the social and legal implications derived from the use of camera traps for wildlife monitoring and conservation

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Received: 3 April 2021 / Revised: 27 May 2022 / Accepted: 29 May 2022 / Published online: 4 June 2022
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Abstract

Camera traps are non-invasive monitoring tools largely used to detect species presence or population dynamics. The use of camera traps for wildlife conservation purposes raises questions about privacy invasion when images of people are taken. Throughout the use of an online questionnaire survey, we assessed the degree of knowledge about social and legal implications derived from the deployment of camera traps. Our results revealed a consistent gap in term of knowledge about legal implications derived by the use of camera traps among respondents. Most of those who were aware of such legislation did not take specific actions to prevent legal consequences, probably to reduce the risk of theft or vandalism. Most respondents declared that images of people were unintentionally collected. Some of them stated that images which may violate privacy issues or showed nefarious activities were stored for internal processing or reported to local authorities. Our research thus confirmed that privacy invasion is a widely poorly treated issue in the wildlife conservation dimension. Furthermore, despite camera traps being used to improve conservation efforts, the detection of individuals engaged in private or illegal activities poses further complications in terms of pursuance of legal actions when an individual is identified by these images. So, appropriate guidelines for images analysis need to be designed, and subsequently followed. Lastly, adopting effective methods to protect cameras from the risk of theft and/or vandalism is of primary concern.

Keywords Camera traps · Human rights · Illegal activities · Legislation · Privacy invasion · Wildlife monitoring

Introduction

The use of camera traps for wildlife monitoring has been practiced since the early twentieth century (Chapman 1927), but in recent years, they are becoming one of the mainstream tools used in conservation biology, ranging from the most basic level aimed at assessing species presence at a site

(Kays et al. 2011; Zaccaroni et al. 2020), abundance estimation (Franchini et al. 2022; Oberosler et al. 2022), and population dynamics studies (Karanth 1995, 2006; Romani et al. 2018; Anile et al. 2020; Augugliaro et al. 2019, 2020) up to the assessment of activity patterns (Andreoni et al. 2020; Anile et al. 2020) and temporal overlap of different species (Mori et al. 2021). This explosion in camera trap use is reflected by the increased number of published papers in recent years. For instance, from 1991 to 2004, the number of publications per year using camera traps was below 50, but starting from 2005 up to 2014, the number of publications per year consistently increased to ~200 publications/year (Rovero and Zimmerman 2016).

Camera traps are concealable devices, ranging in size from a shoe-box to a GPS car navigation unit (or even smaller), generally used to capture images or videos of wild species in the field over periods varying from days to weeks (Kays et al. 2011; Butler and Meek 2013). Generally programmed to operate 24 h a day, and record thousands of images in a short period of time, camera traps have become

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attractive non-invasive monitoring tools for researchers as they offer the opportunity to capture new forms of data that may be difficult or impractical to collect (Kays and Slauson 2008; Kays et al. 2011; Butler and Meek 2013). Often disguised by a camouflage cover, they are set individually or in groups in several habitat types. Cameras are mostly fixed to trees (or rocks) pointing to an animal path or track, in positions that depend on the study design and the target species (Butler and Meek 2013; Harmsen et al. 2017). Moreover, because the equipment does not typically require the target animal to step on or rub against the device, cameras are also minimally intrusive, especially if used without a visible flash (Kays and Slauson 2008). Camera traps take images or videos both day and night, and two kinds of illumination are used: infra-red or incandescent. Infra-red cameras are often undetectable because the illumination operates at 800–950 nm level (light that humans cannot see). During daytime, images are taken in color while during night-time, they are usually in black and white (Butler and Meek 2013). Incandescent cameras use either xenon gas or LED to illuminate the subject. Consequently, images are taken in color during both day and night-time (Butler and Meek 2013).

Despite cameras being often deployed to take images of wild species, they can be equally used to detect human presence (Betts 2015; Hossain et al. 2016; Miller et al. 2017). Trail cameras are unable to distinguish between wild species and humans (Sharma et al. 2020). However, through the implementation of appropriate software used a-posteriori (e.g., Wild.ID), it is possible to discern between people and animals, thus increasing the power of this monitoring tool. Camera traps are sometimes used by conservationists to assess human-wildlife interactions in protected areas (Miller et al. 2017), the impact of anthropogenic activities on the ecosystem (Betts 2015), or to detect illegal activities (Hossain et al. 2016). Nevertheless, the use of human images raises several concerns in terms of infringement of civil liberties and privacy violation (Butler and Meek 2013; Pebsworth and LaFleur 2014; Sharma et al. 2020). This dilemma may become even more incisive especially in those cases in which illegal activities are accidentally captured without being part of a specific purpose. In such case, researchers may have to cope with ethical dilemmas regarding the use of such images to assist law authorities. Indeed, on one side, images may constitute important proof for investigation and prosecution but, on the other side, the privacy of individuals cannot be excluded for consideration (Butler and Meek 2013; Pebsworth and LaFleur 2014). Invasion of privacy is a wide international topic that deserves proper attention because it is managed differently among the countries all over the world (Moore 2013). Definitions of privacy are generally grouped into two types: (i) a descriptive or non-normative account, that describes privacy as “a state or condition of not having undocumented personal knowledge about one possessed by others” and, (ii) a normative account which makes references

to moral obligations (Moore 2013). In this sense, the use of camera traps for wildlife monitoring could lead to privacy violation when, instead of an animal, photos or videos are taken to people transiting along a path and/or when these images are used inappropriately. Thereby, based on this assumption, the definition of camera traps as non-invasive tools as a whole may be questionable, as it may be invasive in regard to violation for human rights. Furthermore, because animals may detect and react to camera traps, the definition of camera-trapping as a non-invasive monitoring method may prompt some further questions. Pebsworth and LaFleur (2014) highlighted some ethical issues that need to be considered, such as how to adequately protect the privacy of people caught on cameras, or how to manage images of people engaged in nefarious activities. Despite the efficiency of camera traps (in terms of wildlife monitoring) being frequently treated in several studies (e.g., Karanth 1995, 2006; Kays et al. 2011; Harmsen et al. 2017), little or almost no attention has been given to the main constraints (Glover-Kapfer et al. 2019) and/or the possible social and legal impacts (Butler and Meek 2013; Miller et al. 2017; Sandbrook et al. 2018; Sharma et al. 2020) that may be associated with their use. Among these, Sharma et al. (2020) provides basic concepts for a code of conduct that includes both legal and social issues that may arise from the use of camera traps for wildlife conservation purposes and that should be taken into account a-priori by the researchers during the planning of monitoring activities which lie on the use of trail cameras.

Social and legal consequences of using unauthorized images from camera traps may be similar to the ones obtained from social media. Similarly, violation of personal privacy when photos of identifiable individuals (humans) are posted to social media, whether in support of a researcher’s conservation efforts (e.g., illustrating illegal hunting or poaching activity), or simply highlighting human activities inadvertently captured by camera traps (e.g., people engaged in private activities) has the potential to derail otherwise well-meaning wildlife conservation and/or social science research efforts through unwanted litigation. The use of social media for citizen-centric data collection has been receiving increased attention in recent years (Pirie et al. 2016; Edelman and Edelman 2017; Chutipong et al. 2019; Bamrah and Girdhar 2020). Data collected throughout social media, beyond representing a cheaper and relatively simple method for data collection, offers the opportunity to assess people’s perception towards multifaceted problems (Bamrah and Girdhar 2020). The information collected from social media assumes remarkable importance in the development of critical studies linked to population dynamics, migratory patterns, and trends of endangered fauna and flora species for conservation purposes (Sullivan et al. 2017; Horns et al. 2018; Humphries 2018). For example, citizen science studies have also applied to assess the illegal trading activities

of endangered species (Siriwat and Nijman 2018) as well as the perceptions towards parks (Plunz et al. 2019). However, despite these similarities, there are also some important differences. In general, most legal apps declare that data (or images in the case of apps that use the cameras) are going to be used somehow, despite most users are unaware of this because this is stated in sections of the app that are generally difficult to find (embedded within the “terms and conditions” of use). So, in a way, and despite the controversies sometimes generated, users approve the use of their data. In the case of camera traps, if they are not informed anywhere, the situation could be similar to that of illegal apps.

Throughout the use of online questionnaires directly shared with known people involved in wildlife conservation and the use of social media, the main purpose of the present work was to investigate the degree of knowledge of actors involved in wildlife conservation regarding the social and legal implications of using camera traps for wildlife monitoring and conservation. We predicted that (i) professional figures who work for private or public institutions (e.g., researchers, wildlife technicians) would be more aware of legal implications derived from the use of cameras rather than students or other categories (e.g., wildlife photographers, amateur naturalists); (ii) figures who were aware of legal implications would be those who would make residents aware of the presence of camera traps within the study site and; (iii) figures who were aware of legal implications would be those who would take further specific actions to prevent legal consequences.

Methods

Questionnaire survey

From January 2018 to December 2019 and from December 2021 to February 2022, the English version of an electronic questionnaire was made available to professionals (e.g., researchers, wildlife technicians), students, and/or other categories (e.g., wildlife photographers, amateur naturalists) who commonly use (or had used in the past) camera traps for monitoring purposes (see Supplementary material). The questionnaire’s online link was distributed via email to known people involved in wildlife conservation, and/or via social media (i.e., Facebook) through national and international pages dedicated to wildlife monitoring throughout the use of camera traps (e.g., camera trap wildlife monitoring, trail cameras photos and videos, wildlife camera trapping, European camera trap society). Furthermore, we used a snowball sampling approach (Newey et al. 2015) through asking respondents to share the questionnaire with other camera trappers belonging to their professional networks. To maximize the honesty of the answers obtained, we clearly

stated that all information provided would be treated anonymously and only for scientific purposes. The questionnaire was designed to be completed in about 10 min.

Research questions

The first part of the research was mainly dedicated to determining the proportion of positive and negative responses obtained regarding the respondents’ knowledge about legislations referring to a privacy violation and action taken to prevent legal consequences. To achieve this goal, we set out to answer the following main research questions—(1) Are/were you aware of the legislation concerning the violation of privacy in the region in which you work/worked? (2) Do/did you take specific actions to prevent legal consequences? (3) If you are/were aware of the legislation concerning the violation of privacy, but you did not take specific measure, why? (4) Are/were residents aware of the presence of camera traps in the region in which you work/worked? (5) Have/were cameras been deployed with the purpose to detect human presence as a part of the scientific objectives? (6) Have you ever documented any activities that may be in violation of laws and regulations pertinent to the specific region where the cameras were deployed (illegal hunting/poaching activities, illegal harvesting of plants, firewood, or other natural materials)? (7) Has it ever happened to record pictures that may violate some privacy issues (people having sex, urinating, etc.)? The second part of the research was dedicated to discriminating those professional figures who were aware the most about legal implications derived from the use of camera traps, from those who were not.

Statistical analysis

A two-tailed one-proportion z test was used to assess (1) the proportion of involved figures who were aware of legislation concerning violations of privacy in the area in which they worked; (2) the proportion of involved figures that took specific actions to prevent legal consequences; (3) the proportion of residents that were informed about the presence of camera traps in the area; (4) the proportion, in terms of the number of cases in which cameras were deployed, with the purpose to detect human presence as a part of scientific objectives; (5) the proportion in terms of the number of cases in which illegal activities were detected by camera traps; and (6) the proportion in terms of the number of cases in which, during monitoring activities, pictures that may violate privacy issues were collected.

We compared the degree of knowledge of the professionals involved in wildlife conservation in terms of social and legal implications derived from the use of camera traps using generalized linear models (GLMs) with residuals showing a binomial distribution through the R package “glm2”

(Marschner 2011) and following Zuur et al. (2009). The absence of overdispersion in the most complex model (i.e., the one containing all the predictors) was assessed by dividing the residual deviance with the corresponding degrees of freedom. Professional position (e.g., researcher, wildlife technician, etc.), number of cameras used and number of days in which cameras were deployed were considered as predictors. Any difference between predictor categories (e.g., professional position) was tested using a pairwise *t* test for multiple comparisons (Patil 2019). Model simplification was done fitting a maximal model and then simplifying it by removing non-significant explanatory variables. Model ranking was carried out based on the Akaike's information criterion (AIC) (Akaike 1974), Δ AIC, and Akaike's weight (ω_i) (Burnham and Anderson 2002, 2004). Models with Δ AIC < 2 were considered as competitors of the best model (Burnham and Anderson 2002, 2004).

Statistical analyses were performed using Software R (v. 4.0 – R Development Core Team 2021) and the level of significance was set at 0.05.

Results

The questionnaire was sent to 135 known people involved in wildlife conservation but only 21 responses were initially received (response rate = 15.55%). A further 96 responses were obtained throughout the use of Facebook pages dedicated to wildlife monitoring using camera traps. Overall, we collected 117 questionnaires, 21 in 2018, 58 in 2019, 35 in 2021, and three in 2022. Most respondents were researchers ($n = 46$; 39.32%), followed by students ($n = 28$; 23.93%), people belonging to other categories ($n = 21$; 17.95%), and wildlife technicians ($n = 19$; 16.24%). Among those respondents who reported their nationality ($n = 38$), 11 (28.95%) were Italians, seven (18.42%) Americans (USA), seven (18.42%) British, five (13.16%) Dutch, two (5.26%) Germans, one (2.63%) Spanish, one (2.63%) Greek, one (2.63%) Austrian, one (2.63%) Australian, one (2.63%) Belizean, and one (2.63%) Bhutanese.

General perception about privacy violation and actions taken (to prevent legal consequences)

“Are/were you aware of the legislation concerning the violation of privacy in the region in which you work/worked?”

The proportion of negative ($n = 65$; 56.03%) and positive ($n = 51$; 43.96%) answers was not significantly different ($X^2 = 1.45$; CI 95% = 0.46 – 0.65; PoS = 0.56; $p = 0.23$). Among the 51 positive responses, 16 respondents (31.37%) stated they were aware of either national

and/or regional legislation related to privacy violation, 12 (23.53%) affirmed that they were aware of existing legislation but without referring to specific articles and/or national/regional laws, 21 (41.18%) did not provide specific information, and two (3.92%) declared that there was no legislation.

“Do/did you take specific actions to prevent legal consequences?”

Among those who were aware about the legislations concerning the privacy violation ($n = 51$; 43.96%), the proportion of negative ($n = 39$; 76.47%) and positive ($n = 8$; 15.68%) answers was significantly different ($X^2 = 19.14$; CI 95% = 0.69 – 0.92; PoS = 0.83; $p < 0.001$) (Fig. 1a). Four people (7.84%) did not provide any information. Among the eight positive answers, five respondents (62.5%) affirmed to have put warning signs close to the cameras to indicate their presence, two (25%) declared that they worked on private land, and one (12.5%) stated that Park authorities were informed.

“If you are/were aware of the legislation concerning the violation of privacy, but you did not take specific measure, why?”

Among those respondents who were aware about the legislations concerning the privacy violation but did not take specific measures ($n = 39$), 36 (92.31%) provided no information, one (2.56%) stated “because it was very difficult,” another (2.56%) affirmed that it was unclear who was the landowner, and the latter (2.56%) declared that it was not relevant.

“Are/were residents aware of the presence of camera traps in the region in which you work/worked?”

The proportion of negative ($n = 55$; 47.41%) and positive ($n = 61$; 52.29%) answers also was not significantly different ($X^2 = 0.21$; CI 95% = 0.38 – 0.57; PoS = 0.47; $p = 0.64$). Among the 61 positive answers, nine respondents (14.75%) stated that residents were informed through public presentations, 17 (27.87%) organized meeting with managers, four (6.56%) used paper media, 11 (18.03%) used other methods (e.g., meeting with local people, warning signs to indicate the presence of camera traps), 15 (24.59%) used more than one method (e.g., meeting with managers combined with paper media), and five (8.20%) did not provide any information.

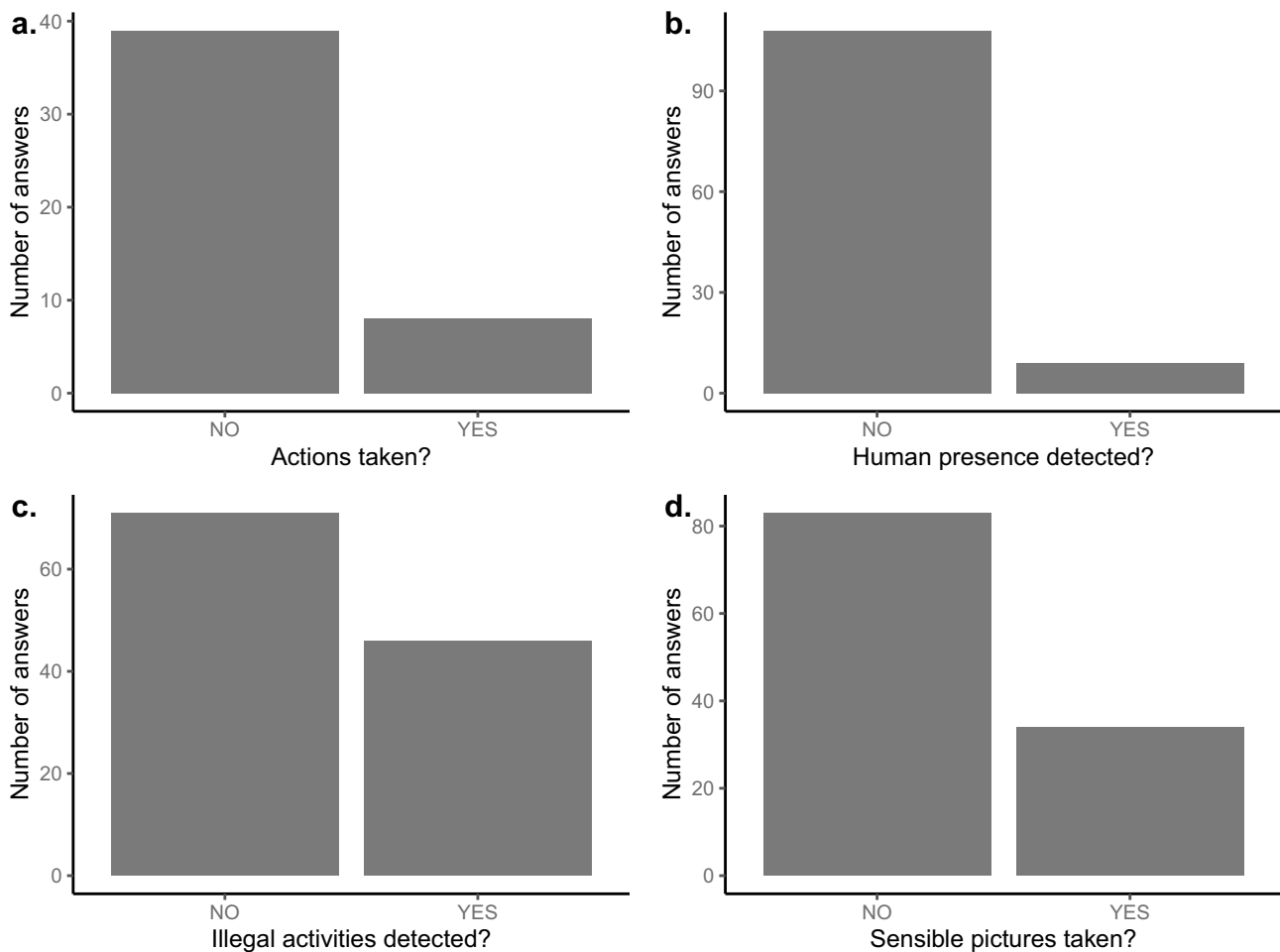


Fig. 1 Number of cases in which **a** professional figures took specific actions to prevent legal consequences, **b** cameras were deployed with the purpose to detect human presence as a part of the scientific objectives, **c** illegal activities (i.e., poaching, harvesting of plants, wood-

fire) were detected during the monitoring, and **d** pictures that may violate privacy issues (i.e., people having sex, urinating, etc.) were collected during camera-trapping sessions

“Have/were cameras been deployed with the purpose to detect human presence as a part of the scientific objectives?”

The proportion of negative ($n = 108$; 92.31%) and positive ($n = 9$; 7.69%) answers was significantly different ($X^2 = 82.08$; $CI\ 95\% = 0.85 - 0.96$; $PoS = 0.92$; $p < 0.001$) (Fig. 1b). Among the 108 negative responses, 58 respondents (53.70%) stated that pictures accidentally obtained were directly deleted ($n = 38$; 65.52%) or deleted after data analysis ($n = 20$; 34.48%), respectively. Contrariwise, 25 respondents (23.15%) declared that images were stored for future work. Only one declared that these pictures were given to law enforcement and protected area management, while another did not provide any information. Regarding the nine positive responses obtained, three respondents (33.33%) stated that cameras were placed to detect human disturbance, three (33.33%) to detect illegal hunting/poaching activities,

two (22.22%) to detect touristic flow and/or sports activities, and one (11.11%) to avoid theft.

“Have you ever documented any activities that may be in violation of laws and regulations pertinent to the specific region where the cameras were deployed (illegal hunting/poaching activities, illegal harvesting of plants, firewood, or other natural materials)?”

The proportion of negative ($n = 71$; 60.68%) and positive ($n = 46$; 39.32%) answers were significantly different ($X^2 = 4.92$; $CI\ 95\% = 0.51 - 0.69$; $PoS = 0.61$; $p = 0.03$) (Fig. 1c). Among the 46 positive responses, 27 respondents (58.70%) stated that images were treated separately to others with humans. Specifically, 22 (81.48%) of them reported violations to the authorities (i.e., Parks employers, members of the Forestry Service, local police), two (7.41%) declared that pictures were used to develop anti-poaching plans,

one (3.70%) declared that pictures were directly deleted, and another (3.70%) did not provide information. Eighteen respondents (39.13%) stated that images were not treated separately to the others with humans, while one (2.17%) did not provide information.

“Has it ever happened to record pictures that may violate some privacy issues (people having sex, urinating, etc.)?”

The proportion of negative ($n = 83$; 70.94%) and positive ($n = 34$; 29.06%) answers were significantly different ($X^2 = 19.69$; CI 95% = 0.62 – 0.79; PoS = 0.71; $p < 0.001$) (Fig. 1d). Among the 34 positive responses, nine respondents (26.47%) declared that pictures were treated separately to others with humans. Among these, six respondents (66.67%) stated that pictures were directly deleted, a second (11.11%) affirmed that pictures were stored for internal processing, a third (11.11%) reported violations to the local authorities (i.e., Parks employers, members of the Forestry Service, local police), and a fourth (11.11%) did not provide information. The remaining 25 respondents (73.53%) affirmed that pictures were not treated separately to the others with humans and were included in the analysis.

Differences among involved professionals

Professional position and number of cameras used were the predictors that better explained the awareness of the respondents about legislation concerning the violation of privacy (see [Research questions](#), question 1) (Table 1). The results obtained from the best model showed a significant difference between involved professional figures (GLM; $resD = 131.98$; $p = 0.04$) and a weakly significant effect for what concerns the number of cameras used (GLM; $resD = 121.54$; $p = 0.06$). However, because ΔAIC of the best (AIC_{min}) and second model was < 2 , there was no substantial difference between the two models (Table 1). Nevertheless, the significant effect of the only variable Professional position was reported even in the second model (GLM; $resD = 131.98$; $p = 0.04$). The pairwise t test for multiple comparisons revealed that such a difference was related to (i) other categories and wildlife

technicians, with wildlife technicians ($nYES = 12$; $nNO = 6$) being significantly (t test; $p = 0.04$) more aware than other categories ($nYES = 6$; $nNO = 15$) in terms of the degree of knowledge about the legal implications as a consequence of privacy invasion (Fig. 2a), and (ii) students and wildlife technicians, with wildlife technicians ($nYES = 10$; $nNO = 3$) being significantly (t test; $p = 0.01$) more aware than students ($nYES = 7$; $nNO = 16$) (Fig. 2b).

Considering only those figures who were aware of legal implications and actions taken to prevent legal consequences (see [Research questions](#), question 2), the number of days in which cameras were deployed was the only predictor better explaining this relation. However, no significant effect (GLM; $resD = 35.91$; $p = 0.42$) was obtained.

Professional position was the only predictor that explained the awareness of residents about the presence of camera traps in the region (see [Research questions](#), question 4) (Table 2). The results obtained from the best model showed a significant difference between involved professional figures (GLM; $resD = 135.95$; $p = 0.04$). Nevertheless, because ΔAIC of the best (AIC_{min}) and second model was < 2 , there was no substantial difference in terms of goodness of fit between the two models (Table 2). In spite of this consideration, the significant effect of the only variable Professional position was reported even in the second model (GLM; $resD = 135.95$; $p = 0.04$). The pairwise t test for multiple comparisons revealed that such a difference was related to (i) researchers and students, with researchers ($nYES = 27$; $nNO = 19$) being significantly (t test; $p = 0.02$) more active than students ($nYES = 9$; $nNO = 19$) in terms of noticing residents about the presence of camera traps in the region (Fig. 3a), and (ii) students and wildlife technicians, with wildlife technicians ($nYES = 12$; $nNO = 6$) being significantly (t test; $p = 0.01$) more active than students ($nYES = 9$; $nNO = 19$) (Fig. 3b).

Discussion

The results obtained from our survey showed that the ratios between stakeholders who were aware (or not) of the legislation concerning the privacy violation in the region in which

Table 1 Generalized linear models (GLMs) with top model marked in italics. Explanatory variable: “Were you aware of the legislation concerning the violation of privacy in the region in which you worked?”.

Model ID	Predictors	K	$-2 \log Lik$	AIC	ΔAIC	ω_i
<i>1</i>	<i>Position + cameras</i>	9	<i>121.54</i>	<i>139.54</i>	<i>0.00</i>	<i>0.53</i>
2	Position	4	131.98	139.98	0.44	0.42
3	Position + cameras + days	14	116.31	144.31	4.77	0.05

K number of parameters, $\log Lik$ log-likelihood, AIC Akaike’s information criterion, ω_i Akaike’s weight

Predictors: *position* = professional position of the figures involved; *cameras* = number of cameras used within the study site; *days* = number of days in which cameras were deployed

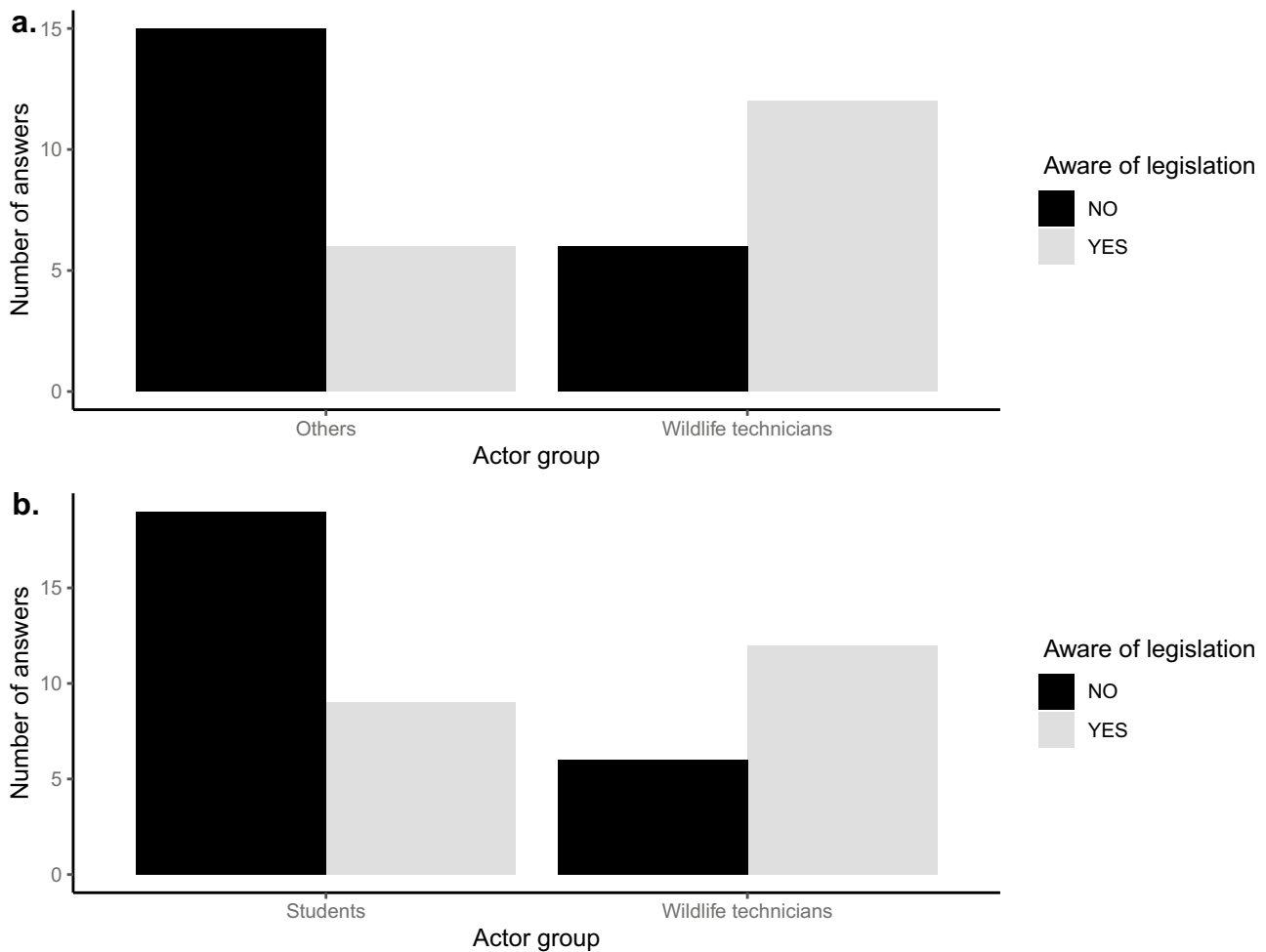


Fig. 2 Difference in terms of the degree of knowledge about legal implications between **a** wildlife technicians and other categories (e.g., amateur naturalists, amateur photographers), and **b** wildlife techni-

cians and students. Binary response categories: 1 = YES (aware about legal implications); 0 = NO (not aware about legal implications)

they worked was mostly balanced towards those who were unaware. A reversing trend was instead observed for what concerns informing (or not) residents about the presence of camera traps in the area. In this case, a higher number of people informed residents about the presence of cameras. However, in both cases, the results obtained were not significant hence highlighting the lack of knowledge regarding the eventual trade-off effects in the form of legal consequences.

Among those who were aware of such legislation, most of them did not take specific actions to prevent legal consequences and did not provide any information about why they decided to move in that direction. We speculate that, probably, they took this decision to prevent the risk of theft or vandalism (e.g., cameras being hidden or damaged) (Miller et al. 2017; Sandbrook et al. 2018; Glover-Kapfer et al. 2019). Theft and/or vandalism are indeed considered as

Table 2 Generalized linear models (GLMs) with top model marked in italics. Explanatory variable: “Were residents aware of the presence of camera traps in the region?”. Predictors: *position*= profes-

sional position of the figures involved; *cameras*= number of cameras used within the study site; *days*= number of days in which cameras were deployed

Model ID	Predictors	<i>K</i>	<i>-2 logLik</i>	AIC	Δ AIC	<i>wi</i>
<i>1</i>	<i>Position</i>	4	135.95	143.95	0.00	0.54
2	Position + cameras	9	126.85	144.85	0.90	0.35
3	Position + cameras + days	14	119.18	147.18	3.23	0.11

K number of parameters, *logLik* log-likelihood, *AIC* Akaike’s information criterion, *wi* Akaike’s weight

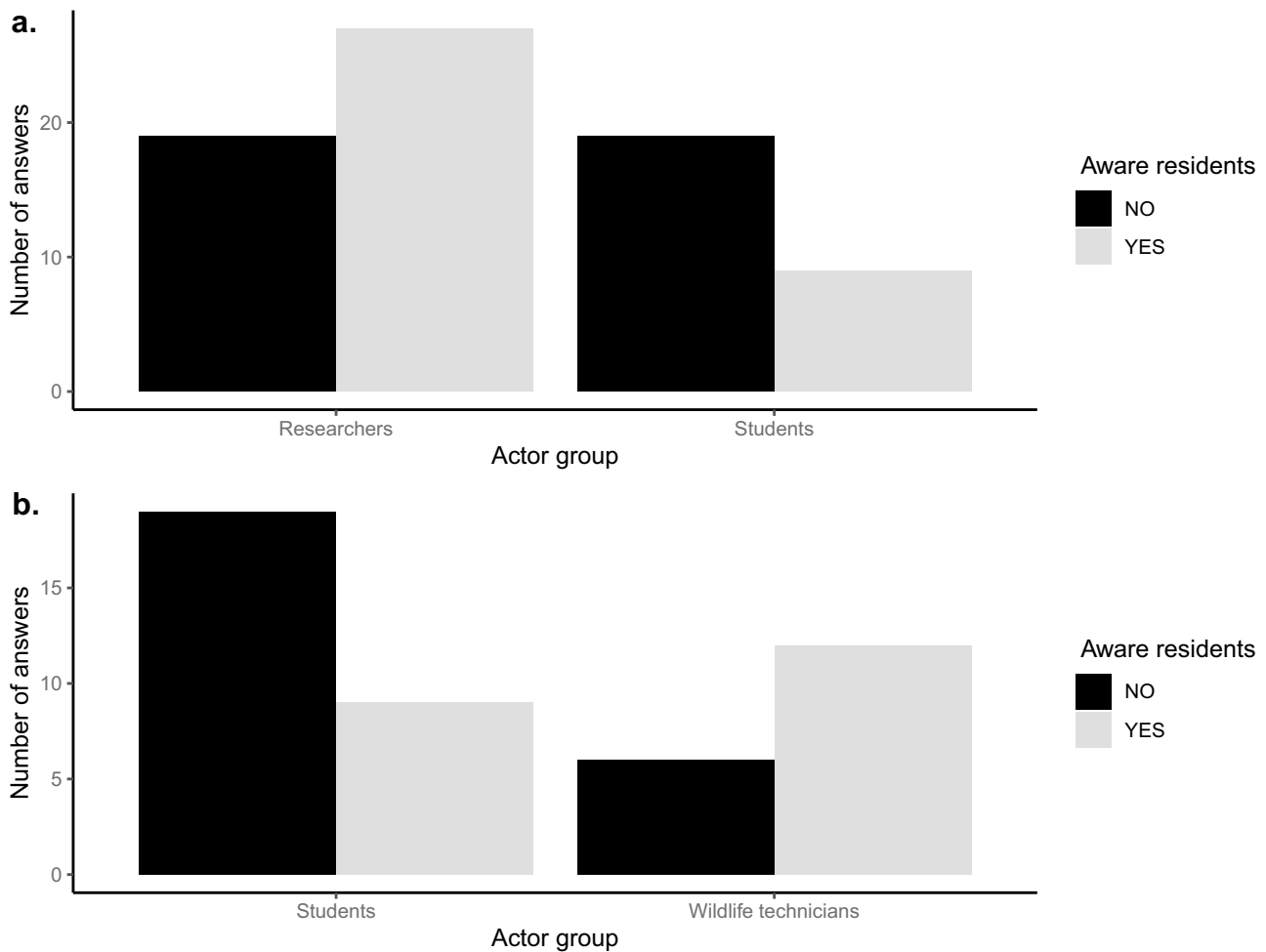


Fig. 3 Difference in terms of informing residents about the presence of camera traps between **a** researchers and students, and **b** wildlife technicians and students. Binary response categories: 1 = YES (aware about legal implications); 0 = NO (not aware about legal implications)

some of the most important constraints on camera-trapping effectiveness (Glover-Kapfer et al. 2019) as they may lead to high financial losses (Meek et al. 2018). In addition, having cameras stolen has consequences both for the robustness of the results (each stolen camera may represent a significant loss of data), and for the budget to replace each camera; so, camera owners may prefer not to share the presence of cameras to local community stakeholders.

Our first prediction regarding professional figures' comparison in terms of the degree of knowledge about legal implications derived from the use of camera traps was only partially met, as a difference was only found between wildlife technicians and both students and other categories (e.g., wildlife photographers, amateur naturalists), with wildlife technicians being significantly more aware about legal implications. The second prediction was partially met as well as a significant difference was showed only comparing researchers and students and wildlife technicians and students. Indeed, both researchers and wildlife technicians

informed more the residents about the presence of cameras in the area. Lastly, the third prediction was not met, as no significant differences among professionals were obtained in terms of action taken to prevent legal consequences. The results obtained highlight a general lack of knowledge (especially among freelancers and students) about issues related to privacy invasion derived from camera traps deployment, and a general tendency to not take actions to prevent legal consequences most likely because reporting the presence of cameras in the area may increase the likelihood of theft or vandalism. The frequency with which cameras take pictures of people suggests that either positive or negative implications of this phenomenon need to be carefully considered (Sandbrook et al. 2018). From the point of view of wildlife conservation efforts, camera traps are considered powerful surveillance tools, as images of people carrying out illegal actions can clearly help other conservation actions (Fletcher 2010; Hossain et al. 2016). Nevertheless, when people that are not doing anything illegal are photographed without

their consent, camera trap owners may face unpleasant legal consequences (Butler and Meek 2013). In this sense, being aware of the legal implications derived from the use of such cameras and informing residents and communicating the presence of camera traps in the region (e.g., public presentation, meeting with managers, information panels) likely is of remarkable importance to prevent potential legal concerns.

Several respondents stated that cameras were not placed with the aim to detect human presence as a part of a specific scientific purpose, and most of them declared that illegal activities and/or pictures that may violate privacy issues (people having sex, urinating, etc.) were collected during the monitoring period. Despite some respondents declaring that violations were reported to local authorities and several reporting that images of people were directly deleted, in most cases, pictures were conserved for internal processing or because of their scientific values. A small portion also affirmed that images were conserved to plan effective anti-poaching strategies, hence highlighting the importance that human pictures may have to counteract illegal practices.

Due to relatively low prices and user-friendly applications, camera traps are increasingly used for wildlife monitoring and conservation. Indeed, camera-trapping represents a useful method to facilitate both touristic flows (Miller et al. 2017) and human activities detection (Hossain et al. 2016), as cameras are used to monitor the distribution and abundance of wild species even in remote areas (Pettorelli et al. 2010). The increased concern in nature-based recreation and tourism (Balmford et al. 2009), and the increase in nature-related tourism itself, highlight the urgency of improving our understanding about how humans use the natural landscape, especially when designing management policies in natural areas. In this regard, collecting simultaneous data of humans and wild species is of vital importance to explore these interactions and to improve wildlife conservation efforts, especially in protected areas (Miller et al. 2017). Since trails are used both by humans and/or wild species to move around the territory (Miller et al. 2017), taking pictures of humans is relatively easy and unavoidable (even when a given experimental design and modelling may exclude the presence or activity of humans). Thereby, to avoid potential legal problems, our suggestion is to report the presence of cameras in the area and to take some precautions to avoid the risk of theft or vandalism. Among the most common solutions involve the use of security cases, cable locks, camouflaging, or cameras with black infrared flash (Glover-Kapfer et al. 2019). Furthermore, even engaging local people within monitoring activities (Glover-Kapfer et al. 2019; Sharma et al. 2020) may provide a considerable contribution as a consequence of increased vigilance performed by locals, and it would produce several benefits in terms of both quantity and quality of data collected because of increasing workforce. However, in cases in which engaging

local communities is poorly effective, fear-based methods (e.g., cameras with a warning sign reporting that they can be tracked) might be considered (Glover-Kapfer et al. 2019).

To sum up, our findings revealed that several points highlighted in the code of conducts proposed by Sharma et al. (2020) have been violated, as several respondents stated that they were unaware about the legislation concerning privacy violation within the study area in which they actually work and/or have worked in the past, and no permissions along with no communication about the presence of camera traps within the area were requested/done. The respect for individual privacy has been met as few respondents declared that trail cameras were set up with the purpose to detect human presence and, most of them, stated that pictures that may violate privacy issues (i.e., people having sex, urinating, etc.) were deleted, stored for internal processing, and/or delivered to local authorities. Furthermore, those pictures showing people engaged in illegal activities were delivered to local authorities thus fulfilling the need to respect the individual privacy and, at the same time, reporting illegal acts. As stated above, when individuals are detected engaged in nefarious activities such as poaching, theft, vandalism, or illegal waste dumping, there may be serious concerns and further complications regarding the pursuance of legal actions when an individual is identified by these images without consent (Butler and Meek 2013). Nevertheless, it is important to consider that privacy is an important right, but not an absolute one. In fact, if researchers refuse to report data on illegal actions they may be considered as abettor to a crime. Therefore, if a serious crime is committed and recorded through cameras, it would be responsibility of researchers to report such illegal actions through sharing sensitive data only with appropriate authorities (Sharma et al. 2020).

Management implications

Camera traps are surveillance technologies widely used for conservation purposes. Nevertheless, strong attention needs to be dedicated to the potential negative and legal consequences. Surely, camera-trapping represents a valuable and effective method providing technical advantages to conservationists and researchers who need data about species presence and distribution. This study revealed that the use of social media may be an important source of data collection especially in the light of wildlife conservation practices. Our findings empirically revealed that camera traps also play a role in people surveillance and/or detection, even involving the detection of illegal human activities. In the light of the importance of camera traps as useful tools for wildlife monitoring and conservation, we elaborated three general conclusions: (i) our results revealed an existing lack of knowledge as far as regards social and legal implications derived by

camera traps deployment among figures involved; (ii) even those respondents who were aware of breaking law implications voluntarily decided to not communicate the presence of cameras within the region, probably, to prevent the risk of theft or vandalism (e.g., cameras being hidden or damaged); and (iii) both illegal activities and pictures that may violate privacy issues (people having sex, urinating, etc.) were collected during the monitoring period and equally conserved for internal processing, because of their scientific values or to inform local authorities. However, detection of individuals engaged in private activities poses a complication in terms of legal persecution when an individual is recognized (Butler and Meek 2013). Thereby, following a strong code of conduct assumes key importance to prevent unpleasant legal implications.

Social and legal implications derived from the deployment of camera traps are key issues that require notable attention to prevent researchers or conservationists from being legally actionable. However, to date, poor bibliographic references highlight these issues (Kays and Slauson 2008; Butler and Meek 2013; Sandbrook et al. 2018; Sharma et al. 2020). As reported by Sandbrook et al. (2018), a recently published standard WWF guideline (Wearn and Glover-Kapfer 2017) offers very useful information as far as regards camera traps image handling. Higher resolution images could make demographic information easier to extract but might be undesirable for privacy reasons in the case that the picture includes people's faces. This issue may be avoided using automated image classification to delete or blur accidental images of people, a technique that has already been used to detect people involved in illegal activities (Betts 2015). Throughout the use of a night-only mode, the risk of detecting people on trails, along with the risk of theft, may be reduced since most people do not walk trails after dark. Furthermore, flashes can be set to go off only at night, when they are less likely to be noticed as a consequence of reduced human presence. Besides, the privacy of people and/or park visitors can be respected by using low-resolution images or through the engagement of local people in camera-trapping research.

Despite our belief that the results presented in this study are interesting and provide a substantial contribution in broadening the degree of knowledge regarding the social and legal implications derived by the use of camera traps for conservation purposes, we are also aware that our work presents some limitations as we obtained fewer responses than anticipated, especially as far as the nationality of the respondents is concerned which in turn did not allow us to elaborate stronger inferences. In fact, because legislation regarding privacy violation may vary between regions or countries, further researches restricted in both geographical and political contexts are strongly needed in the light of future conservation actions. We suggest that reporting the presence of cameras in the study site along with finding novel and effective

methods to protect cameras (e.g., similar to those developed for smartphones "Find My iPhone/Device" for both Apple and Android devices) (Glover-Kapfer et al. 2019), may be effective in the future to prevent (or at least minimize) the risk of theft and/or physical damages.

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1007/s10344-022-01593-8>.

Acknowledgements The authors are very grateful to all respondents who participated in the questionnaire survey. Furthermore, the authors wish to thank Dr. Christian Gortázar (Editor-in-Chief) as well as Dr. Pelayo Acevedo and an anonymous reviewer for the important comments which considerably increased the quality of our manuscript.

Author contribution All authors have contributed equally to the realization of this research.

Funding Open access funding provided by Università degli Studi di Udine within the CRUI-CARE Agreement.

Data availability and material The datasets generated and analyzed during the current study are not publicly available due to the sensitive nature of the data but are available from the corresponding author on reasonable request.

Code availability Not applicable.

Declarations

Ethics approval Permissions and ethical evaluations were requested to the district directors, managers and research committee of the authors' respective institutions which concluded that the questionnaire did not require a full ethics review because this study was deemed low risk.

Consent to participate All respondents provided their consent to participate in the survey.

Consent for publication All respondents provided their consent to publish the contents of the survey.

Competing interests The authors declare no competing interests.

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