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Aware or not aware? A literature review reveals the dearth of evidence on recreationists awareness of wildlife disturbance

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As nature-based recreational activities keep increasing, so does human pressure on wildlife. Several recent reviews provide a comprehensive overview of the impact of recreation on wildlife, but there is no comprehensive study of how humans perceive their own impact while participating in those activities. We fill this gap by summarizing the current state of research with a systematic review of 47 articles published between 1992 and 2018. It unveiled the current lack of research on sporting activities and on terrestrial mammals (in contrast to marine animals). In 43% of the surveys, most respondents were not aware of their impact on wildlife. The variables that were most often explored to explain the perception of disturbance was the experience and knowledge of the respondents. Some interesting results arose, such as the negative correlation between the level of knowledge of wildlife disturbance and awareness, or the transfer of the responsibility of disturbance on other user groups. Although several explanations are provided to explain these counterintuitive results, drawing general patterns stemming from the range of articles we reviewed was limited by the wide heterogeneity in researches aims, protocols and survey designs. In the conclusion we make recommendations to improve the comparability of future research.

Keywords: nature-based recreational activities, outdoor recreation, perception, systematic review, wildlife disturbance

Nature-based recreational activities are increasing in popularity worldwide (Newsome 2014, Balmford et al. 2015). This phenomenon is driven by increasing attraction and concerns both for nature (Bjerke et al. 2006) and for health and well-being benefits expected from outdoor activities (Bowler et al. 2010). However, the increasing numbers of nature based recreationists in nature is an important source of pressure on natural environments, causing impacts on soil, water, vegetation and animals (van der Duim and Caalders 2002, Mounet et al. 2004, Rixen and Rolando 2013, Ballantyne and Pickering 2013, 2015). In a global context of biodiversity loss (IPBES 2018) and human alteration of zooregions (Bernardo-Madrid et al. 2019), disturbance caused by nature-based recreational activities represents an extra source of pressure for wildlife. Studies report impacts such as extra energy expenditure, modification of physiological and behavioural responses, or jeopardised feeding process (Knight and Gutzwiller 1995, Taylor and Knight 2003, Arlettaz et al. 2007, Patthey et al. 2008, Marchand et al. 2014, Gutzwiller et al. 2017). These studies appear in several reviews of literature that have been published in order to globally assess the impact caused by recreation based on different indicators (Boyle and Samson 1985, Steven et al. 2011, Sato et al. 2013, Larson et al. 2016). Between 50% and 88% of publications included in these reviews supported negative rather than positive or non-existent effects. This evidence is leading managers of natural areas to implement measures for wildlife protection (Braunisch et al. 2011, Stenseke and Hansen 2014, Cremer-Schulte et al. 2017) and to reduce recreation-induced disturbance. In places where this process has not started yet, such evidence should contribute to or stimulate the process of implementing conservation measures.

Yet, those measures can only be efficient if visitors understand that they are a source of disturbance and damage, if they agree with conservation goals and if they are willing to comply with measures likely to restrict their activities. All these conditions may not be met among recreationists. For instance, according to Flather and Cordell (1995), the fact that outdoor recreation is dispersed over large areas may contribute to the perception that it has little environmental impact compared to other human uses of natural resources such as agriculture or forestry. Human dimension approaches using the concepts and methods of social sciences are therefore necessary to better understand the profiles and attitudes of visitors taking part in recreational activities, and

to determine how to use that information in natural areas management (Manfredo et al. 1995). Investigation on the foundation of environmental awareness are legion. Researchers have shown that personal and social factors such as gender, age, socioeconomic background or education influence pro-environmental concern and behaviour to a certain extent (Stern et al. 1993, Klineberg et al. 1998, Gifford and Nilsson 2014). In addition, participation in nature-based recreation contributes to the construction of attitudes and behaviour (Bjerke et al. 2006, Bagri et al. 2009, Larson et al. 2011, Kil et al. 2014, Su et al. 2019). Other empirical studies of visitors performed so far have targeted topics such as stands towards management of protected areas (Hall et al. 2010, Sterl et al. 2010, Kaltenborn et al. 2017), behaviour in nature (Lee and Jan 2015), sometimes towards wildlife (Fulton et al. 1996). The field of study of human dimensions of wildlife has theorised the pattern of belief people follow in their relation to wildlife. According to Fulton et al. (1996), wildlife value orientations can take two directions: domination (wildlife should be used for human benefits) and mutualist (wildlife deserves rights and care). Value orientations are expected to influence behaviour towards wildlife is various contexts, including recreation (Jacobs et al. 2018). Studies have indeed revealed that mutualists and dominants have different types of involvement in recreation related wildlife. However, few studies have centred their attention on whether recreationists perceive their own impact on wildlife, even less so, whether value orientations might influence their perception. Yet, assessing recreationists' perception of wildlife disturbance is a necessary step to determine the need for awareness-raising campaigns and adapting them to the target audience. Indeed, knowledge of a self-inflicted impact is an essential drive for visitors to change their behaviour (although it is not the only one) (Clayton and Myers 2009). There is therefore an urgent need to get a comprehensive overview of the knowledge of recreationists, their perception of their own impacts and their views on management measures, to fill the gap between scientific knowledge of the consequences of recreation on wildlife and awareness or perception that visitors might have of the matter.

Hence, the aim of our publication is to summarize the current research on the perception and awareness of nature recreationists of the impact of their activities on wildlife, based on a review of the existing literature. Our goal was threefold: to identify patterns in levels of awareness, to figure out which factors influence the awareness of wildlife disturbance and to ascertain the range of management measures proposed in the selected publications. To this end, we collected publications from online databases, that we selected based on a list of keywords and quality criteria assessed from a detailed reading of the publications (Pickering and Byrne 2014). From this pool of selected publications, we summed up the temporal and geographical distribution of studies, and provided an overview of publications characteristics in terms of goals, activities scrutinized, levels of protection and of conservation status of animal species studied, and methodology used. Then, we proceeded to the analyses pertaining more specifically to the goals of our review by examining the results on the level of awareness across studies, and the factors studied for explaining the level of awareness. We hypothesised that the level of awareness across studies should vary with 1) the activity studied, expecting that occasional tourists may be less aware than recreationists practicing often outdoor as they might not be used to witnessing impacts, 2) the protection status of sites visited, expecting studies performed in National Parks to report the highest level of awareness, since educational signs or other types of information are often provided in protected areas and 3) the level of conservation concern of the animal species studied, expecting studies focusing on highly threatened species to find recreationists to be the most aware of their own potential disturbance. We reviewed whether, as shown in studies dealing with environmental awareness in other contexts (Vaske et al. 2001, Korfiatis et al. 2003, Olofsson and Öhman 2006), the level of awareness of recreationists of their own impact of wildlife depended on respondents' personal features, such as age, gender or education level, but also on previous first-hand experience and knowledge about wildlife disturbance, and on their level of pro-environmental attitudes. Furthermore, we listed the management options devised (when available) to prevent wildlife disturbance, examining whether results on the level of awareness guided the proposed solutions. Based on our review of the existing literature and results therein, we end up by underlining the main gaps in our knowledge about people's awareness of their own disturbance of wildlife, and set up guidelines for further studies.

Methods

To get an overview of the extant knowledge about people's opinion of whether or not recreational activities could be considered a threat to wildlife, we conducted a quantitative literature review based on the method outlined by Pickering and Byrne (2014). The method follows the Preferred Reporting Items for Systematic Review Recommendations (PRISMA). It allows a 'transparent reporting of systematic reviews' by going through each step of the article research and selection (Moher et al. 2009, Fig. 1).

Although we had originally hoped to review articles written in French and in English, the absence of published articles matching the criteria of the systematic review in French led us to focus exclusively on the English language. The research articles were obtained by searching online databases: Google Scholar, ResearchGate and Web of Science. The search was carried out in November and December 2018 using the following search string ((('visitors' OR 'recreationists' OR 'tourists' OR 'nature sports) AND ('perception' OR 'awareness' OR 'knowledge') AND ('wildlife' OR 'fauna') AND ('disturbance' OR 'impact' OR 'effect' OR 'threat)). Book chapters, grey literature, conference papers and bachelor, master or PhD thesis were excluded. The search ended when the results became redundant or irrelevant. In addition, references listed in the articles that we considered the most relevant to this review were used to find more publications Retained publications needed to present empirical data through surveys (questionnaires or interviews) and to question precisely respondents' opinions on the impact of recreational activities on wildlife. We thus excluded publications where the topic of wildlife disturbance was broached but not surveyed. All types of outdoor recreational activities were included, as well as all animal species, excluding enclosed areas where animals could not roam freely, such as zoos.

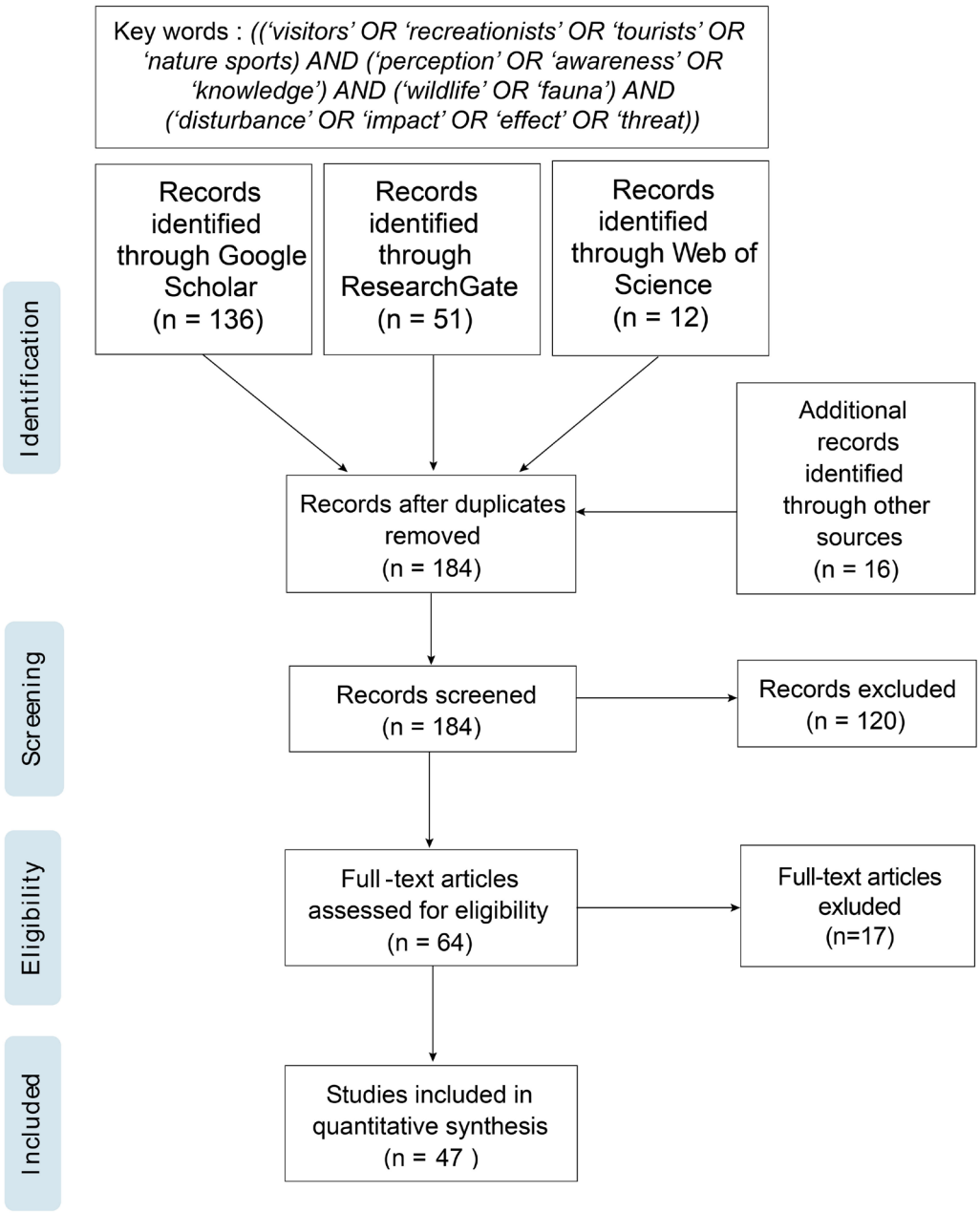

Figure 1. PRISMA literature search flow diagram. Studies that were located and included in the review at each stage of the process.

During the identification process titles and abstracts were read to make sure the study matched most of the inclusion criteria. The screening process was more thorough, mostly dwelling upon figures and lists of variables to identify whether or not the question of our interest was raised. Finally, full-texts were assessed for eligibility and those who turned out to be irrelevant or ambiguous were excluded (see Fig. 1 for the full process).

The 47 selected articles (Appendix 1) were then entered into a new topic-specific database including: 1) basic data on publication including its year of publication, title, author(s) and information about the journal; 2) geographical information about the survey (country, world region), type of environment (marine, shore, forest, mountain, grassland, wetland, polar and river) and type of protected area (National Park, Nature Reserve, Wildlife Conservation Area etc.) if applicable; 3) methods used and type of data, type of statistical analysis performed in the study and whether the article primarily focused on the impact of recreation or on the perception of these impacts; 4) types of animals were organised in five categories (birds, marine life, terrestrial mammals, insects and amphibians), when possible, we included their conservation status based on the IUCN’s Red List of Threatened Species (IUCN 2019); 5) the human dimension, i.e. the types of respondents (visitors, managers, other stakeholders), the types of activities (sorted in six categories: non sporting activities – i.e. tourism wildlife viewing – land-based sports, winter sports, beach activities and water sports); 6) whether or not people were aware of the impact. The latter variable is the response variable we are actually interested in. It was

expressed however by different statistics depending on study protocols. Since the questions related to perception or awareness of the impact of recreation were either presented as a mean (out of five) or as a percentage depending on the type of questions, we recoded the results in three groups to get a proxy of the level of awareness of the respondents comparable across the 47 publications included in our review: above 60% or scores above 3.5: 'aware'; between 40% and 60% or scores between 2.5 and 3.5: 'neutral'; under 40% or 2.5: 'unaware'. We also recorded factors considered as influencing awareness when available (i.e. whether they were activity, experience, respondent or site related, linked to sociological factors or attitudes). Finally, we also included a section to identify if respondents reported the responsibility of disturbance on other users' groups, although this topic was not mentioned in many publications.

The data were stored in an excel database. We plotted descriptive figures to display the temporal history of publications (histogram), the geographical distribution of author address and study sites (map) and the main focus of the studies (word cloud showing up the title words in proportion with their frequency). Then, we analysed the variation in the distribution of recreationists responses in the three recoded levels of awareness across publications. We performed χ^2 tests on contingency tables to study whether the distribution of responses in the three categories of awareness in each paper depended on the type of activity, the protection status or the type of wildlife.

Results

Publication trends and geographic distribution

The earliest article to meet our inclusion criteria was published in 1992. The number of articles published per year has gradually increased ever since, to reach a peak (12 articles) between 2010 and 2014 (Fig. 2a). The word cloud (Fig. 2b) shows the key words that appeared most often in the titles of the publications.

Authors' countries of affiliation were mostly in North America (32%), Europe (28%) and Oceania (19%) (represented by the circles in Fig. 3). Likewise, study sites were situated mostly in Europe (28%), North America (21%) and Oceania (20%) (represent by the colour gradient). Africa, the Middle East and the Caribbean were underrepresented in both number of articles published and location of the study (less than 5%) (Fig. 3).

Studies were conducted in all types of environments, with a slight overrepresentation of marine environment (21%) and shorelines (21%) compared to forest (15%) and mountain environment (15%). Most of the studies (60%) took place in protected areas, 42% of those were National Parks.

Overview of publications characteristics (overarching goals, activities, species, methodology)

All the articles we selected included at least one question on the perception of wildlife disturbance, but only 25% of the surveys focused specifically on this topic and only 15% combined a survey on human perception of disturbance to a study of the actual disturbance of wildlife. The other studies associated the matter of disturbance to general surveys on perception of the positive and negative impacts of an activity, or to the study of a touristic or recreational activity. A minority of the publication we selected focused on visitors' viewpoint, emotions, perception and belief about wildlife and two explored the perception of the management of a protected area (Fig. 4).

A wide variety of recreational activities was studied across the selected publications, however none of the studies focused exclusively on consumptive activities (but four articles mentioned hunting, trapping of fishing), nor on motorized activities (beach driving or boating mentioned in four publications). We distinguished non-sporting activities, such as tourism (when the authors did not give more details on the activities taken part of by the tourists), sightseeing or wildlife viewing and sporting activities that were taken part in either by tourists or by local inhabitants without the geographical origin of participants being a central focus (e.g. hiking, running, skiing, cycling etc.). Non-sporting activities

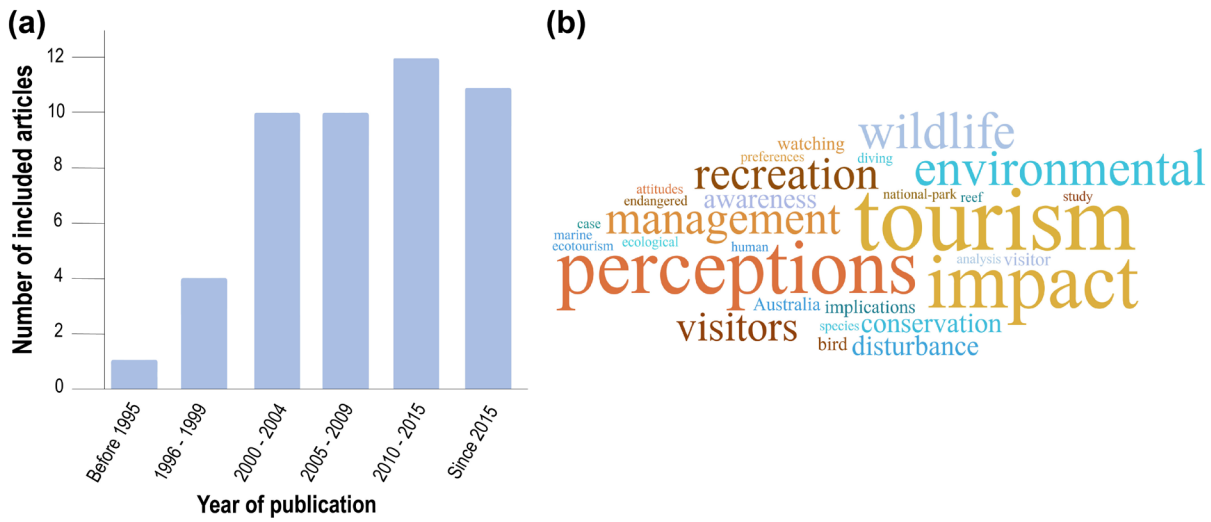

Figure 2. (a) Number of published articles per publication year. (b) Word cloud from included articles titles (word size proportional to occurrences in titles, position is not meaningful).

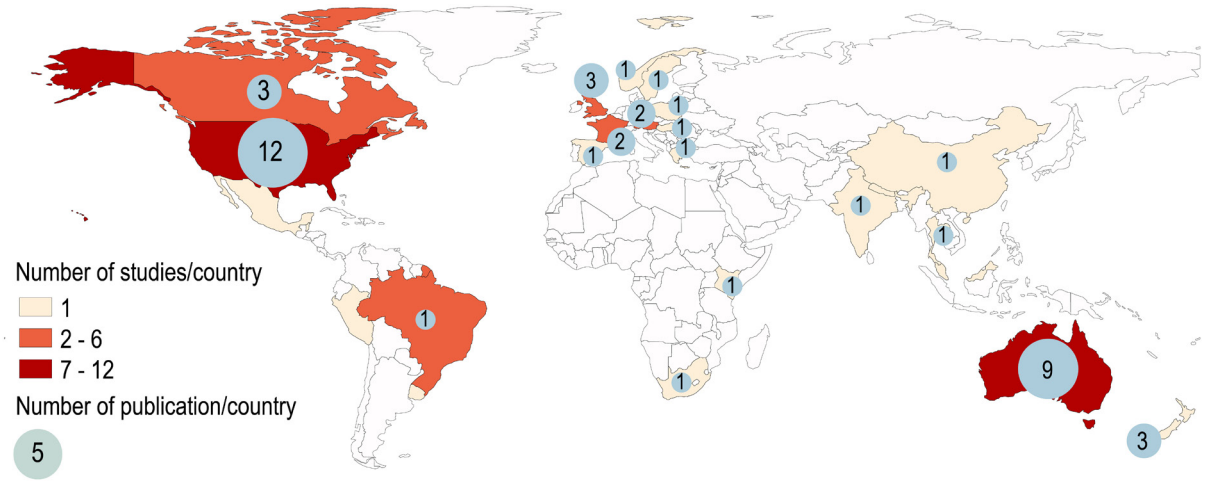

Figure 3. World distribution of published articles per author's country of affiliation (blue circles) and word distribution of study sites (colour shades).

were the most common with 79% of publications, followed by water sports (21%) and land-based sports (19%). Hiking and scuba diving were the most studied sporting activities (Fig. 5a). Only three surveys looked into winter activities.

Most of the surveys were carried out on people who visited natural areas (85%), but some other types of respondents were also surveyed (15% were managers of natural areas, 17% local inhabitants not necessarily participating in

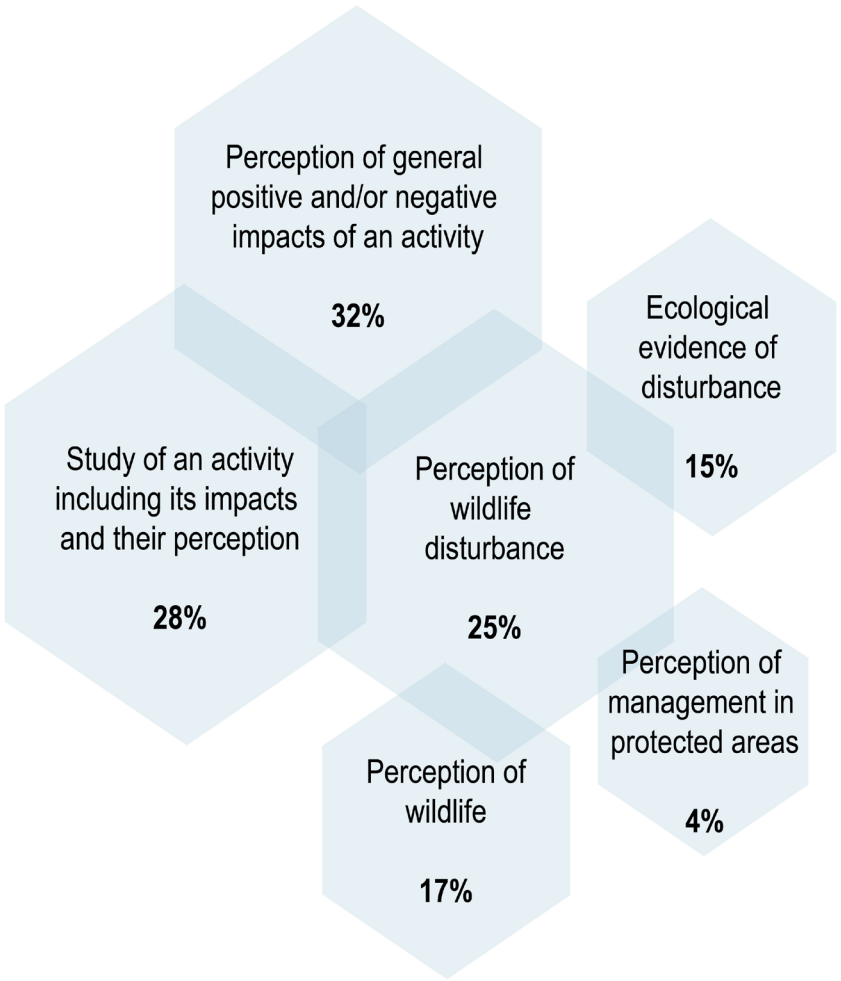

Figure 4. Focus topics of the publications, classified in six categories by L. Gruas. The polygons are scaled to the percentage and the overlapping indicate that the topics were covered jointly by the authors (the total is above 100% as several publications focused on more than one topic).

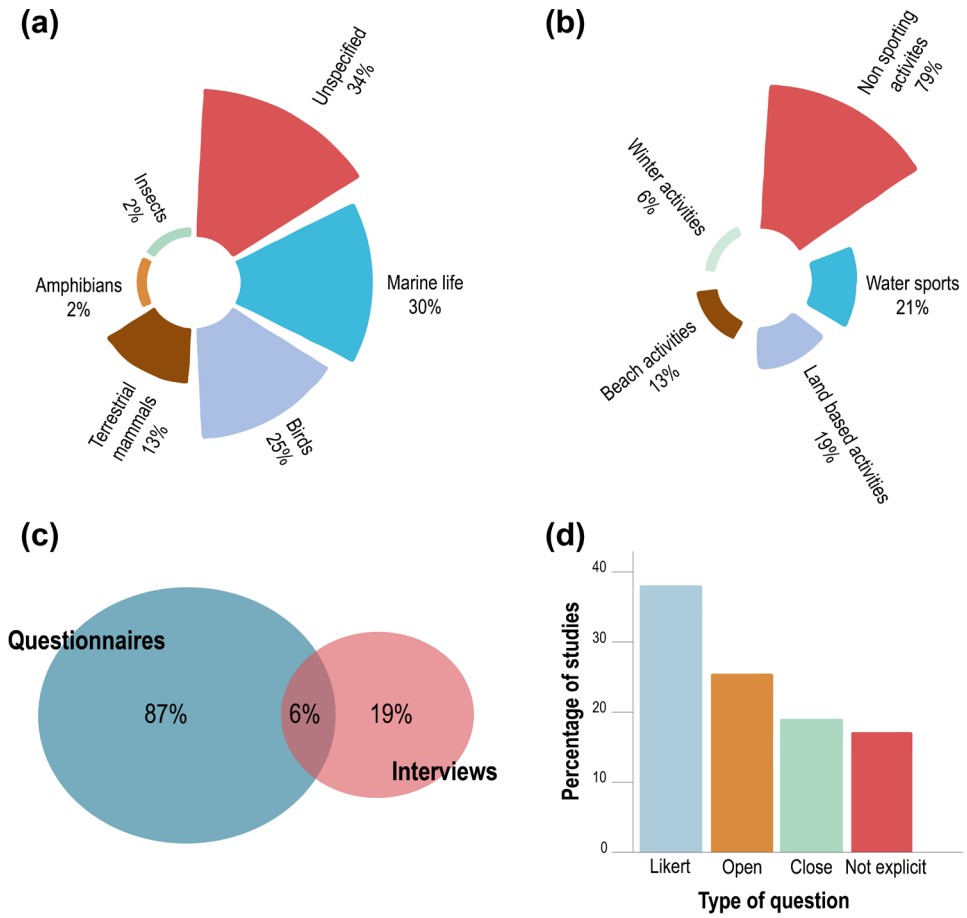

Figure 5. (a) Type of wildlife studied in the articles (five surveys focused on more than one species, hence the percentage >100%). (b) Type of recreational activities studied in articles (the total is above 100% as most articles studied several activities). (c) Survey methodology. (d) Type of question used to assess the level of awareness of the respondents.

recreation and 9% were touristic stakeholders – percentage are >100% because some publication surveyed several types of respondents). Sixty percent of the surveys explored the respondents' sociodemographic characteristics. The percentage of women was slightly higher in non-sporting activities (47%) than in sporting activities (43%). In all publications mentioning education level, the percentage of respondents who were university graduates was larger than the percentage of people with only high school education.

Thirty-four percent of the publications did not focus on a species in particular, but dealt with wildlife in general. Then, marine life (30%), birds (25%) and terrestrial mammals (13%) were the most studied groups of wildlife. Amphibians and insects have not raised much interest so far (one study each in total) (Fig. 5b). Out of the 55% of surveys that focused on a specific species, almost half (46%) were low concern species, 11 were vulnerable or near threatened and only six species were threatened (coral reefs) or endangered, none were critically endangered. Thus, our expectation that most studies would focus on species of conservation concern was not supported.

Data were mostly collected though questionnaires (87%) and interviews (19%), sometimes combined together (6%) or with observation (6%) (Fig. 5c). The type of data is hence mostly quantitative or mixed (75% and 15% respectively), only 10% of the studies being exclusively qualitative. Sample size for qualitative surveys ranged from 15 to 413 (mean = 169.8, median = 68). Sample size for quantitative surveys ranged from 13 to 3017 (mean = 478, median = 302).

The question of the awareness of possible impacts of recreation on wildlife was formulated differently depending on the studies (Fig. 5d). Forty percent of the surveys used Likert-type scales, with items such as 'The survival of animals may be affected by disturbance from wildlife viewers' (Dolsen et al. 1996). Twenty-five percent had open-ended questions, for example asking respondents to lists the impacts resulting from their activities. Nineteen percent used close-ended questions, often as 'yes/no', such as: 'Do you think visitors in general have an adverse effect on the birds of this site?' (Le Corre et al. 2013). Finally, 16% of the publications were not explicit regarding the type of questions used.

Explaining the variation in the levels of awareness across studies

The results about awareness were very variable among the studies: 43% of the articles found a majority of unaware respondents and 34% found a majority of aware respondents. The rest was considered neutral (Fig. 6a). In contrast with our expectations, the level of awareness did not depend on the activity performed ($\chi^2 = 8.15$; ddl =10; $p = 0.61$), the type of wildlife considered in the study ($\chi^2 = 8.70$; ddl

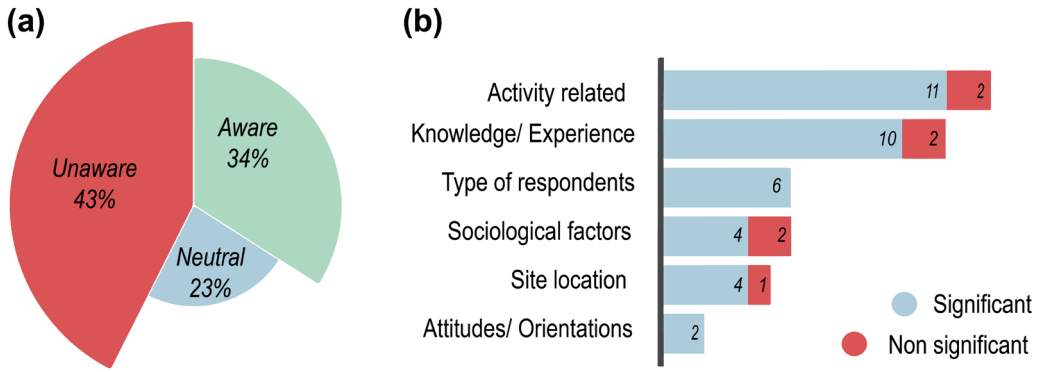

Figure 6. (a) Percentage of papers that found a majority of aware, unaware or neutral respondents in their surveys. (b) Number of paper that explored the effect of human dimension activities and ecological variables. The colours indicate whether the paper found the variable was significant in the publication. (The total is above the total number of articles as most articles had several explaining variables.)

=10, p=0.56), nor the level of protection of studied areas (χ^2=2.19; ddl =4; p=0.70).

Thirty-eight percent of the publications (18 publications) did not investigate the factors that could explain differences in the levels of awareness of the respondents. Among the remaining studies (29 publications), the explaining variables could be grouped into six broad categories (Fig. 6b). Only, 11 publications considered more than one explaining variable and four of those 11 mentioned non-significant variables. It is however not possible to tease apart whether authors tested multiple variables and only presented the significant ones, or if they did not test the different individual characteristics.

The variable that was most often presented as influencing perceptions was related to the activity (tested in 13 surveys and significant in 11 cases). It included people participating in different types of activity, or in the same activity but in a different way (e.g. people watching whales from boats or from the shore – Finkler and Higham 2004). Some studies also investigated whether awareness depended on people's experience level in the activity (Lucrezi et al. 2013), or whether they were interviewed before or after the activity (Dearden et al. 2007). Both experience and before/after interviews significantly influenced the perception of disturbance as witnessing negative impacts during the activity made people more likely to state that they could be a disturbance to wildlife. Six studies segmented the perception of disturbance questions and asked respondents about, on the one hand, impacts caused by their activity, and on the other hand, impact caused by themselves as individual participants. In five cases people claimed that they had not disturbed wildlife during their visit because they were more cautious than others (Orsini and Newsome 2005, Sterl et al. 2008, Le Corre et al. 2013). Generally, respondents believed that other recreationists were more impacting than themselves. Indeed, several studies demonstrated that recreationists tended to transfer the responsibility of disturbance on other user groups such as those practicing a different activity than theirs (Taylor and Knight 2003, Curtin 2010, Johnson and Jackson 2015, Levêque et al. 2015), the same activity but differently (Finkler and Higham 2004, Moyle et al. 2013) or commercial activities (Jones et al. 2011). Five studies highlighted that respondents with a greater knowledge of wildlife and experience in their activity were less aware (or agreed in a lesser extent) that they could disturb wildlife. Consequently, they displayed a lower support to management actions than inexperienced and more naïve respondents. For instance, Levêque et al. (2015) found that the more people visited the forest, the less they thought they impacted amphibians. Similarly, Larm et al.'s study (2018) disclosed that the more people interacted with arctic foxes, the less they believed tourism was likely to endanger the species. Another finding was that awareness was not systematically associated with a change of recreationists' behaviour, as exemplified by Weiss et al.'s survey of skiers (1998). Although experience and knowledge seem to play a part in the perception of disturbance, the results were not consistent across studies.

Comparison between respondents of different statuses (local vs. tourist or local vs. manager) was always significant, however responses did not show a predictable pattern: Hillery et al. (2001) found locals to be more sensitive to the state of the environment in general, including the effects of nature-based recreational activities on wildlife, whereas Weiss et al. (1998) noticed that locals who get income from tourism were less likely than other user groups to state that skiing affected wildlife.

When it comes to sociological factors, gender did not influence the level of awareness although it was only tested in two studied (Haukeland et al. 2013, Jorgensen and Bomberger Brown 2015). Age was not significant either in the same two studies, but Le Corre et al. (2013) found that the older the population was, the less aware of bird disturbance they were. Geographic origins were found to have no effect on perception of environmental state in general or of disturbance in two studies (Prayag and Brittnacher 2014, Jorgensen and Bomberger Brown 2015). Finally, all three studies that explored the influence of education level and occupation found that people with higher education levels or from higher occupational categories were more aware of their impact on wildlife (Grossberg et al. 2003, Haukeland et al. 2013, Le Corre et al. 2013).

Contrary to what we had expected, only two papers explored environmental attitudes as explaining factors, finding that both strong ecological awareness and biocentric value orientations meant strong awareness of wildlife disturbance. In these cases, these indicators explained more of the variability of awareness scores than did sociodemographic variables (Grossberg et al. 2003, Haukeland et al. 2013).

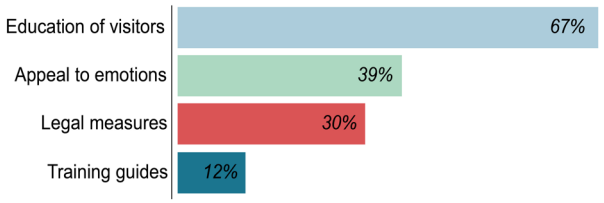

Figure 7. Management measures suggested by the authors of the 32 publications that included suggestions for managers (the total is above 100% as most publications had several explaining variables).

Management measures

An important share (69%) of the articles presented practical steps to minimise disturbance and to increase awareness, they are mostly ideas provided by the authors of the publications. Management recommendations fell into five categories (Fig. 7). First, 67% of the studies underlined the need for education of visitors: information should be present on sites with educative plates, leaflets, interpretive programs, the presence of volunteers or rangers to provide information. Van Polanen Petel and Bunce (2012) suggested that multiple sources of information should be used to promote awareness. To do so, the use of social medias, websites, apps to convey information could also be explored (Levêque et al. 2015). Authors have also suggested to increase the diffusion of scientific knowledge, particularly in the direction of recreationists who might be sceptical about the impacts of wildlife disturbance (Le Corre et al. 2013). To do so, it is important to rely on precise findings. Yet, only six publications in this review combined the perception of disturbance survey to an impact study on wildlife. While all studies found that nature-based recreational activities had an impact on wildlife, only one publication indicated visitors' perception to be in line with the findings of the impact study (Vaske et al. 1992). Two articles showed that respondents perceived that it was acceptable to approach wildlife more closely than wildlife would allow (Stalmaster and Kaiser 1998, Taylor and Knight 2003) and one underlined that tourists saw no harm in provoking monkeys' roar while empirical data proved it to be energetically expensive (Grossberg et al. 2003).

However, education should not only rely on information about ecological impact, management actions or legislation (when applicable): code of conducts must be explained to visitors if they are expected to adopt appropriate behaviours (Grossberg et al. 2003, Jones et al. 2011). Van Winkle and MacKay (2008) actually stress 'the importance of imparting specific information to visitors about how to reduce one's contribution to negative impacts rather than simply providing general information about the environment'.

Secondly, to reach visitors more efficiently, it was advised by 39% of the publications to, not only inform them, but to appeal to their emotions to change their attitudes. This shift can happen thanks to contact with wildlife or with nature that will enhance environmental awareness and conservation attitudes.

Another suggestion that is cited by 30% of the publications is the implementation of legal measures. Different types are mentioned: creation of reserves closed to recreation or a limit of the number of visitors (Stalmaster and Kaiser 1998, Le Corre et al. 2013, Johnson and Jackson 2015, Wu et al. 2015), and presence of on-site staff to prevent people from approaching animals (Tuneu Corral et al. 2017). Entrance fees or taxes are also mentioned in the literature (Jones et al. 2011). However, it is strongly recommended that alternatives are provided to ensure visitors compliance (Levêque et al. 2015). Furthermore, including stakeholders, locals and visitors in the process of planning out management actions would make them more likely to comply to it. Cooperative management in outdoor recreation is indeed highly encouraged (Gayte et al. 2003, Mounet 2007).

Finally, in the context of activities requiring guiding (e.g. tours, SCUBA diving etc.), 12% of the authors insist on the need for well-trained guides to, not only implement knowledge and good practices to participants, but also because their behaviour will be mirrored by visitors once they are on their own.

Discussion

In spite of the limited number of studies and their variety in terms of goals, study designs, study sites, in the methods they implemented to assess the awareness level and in the number of covariables they recorded, our literature review brought up several findings to light. The key result is that most studies revealed recreationists have a low level of awareness. Other important results include that research on recreationists awareness of wildlife disturbance is unevenly distributed, whether geographically, taxonomically or by types of activities. Tied with the variety of approaches, comparing publications to get a comprehensive overview of the human and ecological dimensions of awareness remains difficult even though this topic emerged in the scientific literature about 30 years ago.

Growth of disturbance perception as a research topic and geographical bias

Despite the large number of publications focusing on the impact of human activities on wildlife since the 1990s, studies investigating human awareness of wildlife disturbance remains surprisingly low, with only 47 published publications by 2018.

Most of these studies took place in North America, Europe and Oceania, and there is a clear lack of focus (when screening the literature in English) on recreationists in South America, Africa and Asia, which are popular ecotourism destinations (Christ 2003) with important biodiversity hotspots (Myers et al. 2000) and with many species of conservation concern (IUCN 2019). In 2018, Africa and Asia have recorded important growth (+7% and +6%) in tourist arrivals (UNWTO 2019), and specific studies of their awareness of wildlife sensitivity of disturbance, and of the role they play in this disturbance, and acceptance of rules are badly needed. Wildlife disturbance caused by recreation might not be an urgent concern yet for protected area managers or researchers in these world regions. Alternatively, they may perform studies at a local level that are not published in research journals but rather as grey literature.

A focus limited to certain types of wildlife and activities

Terrestrial mammals were under represented in this research. Only one study focused on insects and one on amphibians, while they are just as much subjected to stress caused by recreation (Welsh and Ollivier 1998). The fauna classified in this review as 'terrestrial mammals' only includes a few ungulates, carnivores and primates, even though they too can undergo severe consequences caused by nature-based recreational activities (Taylor and Knight 2003, Treves and Brandon 2005, Marchand et al. 2014). In addition, none of the surveys include species of urgent conservation concern. Although recreation might not be the primary reason for endangerment, it seems important to include this source of disturbance in the scope of conservation studies. Indeed, 60% of studies took place in protected areas designated to conserve those species and studies have showed that protection statuses work as touristic pull factor and attract visitors (Reinius and Fredman 2007).

Most of the literature is related to wildlife viewing activities and there is less empirical data on recreationists practicing sporting activities (i.e. hiking, running, biking, skiing). Noticeably, few surveys focused on winter activities. Sato et al.'s review (2013) of the effects of winter recreation on alpine and subalpine fauna, clearly documented detrimental effects for wildlife, more specifically on abundance (Patthey et al. 2008), behaviour (Arlettaz et al. 2015) or species diversity (Strong et al. 2002). This is particularly crucial because, contrary to tourists or wildlife viewers who might be accompanied by guides or group leaders, nature sports, whether in summer or winter, are often non-organised. It is therefore more difficult to reach these recreationists, who do not necessarily have knowledge of the natural environments they practice their activities in.

One important point is to tease apart whether visitors who are not complying with management measures are lacking information, are not sensitive to conservation issue (and why), or are not aware that they are themselves a source of disturbance. A specific emphasis could also be paid to the awareness, attitude and opinions, of participants to 'last chance tourism' (Lemelin et al. 2010), given that the desire of tourists to observe disappearing species is likely to increase the disturbance to already weakened species (Dawson et al. 2010). None of the studies included in our review however broached this specific type of tourists.

Variables explaining the level of awareness and limitation in interpreting their effects

Although the heterogeneity of the methodologies used to assess levels of awareness makes it difficult to draw conclusions, the results of the quantitative review clearly shows that a majority of the respondents were not aware of their impact. Indeed, only 34% of the publications have a majority of aware respondents. The overall conclusion when reviewing the selected publications is that there is most often a lack of knowledge and of perspective on the consequences of one's actions. Finding pathways to raise awareness needs to be addressed urgently to minimize disturbance and implement efficient and accepted management mitigation measures.

The most common factors explaining variation in the level of awareness among respondents (when specified) were the activity practiced and the knowledge of and experience with impacts. It makes sense that people who have caused or witnessed a disturbance are more aware than others. Likewise, as interaction with wildlife is more or less likely depending on recreationists' activity (not just the type of activity but also the experience level or location of practice), it was expected that awareness would depend on the activity undertaken. The type of respondent (local, recreationist, manager) influenced the level of awareness, but inconsistently across studies. One explanation for this inconsistency is that, depending on sites and of their involvement in recreationists activities, locals may be reluctant to admit disturbance when their economic activity depends on it.

Sociodemographic factors have not been included in many surveys reviewed here even though they are strong determinants of environmental attitudes. In the context of outdoor recreation, gender, age, education, occupation or geographic origins, have been demonstrated to influence knowledge of and attitude towards wildlife and wildlife conservation (Adelman et al. 2000, Papageorgiou 2001, Lukas and Ross 2005, Cornelisse and Duane 2013, Le Corre et al. 2013). Therefore, we advocate strongly for systematic sociological approaches in studies focusing on the issue of wildlife disturbance awareness. This would allow to improve the comparability of the surveys and to draw more general conclusions about the factors influencing the awareness of disturbance.

Few publications explored variables such as environmental attitudes (Dunlap et al. 2000), wildlife value orientation (Fulton et al. 1996) or place attachment (Low and Altman 1992). Yet, there is a known influence of the interest in outdoor recreation on environmental attitudes, or on wildlife value orientations (Bjerke et al. 2006, Whittaker et al. 2006, Sterl et al. 2010, Kil et al. 2014, Kaltenborn et al. 2017). Surprisingly, place attachment has not yet been considered to explain perception of wildlife disturbance even though it seems to be able to influence environmentally responsible behaviour (Vaske and Kobrin 2001). We could expect that individuals with a strong attachment to a natural area would want to protect it and its fauna.

Some patterns found here, such as the tendency of respondents to deny their own responsibility of wildlife disturbance or to transfer it to other groups of people, call for further investigations. The possible dissonance between real disturbance and respondents' perceptions of it should also be looked into. This translates in the observation that recreationists who had more experience of wildlife and of the area were less aware of their own disturbance than those with less experience. This can be explained by the facts that 1) individuals that visit natural environments often and see no or little disturbance may conclude they have no impact themselves (Levêque et al. 2015). Furthermore, visitors with high levels of experience may be less affected by new information (i.e. new postsigns), 2) management measures for protection of wildlife may be seen as an inconvenience for regular visitors so they might not want to minimize their impact (Maguire et al. 2013, Jorgensen and Bomberger Brown 2015). The dissonance between real disturbance and respondents' perceptions of it is also conveyed by that fact that some believed others were more disturbing than themselves. Several reasons can explain the transfer of

responsibility of the disturbance to others: 1) this could be a sign of underlying user-conflicts, a way to transfer responsibility to a type of user in order to legitimise their own use (Mounet 2007); 2) the concept of self-serving bias can also explain these phenomena. This cognitive process is triggered by the need to preserve self-esteem; people thus seek recognition for praiseworthy behaviour (positive impact such as economic) but deny responsibility for blameworthy behaviour (Miller and Ross 1975). Views that one's own positive or negative influence is different from that of others has been reported in other studies, such as in Moyle et al.'s survey (2013), where respondents rated their own positive impact (e.g. economical, or as a provider of conservation support) higher than they rated the impact of nature-based recreational activities in general. The relativity of the awareness of one's own role and possible denial is a realm of study in social–psychology which resembles scapegoating, defined by Rothschild et al. (2012) as allowing one to maintain 'perceived personal value by minimizing feelings of guilt over one's responsibility for a negative outcome'. This would deserve more detailed interdisciplinary investigations.

Finally, another reason why people may underrate their own impact on nature is that they balance it with the positive consequences of their outdoor activities on, for instance, local economy. Van Winkel and MacKay (2008) noted that camping sites visitors believed that economic impacts (employment) were likely to increase as a result of their visit, and thought they had no or limited impacts on the disturbance of wildlife or on vegetation. People's evaluation of how they impact nature and wildlife may therefore be relative, both to other people and to 'the global picture', be it health benefit for themselves, economic benefit for the society.

Implications for management

Research in environmental psychology has come up with numerous theoretical models to explain the gap between environmental awareness and behaviour (Kollmuss and Agyeman 2002). Ways to make humans aware of issues and to encourage pro-environmental behaviours have also been studied and are summed up in Steg and Vlek's integrative review (2009). One of their main findings is that a theory which is particularly successful in a specific context might not apply with other environmental issues. Thus, the context must be considered carefully before deciding which theory to use. With nature-based recreation, the transfer of a few concepts coming from environmental psychology to nature managers and conservationists could help raise awareness effectively and change behaviours:

- 'Social norms' are defined by Heywood (2011) as 'informal rules shared by groups or societies that guide behavior and have positive and/or negative consequences that help to make the behavior more or less self-correcting'. Applied to wildlife conservation, this suggests that recreationists would tend not to adopt behaviours that are considered by their peers as causes of disturbance (Stensland et al. 2013, 2018). This means that identifying role models or leaders in an activity, who would behave with care and let it know to their peers, could have a cascading effect for other recreationists performing the same activity.
- 'Contextual factors' facilitate or constrain behaviour (Stern et al. 1999) i.e. availability of recycling facilities, public transportation, organic goods etc. In nature for example, it is necessary to provide recreationists with alternative routes if they are expected to avoid a sensitive area, and render access to the latter more difficult.
- 'Habitual behaviour' is developed through the cognitive structure of learning, storing and retrieving information from the memory in situations that appeal to it (Steg and Vlek 2009). Managing to implement new habits for recreationists (based on the type of environment, of wildlife and of activity), is a real challenge for managers. When achieved, it should produce efficient long-term results for conservation as recreationist would repeat their previous careful behaviour without having to acquire it every time. Targeting beginners and young recreationists may be a way to implement 'virtuous' behaviour towards wildlife.

In publications reviewed here, practical measures were varied and abundant, which shows that human dimension studies are a field that favours applied research and provides information to managers. Although the most common recommendation is education of visitors, this was only the second most tested factor to influence awareness. In addition, even though appealing to emotions to change attitudes is the second most common recommendation, attitudes were only tested in two publications. This gap highlights the need for experimental research in order to test the effectiveness of the recommended measures.

We suggest that techniques of differentiated instruction (as encouraged in school pedagogy – Rock et al. 2008) should be explored. They would help reach and educate different types of recreationists with different attitudes, value, social backgrounds and receptiveness to management measures based on their profiles. To that extent, it is very important to continue to improve our understanding of visitors. Knowing their motivations and acceptance of rules (Gundersen et al. 2015, Immoos and Hunziker 2015) will allow to target them with awareness-raising messages that match their beliefs. On a more practical note, knowledge of the spots of practice, means of transportation, websites visited to prepare outing, favourite shops and brands, ambassadors in the activities, should also be useful to adapt the channel of communication. A more comprehensive approach of recreationists, involving collecting information on their mobility and socio-economic habits, is therefore badly needed in addition of studies of recreationists behaviour once in nature. Conservation marketing techniques (Jacobson et al. 2006, Wright et al. 2015) are starting to be used, or at least recommended by researchers, in biodiversity conservation and human–wildlife coexistence (Veríssimo 2019, Veríssimo et al. 2019). In the sociological approaches that we encourage, protected areas managers have an important educational role to play. Indeed, they participate in a form of secondary socialisation that can contribute to the construction of visitors' dispositions towards nature, in the same way as primary socialisation with parents or at school would.

Recommendations for future studies and conclusion

This review of the literature of the human dimension of wildlife disturbance allowed us to point out which type of

Table 1. Summary of recommendations for future research on the perception of impacts caused by recreation to wildlife.

Recommendation for future research
Widen geographical focus to emerging eco-tourism destinations i.e.:
– Asia
– Africa
Widen the focus to less studied species i.e.:
– Terrestrial mammals
– Insects
– Amphibians
Widen the focus to less studied activities i.e.:
– Mountain and winter sports
– Consumptive activities
– Motorized activities
Include and explore more explaining variables to the perception of disturbance i.e.:
– Environmental attitudes
– Place attachment
– Sociological aspects
Management
– Include testing of management measures
– Generalise specific management recommendations to wildlife and activities studied
Interdisciplinarity
– Generalise a coupled approach with ecology to measure actual impact

environment, wildlife and activities have been studied so far, highlighting limits of extant studies and gaps in knowledge, which allows us to make recommendations for future research (Table 1).

Contrary to what we had hoped it was not possible to draw general patterns on which factors were most significant in explaining awareness of people of the disturbance of wildlife. Indeed, the study designs, type of questions, number of explanatory variables and precision in reporting results, all varied greatly among publications. It was therefore difficult to perform statistical analysis on whether factors were consistently important for explaining the different awareness levels among studies. Nonetheless, most surveys found a higher proportion of respondents who were not aware of their impact than of those who were. In addition, it appeared that respondents tended to diminish and/or justify their own impact. This suggests that efforts still need to be made by managers to improve communication and to minimise the effects of disturbance on wildlife.

While there is an abundance of publications on the impact of disturbance, and a few on the perception of the impact, only six publications collated data on these two aspects. Delving into the issue of disturbance, both from the human and animal dimensions, highlights the strong need to bring together social sciences and ecology to mitigate the sources and impacts of disturbance efficiently.

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Appendix 1. Details of the 48 studies examining human perception of impacts caused to wildlife by nature-based recreational activities.

Authors (year)	Publication title	Location	Journal
Apps et al. (2016)	In the water with white sharks (*Carcharodon carcharias*): participants' beliefs toward cage-diving in Australia	Australia	Anthrozoös
Bouton and Frederick (2003)	Stakeholders' perceptions of a wading bird colony as a community resource in the Brazilian Pantanal	USA	Conservation Biology
Chin et al. (2000)	Ecotourism in Bako National Park, Borneo: visitors' perspectives on environmental impacts and their management	Australia	Journal of Sustainable Tourism
Christensen et al. (2007)	Value orientations, awareness of consequences and participation in a whale watching education program in Oregon	USA	Human Dimensions of Wildlife
Cornelisse and Duane (2013)	Effects of knowledge of an endangered species on recreationists' attitudes and stated behaviors and the significance of management compliance for ohlone tiger beetle conservation: recreation knowledge, attitude and behavior	USA	Conservation Biology
Curtin (2010)	Managing the wildlife tourism experience: the importance of tour leaders	United Kingdom	International Journal of Tourism Research
Dearden et al. (2007)	Perceptions of diving impacts and implications for reef conservation	Canada	Coastal Management
Dolsen et al. (1996)	Beliefs about wildlife-related recreation in Montana	USA	Human Dimensions of Wildlife
Dutta (2015)	Sustainability and tourist-crowding trade-off at wildlife based tourist spots in Dooars Region of North Bengal: a study on ecotourism carrying capacity of chapramari wildlife sanctuary in Dooars, Jalpaiguri (W.B.)	India	International Journal of Application or Innovation in Engineering and Management
Finkler and Higham (2004)	The human dimensions of whale watching: an analysis based on viewing platforms	New Zealand	Human Dimensions of Wildlife
Garcià-Cegarra and Pachego (2017)	Whale-watching trips in Peru lead to increases in tourist knowledge, pro-conservation intentions and tourist concern for the impacts of whale-watching on humpback whales	Chile	Aquatic Conservation: Marine and Freshwater Ecosystems
Giglio et al. (2015)	Marine life preferences and perceptions among recreational divers in Brazilian coral reefs	Brazil	Tourism Management
Grossberg et al. (2003)	The incidental ecotourist: measuring visitor impacts on endangered howler monkeys at a Belizean archaeological site	USA	Environmental Conservation
Haukeland et al. (2013)	Visitors' acceptance of negative ecological impacts in national parks: comparing the explanatory power of psychographic scales in a Norwegian mountain setting	Norway	Journal of Sustainable Tourism
Hillery et al. (2001)	Tourist perception of environmental impact	Australia	Annals of Tourism Research
Johnson and Jackson (2015)	Fisher and diver perceptions of coral reef degradation and implications for sustainable management	USA	Global Ecology and Conservation
Jones et al. (2011)	Visitors' perceptions on the management of an important nesting site for loggerhead sea turtle (*Caretta caretta*): the case of Rethymno coastal area in Greece	Greece	Ocean and Coastal Management
Jorgensen and Bomberger Brown (2015)	Evaluating recreationists' awareness and attitudes toward piping plovers (*Charadrius melodus*) at Lake McConaughy, Nebraska, USA	USA	Human Dimensions of Wildlife
Kassilly (2003)	Visitor behaviors and wildlife impacts in Kenya: perceptions of wardens	Kenya	Human Dimensions of Wildlife
Kazmierow et al. (2000)	Ecological and human dimensions of tourism-related wildlife disturbance: White herons at Waitangiroto, New Zealand	New-Zealand	Human Dimensions of Wildlife
Kelly et al. (2004)	Management of marine wildlife disturbance	UK	Ocean and Coastal Management
Larm et al. (2018)	The role of wildlife tourism in conservation of endangered species: implications of safari tourism for conservation of the Arctic fox in Sweden	Sweden	Human Dimensions of Wildlife
Le Corre et al. (2009)	Bird disturbance on conservation sites in Brittany (France): the standpoint of geographers	France	Journal of Coastal Conservation
Le Corre et al. (2013)	Wintering waterbirds and recreationists in natural areas: a sociological approach to the awareness of bird disturbance	France	Environmental Management
Lemelin and Wiersma (2007)	Perceptions of polar bear tourists: a qualitative analysis	Canada	Human Dimensions of Wildlife

Levêque et al. (2015)	Forest visitor perceptions of recreational impacts on amphibian wildlife	UK	European Journal of Wildlife Research
Lucrezi et al. (2013)	Managing diving impacts on reef ecosystems: analysis of putative influences of motivations, marine life preferences and experience on divers' environmental perceptions	South-Africa	Ocean and Coastal Management
Maguire et al. (2013)	Stakeholder perceptions of threatened species and their management on urban beaches	Australia	Animals
Moyle et al. (2013)	Visitors' perceptions of tourism impacts: Bruny and Magnetic Islands, Australia	Australia	Journal of Travel Research
Nyaupane and Thapa (2006)	Perceptions of environmental impacts of tourism: a case study at ACAP, Nepal	USA	International Journal of Sustainable Development and World Ecology
Orsini and Newsome (2005)	Human perceptions of Hauled Out Australian Sea Lions (*Neophoca Cinerea*) and implications for management: a case study from Carnac Island, Western Australia	Australia	Tourism in Marine Environments
Phumsathan (2013)	Environmental value orientation and environmental impact perception of visitors to Khao Yai National Park	Thailand	Kasetsart Journal, Social Sciences
Pickering et al. (2003)	Environmental impacts of tourism on the Australian Alps protected areas: judgments of protected area managers	Australia	Mountain Research and Development
Prayag and Brittnacher (2014)	Environmental impacts of tourism on a French urban coastal destination: perceptions of German and British visitors	New-Zealand	Tourism Analysis
Puczkó and Rátz (2000)	Tourist and resident perceptions of the physical impacts of tourism at Lake Balaton, Hungary: issues for sustainable tourism management	Hungary	Journal of Sustainable Tourism
Skłodowski et al. (2013)	The preferences of visitors to selected forest areas for tourism and recreational purposes	Poland	Forest Research Papers
Stalmaster and Kaiser (1998)	Effects of recreational activity on wintering bald eagles	USA	Wildlife Monographs
Sterl et al. (2008)	Visitors' awareness and assessment of recreational disturbance of wildlife in the Donau-Auen National Park	Austria	Journal for Nature Conservation
Taylor and Knight (2003)	Wildlife responses to recreation and associated visitor perceptions	USA	Ecological Applications
Thapa et al. (2005)	Moderator and mediator effects of scuba diving specialization on marine-based environmental knowledge–behavior contingency	USA	The Journal of Environmental Education
Tuneu Corral et al. (2017)	Watching wildlife in Cabo Polonio, Uruguay: tourist control or auto-control?	Spain	Journal of Ecotourism
van Polanen Petel and Bunce (2012)	Understanding beach users' behavior, awareness and attitudes to shorebird conservation in Central Queensland: tools for effective shorebird conservation	Australia	Coastal Management
Van Winkle and MacKay (2008)	Self-serving bias in visitors' perceptions of the impacts of tourism	Canada	Journal of Leisure Research
Vaske et al. (1992)	Barrier beach impact management planning: findings from three locations in Massachusetts	USA	Canadian Water Resources Journal
Weiss et al. (1998)	Ski tourism and environmental problems: ecological awareness among different groups	Austria	International Review for the Sociology of Sport
Weston et al. (2015)	Do birdwatchers care about bird disturbance?	Australia	Anthrozoös
Wu et al. (2015)	Environmental and management issues associated with backpacker tourism in mountainous protected areas, China	China	eco.mont