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Source: Mountain Research and Development, 38(4) : 380-389

Published By: International Mountain Society

URL: https://doi.org/10.1659/MRD-JOURNAL-D-17-00039.1

Mountain Research and Development (MRD)
An international, peer-reviewed open access journal
published by the International Mountain Society (IMS)
www.mrd-journal.org

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Using a Social Science Approach to Study Interactions Between Ski Tourers and Wildlife in Mountain Protected Areas

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Development of winter outdoor leisure activities in areas of high natural value is a key issue in the sustainable use of mountain environments. Ski touring, an emerging outdoor activity in the Tatra Mountains, is believed to affect protected mammal species such as the Tatra chamois (Rupicapra rupicapra tatrica)*, alpine marmot* (Marmota marmota latirostris)*, red deer* (Cervus elaphus)*, European roe deer* (Capreolus capreolus)*, brown bear* (Ursus arctos)*, and red fox* (Vulpes vulpes)*. To assess the impact of ski touring on these species, various studies are underway in Tatra National Park. The aim of this study was to investigate the interactions between ski tourers and large mammals in the park using a social science approach. A total of 274 skiers completed an online questionnaire about their encounters with large mammals during their ski tours in Tatra National Park and their perceptions of animals' reactions to their presence. Just over half of the respondents reported encounters with large mammals—most often with chamois, followed by deer (red or roe), foxes, and marmots. Only 6% reported encounters with brown bears. The most commonly reported animal reactions were vigilance and indifference (no reaction). Flight or aggression occurred less often—in about 22% of encounters with all species and 12% of encounters with chamois. An online survey on human–wildlife interactions can provide a cost- and labor-efficient complement to field research such as direct observation, GPS tracking, and physiological testing.*

Keywords: *Human–animal interaction; skiing; ski touring; tourism; large mammals; wildlife; Tatra National Park; social science; online survey.*

Peer-reviewed: *March 2018* ***Accepted:*** *September 2018*

Introduction

Many mountain ecosystems are rich in endemic species. Therefore, protected areas are often established in these vulnerable environments (Dudley 2013; Worboys el al 2015). At the same time, mountain destinations provide distinctive opportunities for outdoor recreation and serve as tourist attractions (Richins and Hull 2016). Large numbers of visitors pose serious issues for the management of popular mountain protected areas. Threats to the environment in these areas occur in both summer (Skawiński and Krzan 1996; Cole 2004; Skawiński 2010; Fredman et al 2012; Manning and Anderson 2012) and winter (Olliff et al 1999; Bushell et al 2007; Caprio et al 2011; Roux-Fouillet et al 2011; Bielański 2013; Rixen and Rolando 2013; Sato et al 2013). Because of their spatial and temporal dynamics, the effects of recreational activities on wildlife are often difficult to measure, and it is challenging to delimit problem areas exactly (Braunisch et al 2011). As a result, those threats may be overlooked by nature conservation services (Varley 1999), or the actions undertaken may be reactive rather than proactive and lag behind the emerging problems (Behrens et al 2009; Leung 2012). This problem is often associated with a lack of current data due to the high cost of monitoring projects, which are often reduced because of budget constraints (Bushell et al 2007; Pawlaczyk 2011; Polish Ministry of Environment 2013).

In national parks, data on wildlife disturbances caused by visitor behavior are critical to the management of wildlife protection (Varley 1999; Suchant and Braunisch 2004; Stankowich 2008). Recognition of the risk of

 http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00039.1

disturbance is particularly important, as the energy expenditure caused by heavy stress can irreversibly disturb an animal's energy budget (Legg 1999; Carlson 2011). Animals' flight-or-fight responses can reduce population numbers or even cause a species to retreat completely from areas penetrated by winter visitors (Arlettaz et al 2007, 2013; Stankowich 2008; Gils et al 2011). Targeted communicative and on-site measures (tourist information and infrastructure) are necessary to minimize the negative impact of winter activities on wildlife (Immoos and Hunziker 2015; Hubschmid and Hunziker 2018).

Ski touring (also called backcountry skiing or ski mountaineering) uses ski equipment that allows both ascending and descending off-piste terrain covered with snow. Once the top of a slope is reached skiers reset their equipment (bindings and boots, skins taken off the skis) for the descent. Touring on skis is much faster than hiking or snowshoeing because skis do not sink into deep snow and the descent is very rapid. The popularity of this activity is rapidly increasing as it allows exploring mountain environments that often remain almost impossible to reach on foot. Ski touring does not require extensive infrastructure; preparation of slopes is usually limited to marking the preferred route by laying down the first ski track (Arlettaz et al 2013; Bielański et al 2013). It occurs in all elevation zones (eg in the Tatra Mountains from the mixed-forest zone up to the subnival zone), which are inhabited by highly endangered mammalian and avian species.

The management of ski touring, like that of other outdoor recreational activities, has suffered from poor and delayed recognition of the threats it poses to protected natural areas (Olliff et al 1999; Bielański 2013). Studies of the effect of this activity on alpine fauna have primarily focused on the behavior of the people pursuing it (Rupf et al 2011; Bielański 2013; Bielański et al 2018) and the reactions of animals to this behavior (Sterl et al 2008; Arlettaz et al 2013). Most studies of short-term stress in animals associated with the presence of humans have been based on observations.

Direct observations focus either on the behavior of tourists and the corresponding reactions of animals (Varley 1999; Stankowich 2008) or on the reactions of animals to a researcher performing a recreational activity (Ingold 2005; Sterl et al 2008). Liddle (1997) presented a 3-step categorization of human behavior that disturbs animals and animal responses to it. In simplified form, these are as follows:

1. interruption of tranquility—little or no reaction;
2. interference with rights or property—vigilance;
3. molestation—flight or aggression.

Observations may also include measurements of physiological parameters in animals (eg of pulse—MacArthur et al 1982; Carlson 2011), biochemical measurements (eg of cortisol level—Arlettaz et al 2007; Zwijacz-Kozica et al 2012), and other similar methods (Carlson 2011). It is assumed that the intensity of a physiological or biochemical reaction is positively correlated with the level of stress in a given individual (MacArthur et al 1982; Arlettaz et al 2007; Carlson 2011).

Since the early 1990s, there has been a gradual increase in the use of social science methods to address ecological issues (White et al 2005). In addition to positivist approaches, with the emphasis on obtaining precise quantitative data, where the researcher remains objective and detached (Neuman 1997), alternative research paradigms—such as interpretative and participatory approaches (Pretty et al 1995; Treves et al 2006), in-depth interviews (Rubin and Rubin 1995), and focus groups (Bloor et al 2000)—are being applied. Recently a citizen science approach, in which nonprofessionals record biological data, has been increasingly applied in ecological research (Bonney et al 2009, 2014; Silvertown 2009; Dickinson et al 2010, 2012; Science Communication Unit, University of the West of England, Bristol 2013; Sullivan et al 2014). However, to our current knowledge, so far no social science studies have focused on the interaction between winter recreationists and wildlife in mountain areas.

The objective of this study was to ask tourists to self-report their encounters with large mammals during their ski tours in Tatra National Park, using an unrestricted online survey, and to explore the usefulness of this method to research in recreation ecology and nature conservation management.

Study area

The Tatra Mountains are the highest massif in the great Carpathian arc and the highest alpine-type mountains between the European Alps and the Caucasus (Mirek 1996). They are located in central Europe, in the border region of Poland and Slovakia. Their elevation ranges from 900 to 2655 m above sea level (Mirek 1996), and the total area is 785 km^2. This study focused on the Polish part of Tatra National Park, which includes approximately 20% of the entire area of the Tatra Mountains and some neighboring lands (in total 212 km^2).

This park became a designated protected area in 1954 and belongs to the International Union for Conservation of Nature's protected-area management category II. The climate in the Tatra Mountains is differentiated into vertical zones (Hess 1996). The number of days with precipitation and the duration of snow cover rise with elevation. The latter increases from 100 days at the base of the massif to 290 days in the alpine zone, where the thickness of the snow cover often exceeds 2 m. Slopes often exceed 30°, which results in the occurrence of snow avalanches.

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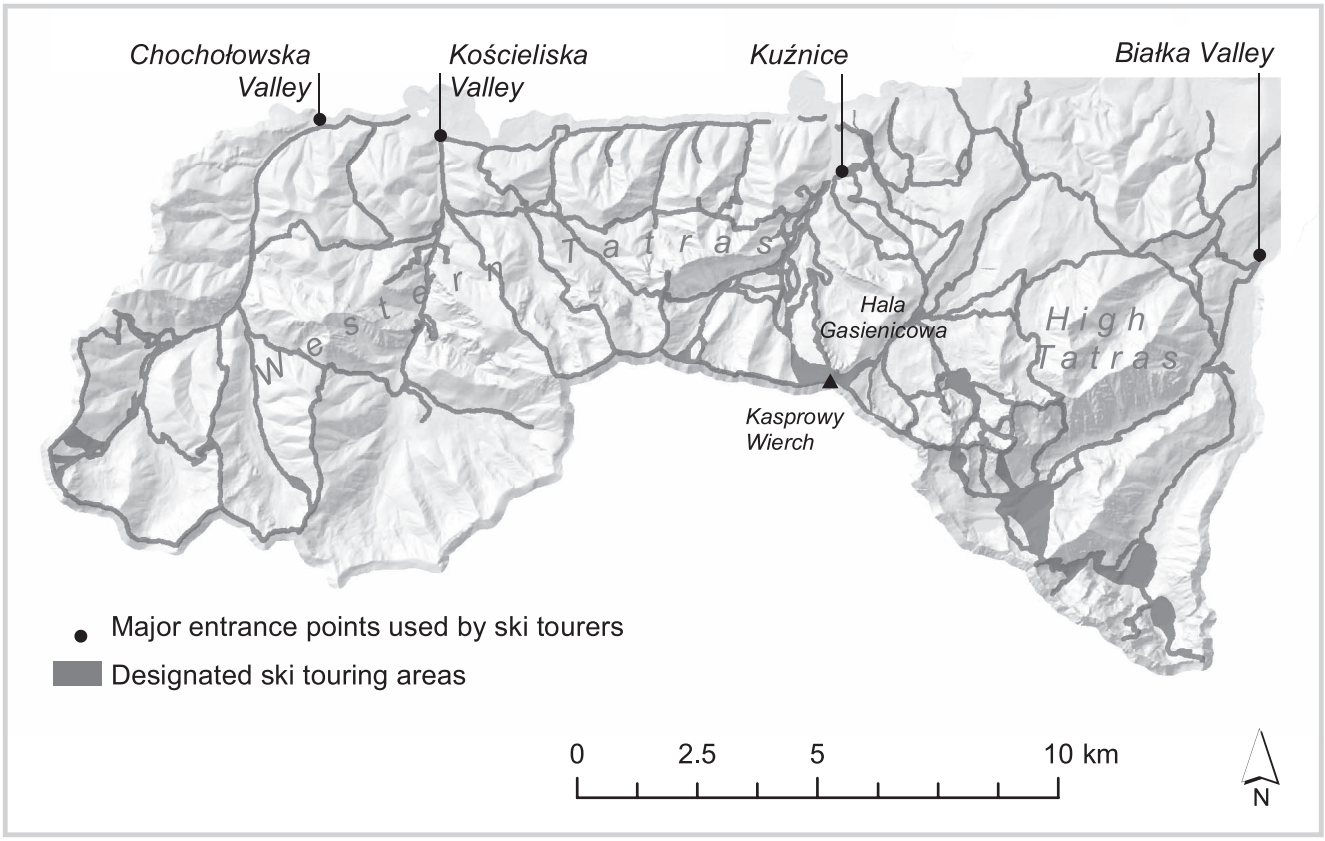
FIGURE 1 Designated ski touring areas in Tatra National Park in Poland. (Map by the authors)



The area's advantageous climate and its well-developed alpine and subalpine zones (unique in the Polish landscape) have attracted growing interest from winter visitors. Ski touring has recently emerged as a popular outdoor activity in the Tatra Mountains. It is less widespread in the Tatras than in other mountain areas, such as the European Alps (Arlettaz et al 2007); but in the last decade it has rapidly increased in Tatra National Park, where it was first systematically monitored in 2011 (Bielański 2013). The number of ski tourers was estimated at 1500 in 2011, with some 6000 visits to the park (Bielański 2013), still a relatively small proportion of park visitors. But the number has grown rapidly since then, and in 2013 reached 10,000 visits by an estimated 3500 people (Bielański 2013).

Ski touring in the park is restricted to designated areas (Director of Tatra National Park 2013), which constitute 13% of the park's area (Figure 1); the total length of ski trails is about 200 km (Bielański 2013). Going outside the designated areas is illegal and punishable by a fine of up to 500 Polish zlotys (about € 125/US$ 142). These regulations were introduced to protect the natural environment, specifically some species of large mammals that are active during the ski touring season (Figure 2; Table 1).

Methods

Data collection

The focus of the study was ski tourers visiting Tatra National Park. To reach them quickly and affordably in a culturally sensitive way, an unrestricted online survey was conducted from 1 February to 31 April 2011, designed to explore respondents' level of impact on the natural environment of the park. The study was fully anonymous; personal data were not registered. Internet protocol (IP) addresses were not stored, but only 1 response per IP address was allowed. A link to the questionnaire was placed on websites associated with ski touring and other mountain-related interests: www.wspinanie.pl (the largest Polish portal for people interested in mountains), www.skitury.fora.pl (the only dedicated ski touring portal, which hosts a forum for ski tourers); and www.polarsport.pl (the leading retailer of mountaineering and ski touring equipment). The link to the survey was also sent out via the mailing lists of the Tatra Mountain Guides' Association of Kraków and the Alpine Club in Zakopane. Respondents then voluntarily followed the link to activate the survey. In total, 274 ski tourers participated in the survey; 14 incomplete questionnaires were excluded from analysis.

FIGURE 2 Prevalence of large mammals in Tatra National Park by vegetation zone (elevation). (Illustration by the authors, with elements from *The skier clipart* [https://openclipart.org/detail/76999/ski-silhoette] published under Creative Commons Zero 1.0 License at https://openclipart.org/share)

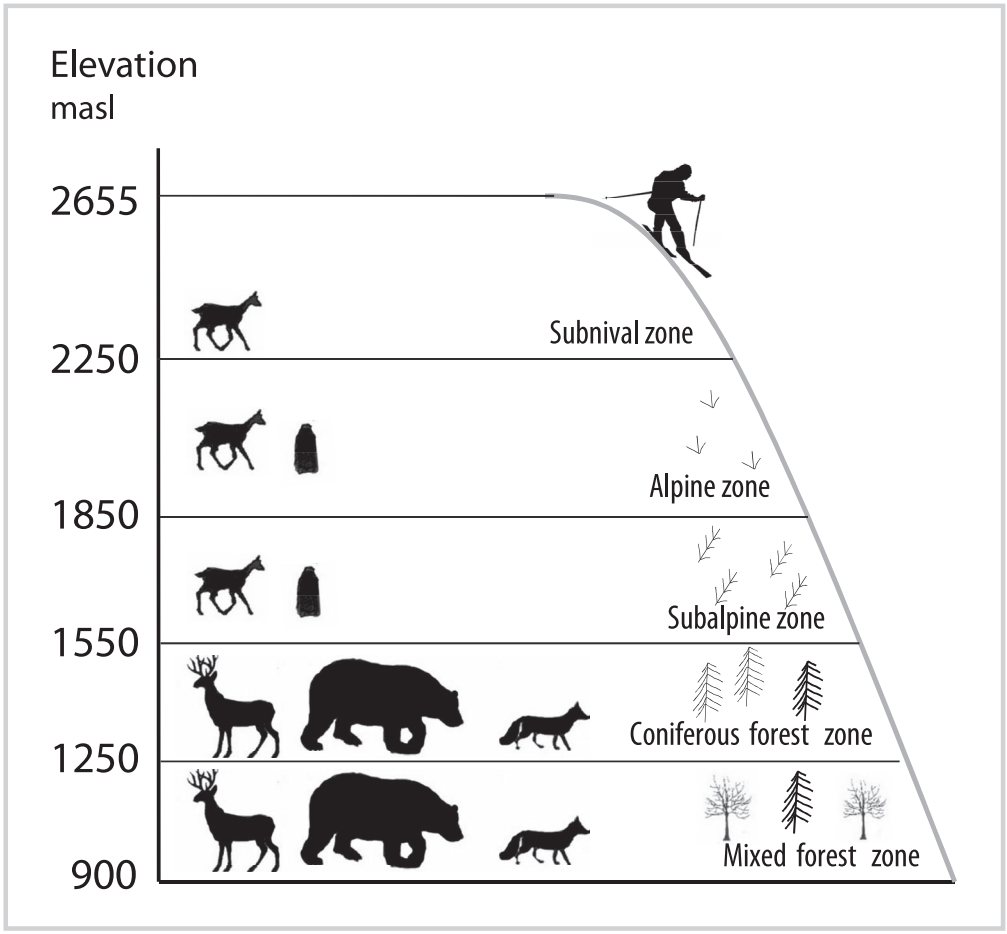


TABLE 1 Large mammals in Tatra National Park and their locations and times of greatest activity and greatest vulnerability.

Species	Estimated population	Vegetation zones (elevation)	Active period	Vulnerable period
Chamois (*Rupicapra rupicapra tatrica*)	350	Above forest zones: subalpine, alpine, and subnival zones (lower in winter)	All year	Winter and spring (pregnancy) May (parturition)
Alpine marmot (*Marmota marmota latirostris*)	150–200	Above forest zones: subalpine and alpine zones	April to October (hibernate through the winter)	April to July (awakening, mating, parturition)
Brown bear (*Ursus arctos*)	8–10	Forest zones (mixed-forest zone and coniferous-forest zone) Sometimes higher in summer	March to November (hibernate in winter but sometimes wake up)	From first spring warming (new offspring ~ end of March)
Red deer (*Cervus elaphus*)	200–230	Coniferous-forest zone and above	All year	All year
Roe deer (*Capreolus capreolus*)	100	Coniferous-forest zone and above	All year	All year
Red fox (*Vulpes vulpes*)	100	Mixed-forest zone and coniferous-forest zone	All year	All year

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FIGURE 3 Average duration of respondents' ski tours ($n = 260$).

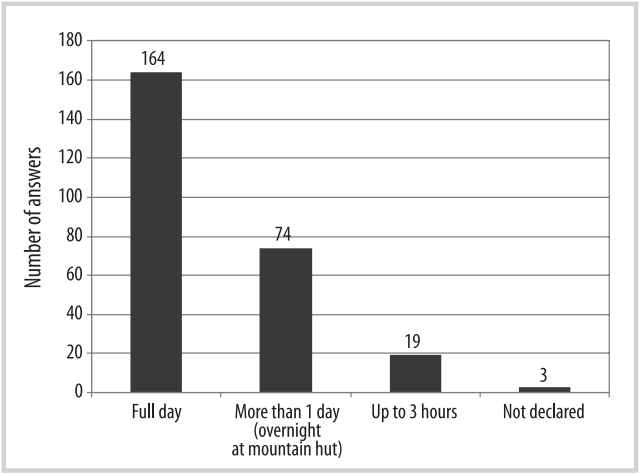
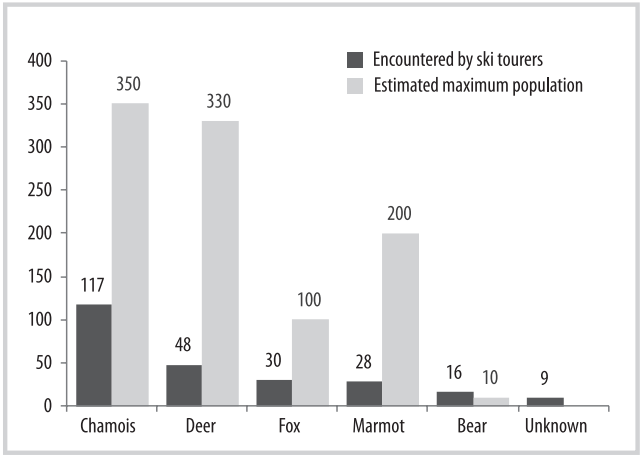


FIGURE 4 Animals encountered by respondents ($n = 260$). Multiple species could be reported; the total number of answers was 248.



To test the questionnaire and identify potential gaps, a pilot study ($n = 80$) was conducted on site in Tatra National Park in 2009 (Bielański 2010) during the Malinowski Memorial Competition, the biggest ski touring event of the year for both professional and amateur competitors. It attracts participants from all Polish and some international ski touring societies; in 2011, it hosted the International Ski Mountaineering Federation's World Cup Final. This event closes the season and celebrates the sport of ski touring.

The online survey asked participants to rate their ski touring skill level, describe their motives for pursuing the sport, and say how often they undertook ski touring in the area and how long their average trip was. They were asked about behavior that could have an impact on the park, including encountering wildlife and leaving marked paths, and about their observations of the selected animal species and the animals' reactions to their presence.

Animals' reactions were classified based on the categories proposed by Liddle (1997) and described above (little or no reaction, vigilance, and flight or aggression). The online survey concentrated on the following species:

- Tatra chamois (*Rupicapra rupicapra tatrica*);
- alpine marmot (*Marmota marmota latirostris*);
- red deer (*Cervus elaphus*);
- roe deer (*Capreolus capreolus*);
- brown bear (*Ursus arctos*);
- red fox (*Vulpes vulpes*);
- other.

These species were all mentioned by participants in the pilot study. They were chosen because they are active during the ski-touring season; are easy to recognize, even from long distances by nonprofessionals (except the roe and red deer, which were treated as a single category in this study); and react in a way that is easy to interpret.

Data analysis

Since most of the data obtained from questionnaires were of a categorical or ordinal type, the statistical analysis was based chiefly on the estimation of frequencies of the answers obtained. To test relationships between variables, we used the Pearson test (χ^2), or the likelihood ratio (G^2) if there were 0 values among the results. Results were considered statistically significant when $P < 0.05$, close to significance when $0.05 < P < 0.1$, and nonsignificant when $P \geq 0.1$.

Results

General characteristics of ski tourers' activity

One-day ski tours were the most popular visit type, reported by more than 60% of respondents (Figure 3). The most popular destinations among respondents were the Hala Gasienicowa and Kasprowy Wierch peak.

Interactions with animals

Slightly over half (52.7%) of respondents reported encounters with large mammals. The most frequently seen species was the chamois (Figure 4), followed by red deer and roe deer, which were counted together because of the difficulty nonprofessionals might have distinguishing between them. The next in the order of frequency of encounters were red foxes, followed by marmots. Sixteen people reported encounters with bears while on trips. Nine respondents reported observing mammals they did not recognize or could not confidently identify.

Most animals responded to human presence either with no reaction (37%) or vigilance (40%) (Table 2). Reactions differed significantly among the species ($\chi^2 = 35.415$, $P = 0.0004$). Brown bears did not react to skiers' presence significantly more often than other species. Chamois and marmots displayed vigilance significantly more often than foxes and bears, whereas the frequency of this reaction in deer was intermediate (they did not differ

TABLE 2 Reactions of different species to the presence of ski tourers. Respondents ($n = 260$) could report multiple reactions; the total number of answers was 292.

Animal	Little or no reaction	Vigilance	Flight	Aggression	Total
Chamois	38.73% (55)	49.30% (70)	11.27% (16)	0.70% (1)	100% (142)
Brown bear	57.89% (11)	21.05% (4)	15.79% (3)	5.26% (1)	100% (19)
Alpine marmot	25.64% (10)	48.72% (19)	23.08% (9)	2.56% (1)	100% (39)
Deer (red and roe)	33.93% (19)	30.36% (17)	33.93% (19)	1.79% (1)	100% (56)
Red fox	36.11% (13)	19.44% (7)	41.67% (15)	2.78% (1)	100% (36)
All 6 species	37% (108)	40% (117)	21% (62)	2% (5)	100% (292)

significantly from chamois and marmots or from foxes and bears). Flight was the most frequent reaction of foxes, but generally, no statistically significant differences between species were found for this reaction.

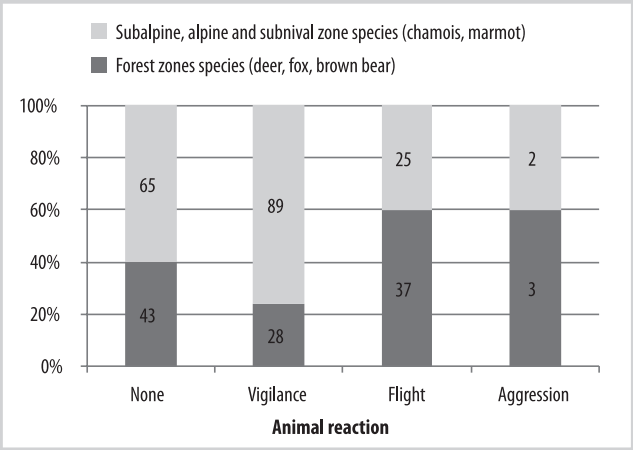
Species typical of upper elevation zones (chamois and alpine marmot) reacted differently than species of the forest zones (deer, fox, brown bear) ($\chi^2 = 23.370$, $P < 0.0001$). The subalpine-, alpine-, and subnival-zone animals showed vigilance more often but fled significantly less often than the species living in the forest zones (Figure 5).

Discussion

Social science in ecological research

Biological recording by nonprofessionals is a topical issue in ecological research (Silvertown 2009; Dickinson et al 2010, 2012; Bonney et al 2014). We agree that reporting based solely on respondents' recall of wildlife encounters cannot fully or precisely document the impact of park visitors on animals. However, visitor surveys can complement the field observations used in traditional ecological research (White et al 2005).

FIGURE 5 Animal reactions to human contact as reported by respondents ($n = 260$), grouped by elevation zone. Multiple reactions could be reported; the total number of answers was 292.



Thus, the combination of observation and self-report surveys provides more complete data on visitor behavior. We believe that this makes it different from observation methods that record single incidents: our method examines the whole experience of the surveyed tourist population (eg not only single encounters observed in a traditional way, but visitors' recalling of encounters across several visits to the park). This, in our opinion, is the most valuable feature of online surveying. Additional examples of applying a combined methodology to investigate human–wildlife relations may be found in the work of Cessford and Muhar (2003) as well as Bielański (2013).

In this study, the biological observations (reported encounters with wildlife) were done by tourists, most of whom were probably not experienced at observing wildlife behavior. However, the large mammals that were the focus of this study are relatively easy to distinguish—more so than, for example, many birds and reptiles. The only species in our study for which this was not true were the 2 deer species, which can indeed be difficult to distinguish; these were analyzed as one category in order to avoid potential interpretation errors.

In addition to species identification, respondents were asked to describe animal reactions to their presence. These assessments may be subjected to greater criticism over their reliability, especially in the first 2 categories: lack of noticeable reaction and vigilance. (Animal reactions in the third category—flight or aggression—are easier to recognize.) However, one recent study (Matyja 2015) found that ski tourers had a significantly higher level of ecological awareness and environmental knowledge than other visitors to Tatra National Park.

One issue considered during survey design was the survey's focus on respondents who were believed to have a negative impact on the investigated species. To exclude potential conflict between the national park authorities and ski tourers and to reduce survey bias related to a sensitive topic, the survey was promoted through information channels associated not with nature protection agencies (which have a negative reputation among ski tourers), but rather with outdoor (and specifically mountain) recreation. Additionally, the anonymous character of the survey was emphasized in the

project description. This very likely enhanced the accuracy of responses, particularly with regard to respondents' behavior in the protected area and the animals' reactions to it. The questionnaire offered respondents an interesting form of self-assessment of their behavior and their potential impact on wildlife.

White et al (2005) emphasized the need to follow strict sampling procedures in surveys used in ecological studies. We believe that our survey respondents constituted a representative sample (confidence level = 95%, confidence interval = 6) (Bartlett et al 2001). The sample size was 260 people, more than 17% of all ski tourers visiting Tatra National Park, estimated at 1500 in 2011, the year the survey was conducted (Bielański 2013). The responses of this representative sample made it possible to estimate the frequency of visitor–wildlife encounters for all ski tourers in the park. That is practically impossible with any other small-scale research method (such as direct observation or GPS tracking, mostly used to study a limited area or a small group of visitors). Additionally, to ensure the effectiveness of the questionnaire, a pretest of the survey took place on site in the park ($n = 80$; Bielański 2010).

A comparison of the responses to the on-site (2009) and online (2011) surveys (*Supplemental material*, Table S1: http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00039.S1) revealed statistically significant differences in 4 cases:

1. *Residence*. In the on-site survey there was a higher percentage of people from small towns.
2. *Frequency of visits*. A higher percentage of visits was observed for the on-site group, probably due to a larger number of local people in that group.
3. *Animal reactions*. In the online survey there was a significantly higher percentage of reports of animal behavior indicating vigilance. This difference, too, might be a result of the higher percentage of local people in the on-site survey. Living in closer proximity to the park, they may be more familiar with the observed species and might not consider the vigilance behavior worth noticing.
4. *Littering*. In the on-site group, a higher percentage of respondents admitted littering, but with low frequency. This might be due to the higher share of residents of larger cities in the online group, who, due to their higher level of education, also have a higher level of ecological awareness (Adamski et al 2016).

Thus, we assume the online survey provided reliable results.

Visitor perception of human–animal interactions

Reporting encounters: This method enabled us to confirm that interactions between ski tourers and animals occur in Tatra National Park. Over 50% of the respondents said they had encountered some species of alpine fauna during ski tours in the study area. When creating the questionnaire, we discussed this issue among ourselves and consulted with the park management. As a result of these discussions, we did not question respondents about their distance from the animal during the encounter. We believe that our respondents, during their ski tour, had a different focus and thus would be unlikely to precisely assess the distance of the animal, especially after some time. Also, asking nonprofessionals to assess the observation distance could create, in our opinion, high inaccuracy in results. The questionnaire asked simply: "Did you meet animals during your ski tour?" We believe this wording can reveal the general trend of human–wildlife interactions. We think that introducing questions to estimate the distance between the visitor and the encountered animal would be an interesting approach in future research, but it could be difficult to collect precise and reliable information. Perhaps other methods (eg observations or GPS-based data) would provide more accurate data on this matter.

The most frequently named species were several large mammal species present in the alpine and subalpine zones (rocky peaks, mountain pastures, and dwarf-pine zone) of the Tatra Mountains. The number of encounters with each species (Figure 4) generally corresponded with the size of its population (Table 1). Apart from chamois and alpine marmots, which are typical of the alpine zone, the respondents also listed 2 species of deer and 2 predator species (brown bear and red fox). None of the respondents observed wolves or lynx, species that permanently range over the Tatra Mountains (Kovac 2003). Perhaps they were among the mammals that respondents could not identify (1 respondent indicated that an "unknown" species might have been a lynx). On the other hand, respondents relatively frequently reported observations of brown bears, a species with a small population (only 10 known individuals) in the Tatra Mountains (Jakubiec and Buchalczyk 2001). Taking into account that brown bears hibernate, the high rate of their encounters with skiers requires further explanation. One explanation could be the timing of the ski tours, which usually take place in March and April (Bielański 2013), the period when bears awaken from hibernation.

Describing animal reactions: The survey asked respondents to describe animal reactions to their presence. Usually such data are collected during field studies in experimental settings (Ingold 2005; cf Sterl et al 2008, 2010) or by direct observation by researchers of tourist–animal interactions (Liddle 1997).

Reported animal reactions indicate the degree of encroachment of ski tourers into the rights or property of animals within the meaning attributed to them by Liddle (1997). The high frequency with which animals showed no reaction or only increased vigilance could suggest that the mammals of the Polish Tatras have undergone a certain

level of synanthropization. If there is no hunting in an area, the docility of the animals often is higher.

Flight or aggression occurred in 23% of the human–animal encounters reported in the survey. Among chamois, the most frequently encountered species, this reaction was significantly less frequent than for any of the other observed species, about 12% (Table 2). A recent study (Zwijacz-Kozica et al 2012) found that the level of cortisol (which indicates stress) in the Tatra chamois was highest during summer, the season of mass tourism, and lowest in winter. This suggests that the ski tourers, in their relatively small numbers, are not perceived by these animals as a real threat so far.

While fewer stressful encounters may occur in winter, any flight in winter requires significant energy expenditure at a time when fodder is limited (Carlson 2011). Monitoring of ungulates in Yellowstone National Park has revealed that frightening an animal can result in an imbalance in its energy budget (Clark 1999; Legg 1999; Varley 1999). A further consequence of frightening animals is increasing their exposure to predators and, in some cases, causing them to leave the area altogether (Clark 1999; Legg 1999). In contrast to the effect on ungulates, the presence of ski tourers in winter exerts only a little effect on large predators, and may even bring some benefits. When humans disturb ungulates, they reveal their hiding places to predators. Additionally, lynx and wolves use paths created by hikers and skiers, which enable them to move quickly around the area during winter (Halfpenny 1999; Reinhart 1999).

Sporadically recorded aggression by animals toward ski tourers presents a separate issue. The studies conducted in Yellowstone National Park noted such aggression in many species, particularly a local species of mountain goat (*Oreamnos americanus*) and bears. Incidents of aggression against ski tourers were dangerous enough to force the park authorities to react (Reinhart and Tyers 1999).

Conclusions

The use of a social science approach, more specifically an unrestricted online survey, gave new insights into the interactions between ski tourers and large mammals in Tatra National Park. This approach complements traditional methods such as field observations and telemetry (eg GPS tracking). Ski tourers' survey responses yielded new and valuable data on human–animal encounters in the park and their impact on large mammals. This kind of information is essential for the management of winter outdoor recreational activities such as ski touring. In future, ski tourers, as well as the general public, can be addressed by public participatory management campaigns that elaborate area use rules. This can be done with stakeholders such as the Polish Alpine Federation (Polski Zwiazek Alpinizmu), local alpine clubs, and protected area management teams—both Polish and Slovakian in the case of Tatra National Park.

Future research should be extended to investigate skier interactions with species such as capercaillie (*Tetrao urogallus*) and black grouse (*Tetrao tetrix*), which have been a focus of several studies in the Alps in recent years.

Online surveys are an efficient research method (with low staff and financial requirements) that can provide a complementary tool for exploring human–wildlife interactions and visitors' perceptions of their impact on wildlife. This methodology can easily be adapted to any outdoor recreational setting worldwide.

ACKNOWLEDGMENTS

The authors wish to thank the Tatra National Park staff, especially P. Skawiński, Sz. Ziobrowski, T. Zwijacz-Kozica, and J. Krzeptowski, for advice and support during this study. The authors also acknowledge the Austrian Federal Ministry of Science, Research and Economy's bilateral cooperation program "Wissenschaftlich-Technische Zusammenarbeit" (WTZ), supporting researchers' travel between Poland and Austria (grants PL02/2014 and PL01/2016). Publication was supported by BOKU Vienna's Open Access Publishing Fund.

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Supplemental material

TABLE S1 Significance level of differences between the results of the on-site pilot study in 2009 ($n = 80$) and the online survey in 2011 ($n = 260$).

Found at DOI: http://dx.doi.org/10.1659/MRD-JOURNAL-D-17-00039.S1 (133KB PDF).