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**“If we really disturbed them, they would leave”:
Mountain sports participants and wildlife disturbance in
the northern French Alps**

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“If we really disturbed them, they would leave”: Mountain sports participants and wildlife disturbance in the Northern French Alps --Manuscript Draft--

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Abstract:	<p>This article aims to participate in filling the gap of knowledge in mountain sports participants' perception of wildlife disturbance. In a context of growing popularity of these activities and, consequently, of increase of visitors in the Northern French Alps, we examines visitors of protected areas attitudes toward disturbance and wildlife tranquility areas. The quantitative survey focused on ski tourers and hikers (N=2 050), it shows that respondents who witnessed disturbance, such as flight response from wildlife, are much more likely to state that they might be a source of disturbance. Additionaly, results show that attitudes and values towards wildlife and disturbance are more important than sociodemographic or activity related characteristics to explain perception of self-caused disturbance or avoidance of tranquility areas.</p>
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Opposed Reviewers:	

1. Introduction

1
2 Sport tourism and active leisure activities in natural areas are increasing in popularity all over the
3 world (Gibson et al., 2018; Melo et al., 2020). However, increasing numbers of nature-based rec-
4 reationists and tourists are an important source of pressure on natural environments, causing im-
5 pacts on soil, water, vegetation and animals (Ballantyne & Pickering, 2013, 2015; Mounet et al.,
6 2004; Rixen & Rolando, 2013; van der Duim & Caalders, 2002). Disturbance caused by nature-
7 based activities represents a source of pressure for wildlife. Studies report impacts such as extra
8 energy expenditure, modification of physiological and behavioural responses, or jeopardised feed-
9 ing process (Arlettaz et al., 2015; Gutzwiller et al., 2017; Knight & Gutzwiller, 1995; Marchand et
10 al., 2014; Patthey et al., 2008; Taylor & Knight, 2003). These studies appear in several reviews of
11 literature that have been published in order to globally assess the impact caused by recreation
12 based on different indicators (Boyle & Samson, 1985; Larson et al., 2016; Sato et al., 2013; Steven
13 et al., 2011) Between 50% and 88% of publications included in these reviews supported negative
14 rather than positive or non-existent effects.

1.1 *Outdoor recreationists' awareness of recreational impacts on wildlife*

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16 Although wildlife disturbance is well documented in ecological research, few studies have focused
17 on the human dimension of this disturbance. In a published literature review (Gruas et al., 2020)
18 on the perception of wildlife disturbance relying on 47 papers, authors show that most articles
19 found that the majority of respondents were not aware that they might disturb wildlife. Among
20 the factors that influence awareness, **experience in nature and knowledge of wildlife** was one of
21 the most commonly looked at by researchers. Studies revealed for instance that witnessing
22 negative impacts during the activity made people more likely to state that they could be a
23 disturbance to wildlife (Dearden et al., 2007; Lucrezi et al., 2013; Orsini & Newsome, 2005).
24 Experience in nature is strongly related to **experience in the activity** which also influenced
25 perception. For instance, Thapa et al. (2005, p. 65) showed that *“divers who had higher levels of
26 specialization tended to have stronger marine-based environmental knowledge. In addition,
27 specialization was a mediator in that those with higher levels of specialization also reported more
28 pro-environmental behaviours”*. However, other studies suggest that respondents with greater
29 knowledge of wildlife and experience of their activity were less aware of the disturbance they can
30 potentially cause. For instance, Levêque et al. (2015) found that the more frequently people
31 engaged in a recreational activity in the forest, the less impact they thought they had on

1 amphibians. They were therefore less supportive of management measures than inexperienced
2 respondents. This was also shown by Wu et al. (2015) for backpackers: most respondents had little
3 awareness of their environmental impacts and held negative attitudes toward restricted activities
4 in the non-tourist district of protected areas. Another study (Hillery et al., 2001) points up that
5 tourists are less sensitive than locals recreationists to the state of the environment in general,
6 including the effect of nature-based recreational activities on wildlife. It also appears that
7 awareness is not systematically associated with a change in behaviour, as illustrated by Weiss et
8 al. (1998) survey on ski tourism. According to the review, few studies have considered **socio-**
9 **demographic factors** to investigate their influence on awareness of wildlife disturbance. The few
10 studies that took it into account show that gender does not seem to influence the level of
11 awareness (Haukeland et al., 2013; Jorgensen & Bomberger Brown, 2016, 2016). Age was also not
12 significant in the same two studies, but Le Corre et al. (2013) found that the older the population,
13 the less aware people were of bird disturbance. Geographical origins had no effect on perceptions
14 of the state of the environment or of disturbance in two studies (Jorgensen & Bomberger Brown,
15 2016; Prayag & Brittnacher, 2014). Three studies that explored the influence of education and
16 occupation revealed that people with higher levels of education or in higher occupational
17 categories were more aware of their impact on wildlife (Grossberg et al., 2003; Haukeland et al.,
18 2013; Le Corre et al., 2013). Finally, although only two surveys have studied the weight of
19 **environmental attitudes** (Grossberg et al., 2003; Haukeland et al., 2013), both found that high
20 environmental sensitivity implied a high level of awareness of wildlife disturbance and that it
21 explained more variance than the sociodemographic variables. Regardless of the factors
22 influencing perception, respondents generally believed that other recreationists were more
23 impacting than themselves. Several studies demonstrated that recreationists and tourists tended
24 to transfer the responsibility of disturbance on other user groups such as those practicing a
25 different activity than theirs (Johnson & Jackson, 2015; Levêque et al., 2015; Taylor & Knight,
26 2003).

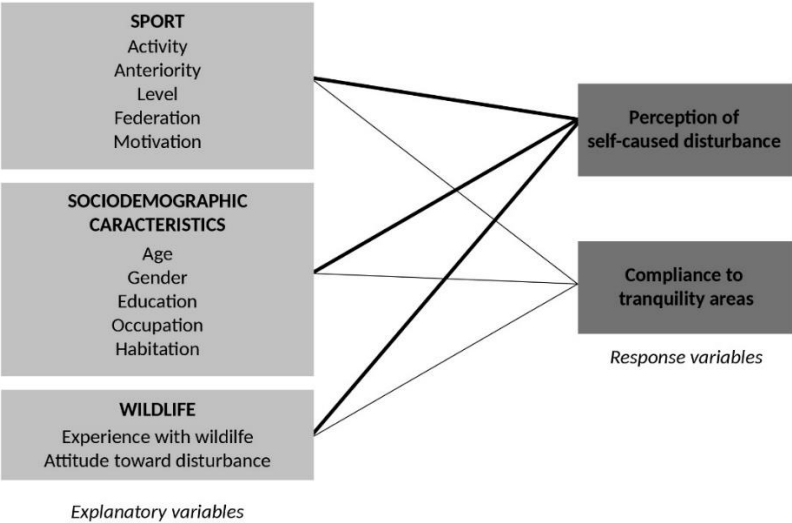
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49 The literature review insists on several limits to previously led surveys on nature recreationists
50 perception of wildlife disturbance. The biggest one being that very few have taken into account or
51 reported on the effect of multiple factors to explain perception of disturbance, making it
52 impossible to explain the variation in the levels of awareness across studies. Authors thus
53 concluded the review with a list of recommendations (see table 1 of Gruas et al. 2020) such as
54 widening the focus to less studied activities, including more explaining variables, reporting on the
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1 effect of non-significant variables and encompassing the perception of management measure in
2 the studies.

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5 *1.2 Research question and hypothesis*
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8 The research draws from this literature review in order to participate in filling the dearth of
9 evidence regarding recreationists' awareness of wildlife disturbance in the northern French Alps.
10 Indeed, information about visitors and their perception of wildlife, disturbance and tranquillity
11 areas is needed by protected areas managers who are currently facing a large increase in visitors.
12 They need to be able to make recreationists aware of the consequences of disturbance and of the
13 necessity to comply to tranquillity areas. Information about visitors is useful as it allows to target
14 them adequately with awareness raising measures.
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22 The study focuses on two mountain sports: hiking and ski touring, and on four mountain ranges
23 (Bauges, Belledonne, Aiguilles Rouges and Vanoise – see map 1). We intend to gain a better
24 understanding of which factors influence (1) The perception of self-caused wildlife disturbance:
25 how do mountain sports participants perceive their own impact on wildlife? What makes them
26 aware or unaware of their impact? (2) Compliance to tranquillity areas for wildlife aiming to
27 reduce disturbance: who tends to avoid it and who does not? We intend to delve deeper into the
28 role of sociodemographic variables and attitudes, two factors that have seemingly been over
29 looked by previous studies, despite their important explaining capacities. We will also explore the
30 role of activity and wildlife related factors (see figure 1).
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60 Figure 1: Explanatory variables and response variables considered in the analysis

Based on the literature review, we make the following hypotheses:

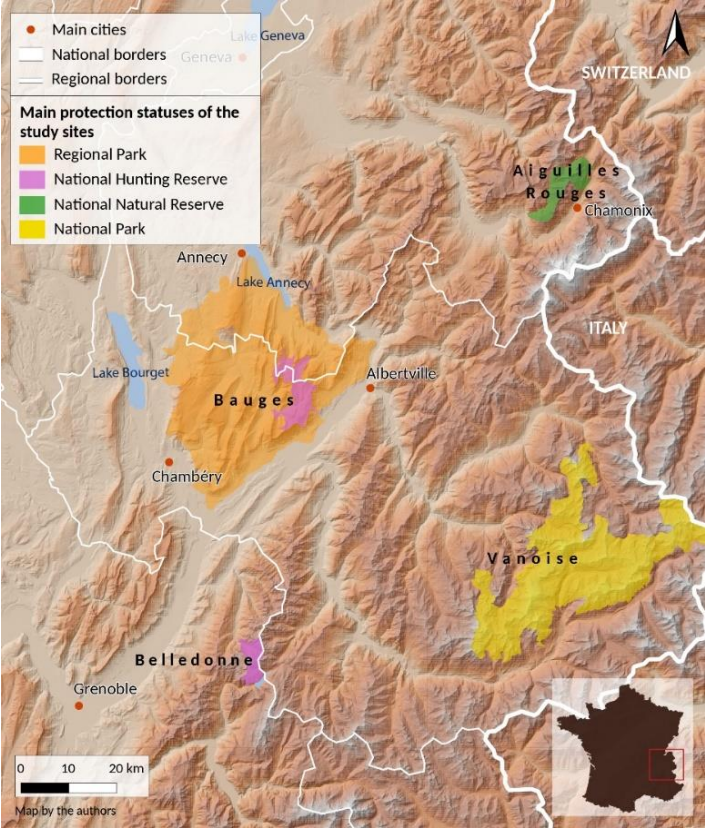
- H1: We expect sports related factors to influence perception of self-caused disturbance and compliance to tranquillity areas
 - o H1a: Because awareness raising campaigns mostly focus of winter disturbance, winter participants will be more aware of disturbance and more likely to comply to tranquillity areas,
 - o H1b: Anteriority of practice and level in the activity should also play a role, with the most experienced participants being most knowledgeable,
- H2: We expect sociodemographic characteristics to influence perception of self-caused disturbance and compliance to tranquillity areas, especially:
 - o H2a: Respondents with the highest levels of education or in higher occupational categories could be more aware of wildlife disturbance,
 - o H2b: Unlike Le Corre et al. (2013), we expect older participants to be more aware and more careful of wildlife disturbance because they will most likely be more experienced,
- H3: We expect experience with wildlife and attitude towards it to influence perception of self-caused disturbance and compliance to tranquillity areas
 - o H3a: Previous experience with wildlife observation is likely to influence perception of disturbance,
 - o H3b: General attitudes towards the environmental impact of mountain sports will influence perception of disturbance and avoidance of tranquillity areas the most.

2. Methods

2.1 Study area

Bauges regional park and hunting reserve, Belledonne hunting reserve, Aiguilles Rouges national natural reserve and Vanoise national park are all located in the northern French Alps (see map 1). Although the historical implementation of the protection statuses varies (from as early as 1913 for the Bauges hunting reserve, to 1986 for Belledonne), they were all motivated on same grounds: the increase of tourism in the region, particularly alpine skiing with the development of ski resorts and the protection of local large ungulates (chamois, ibex and mouflon). Nowadays, all four sites attract mountain sports enthusiasts : locals from the nearby urban centers (mostly in Bauges and

Belledonne), as well as national and international tourists (mostly in Aiguilles Rouges and Vanoise) (Gruas, 2021).



Map 1 : localisation of the fields of study (map by the authors)

On the initiative of natural areas managers, studies have been led at the scale of each range to quantify actual or potential levels of interactions between wildlife and recreational activities. All studies show that it is difficult for wildlife to limit interactions with recreational activities as areas used by summer and winter activities overlap with wildlife refuge areas (Cuisson, 2018; Landreau, 2006; Lavorel et al., 2020). In addition, in Bauges, Duparc et al. (2017) showed that actual interactions led to behavioral changes in ungulates. However, so far, nothing proves that these interactions and behaviour modification is harmful or will cause long-term impacts on wildlife (Duparc et al. 2017).

In the absence of scientific evidence of the impact of disturbance on animal populations, the precautionary principle prevails and has motivated the creation of tranquillity areas in those ranges. These areas are placed in strategic locations carefully selected by managers and represent refuge areas for wildlife. The zones can be regulatory, such as in the Hauts de Villaroger and Plan de Tuéda nature reserves (Vanoise), where ski touring is forbidden and offenders are liable to fines. On some

1 sites, access can be restricted to a recommended route to minimise the risk of disturbance, but
2 trespassers cannot be charged. This type of zone is present in the Bauges, Belledonne and Aiguilles
3 Rouges, but also in many other Alpine massifs, in and out of ski resorts. Both types of zone, regu-
4 latory and non-regulatory, are indicated on the protected areas' websites or on maps provided by
5 social networks specialised in mountain sports (such as camptocamp.com). On the field, they can
6 be (but are not systematically) indicated with signs at the start of or along the hiking route (see
7 photo 1) and, less often, delimited with ropes.



44 Photo 1: Sign indicating the entrance in the national hunting and wildlife reserve, in 2018 managers added a
45 supplementary sign to indicate wildlife tranquility areas for black grouse (not regulatory). The sign reads "Let's
46 share the powder", map legend designate yellow zones as "wintering areas to avoid" and the arrows indicates
47 "not recommended downhill skiing itineraries", the text gives information about black grouse ecology and
48 explains that the zones were set up in concertation with ski touring clubs and federations (photo by the
49 authors).

52 2.2 Quantitative survey

53 The method of data collection is mainly based on a questionnaire survey. The survey took place
54 between January 2018 and August 2019 in order to include two winter and two summer admin-
55 istration periods and to collect questionnaires in 17 sites over the four ranges. Questionnaires
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were handed out and self-administered after the outings, we met participants directly on the recreational sites (on the car parks or in mountain huts in summer), acceptance rate was about 70%. Interviewers were instructed to reach out to all visitors above 15 years old who took part in either ski touring or snowshoeing in winter, and in either hiking or trail running in summer. In total 2 786 people took part in the survey. Incomplete or incoherent questionnaires were discarded, resulting in a total of 2 559 valid surveys. In this paper we only focus on ski tourers and hikers, thus relying on 2 050 surveys. Table 1 presents the repartition of respondents per activity and mountain range.

	Ski touring		Hiking		Total	
	N	%	N	%	N	%
Bauges	237	23%	205	20%	442	22%
Belledonne	292	29%	207	20%	499	24%
Aiguilles Rouges	254	25%	305	30%	559	27%
Vanoise	233	23%	317	31%	550	27%
Total	1016	100%	1034	100%	2050	100%

Table 1: Repartition of respondents depending on activity they took part in and the range they visited

The questionnaire was organised around four main themes. (1) Practice of the activity, aiming to assess the level, habits, motivations and experience with that sport. (2) Attitude towards and experience with wildlife. In this section we included a scale in order to measure the attitudes towards the impact of the activity on wildlife, the scale is directly borrowed from Sterl et al. (2010) who have used it to understand the attitude of ski tourers towards a management measure aiming to protect the capercaillie and black grouse in Austria. To confront attitude with reality, we also enquired about respondents' encounters with wildlife and their perception of the disturbance they might have caused on this occasion, their knowledge of tranquillity areas that are set up on the sites, and whether or not they tend to avoid them. (3) Environmental attitudes and eco-friendly behaviours in daily life. (4) Sociodemographic characteristics (age, gender, education level, occupation etc.)

2.3 Quantitative analysis

2.3.1 Models specification and variables selection

We used binary logistic regression to come up with two separate models that allow to understand the position of respondents on two dependent variables: (1) perception of their own impact on wildlife (yes/no) (2) compliance to tranquillity areas (always/not always).

1 The independent variables of both models were (1) sociodemographic variables (gender, age,
2 education, profession), (2) type of visitor, (3) sports characteristics (activity, level, anteriority of
3 practice, motivations), (4) experience with wildlife during an encounter, and (5) attitudes towards
4 the impact of mountain sports on wildlife. We chose a significance level of $p < 0.05$ for the stepwise
5 regression method and reference category was either the first one in the case of ordinal variables
6 (for example “beginner” rather than “intermediary” or “expert” for the level of practice) or the
7 one with most respondents.
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13 *2.3.2 Variable transformation and treatment of data*

14 The dependent variable “Disturbance of wildlife” (first model) was recoded in a binary variable: “a
15 lot” and “probably” became “yes”, and “not really”, “not at all” and “I don’t know” became “no”.
16 The analysis only applied to people who had already met wildlife while practising a mountain sport
17 (n=1 748). The dependent variable “avoidance of tranquillity areas” (second model) was also
18 recoded in a binary variable (“never”, “rarely” and “often” became “not always”, and the modality
19 “always” remained the same). This analysis only applied to people who knew about tranquillity
20 areas (n=1 180).
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30 Missing values were replaced by the mean value for continuous variables. For qualitative variables,
31 respondents with missing values were discarded from the analysis.
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35 We used the statistical programme Spad to analyse the data.
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39 *2.4 Qualitative material*

40 To complete the quantitative data, we carried out 30 semi-directive interviews with skitourers.
41 Interviewees were selected so as to represent the diversity of profiles of participants: different
42 motivations, modalities of practice and levels of experience. The interview guide was organised in
43 two sections: practice of the sports activity and perception of the natural environment. The inter-
44 views were entirely transcribed and a thematic analysis (Braun & Clarke, 2021) was performed on
45 the corpus.
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54 **3. Results**

55 *3.1 Explanatory variables*

3.1.1 Background data on sociodemographic and sports characteristics

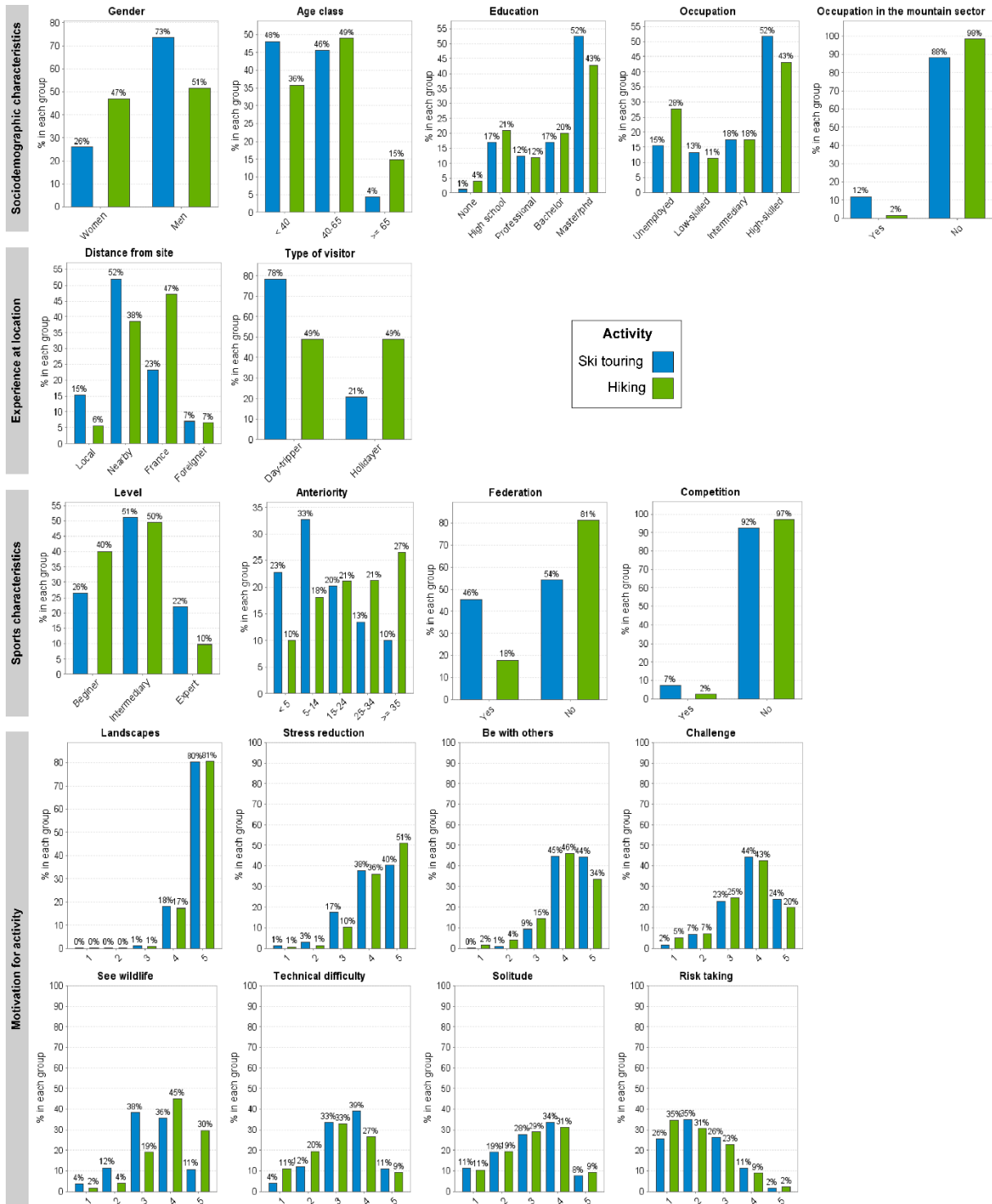


Figure 2: Socio-demographics, experience at location and sports characteristics (n = 2 050)

Our sample consisted of 63% of men and 37% of women. The repartition differed with 74% of men in ski touring and 54% in hiking (see figure 2 and supplementary table 1) for distinction between ski tourers and hikers). Mean age was 44 years old but it varied depending on the activities.

Participants belonged to the most well-off social classes: 47% graduated from a master’s degree or higher and 47% have high-skilled occupations, mostly in the private sector (41%). 7% of respondents worked as mountain professionals (mountain guides, ski instructors, etc.) Most visitors were day-trippers (79% in winter, 50% in summer). Geographical origins varied, with 10% of locals (who travel on average 10 km to reach the site of practice), 44% of nearby inhabitants (32 km), 38% of people travelling from the rest of France (515 km) and 7% of foreigners (mostly Switzerland, Belgium and Great Britain).

The sample is composed of 49.6% ski tourers and 50.4% hikers. Participants estimated that their level was mostly intermediary (51%) and only 16% considered themselves experts. Mean anteriority of practice was 19 years (24 years for hikers and 15 for ski tourers). 32% of respondents belonged to a mountain sports federation (mainly ski tourers – 60%). The top three motivations were “landscapes observation”, “stress reduction” and “conviviality, spending time with others”.

3.1.2 Attitudes towards wildlife disturbance caused by mountain sports

Although a large majority of respondents agreed that mountain sports can disturb wildlife, and few thought that wildlife was used to disturbance, most of them still believed that ski touring had no negative effects on nature and wildlife if recreationists did not turn up in crowds (see table 3). Even though most people agreed with the statement that “Temporal or spatial limitations of mountain sports are necessary for nature conservation” (82% totally agreed or agreed), respondents seemed more willing to accept restrictions of access in habitats of rare or endangered species. Furthermore, the majority agreed to the statement that mountain sports should be possible without any limitations. The activity did not influence participants’ views on disturbance and tranquillity areas. The interviews reinforce the results that most respondents are aware that mountain sports impact the environment, including disturbance of wildlife. Like several others, this skier admits in an interview: *“I know that even though we love nature, we do a lot of damage, especially to trees. Skiing in the forest is great, but we cut off the tops of all the little fir trees, with the ski blades. So we prevent them from growing. I know that we sometimes disturb animals too.”*

Items	Attitudes			PCA	
		Ski touring	Hiking	Factor 1 “impact awareness”	Factor 2 “restriction rejection”
In habitats of rare or endangered species access restrictions are acceptable	Mean	4,32	4,45	0,814	-0,014
	5	49%	60%		
	4	39%	30%		
	3	9%	7%		

	2	3%	2%		
	1	1%	1%		
Visitors have no negative impact on nature and wildlife as long as they do not turn up in crowd	<i>Mean</i>	3,45	3,37	0,127	0,821
	5	12%	10%		
	4	45%	45%		
	3	21%	21%		
	2	19%	21%		
	1	3%	3%		
The access to natural areas should not be restricted	<i>Mean</i>	3,45	3,09	-0,354	0,447
	5	20%	12%		
	4	32%	26%		
	3	25%	27%		
	2	19%	30%		
	1	4%	5%		
Wildlife is used to recreationists and hardly reacts to that disturbance	<i>Mean</i>	2,42	2,38	-0,229	0,672
	5	1%	3%		
	4	14%	12%		
	3	25%	22%		
	2	45%	47%		
	1	15%	16%		
Visitors might disturb wildlife	<i>Mean</i>	4,06	4,01	0,435	-0,457
	5	27%	26%		
	4	58%	56%		
	3	12%	15%		
	2	3%	3%		
	1	1%	2%		
Nature recreation necessitates temporal or spatial limitations of outdoor recreation	<i>Mean</i>	4	4,28	0,794	-0,175
	5	31%	46%		
	4	44%	41%		
	3	18%	11%		
	2	5%	2%		
	1	1%	1%		
<i>Variance</i>				36%	17,70%
<i>Eigenvalue</i>				2,181	1,06

Table 3: Attitudes towards environmental impacts of mountain sports (1 = totally disagree, 5 = totally agree) and results of factor analysis using varimax rotation for the extraction of orthogonal factors. Items were assigned to dimensions on the basis of a factor loading ≥ 0.40 .

Like Sterl et al. (2010) did on that same scale, a factor analysis was applied to determine the underlying dimensions of the respondents' attitudes towards environmental impacts of their activity. The PCA was performed on skiers and hikers taken together and it resulted in two factors explaining 54 % of the total variance (Table 3, and supplementary figure 1). Items that indicate agreement with the fact that mountain recreation can impact wildlife and should be restricted to protect animals contributed most to factor 1. The first factor thus indicates respondents level of awareness of the impacts and will be referred to in the rest of the article as "impact awareness". On the contrary, items that contributed the most to factor 2 were related to the idea that mountain sports had no or little impact on wildlife and should not be restricted, indicating to what

1 extent respondents rejected restrictions. This factor will thus be referred to as “restriction
 2 rejection”.

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 5 **3.1.3 Actual experience with wildlife and wildlife disturbance management measures**
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7 When it comes to actual experience with wildlife, it appears that 92% of respondents had already
 8 seen animals while practicing mountain sports (figure 3 and supplementary table 2). Most of them
 9 state that the specie they were able to observe (mostly chamois or bouquetin, more rarely
 10 mouflon) did not seem to react to their presence, either because they did not move or because
 11 they were too far to tell, as related by this interviewee: *"Sometimes I have passed by herds of*
 12 *chamois. It didn't even traumatise them. One of them moved a little, and that was it; almost*
 13 *nothing"*. Considering both hikers and skiers, only 26% think that they disturbed wildlife (“a lot”
 14 or “probably”) which contrast with the fact that 82% of visitors agreed or totally agreed with the
 15 idea that mountain sports might disturb wildlife (table 3). This indicates a very significant
 16 difference between the disturbance that one knows can occur and the disturbance that one thinks
 17 they have caused.
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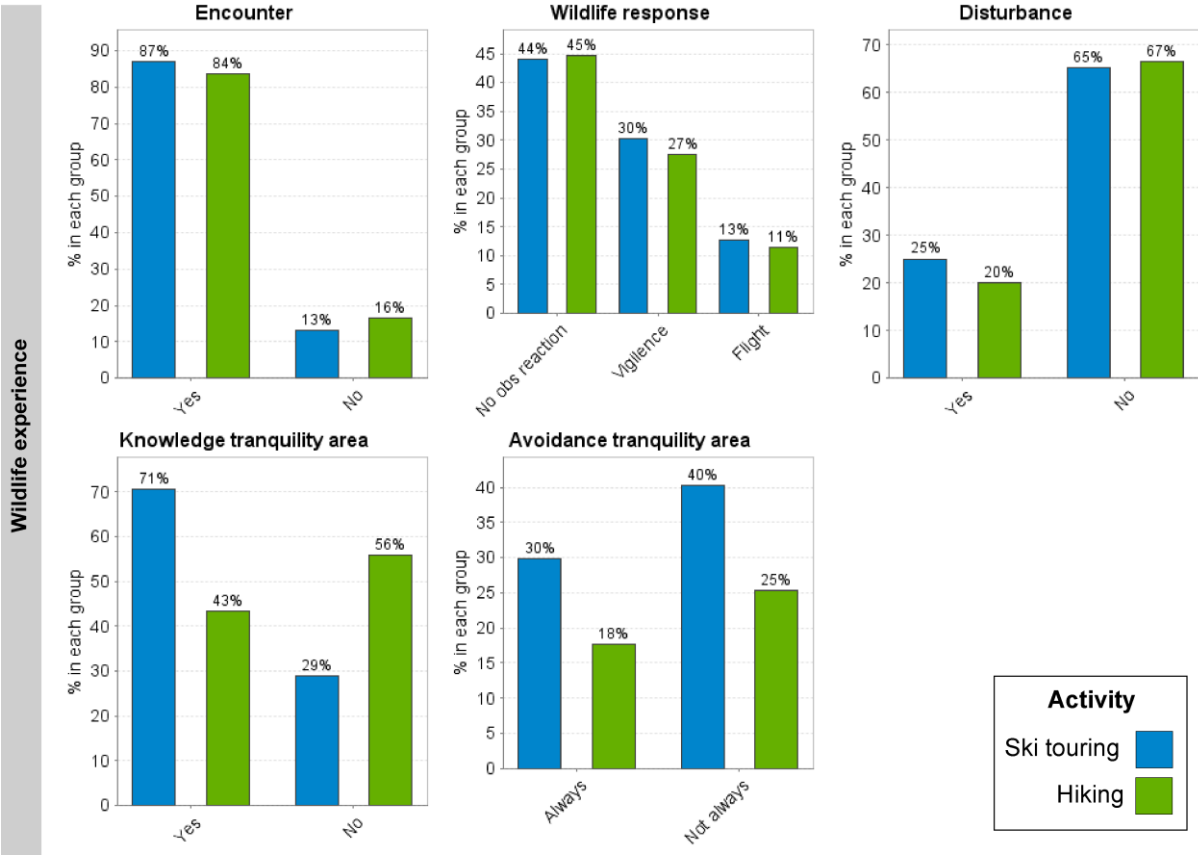


Figure 3: Actual experience with wildlife and tranquillity areas for wildlife (n=2 050)

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57% of respondents knew about the concept of tranquility areas for wildlife (regulatory and non-regulatory, see 2.1), however the proportion of skiers aware of the existence of such zones was significantly higher: 71% vs. 44% ($\chi^2=154,612$, $df=1$, $p=0,000$). This can be explained by the larger diffusion of awareness raising campaign in winter, when wildlife is considered more vulnerable. Out of the people who knew about tranquillity areas, 42% stated that they always avoided them, proportions were similar among skiers and hikers.

3.2 Factors influencing perception of disturbance and compliance to tranquillity areas

Variables included in the first model accounted for 34% variation in perception of disturbance (Nagelkerke $R^2 = 0,338$), results of the Hosmer–Lemeshow test indicated a good fit of the data to the logistic regression method (Hosmer–Lemeshow $\chi^2 = 6,315$; $df = 8$; $p=0,612$). For the second model, variables accounted for 13% of variation in compliance to tranquillity areas (Nagelkerke $R^2 = 0,128$) and data also fitted the method (Hosmer–Lemeshow $\chi^2 = 2,927$; $df = 8$; $p=0,939$).

3.2.1 Perception of disturbance

The regression analysis identified four variables influencing the perception of disturbance (table 5). The significant variables included both factors of attitudes towards environmental impacts of mountain recreation: “impact awareness” and “restriction rejection” (see 2.3), level in the activity and reaction of the animal on the occasion of the encounter. It appears that, the more aware respondents of theoretical disturb disturbance the more likely they were to be aware of their own disturbance (odds ratio=1,23, $p=0,002$). On the opposite, visitors who rejected access restrictions tended to state that they personally did not disturb wildlife (odds ratio=0,55, $p=0,000$). The most experienced respondents were more aware about their own disturbance: intermediary (odds ratio=1,50, p value=0,008) and expert (odds ratio=1,9, p value= 0,001) level respondents were more likely to state that they had disturb wildlife than beginners. However, there was no significant difference between intermediary and expert level participants.

The variable that seemed to weight the most on perception of disturbance was the behaviour of the animal during an encounter (Wald statistic = 284,13). The more alert the behaviour, the more the animal was considered to be disturbed: if it had a vigilant behavioural response - such as interrupt feeding process and/or looked around but did not move (odds ratio = 4,79, p value=0,000), or if it ran away or moved (odds ratio=22,29, p value=0,000), recreationists were more likely think they had disturbed it then if it remained static or was too far away to judge. This

1 observation is corroborated with interviews, a participant for instance states: "*I tell myself that if*
 2 *I don't see them, I'm not disturbing them*". In some case participants seem to have an
 3 anthropomorphic perception of disturbance as the interpretation of the animal's reaction echoes
 4 the interpretation that one would have of a human behavior: "*For me, an animal is disturbed from*
 5 *the moment it goes away and people follow it*", "*If we really disturbed them, I think they would*
 6 *leave*", "*They know very well that we can't join them so ... So, we don't disturb them that much*".

11 Table 5: Results of the binary logistic regression using stepwise regression (dependent variable: 1 = I disturbed
 12 wildlife; 0 = I did not disturb wildlife), Nagelkerke $R^2 = 0,338$; Hosmer–Lemeshow $\chi^2 = 6,315$; $df = 8$; $p=0,612$.

Variable	Regression coefficient	Standard error	Wald statistic	P-value	Odds ratio	OR confidence interval 95%	
						Inferior	Superior
Level (ref= Beginner)			12,009	0,000			
Level (Intermediary)	0,403	0,151	7,084	0,008	1,497	1,112	2,014
Level (Expert)	0,642	0,195	10,805	0,001	1,899	1,296	2,784
Wildlife response (ref= No observable reaction)			284,127	0,000			
Wildlife response (Vigilance)	1,566	0,148	111,304	0,000	4,789	3,580	6,407
Wildlife response (Flight)	3,104	0,186	277,759	0,000	22,287	15,471	32,105
Impact awareness (Factor 1)	0,208	0,068	9,309	0,002	1,231	1,077	1,408
Restriction rejection (Factor 2)	-0,600	0,067	79,687	0,000	0,549	0,481	0,626
Constant (intercept)	-2,709	0,162	279,126	0,000			

3.2.2 Avoidance of tranquillity areas

36 The model was composed of the same variables as the first one, with the addition of the
 37 perception fo disturbance. The regression analysis identified 4 variables influencing systematic
 38 compliance to tranquillity areas (Table 6). "Impact awareness" and "Restrictions rejection" (factor
 39 1 and 2) were again good predictors of behaviour towards tranquillity areas, with people scoring
 40 high on factor 1 being more likely to always avoid the zones (odds ratio=1,45; $p=0,000$), and people
 41 scoring high on factor 2 less likely (odds ratio=0,72; $p=0,000$). The only activity related significant
 42 variable was the motive "risk taking", the more respondents were attracted by it, the less likely
 43 they were to avoid the areas (odds ratio=0,77; $p=0,000$). Age was also a good predictor of
 44 avoidance with people aged 40-65 being more likely to avoid tranquillity areas (odds ratio=1,939;
 45 $p=0,000$) than younger respondents.

Table 6: Results of the binary logistic regression using stepwise regression (dependent variable: 1 = I always avoid tranquillity areas; 0 = I don't always avoid tranquillity areas); the Wald-statistic tests whether a variable is significant.

Variable	Regression coefficient	Standard error	Wald statistic	P-value	Odds ratio	OR confidence interval 95%	
						Inferior	Superior
Risk taking	-0,265	0,061	19,138	0,000	0,767	0,681	0,864
Impact awareness (Factor 1)	0,373	0,066	31,611	0,000	1,452	1,275	1,654
Restriction rejection (Factor 2)	-0,326	0,063	27,199	0,000	0,722	0,639	0,816
Age_class (ref= < 40)			27,851	0,000			
Age_class (40-65)	0,662	0,134	24,595	0,000	1,939	1,492	2,519
Age_class (>= 65)	-0,013	0,229	0,003	0,956	0,987	0,631	1,546
Constant (intercept)	-0,090	0,173	0,272	0,602			

In depth discussion with the interviewees allowed to better understand the reasons why they don't always avoid protected areas for wildlife. Arguments fall into three main themes.

3.4.2.1 No evidence of wildlife in the area

Some argue against the merits of zones and the restrictions by using the perceived absence of wildlife in these areas: *"We know that there is a zone there [location in the Bauges massif], but in the end, we never see chamois. So, we wonder about its utility"*. Two other skiers state: *"It's funny because this area is protected and we never see anything there"*, *"Honestly, I thought that even though it was a protected area I didn't disturb much because I didn't see any animals."* The last quote conveys the idea that the skier interprets not seeing wildlife as an absence of it, but also, as we noted earlier, the absence of an encounter with animals as an absence of disturbance.

3.4.2.2 Safety first

The safety can be the source of a joke for some: *"If they keep making tranquillity areas wildlife they shouldn't be surprised if skiers end up in dangerous, avalanche prone zones to avoid animals being disturbed!"* It is also used in a more serious way: *"The snow conditions dictate the danger, the crowd, the exposure. So, if I see that the quality of the snow changes, a cornice is ready to break, the sun heating up more than expected, fog setting in, I might change my itinerary. If I have to go into a tranquillity area to do so, I will"*. While it is true that skiers must adapt their itinerary and prioritise their safety in dangerous conditions, the safety argument sometimes seems to be used to absolve themselves of a certain responsibility, to justify the desire to enjoy immaculate powder snow.

3.4.2.3 Fun and performance

Picking fun and performance over wildlife tranquility regularly comes out in the interviews, it appears as a kind of “guilty pleasure” for ski tourers: *“Sometimes, skiers tend to want to enjoy themselves above all. It’s hard to say no to a beautiful field of powder sparkling in the sun, if the snow is good and even if it is a protected area; I think I will go”*. *“The combe was really tempting and it was fantastic to ski. I went down there knowing that it was forbidden. And we didn't even disturb any ungulates.”* It seems that the search for performance, pleasure and sensations influences what participants allowed themselves to do or not.

4. Discussion

In this study we investigated the factors influencing perception of wildlife disturbance and avoidance of tranquillity areas. The study deals with visitors of four mountain ranges of the northern French Alps, taking parts in winter and summer mountain sports. Our survey and analysis was conveyed drawing from the results and recommendations from a systematic quantitative literature review focusing of the perception of disturbance caused by recreation (Gruas et al. 2020).

4.1 Sports related factors

Sports related factors were represented in both models. However, the activity did not influence the perception of disturbance which goes against the observation made by several other authors (Maguire et al., 2013; Stalmaster & Kaiser, 1998; Taylor & Knight, 2003; Vaske et al., 1992) and invalidate hypothesis H1a. Perception of disturbance was however influenced by level in the activity, which validates hypothesis H2b, with beginners being less likely to state they have disturbed wildlife. This may be related to the degree and familiarity with wildlife gained with experience and therefore a better understanding of behavioural responses, but also simply because when accessing less isolated and more frequented areas the chances of encountering animals and disturbing them are lower and disturbance is thus less easily observed.

When it comes to compliance to tranquillity areas, it seems that the choice of whether or not to comply to it results from an internal compromise between the search for performance and sensations and one's personal ethics. This process seems especially significant among skiers whose

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practice is more committed, as shown by the “risk taking” motive that comes out in the regression model.

Although the variable “professional of the mountain sector” was included in both models, it was never significant. This observation raises the important question of the training of mountain professionals, who act as authorities on outings with their clients. Although knowledge of fauna and flora is an integral part of the training of mountain leaders until recently it did not include wildlife disturbance, or only at the discretion of the trainers, depending on their sensitivity to the issue. The same applies to the training of high mountain guides provided by the national ski and alpinism school (ENSA). The French national training centre is gradually integrating awareness-raising module to winter disturbance. However, these actions are very recent and still limited. In our survey, mountain professionals were not more aware than others of their impact on wildlife (or at least they were not more likely to admit having an impact), which is partly consistent with the results of Weiss et al (1998) who noticed that locals who get income from ski tourism were less likely than other user groups to state that skiing affected wildlife.

4.2 Sociodemographic variables

Contrary to observation made in several studies (Grossberg et al., 2003; Haukeland et al., 2013; Le Corre et al., 2013) perception of self-caused disturbance was never influenced by sociodemographic variables as neither age, gender, location of habitation, education or profession were significant in the regression. Indeed, unlike previous results (Grossberg et al., 2003; Haukeland et al., 2013; Le Corre et al., 2013), respondents with higher educational and professional capitals were not more likely to think they had disturbed wildlife nor to avoid tranquillity areas thus invalidating hypothesis H2a. This could be explained by a very socially homogenous sample. Indeed 47% of the sample graduated from a master degree or higher, which is only the case of 10% of the French population (INSEE, 2022), and 47% have a manager occupation vs. 9% of the population (INSEE, 2022).

Compliance to tranquillity areas however can be predicted by the age variable with respondents aged 40-65 being more likely to avoid the areas than respondents under 40 years old. This can be explained by a higher commitment of young participants (more attracted to the risk taking motive for instance) being thus less prone to avoiding tranquillity areas. These results validate hypothesis H2b.

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4.3 Gap between disturbance in general and self-caused is mostly explain by wildlife response behaviour

Another striking result of the study is the assessment that although the majority of respondents is aware that their activity might disturb wildlife, most of them also tend not to personally think that they have disturbed it. Few studies have explored the difference of perception between general and self-caused disturbance. In the studies published by Sterl, Brandenburg and Arnberger (2008), Orsini and Newsome (2005) and Wu et al. (2015), respondents are consistent as they deny both the general impact of the activity and their personal impact. The phenomenon of denying one's own responsibility, on the other hand, is observed by Van Winkel and MacKay (2008) and by Le Corre et al. (2013). In the latter study, the results are particularly close to those of this survey, with 66% of respondents believing that protected areas visitors can have negative effects on birds, but only 17% believing that their presence has a negative effect. These observations therefore indicate a form of cognitive dissonance (Festinger, 1957). When realising inconsistency between their beliefs (my activity disturbs) and behaviour (I practise this activity), recreationists modify the perception of their own impact, and even argue to justify the harmlessness of their presence. The theory of cognitive dissonance is regularly used to explain inconsistencies between values and environmentally responsible behaviour (Thøgersen, 2004). In the context of recreational activities, Wu, Lein and Liu (2020), focused on the intentional aspect, showing a strong cognitive dissonance among visitors who leave their waste behind in a national park. Juvan and Dolinca (2014) showed that even people who are actively engaged in environmental protection in their daily lives nevertheless engage in behaviours that have negative environmental consequences, even unintentionally, during their holidays.

As exemplified by the results of the first regression model, the cognitive dissonance diminishes when the disturbance is undeniable, for instance when respondents witness a flight reaction from an animal and thus state that they have indeed disturbed it. This validates hypothesis H3a and demonstrate how difficult it is for most recreationists to picture what they do not see with their own eyes. Qualitative results hint that some visitors seem to consider that their experience gives them a layman's knowledge of animal behaviour, for instance when they use terms such as: "*it's obvious*", "*they don't seem disturbed*". They interpret wildlife reactions with an anthropomorphic view: thus those who do not flee are not considered to be disturbed. These situations are in line with the observations of Stalmaster and Kaiser (1998) and Taylor and Knight (2003), who show

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2 through questionnaires and wildlife observation that recreationists consider it acceptable to get
3 closer to wildlife than wildlife actually allows (flight distance is greater than visitors imagine).

4 5 *4.4 General attitudes influence more than anything else*

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7 Both self-caused perception of disturbance and compliance to tranquility areas were mainly
8 explained by attitudes towards the environmental impact of mountain sport. Indeed, respondents
9 who agreed with the fact that mountain recreation can impact wildlife and should be restricted
10 were much more likely to state that they had disturbed wildlife and that they usually complied to
11 tranquillity areas. On the contrary respondents who believed mountain sports had no or little
12 impact on wildlife and should not be restricted, were more likely to state that they had not
13 disturbed wildlife and that they do not always avoid tranquillity areas; hypothesis H3b is thus
14 confirmed. Despite a previously noted cognitive dissonance between one's personal impact and
15 the impact of other participants, this result translates consistency between general and specific
16 attitudes towards disturbance and between general attitudes and behaviour.

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18 The concepts of "attitude towards behaviour" or "behavioural intentions" from the theory of
19 planned behaviour (Ajzen, 1991) explain best this consistency. The assessment of a specific behav-
20 iour and one's intention to perform it immediately precedes actual behaviours and is thus more
21 to influence it. As pointed out by Immoos and Hunziker (2015), this suggest that on-sites measures
22 aiming to reduce wildlife disturbance have little effect on behavior compared to preexisting values
23 and attitudes of visitors.

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25 However, the French context is a bit specific. Indeed, nature sports participants tend to believe
26 that they should benefit from a total freedom to move around in the natural environment. This
27 idea inherent to the development of nature sports in France, which are considered to be free,
28 unrestricted and carried out in an undeveloped environment (Corneloup & Bourdeau, 2004). It
29 emerged from the interviews that the common sense of the participants should take precedence
30 over the prohibition. Access restrictions are seen as an obstacle to personal freedom, especially
31 during leisure time (Zeidenitz et al., 2007). Krieger, Deldrève and Lewis (2017) describe this
32 phenomenon as "the urge to tear down barriers". Even if users of a natural areas declare that they
33 understand the environmental interest of protection, they do not wish to see the environment
34 denatured by it. The authors explain that "environmental measures reaffirm the power of the

1 domestic, made apparent by barriers and prohibitions, in a world where users cultivate the
2 experience of the 'wild' and the distance from social constraints”.

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5 *4.1 Limitations of the study*

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8 This study is subject to some limitations. The first limitation lies in the quantitative methods and
9 the biases it induces when measuring behaviours as compliance with restrictive areas is only
10 declarative. Second, the analysis show that both models have a low explaining power which
11 suggest that other variables that were not included in analysis play an important part in explaining
12 perception of disturbance and avoidance of tranquillity areas.
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18 **5. Conclusion and implications for management**

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21 This article presented the findings of a large scale quantitative survey regarding mountain sports
22 and wildlife disturbance. The study found that witnessing or experiencing undeniable disturbance
23 (i.e a behavioral response such as flight) is what makes respondents aware that they can cause
24 disturbance to wildlife (not only other participants). These results seem to be bolstering findings
25 on the matter. We also show that attitudes and values towards wildlife and disturbance are more
26 important than activity related characteristics to explain perception of self-caused disturbance or
27 avoidance of tranquillity areas. Those results shed a new light on the study of wildlife disturbance
28 as values, attitudes and orientations had rarely been taken into consideration in previous studies
29 (Gruas et al., 2020).
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39 These results have direct implication for managers of protected areas as they provide useful and
40 rare insight on mountain sports participants. This information can be used to target and raise
41 awareness in ways that appeal directly to them. Since evidence of disturbance and attitudes
42 towards it are most likely to influence perception or compliance to management measures, we
43 suggest using photos and videos of distressed fleeing wildlife to not only show the reality and
44 immediate consequences of disturbance, but also to appeal to emotion and participate in shifting
45 attitudes toward restricted areas and management measures. Such visual supports could be
46 broadcasted in ski resorts and tourist centers, as well as on websites that are often visited to
47 prepare the itineraries (avalanche forecast, route planning website, hikers/skiers groups and
48 communities on social media). We also suggest targeting participants depending on their level and
49 involvement in the activity. By posting guards on easier routes to talk with families and beginners
50 about disturbance: its consequences for wildlife and the importance of complying to management
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measures. Higher level participants (i.e people stating they enjoyed “risk-taking”), could be targeted during various events (mountain film festivals, ski mountaineering competitions). In addition, training of mountain professionals (mountain guides, ski instructors, mountain leaders etc.) absolutely needs to be reinforced with courses on the ecology and biodiversity of mountain ecosystems. This would allow to target high-level participants and to encourage them to pass on knowledge about disturbance and the importance of respecting management measures to future clients.

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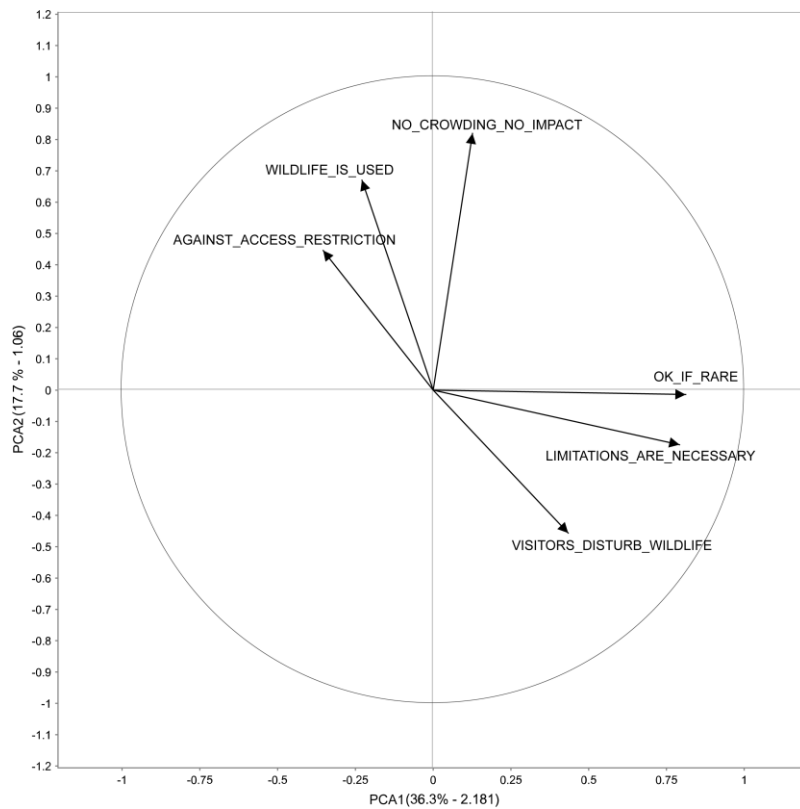
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Supplementary material

Sociodemographic characteristics		Ski touring (n= 1 016)	Hiking (n= 1 034)
Age	<i>Mean</i>	42	46
Age group in %	<i>Under 40</i>	49	36
	<i>40-65</i>	47	49
	<i>Over 65</i>	4	15
Gender	<i>Women in %</i>	26	48
Education in %	<i>None</i>	1	4
	<i>High school or under</i>	17	21
	<i>Professional training</i>	12	12
	<i>Bachelor degree</i>	17	20
	<i>Master degree or PhD</i>	52	43
Occupation in %	<i>Unemployed or student</i>	9	12
	<i>Retired</i>	7	16
	<i>Low-skilled occupations</i>	13	11
	<i>Intermediary</i>	18	18
	<i>High-skilled occupations</i>	53	43
Mountain professional in %	<i>Yes</i>	12	98
	<i>No</i>	88	2
Experience at location			
Visitor type in %	<i>Day tripper</i>	79	50
	<i>Holidayer</i>	21	50
Distance from site in %	<i>Locals</i>	16	6
	<i>Nearby</i>	53	39
	<i>France</i>	24	48
	<i>Foreigner</i>	7	7
Sport characteristics			
Level in %	<i>Beginner</i>	27	40
	<i>Confirmed</i>	51	50
	<i>Expert</i>	22	10
Anteriority in years	<i>Mean</i>	15	24
Federation in %	<i>Yes</i>	46	82
	<i>No</i>	54	18
Motivation for activity (mean score, scale: 1 = totally disagree, 5 = totally agree)	<i>Landscapes observation</i>	4,79	4,79
	<i>Stress reduction</i>	4,14	4,36
	<i>Be with others</i>	4,32	4,06
	<i>Challenge</i>	3,82	3,65
	<i>See wildlife</i>	3,39	3,97
	<i>Technical difficulty</i>	3,41	3,04
	<i>Solitude</i>	3,07	3,09
	<i>Risk taking</i>	2,28	2,13

Supplementary table 1: Socio-demographics, experience at location and sports characteristics (n = 2 050)



Supplementary figure 1: Graphical representation of PCA

Wildlife experience		Ski touring	Hiking
Encounter with wildlife during activity in % (not necessarily on the day of survey)	Yes	87	84
	No	13	16
Wildlife response during encounter in %	Flight	15	14
	Vigilance	35	33
	No observable reaction	51	53
Disturbance of wildlife in %	A lot	1	0,6
	Probably	26	23
	Not really	47	53
	Not at all	18	17
Knowledge of tranquillity areas in %	I don't know	7	6
	Yes	71	44
Avoidance of tranquillity areas in %	No	29	56
	Always	43	41
	Often	43	41
	Rarely	12	14
	Never	2	4

Supplementary table 4: Actual experience with wildlife and tranquillity areas for wildlife (n=2 050)

***“If we really disturbed them, they would leave”*: Mountain sports participants and wildlife disturbance in the Northern French Alps**

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Abstract: This article aims to participate in filling the gap of knowledge in mountain sports participants' perception of wildlife disturbance. In a context of growing popularity of these activities and, consequently, of increase of visitors in the Northern French Alps, we examine visitors of protected areas attitudes toward disturbance and wildlife tranquility areas. The quantitative survey focused on ski tourers and hikers ($N=2\ 050$), it shows that respondents who witnessed disturbance, such as flight response from wildlife, are much more likely to state that they might be a source of disturbance. Additionally, results show that attitudes and values towards wildlife and disturbance are more important than sociodemographic or activity related characteristics to explain perception of self-caused disturbance or avoidance of tranquility areas.

Keywords: mountain sports, wildlife disturbance, perception of disturbance, wildlife tranquility areas

Management implications: Results illustrate the importance of providing protected areas managers with information on visitors as it can help targeting and raising awareness in ways that appeal directly to them, such as:

- By using photos and videos of distressed fleeing wildlife to appeal to emotion and to participate in shifting attitudes toward restricted areas and management measures;
- Targeting participants depending on their level and involvement in the activity;
- Reinforcement of mountain professionals training (mountain guides, ski instructors, mountain leaders etc.) with courses on the ecology and biodiversity of mountain ecosystems.

Dear editors,

On behalf of my co-authors, I am pleased to submit the manuscript entitled “*If we really disturbed them, they would leave*”: Mountain sports participants and wildlife disturbance in the Northern French Alps” by Léna Gruas, Anne Loison, Moussa Ba, Clémence Perrin-Malterre for publication as an original article in the Journal of Outdoor Recreation and Tourisme.

This research is based on a previous systematic review that contributed in mapping the current state of research in wildlife disturbance caused by recreation by showing the gaps in the literature when it comes to the human side of the research. This paper, (« Aware or not aware? A literature review reveals the dearth of evidence on recreationists awareness of wildlife disturbance. » *Wildlife Biology*, n° 4 (2020). <https://doi.org/10.2981/wlb.00713>.) has helped us to prepare the ground for our own research, which is partly presented in this paper.

We are a team of sociologists, ecologist and protected areas managers working hand in hand to characterise the impact and perception of it by skiers and hikers in the French Alps, and we believe publishing our paper in the Journal of Outdoor Recreation will be an opportunity to continue to bring together social sciences and ecology to mitigate the sources and impacts of disturbance efficiently.

We hope you will enjoy reading it as much as we enjoyed writing it.

Best regards,

Dr. Léna Gruas – Post-doc at EDYTEM CNRS, Université Savoie Mont Blanc