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The Impact of Tourist Destinations on Wildlife in Northern Finland

Esa Huhta*

Institute of Natural Resources, Rovaniemi, Finland

Research Article

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***For Correspondence:** Esa Huhta, Institute of Natural Resources, Rovaniemi, Finland

E-mail: esa.huhta@luke.fi

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ABSTRACT

The expansion of tourism in natural areas can have various effects on wildlife species due to urban development, fragmentation of landscapes, and increased disturbance. I conducted a study to examine the potential effects of tourist destinations on four forest grouse and five mammalian species in northern Finland. I analyzed density data obtained from wildlife counts conducted in late summer and mid-winter carried out by hunters between 1989 and 2006. The data was collected in 88 wildlife triangles, each with a length of 12 km, within a 40 km radius around ten tourist destinations in northern Finland. I found that the densities of mountain hare (*Lepidus timidus*) and mustelid species were negatively correlated with the distance to a tourist destination. On the other hand, the densities of adult grouse, juvenile grouse, mountain hare, and mustelids were positively correlated with the area of mixed forests surrounding the destinations. The densities of adult and juvenile grouse were positively correlated, while the densities of pine marten and mustelids were negatively correlated with the area of agricultural land surrounding the destinations. The densities of the studied wildlife species varied among the destinations and years. Based on the results, it can be concluded that the current recreational activities have not caused significant changes in the wildlife in the areas surrounding the tourist destinations studied, when measuring the occurrence and abundance of species. The location of a destination, predator densities, and the landscape structure around the destinations were found to have the most significant impact on the density of wildlife species.

Keywords: Tourist destination; Biodiversity; Forest grouse; Predator species; Wildlife triangle

INTRODUCTION

There is a long-standing tradition of tourism in Lapland, northern Finland. In recent decades, tourism has become a significant source of income, and the leisure industry is now one of the most important economic sectors in Lapland. The number of registered overnight stays in Lapland has been increasing [1]. Tourist destinations, ski resorts, and accommodation areas have often been developed in wilderness or protected areas, such as national parks that are part of the Natura 2000 conservation network. This is because the biodiversity in these areas is an important attraction for tourists. The number of visitors to national parks in Lapland has significantly increased [2]. As the number of visitors continues to rise, there is a greater need for space, infrastructure, and other facilities, which can have negative impacts on wildlife species that are sensitive to disturbances. The increasing popularity of outdoor activities, nature-based tourism, and recreation among tourists leads to urban development, fragmentation of landscapes, and increased disturbance in natural areas. Recreation activities are expanding into new areas, and existing leisure facilities are being expanded. The expansion of tourism, including outdoor sports, recreation, and infrastructure development, into natural areas can have various impacts on biodiversity and wildlife species. These impacts can be either direct such as animals being killed in cable-collisions [3,4] and waste providing supplementary food, or indirect through habitat modification and fragmentation [5]. The expansion of tourist destinations and recreational activities can change the structure of the landscape, resulting in a reduction of wildlife habitats or the degradation of existing habitats. The development of tourist infrastructure, such as buildings, trails, roads, and ski-lifts, creates areas that are unsuitable for wildlife, leading to fragmentation and an increase in human activity in the area. Loss and fragmentation of habitats at local levels can result in the loss of connectivity and gene flow within a population [6]. Additionally, outdoor recreation can disturb wildlife, increase their energy expenditure, lead to reproductive failures, alter their behavior, and cause them to avoid otherwise suitable habitats. Therefore, it is crucial to understand the limits of urban growth and the ecological impacts of urban sprawl, particularly in areas near ecologically valuable regions. This knowledge is also essential for the planning and management of recreational areas as part of ecologically sustainable tourism.

Forest grouse species (tetraonids), as a representative of wildlife species, are considered to be good indicators for habitat and landscape quality [7]. For example, the capercaillie (*Tetrao urogallus*) has been shown to act as an umbrella species for several endangered mountain birds in Central Europe [8]. Forest grouses have large home ranges and they are often characterized by limited habitat preference. They are highly sensitive to human disturbance and to habitat alterations which is needed to be taken into account with regard to tourism projects [9-12]. Several harmful effects of tourism on grouse species have been reported. For example, in areas with ski resorts, collisions with wire fences, overhead wires, and ski wires often result in the death of grouse [3,13]. In the Alps, the disturbance caused by snow sport free-riders increases the concentration of faecal stress hormone in the Black Grouse (*Terao tetrix*) [14]. Cross country ski trails and tracks have been found to reduce the available range for the capercaillie [15,16]. Brenot et al. discovered that when the capercaillie habitat overlaps with cross country skiing facilities in Midi Pyrénées, the population of capercaillie wintering in the area declines [17]. The presence of human activity in the Black Grouse winter habitat may result in a negative energy budget, leading to deaths from starvation or making weakened individuals easy prey for predators [15]. Furthermore, disturbances at traditional lekking sites, which are typically located on ridges and hilltops that are also popular for winter sports, can have a negative impact on the social system of the Black Grouse and consequently their ability to reproduce successfully [15]. In areas where downhill skiing is common, activities such as cleaning up ski centers during the summer and starting the hiking season early can disrupt black grouses during the incubation and rearing of their young [10].The populations of generalist nest predators, such as corvids and red foxes (*Vulpes vulpes*), have been found to be high in urban areas and tourist destinations due to human-generated waste and feeding [11,13,14,18]. In the areas surrounding tourist destinations, corvids and red foxes can have significant impacts on prey species like forest grouses [19-22]. The purpose of this study is to assess how tourist destinations in northern Finland may affect the populations of forest grouse, mammalian predators, and mountain hare (*Lepus timidus*). I predict that the number of forest grouse will increase as the distance from tourist destinations increases, due to reduced human disturbance. Another hypothesis is that tourist destinations may lead to higher densities of mammalian predators. These species may directly or indirectly benefit from human activity, which enhances habitat productivity and provides anthropogenic waste.

MATERIALS AND METHODS

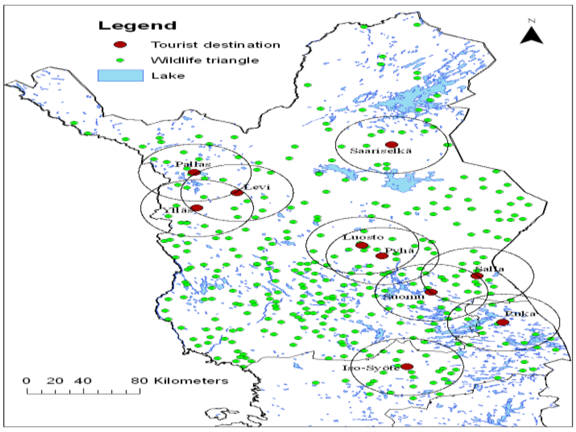
Study area

The study area, which is approximately 36.52 km^2, is primarily located in the northern boreal zone. Only the southernmost parts of the study area are situated in the midboreal zone. The landscape in these areas is characterized by coniferous forests and open mires. In the northern parts of the study area, the average length of the growing season (defined as days with an average temperature of +5˚C or higher) is approximately 100-120 days. The ground is covered in snow for about 6-7 months of the year. The study was conducted in ten tourist destinations and their surrounding areas: Iso-Syöte, Levi, Luosto, Pallastunturi, Pyhätunturi, Ruka, Saariselkä, Sallatunturi, Suomu, and Ylläs. These destinations are all downhill skiing centers, with elevations ranging from approximately 400 meters to over 700 meters a.s.l. (Table 1 and Figure 1).

Table 1. The basic features of the tourist destinations studied. The numbers of registered overnights for Pallas and Suomu were not available. The overnights for Pyhätunturi and Luosto were combined.

Destination	Registered overnight stays	Beds	Length of snowmobile tracks (km)	Length of snowmobile tracks (km)
Pallas	-	130	160	150
Levi	271640	16000	230	750
Ylläs	267339	16000	320	300
Saariselkä	276524	11000	240	1000
Luosto	122090	3500	95	250
Pyhätunturi		3500	70	250
Sallatunturi	66971	2500	110	160
Suomu	-	1500	40	150
Ruka	332227	16000	216	500
Iso-Syöte	51025	5000	120	197

Figure 1. The tourist destinations are represented by red circles. The study areas around each destination are presented as circles with a radius of 40 km. The established wildlife triangles in the study are represented by small green circles.



The main tourist season in the ski centres is winter because they are popular destinations for skiing. However, due to the increasing popularity of nature-based tourism, other seasons such as summer and autumn are also becoming more popular. The number of registered overnight stays in these destinations and their main features during the study period are presented in Table 1. In addition to downhill skiing, there are various activities available for tourists, including cross-country skiing, snowshoe walking, winter fishing, ice climbing, winter golf, dog-sled and reindeer safaris, and snowmobile driving. During the snow-free time, leisure activities such as hiking, berry picking, white water rafting, paddling, fishing, mountain biking, horseback riding, bird watching, rock climbing, hunting, and buggy driving are available. It is important to note that all of these activities may disturb wildlife.

Wildlife triangle data

I used data from Finnish wildlife triangle censuses of tetraonids conducted between 1989 and 2006. The wildlife triangle is the basic unit used to assess wildlife populations in Finland. This monitoring program is organized by the Natural Resources Institute and the Finnish Wildlife Agency, and it is carried out by volunteers. The triangle is a permanent, triangular route that measures 12 km in total (each side is 4 km). It is censused twice a year, once in late summer and once in mid-winter. To ensure random selection of routes, each wildlife triangle is limited to a topographic map sheet measuring 10 x 10 km, and no map sheet should have more than one triangle [23]. The main objective of summer censuses is to count the number of grouse species within a 60 meter wide belt using a chain of three people. All observations of grouse are marked on a topographic map with a scale of 1:20,000. During the winter count, all tracks made by mammals in the snow are recorded. The winter count can be done by one person, and it is recommended to carry out the actual count within a day after a pre-check or a significant snowfall. The total area covered by one triangle in the census is 0.72 km^2. The unit used to measure grouse densities is individuals per square kilometer on forest land, while the densities of mammal species are measured as crossings per 24 hours per 10 kilometers [23].I collected data from 88 wildlife triangles located near tourist destinations within a 40-kilometer radius. If there were multiple tourist destinations within this radius, only the closest destination to each triangle was included. Each triangle was only used once in the study. I measured the distance from the center point of each triangle to the nearest tourist destination. The center point of the tourist destination was determined by either the largest hotel or the hotel closest to the main ski lift. Because not every single triangle was counted every year, I only selected those triangles that were counted at least ten times during the study period. I selected the density data for Capercaillie, Black Grouse, Hazel Grouse (*Bonasa bonasia*), and Willow Grouse (*Lagopus lagopus*) from the summer censuses. From the winter counts, I selected the track density data of mammalian predators, including the red fox (*Vulpes vulpes*), stoat (*Mustela erminea*), least weasel (*Mustela nivalis*), and pine marten (*Martes martes*). Additionally, I assessed the data of mountain hare, which is an important prey species for many predators, from the winter survey data. The analyses were conducted separately for adult and juvenile grouse because the potential effects of tourist destinations may vary between adults and juveniles. In this study, I combined the data from different grouse species because I was interested in the overall effects of tourist destinations on grouse, rather than the effects on individual grouse species. For further analyses, I combined the data of stoats and least weasels, considering them as mustelids.

Landscape data and analyses

Landscape analyses were carried out with ArcMap (ArcGis 9.2) from the CORINE2000 Land Cover. The CORINE2000 classification was based on the interpretation of LANDSAT 7 ETM satellite images from years 1999-2002 and data integration with existing digital map data. The IMAGE2000 national satellite image mosaic was produced from the LANDSAT 7 ETM satellite images. The CLC2000 uses information from several sources: The Finnish Environment Institute, National Land Survey of Finland, The Ministry of the Agriculture and Forestry, Population Register Centre (build-up areas), and satellite image interpretation (Metsähallitus and UPM Kymmene Oy). I created a circle with a radius of 2.5 kilometers (approximately covering an area of 19.63 km^2) around the center point of each wildlife triangle. Within this circle, I determined the proportions of different habitat classes (Table 2). Using a circle with a radius of 2.5 kilometers is a reasonable way to cover the entire triangle area [24]. In order to have more meaningful variables for analysis, I combined discontinuous urban fabric with sport and leisure facilities to represent built-up areas. I also combined non-irrigated arable land and land primarily used for agriculture, which also had significant areas of natural vegetation, into agricultural areas. Shrubs and open areas were derived from classes such as moors and heathland, transitional woodland/shrub (including clear cutting areas and sapling stands), and bare rock. Water courses and water bodies were combined to represent water areas. Broad-leaved forest, coniferous forest, mixed forest, and peat bog were treated as separate habitat classes (Table 2).

Table 2. The average proportions (± S.D) of the different habitat classes in the wildlife triangles surrounding the tourist destinations (within a radius of 2.5 km).

Habitat		Pallas	Levi	Ylläs	Saariselkä	Luosto	Pyhätunturi
Build-up areas		0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.003 ± 0.008
Agricultural areas	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.011 ± 0.020	
Broad-leaved forest	0.064 ± 0.083	0.075 ± 0.069	0.050 ± 0.065	0.014 ± 0.022	0.023 ± 0.024	0.032 ± 0.051	
Coniferous forest		0.224 ± 0.147	0.296 ± 0.140	0.250 ± 0.188	0.540 ± 0.249	0.258 ± 0.168	0.208 ± 0.136
Mixed forest		0.368 ± 0.153	0.265 ± 0.125	0.467 ± 0.158	0.251 ± 0.216	0.335 ± 0.186	0.459 ± 0.196
Shrubs/open areas	0.148 ± 0.203	0.241 ± 0.200	0.211 ± 0.082	0.146 ± 0.187	0.281 ± 0.112	0.188 ± 0.118	
Peatbogs		0.180 ± 0.095	0.117 ± 0.091	0.022 ± 0.015	0.036 ± 0.032	0.066 ± 0.032	0.077 ± 0.055
Water areas		0.018 ± 0.016	0.006 ± 0.129	0.001 ± 0.003	0.014 ± 0.011	0.025 ± 0.026	0.021 ± 0.033

Statistical methods

We chose to use correlation-based principal component analysis in order to minimize the effects of multicollinearity and identify patterns in the data related to habitat structure [25]. The main goal of PCA is to summarize the information from a large number of original variables into a smaller set of composite dimensions, while minimizing the loss of information. PCA is an unconstrained ordination technique, meaning it does not attempt to define the relationship between independent variables and dependent variables. This task is left to subsequent analyses [25]. Only components with an eigenvalue greater than 1.0 were included in further analyses. Coniferous and deciduous forests, as well as shrubs and open areas, were the most dominant habitat classes in the wildlife triangles around the destinations (Tables 2 and 3). In the principal component analysis, the first two components accounted for the majority of the variation. The first principal component axis explained 25.9% of the total variation and showed a positive correlation with the amount of mixed and broad-leaved forests, which represent mixed forests. The second principal component axis explained 23.0% of the total variation and showed a positive correlation with agricultural and built-up areas, representing agricultural land (Table 3).

Table 3. The variables describing the composition of the landscape around the wildlife triangles (with a radius of 2.5 km) are displayed. The component loadings from the PCA analysis, along with the eigenvalues and the proportion of variation explained, are shown. The highest component loadings are highlighted in bold.

Variable	PC1	PC2
Build-up areas	0.222	0.596
Agricultural areas	-0.257	**0.832**
Broad-leaved forest	0.61	0.019
Coniferous forest	-0.841	-0.111
Mixed forest	**0.837**	0.285
Shrubs/open areas	-0.013	-0.402
Peatbogs	0.012	-0.377
Water	-0.416	0.631
Eigenvalues	2.069	1.844
% of variation explained	25.9	23

I used General Linear Models (GLM) to analyze the factors that influence the densities of the species studied, including adult and juvenile forest grouse and predator species. The independent variables in the model were tourist destination (a fixed factor), year (a random factor), distance from the triangle to the nearest tourist destination, and the first two habitat components derived from the PCA (covariates). The interaction term between a tourist destination and distance was also included. However, since distance did not have a significant effect, the interaction term was not included in the final model. Relationships between densities of prey species and predator species were analyzed with general linear models. I only included wildlife triangles that were counted in both summer and winter in the analysis. The models for prey species densities included habitat components (PC1 and PC2), year, and the abundance of the red fox. The red fox was chosen to the models because it is an important predator that limits the numbers of hare and grouse [26]. All statistical analyses were conducted using SPSS 9.05 for Windows.

RESULTS

In general, the densities of adult and juvenile grouse, mountain hare, redfox, and mustelids varied between the study years (Table 4). Further the densities of wildlife species varied between the surroundings of the tourist destinations studied (Tables 4 and 5). The spatial variation in densities was higher in mountain hare (2.1-15.1 crossings/24 h/10 km) and grouse species (2.7-12.0 individuals/km^2) than in predator species (Table 4).

Table 4. The mean (± S.D) abundances of wildlife species around the tourist destinations.

Destination	N	Mean (± S.D)					
		Red fox	Mustelids	Mountain hare	Pine marten	Adult grouse	Juvenile grouse
Pallas	57	2.3 ± 2.6	1.5 ± 2.5	5.8 ± 7.4	1.0 ± 1.3	2.7 ± 2.4	4.0 ± 6.5
Levi	37	3.9 ± 2.8	2.1 ± 4.0	5.2 ± 4.7	0.7 ± 1.1	3.4 ± 3.7	3.2 ± 4.8
Ylläs	83	3.1 ± 2.4	1.9 ± 3.0	8.7 ± 9.7	0.6 ± 1.4	4.7 ± 5.2	3.8 ± 5.0
Saariselkä	67	1.9 ± 1.6	1.1 ± 1.6	2.1 ± 2.9	0.3 ± 0.5	3.2 ± 3.2	3.3 ± 5.2
Luosto	57	2.5 ± 2.2	0.9 ± 1.5	8.3 ± 9.6	0.3 ± 0.6	4.3 ± 3.8	5.9 ± 9.0
Pyhätunturi	183	3.8 ± 3.3	2.5 ± 6.4	12.9 ± 13.5	0.5 ± 1.0	7.4 ± 6.0	8.8 ± 11.3
Sallatunturi	194	3.7 ± 6.1	2.0 ± 2.7	13.9 ± 15.6	0.3 ± 0.8	6.9 ± 7.2	7.2 ± 8.2
Suomu	169	3.7 ± 4.7	2.0 ± 4.0	12.7 ± 15.1	0.4 ± 0.8	6.4 ± 5.3	7.1 ± 8.9
Ruka	44	3.2 ± 2.8	2.2 ± 3.0	10.5 ± 8.5	0.5 ± 1.1	9.3 ± 6.8	12.0 ± 14.6
Iso-Syöte	142	4.0 ± 3.3	1.6 ± 2.8	15.1 ± 16.7	0.6 ± 0.8	8.8 ± 6.3	8.7 ± 8.9

Note: N=number of observations. The unit for grouse densities is individuals per square kilometer on forest land, and for densities of mammal species, it is crossings per 24 hours per 10 kilometers.

Based on the results, the densities of mountain hares and mustelids decreased as the distance to tourist destinations increased. However, there was no correlation between the distance to a tourist destination and grouse densities or the densities of red foxes and pine martens. Among the habitat variables, the densities of adult and juvenile grouse, mountain hares, and mustelids were positively correlated with the amount of mixed forest. The densities of adult and juvenile grouse were positively correlated, while the density of pine martens and mustelids were negatively correlated with the amount of agricultural land (Table 5).

Table 5. The results of general linear models for wildlife densities, year, habitat, variables, and distance to destination. PC1 represents mixed forest habitat, while PC2 represents agricultural land.

(5a) Adult grouse individuals/km^2

Source	B	Std. error	df	F	t	p
Intercept	10.78	0.87	1, 52.458	73.886	12.391	<0.001
Year			17, 1149	10.11		<0.001
PC1	0.982	0.189	1, 1149	27.018	5.198	<0.001
PC2	0.966	0.18	1, 1149	28.889	5.375	<0.001
Distance	0.01	0.017	1, 1149	0.374	0.612	ns
Destination			9, 1149	17.466		<0.001

(5b) Juvenile grouse individuals/km^2.

Source	B	Std. error	df	F	t	p
Intercept	13.858	1.452	1, 112.712	64.2	9.542	<0.001
Year			17, 1149	4.756		<0.001
PC1	1.044	0.315	1, 1149	10.969	3.312	<0.01

PC2	0.877	0.3	1, 1149	8.547	2.923	<0.01
Distance	-0.028	0.028	1, 1149	1.012	-1.006	ns
Destination			9, 1149	7.205		<0.001

(5c) Mountain hare crossings/24 h/10 km.

Source	B	Std. error	df	F	t	p
Intercept	17.856	2.2	1, 78.750	75.534	8.116	<0.001
Year			17, 1003	6.288		<0.001
PC1	2.966	0.54	1, 1003	30.165	5.492	<0.001
PC2	0.285	0.529	1, 1003	0.289	0.538	ns
Distance	-0.118	0.046	1, 1003	6.568	-2.563	<0.05
Destination			9, 1003	10.4		<0.001

(5d) Red fox crossings/24 h/10 km.

Source	B	Std. error	df	F	t	p
Intercept	3.519	0.704	1, 315.504	76.12	4.997	<0.001
Year			17, 1003	1.944		<0.05
PC1	0.016	0.173	1, 1003	0.009	0.095	ns
PC2	0.087	0.169	1, 1003	0.263	0.513	ns
Distance	-0.002	0.015	1, 1003	0.017	-0.13	ns
Destination			9, 1003	2.708		<0.01

(5e) Pine marten crossings/24 h/10 km

Source	B	Std. error	df	F	t	p
Intercept	0.7	0.164	1, 394.284	37.506	4.265	<0.001
Year			17, 1003	1.603		ns
PC1	0.011	0.04	1, 1003	0.072	0.268	ns
PC2	-0.165	0.039	1, 1003	17.532	-4.187	<0.001
Distance	-0.001	0.003	1, 1003	0.05	-0.223	ns
Destination			9, 1003	3.811		<0.001

(5f) Mustelids crossings/24 h/10 km

Source	B	Std. error	df	F	t	p
Intercept	0.7	0.164	1, 394.284	37.506	4.265	<0.001
Year			17, 1003	1.603		ns
PC1	0.011	0.04	1, 1003	0.072	0.268	ns
PC2	-0.165	0.039	1, 1003	17.532	-4.187	< 0.001
Distance	-0.001	0.003	1, 1003	0.05	-0.223	ns
Destination			9, 1003	3.811		< 0.001

The abundance of red foxes significantly explained the densities of mountain hares, but the abundances of predators did not affect grouse densities (Table 6).

Table 6. The results of general linear models for the densities of prey species, habitat variables and red fox density. PC1 represents mixed forest habitat, while PC2 represents agricultural land.

(6a) Mountain hare crossings/24 h/10 km.

Source	B	Std. error	df	F	T	p
Intercept	7.004	1.928	1, 25.326	46.65	3.632	<0.001
Year			17, 843	5.171		<0.001
PC1	2.285	0.473	1, 843	23.291	4.826	<0.001
PC2	0.797	0.473	1, 843	2.834	1.683	ns
Red fox	1.306	1.129	1, 843	103.075	10.153	<0.001

(6b) Adult grouse individuals/km^2.

Source	B	Std. error	df	F	T	p
Intercept	8.03	0.849	1, 22.244	114.409	9.459	<0.001
Year			17, 843	7.935		<0.001
PC1	0.375	0.208	1, 843	3.233	1.798	ns
PC2	1.653	0.208	1, 843	62.978	7.936	<0.001
Red fox	0.079	0.057	1, 843	1.934	1.391	ns

(6C) Juvenile grouse individuals/km^2.

Source	B	Std. error	df	F	T	p
Intercept	10.389	1.399	1, 28.375	88.116	7.427	<0.001
Year			17, 843	3.902		<0.001
PC1	-0.04	0.343	1, 843	0.014	-0.116	ns
PC2	2.216	0.343	1, 843	41.688	6.457	<0.001
Red fox	0.107	0.093	1, 843	1.308	1.144	ns

DISCUSSION

The densities of the grouse species that were studied were not affected by the distance to the tourist destinations. However, the densities of the mountain hare and the mustelids increased as they got closer to the destinations. Based on these findings, it can be concluded that the current recreational activities have not had significant negative effects on the wildlife living near the tourist destinations studied. The tourist destinations may offer human-made food sources and suitable foraging habitats, such as edge habitats and open areas. These factors can have a positive impact on the survival of wildlife. Mustelids may follow their main prey species, small rodents, which are likely to prefer urban and cultivated areas within the destinations. Most vole species eat the bark of trees and bushes, as well as the roots of young trees, Carex species, and grasses. These types of food are abundant in gardens, grassy areas, and edge habitats. According to a study conducted by Heikkilä et al. in the Levi and Ylläs tourist destinations, the density of mountain hares and mustelids was higher in the developed areas and campfire sites of the destinations compared to forest areas in the Pallas-Yllästunturi National Park [27]. Additionally, the density of voles was higher in areas with tourism-related infrastructure than in natural areas. The reason for the higher densities of mustelids near the destinations may be that mustelids, being more specialized predators of voles compared to red foxes and pine martens, prefer the same habitats that voles inhabit [28]. The presence of agricultural land is positively correlated with higher densities of adult and juvenile grouse, but negatively correlated with densities of pine marten. This suggests that the agricultural habitat is generally more productive for grouse. Previous studies have shown that the likelihood of finding a grouse hen with a brood is much higher in wildlife triangles located near fields. In areas with high productivity, agricultural lands have been cleared. As a result, the surrounding forest stands may also have higher productivity and offer a more suitable breeding habitat for grouse [29,30]. The pine marten is a species that is strictly dependent on forests [31]. In our study, we observed a positive relationship between pine marten density and mixed forests, as well as a negative relationship between marten density and agricultural land. Kurki et al. found that the negative effect of increasing agricultural land was particularly strong in northern Finland [32]. They suggested that the presence of agricultural fields likely indicates the presence of villages, and that disturbance and hunting pressure may be higher near villages. This could explain the negative correlation between pine marten abundance and agricultural land. The presence of mixed forests is positively associated with the populations of mountain hare, adult grouse, and juvenile grouse. Hiltunen et al. found that hares prefer thickets of willow Salix spp., downy birch *Betula pubescens*, and spruce Picea *abies* during the summer [33]. Additionally, aspen is known to be an important source of nutrition for hares in their winter diet in Finnish Lapland [34]. Dense understories are crucial for the mountain hare's habitat use, as they provide both food and protection against predators [33]. The significance of mixed forests for grouse is not surprising, as all grouse species require both conifers and broad-leaved trees for either food or shelter from predators [12,35,37,38].

The density of all species varied among the tourist destinations, with most species being more abundant in southern destinations compared to northern ones. The differences in species densities between destinations are likely due to a general decrease in productivity from south to north. The density of wildlife species, except for the density of pine marten, also varied between different study years. This finding aligns with previous studies [39,40] that have reported significant temporal variations, sometimes in a cyclic pattern, in wildlife species densities. These results emphasize the importance of conducting research over multiple years when studying the habitat association of wildlife species. The landscape data was only available for the year 2000, so how the landscape has changed over the past eighteen years remains unknown. Additionally, digital data on the location and length of snowmobile and cross-country ski routes, which could potentially disturb the landscape and have a negative impact on species like grouse during their display season was not available. More information is needed on the spatial distribution and frequency of use of cross-country ski routes and snowmobile routes, among other factors [41-45].

CONCLUSION

Overall, the tourist destinations do not have a significant impact on the densities of the wildlife species studied when measuring the occurrence and abundance of species in the area. The densities of the species were not lower near the tourist destinations; in fact, the numbers of mountain hare and mustelids were higher near the tourist destinations compared to areas further away. This suggests that human disturbance and recreational activities are not negatively impacting the species, at least within the spatial scale of this study. The location of the tourist destinations and the surrounding landscape structure seem to have a greater influence on the densities of wildlife species than the tourist destinations themselves. The tourist destinations that were studied are relatively small, indicating that the level of human disturbance is not very high. Additionally, some of the destinations are located in the middle of wilderness areas with a large proportion of old forests. The nearby pristine forest landscape may offset any harmful effects of the tourist destinations on wildlife populations by providing alternative habitats for the animals from the surrounding pristine forest. However, it is possible that negative impacts of tourism on wildlife populations may occur with a delay.

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REFERENCES

1. Official Statistics of Finland. Accommodation statistics [e-publication]. 2022.
2. Metsähallitus. Development of national park visits and national park network. 2012-2022.
3. Miquet A. A contribution to the study of the relation between the black grouse (*Tetrao tetrix L., Tetraonidae*) and winter tourism in Haute-Tarentaise. Acta Oecol (Oecologia Applicata). 1986;7:325-335.
4. Storch I. Chairman´s column. Grouse News. 1998;15:3-8.
5. Storch I. An overview to population status and conservation of black grouse worldwide. Cahiers d'Ethologie. 2000;20:153-164.
6. Saunders DA, et al. Biological consequences of ecosystem fragmentation: A review. Conserv Biol. 1991;5:18-32.
7. Lindén H, et al. Preface: The welfare on wildlife reflects the welfare of nature – wildlife monitoring produces easily understandable parameters. Finnish Game Research. 1996;49:3.
8. Suter W, et al. Capercaillie (*Tetrao urogallus*) and avian biodiversity: testing the umbrella-species concept. Conserv Biol. 2002;16:778-788.
9. Rolstad J, et al. Habitat characteristics of capercaillie *Tetrao urogallus* display grounds in southeastern Norway. Holarctic Ecology. 1987;10:219-229.
10. Zeitler A. Human disturbance, behaviour and spatial distribution of black grouse in skiing areas in the Bavarian Alps. Cahiers d'Ethologie. 2000;381-402.
11. Storch I, et al. Tourism, mountain huts and distribution of corvids in the Bavarian Alps, Germany. Wildlife Biol. 2003;9:301-308.
12. Sachot S, et al. Winter habitat selection by two sympatric forest grouse in western Switzerland: Implications for conservation. Biol Conserv.2003;112:373-382.
13. Watson A, et al. Impacts of ski-development on ptarmigan (*Lagopus mutus*) at Cairn Gorm, Scotland. Biol Conserv. 2004;116:267-275.
14. Arlettaz R, et al. Spreading free-riding snow sports represent a novel serious threat for wildlife. Proc Biol Sci. 2007;74:1219-1224.
15. Ménoni E, et al. Human disturbance of grouse in France. Grouse News. 1998;15:4-8.
16. Summers RW, et al. Measuring avoidance by cappercaillies *Tetrao urogallus* of woodland close to tracks. Wildlife Biol. 2007;13:19-27.
17. Brenot JF, et al. The effects of the Plateau de Beille cross-country ski station (Ariège) on an important population of the capercaillie *Tetrao urogallus*. Alauda.1996;64:249-260.
18. Jokimäki J, et al. Artificial nest predation and abundance of birds along an urban gradient. The Condor 2000;102:838-847.
19. Huhta E. et al. The impact of nature-based tourism on bird communities: A case study in Pallas-Ylla¨stunturi national park. Environ Manage. 2014;53:1005–1014.
20. Vainio M, et al. The winter diet of red fox in eastern Central Finland. Suomen Riista. 1997;43:56-64.
21. Pickering CM, et al. Environmental impacts of tourism on the Australian Alps protected areas. MRD. 2003;23:247-254.

22. Contesse P, et al. The diet of urban foxes (*Vulpes vulpes*) and the availability of anthropogenic food in the city of Zurich, Switzerland. Mamm Biol. 2004;69:81-95.
23. Lindén H, et al. Wildlife triangle scheme in Finland: Methods and aims for monitoring wildlife populations. Finnish Game Research. 1996;49:4-11.
24. Helle P, et al. Usage of Geographic Information Systems (GIS) in analyses of wildlife triangle data. Finnish Game Research. 1996;49:26-36.
25. McGarigal K, et al. Multivariate statistics for wildlife and ecology research. 2000. [Google Scholar]
26. Lindström ER, et al. Disease reveals the predator: sarcoptic mange, red fox predation, and prey populations. Ecol. 1994;75:1042-1049.
27. Heikkilä T, et al. Effects of nature-based tourism on mammal densities on three different levels of disturbance in western Finnish Lapland. Nature and Tourism. 2007.
28. Hanski I, et al. Specialist predators, generalist predators, and the microtine rodent cycle. J Anim Ecol. 1991;60:353-367.
29. Kurki S, et al. Forest fragmentation due to agriculture affects the reproductive success of the ground-nesting black grouse *Tetrao tetrix*. Ecography. 1995;18:109-113.
30. Kurki S, et al. Landscape fragmentation and forest composition effects on grouse breeding success in boreal forests. Ecology. 2000;81:1985-1997.
31. Storch I, et al. Diet and habitat selection of the pine marten in relation to competition with the red fox. Acta Theriologica. 1990;35:311-320.
32. Kurki S, et al. Abundances of red fox and pine marten in relation to the composition of boreal forest landscapes. J Anim Ecol. 1998;67:874-886.
33. Hiltunen M, et al. Habitat use of the mountain hare *Lepus timidus* in summer: the importance of different vegetation layers. Acta Theriologica. 2004;49:479-490.
34. Pulliainen E, et al. Winter diet, habitat selection and fluctuation of a mountain hare *Lepus timidus* population in Finnish Forest Lapland. Holarctic Ecology.1987;10:261-267.
35. Seiskari P. On the winter ecology of the capercaillie, *Tetrao urogallus*, and black grouse, *Lyrurus tetrix*, in Finland. Game Research. 1962;22:1-119.
36. Pulliainen E. Autumn and winter habitat selection in the willow grouse (*Lagopus lagopus*) in northern Finland. Suomen Riista. 1982;29:46-52.
37. Åberg J, et al. The habitat requirements of hazel grouse (*Bonasa bonasia*) in managed boreal forest and applicability of forest stand descriptions as a tool to identify suitable patches. For Ecol Manag. 2003;175:437-444.
38. Siivonen. On the short-term fluctuations in numbers of tetraonids. Game Research. 1954;13:1-10.
39. Lindén, H. Characteristics of tetraonid cycles in Finland. Finnish Game Research. 1989;46:34-42.
40. Ahti T, et al. Vegetation zones and their sections in northwestern Europe. Ann Bot Fenn. 1968;5:169-211.
41. Aunapuu M, et al. Habitat selection of coexisting competitors: a study of small mustelids in northern Norway. Evol Ecol. 2003;17:371-392.
42. Hansson L. Dynamics and trophic interactions of small rodents: Landscape or regional effects on spatial variation? Oecologia. 2002;130:259-266.
43. Henttonen H. Does an increase in the rodent and predator densities, resulting from modern forestry, contribute to the long-term decline in Finnish tetraonids? Suomen Riista. 1989;35:83-90.

44. Kurki S, et al. Breeding success of black grouse and capercaillie in relation to mammalian predator densities on two spatial scale. Oikos. 1997;79:301-310.
45. Väisänen RA. Winter birds in Finland in 1993/94 and the most abundant species in the censuses of last 19 winters. Linnut. 1994;29:20-26.