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# The impact of tourist destinations on wildlife in northern Finland

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## ABSTRACT

Increased tourism impact, recreational activities and structures in natural areas can affect wildlife by increasing urbanization, landscape fragmentation and disturbance. I examined the potential effects of tourist destinations on four forest grouse (Tetraoninae) and five mammalian species in northern Finland. I analyzed density data obtained from wildlife counts carried out by hunters around ten tourist destinations. The densities of mountain hare and mustelid species were negatively correlated with the distance to a tourist destination. 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 destinations and years. It seems that current recreational activities have not caused significant changes in the occurrence and abundance of wildlife species in the surroundings of the tourist destinations studied. Location of a destination, predator densities, and landscape structure around the destination had the most impact on the density of wildlife species.

## RÉSUMÉ

L'augmentation des effets du tourisme, des activités de récréation et des infrastructures dans les zones naturelles peut affecter la faune en augmentant l'urbanisation, la fragmentation du paysage et les perturbations. J'ai examiné les effets potentiels de destinations touristiques sur quatre espèces de Tetraoninae (tétràs, gélinottes et lagopèdes) et cinq espèces de mammifères dans le nord de la Finlande. J'ai analysé les données de densité obtenues de comptages faits par des chasseurs autour de dix destinations touristiques. Les densités de lièvres variables et de mustélidés étaient corrélées négativement avec la distance à une destination touristique. Les densités de Tetraoninae jeunes et adultes, de lièvres variables et de mustélidés étaient positivement corrélées avec la superficie de forêt mixte autour des destinations. Les densités de Tetraoninae jeunes et adultes étaient positivement corrélées avec la superficie de terres agricoles autour des destinations, alors que les densités de martres des pins et de mustélidés étaient négativement corrélées. Les densités des espèces étudiées variaient selon les destinations et les années. Il semble que les activités récréatives actuelles n'ont pas causé de changements significatifs de l'occurrence et de l'abondance des espèces fauniques entourant les destinations touristiques étudiées. L'emplacement d'une destination, les densités de prédateurs et la structure du paysage autour de la destination avaient le plus d'effet sur la densité des espèces fauniques.

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récréation; effet du tourisme

## 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 (Official Statistics of Finland, 2022). 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 biodiversity in these areas is an

important attraction for tourists (Puustinen et al. 2009; Lyon et al. 2012; Siikamäki et al. 2015). Protected areas with high biodiversity values can attract more visitors and can further have greater potential for delivering socio-economic benefits to local communities through nature-based tourism, thus providing economic justification for nature protection (Naidoo et al. 2011; Lyon et al. 2012). The importance of nature as a tourist attraction has increased visitor numbers in protected areas globally (Balmford et al. 2009; Siikamäki et al. 2015). The number of visitors to national parks in Lapland has significantly increased (Metsähallitus, 2022). As the number of visitors

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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.

Tourism and recreation are known to affect wildlife directly and indirectly (Tolvanen and Kangas 2016). The increasing popularity of outdoor activities, nature-based tourism, and recreation leads to urban development, landscape fragmentation, and increased disturbance in natural areas (e.g., Tolvanen and Kangas 2016). Recreation activities are expanding into new areas, and existing leisure facilities are being expanded. The increase 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 (e.g., Miquet 1986; Storch 1998) or waste providing supplementary food (e.g., Pickering et al. 2003), or indirect through habitat modification and fragmentation (Storch 2000). The expansion of tourist destinations and recreational activities can change the structure of the landscape, resulting in degradation and reduction of wildlife habitats. The development of tourist infrastructure, such as buildings, trails, roads, and ski-lifts, creates areas that may be unsuitable for wildlife, leading to habitat fragmentation and increased human activity (Pickering et al. 2003; Laiolo and Ronaldo 2005; Balmford et al. 2009).

Loss and fragmentation of habitats at local levels can result in the loss of connectivity and gene flow within a population (Saunders et al. 1991). 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 (Burger and Gochfeld 1998; Miller and Hobbs 2000; Taylor and Knight 2003; Laiolo and Ronaldo 2005; Balmford et al. 2009; Tolvanen and Kangas 2016; Larm et al. 2021). 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. Sustainability principles refer to the suitable balance between management, environmental, economic, and socio-cultural aspects of tourism development necessary to guarantee its long-term sustainability (World Trade Organization, 2004; Lim and McAleer 2005).

Forest grouse species (Tetraoninae) are considered to be good indicators of habitat and landscape quality (Lindén and Helle 1996). For example, the capercaillie (*Tetrao urogallus*) has been shown to act as an umbrella species for several endangered mountain birds in

Central Europe (Suter et al. 2002). 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 need to be taken into account in tourism projects (Rolstad and Wegge 1987; Zeitler 2000; Sachot et al. 2003).

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 (e.g., Miquet 1986; Watson and Moss 2004). In the Alps, the disturbance caused by snow sport free-riders increases the concentration of faecal stress hormone in the black grouse (*Tetrao tetrix*) and capercaillie (Arlettaz et al. 2007; Thiel et al. 2011). Cross country ski trails and tracks have been found to reduce the available range for the capercaillie, black grouse, and hazel grouse (*Tetrastes bonasia*) (Brenot et al. 1996; Ménoni and Magnani 1998; Summers et al. 2007). According to Matysek et al. (2020) and Tost et al. (2020), when capercaillie habitat overlaps with cross country skiing facilities in Midi Pyrénées, the population of capercaillie wintering in the area declines. 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 (Ménoni and Magnani 1998). 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 (Ménoni and Magnani 1998). 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 (Zeitler 2000).

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 (Jokimäki and Huhta 2000; Storch and Leidenberger 2003; Watson and Moss 2004; Huhta and Sulkava 2014). In the areas surrounding tourist destinations, corvids and red foxes can have significant impacts on prey species like forest grouses (Vainio et al. 1997; Pickering et al. 2003; Contesse et al. 2004; Kaisanlahti et al. 2012).

The purpose of this study was to assess how tourist destinations in northern Finland affect the populations of forest grouses, mammalian predators, and mountain hares (*Lepus timidus*). I predicted that the number of forest grouses would increase as the distance from tourist destinations increases, due to reduced human

disturbance. The second hypothesis I tested was 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.

## Material and methods

### Study area

The study area, which is approximately 36522 km<sup>2</sup>, is primarily located in the northern boreal zone. Only the southernmost parts of the study area are located in the midboreal zone (Ahti et al. 1968). 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 (Finnish Meteorological Institute, n.d.). The study was conducted in the ten largest tourist destinations in Finnish Lapland and their surrounding areas: Iso-Syöte, Levi, Luosto, Pallastunturi, Pyhäntunturi, Ruka, Saariselkä, Sallatunturi, Suomu, and Ylläs. These destinations are all downhill skiing centers, with elevations ranging from approximately 400 m to over 700 m a.s.l (Official Statistics of Finland 2022, Table 1, Figure 1).

The main tourist season in the study sites 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 (Official Statistics of Finland 2022). 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. All of these activities may disturb wildlife.

### Wildlife triangle data

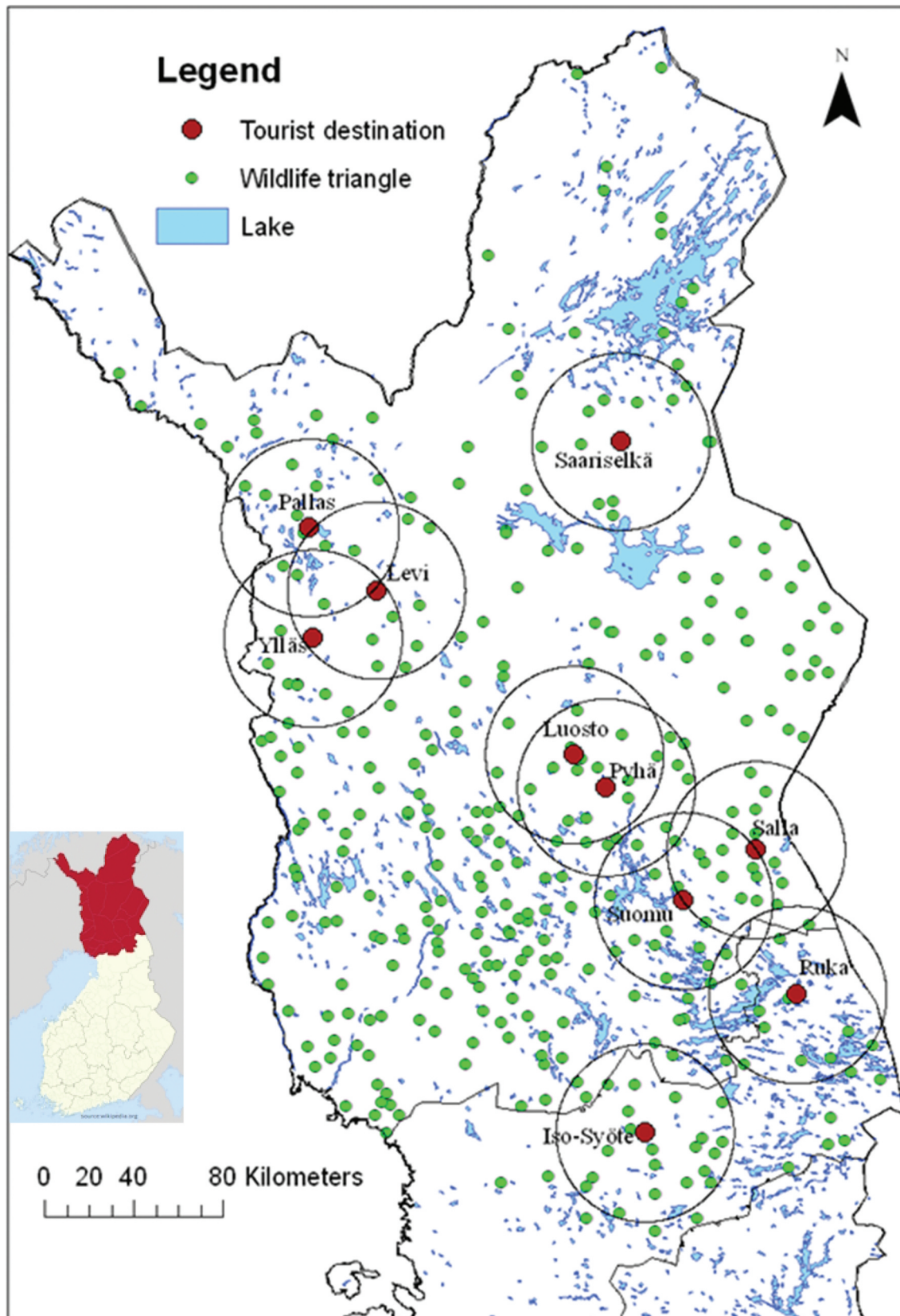
I used data from Finnish wildlife triangle censuses of tetraonids (Lindén et al. 1996; Natural Resources Institute Finland n.d.). The wildlife triangle is the basic unit used to assess wildlife populations in Finland. This monitoring program is organized by the Natural Resources Institute and the Finnish 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 × 10 km, and no map sheet has more than one triangle (Lindén et al. 1996).

The main objective of summer censuses is to count the number of grouse species within a 60-m 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<sup>2</sup>. The unit used to measure grouse densities is individuals/km<sup>2</sup> on forest land, while the densities of mammal species are measured as crossings/24 h/10 km (Lindén et al. 1996).

I collected data from 88 wildlife triangles located near tourist destinations within a 40-km 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

**Table 1.** Basic features of the studied tourist destinations (Official Statistics of Finland 2022). Numbers of registered overnights for Pallas and Suomu were not available. The overnights for Pyhäntunturi and Luosto were combined.

Destination	Registered overnight stays	Beds	Length of ski 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
Pyhäntunturi	-	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.** Locations of the studied tourist destinations (red circles). The study area around each destination is represented as a circle with a radius of 40 km. The established wildlife triangles in the study are represented by small green circles.

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 (*Tetrastes bonasia*), and willow grouse (*Lagopus lagopus*) from the summer censuses. From the winter counts, I selected the track density data of small and medium-sized mammalian predators; red fox, 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 with age. 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 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 (built-up areas), and satellite image interpretation (Corine Land Cover 2000).

I created a circle with a radius of 2.5 km (approximately covering an area of 19.63 km<sup>2</sup>) 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 km is a reasonable way to cover the entire triangle area (Helle and Nikula 1996). 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 clearcut areas and sapling stands), and

Table 2. Average proportions ( $\pm$  S.D.) of different habitat classes in the wildlife triangles surrounding the studied tourist destinations (within a radius of 2.5 km).

Habitat	Pallas	Levi	Yläis	Saariselkä	Luosto	Pyhäntunturi	Sallatunturi	Suomu	Ruka	Iso-Syöte
Built-up	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.003 $\pm$ 0.008	0.000 $\pm$ 0.000	0.000 $\pm$ 0.002	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000
Agricultural	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.000 $\pm$ 0.000	0.011 $\pm$ 0.020	0.009 $\pm$ 0.021	0.006 $\pm$ 0.011	0.043 $\pm$ 0.039	0.005 $\pm$ 0.008
Broad-leaved forest	0.064 $\pm$ 0.083	0.075 $\pm$ 0.069	0.050 $\pm$ 0.065	0.014 $\pm$ 0.022	0.023 $\pm$ 0.024	0.032 $\pm$ 0.051	0.031 $\pm$ 0.055	0.014 $\pm$ 0.040	0.000 $\pm$ 0.000	0.003 $\pm$ 0.008
Coniferous forest	0.224 $\pm$ 0.147	0.296 $\pm$ 0.140	0.250 $\pm$ 0.188	0.540 $\pm$ 0.249	0.258 $\pm$ 0.168	0.208 $\pm$ 0.136	0.252 $\pm$ 0.163	0.464 $\pm$ 0.206	0.438 $\pm$ 0.163	0.363 $\pm$ 0.183
Mixed forest	0.368 $\pm$ 0.153	0.265 $\pm$ 0.125	0.467 $\pm$ 0.158	0.251 $\pm$ 0.216	0.335 $\pm$ 0.186	0.459 $\pm$ 0.196	0.406 $\pm$ 0.179	0.247 $\pm$ 0.205	0.191 $\pm$ 0.194	0.260 $\pm$ 0.154
Shrubs/open	0.148 $\pm$ 0.203	0.241 $\pm$ 0.200	0.211 $\pm$ 0.082	0.146 $\pm$ 0.187	0.281 $\pm$ 0.112	0.188 $\pm$ 0.118	0.191 $\pm$ 0.079	0.192 $\pm$ 0.113	0.146 $\pm$ 0.098	0.260 $\pm$ 0.117
Peat bog	0.180 $\pm$ 0.095	0.117 $\pm$ 0.091	0.022 $\pm$ 0.015	0.036 $\pm$ 0.032	0.066 $\pm$ 0.032	0.077 $\pm$ 0.055	0.103 $\pm$ 0.108	0.041 $\pm$ 0.046	0.052 $\pm$ 0.077	0.097 $\pm$ 0.116
Water	0.018 $\pm$ 0.016	0.006 $\pm$ 0.129	0.001 $\pm$ 0.003	0.014 $\pm$ 0.011	0.025 $\pm$ 0.026	0.021 $\pm$ 0.033	0.009 $\pm$ 0.011	0.036 $\pm$ 0.034	0.130 $\pm$ 0.142	0.013 $\pm$ 0.014

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).

### Statistical methods

I chose to use correlation-based principal component analysis (PCA; McGarigal et al. 2000) in order to minimize the effects of multicollinearity and identify patterns in the data related to habitat structure. 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 (McGarigal et al. 2000). 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).

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 for the models because it is an important predator that limits the numbers of hare and grouse (Lindström et al. 1994). All statistical analyses were conducted using SPSS 9.05 for Windows. The reported significance level is  $p < 0.05$ .

### Results

In general, the densities of adult and juvenile grouse, mountain hare, red fox, and mustelids varied between study years and tourist destinations (Tables 4 and 5). The spatial variation in densities was higher for mountain hare (2.1–15.1 crossings/24 h/10 km) and grouse species (2.7–12.0 individuals/km<sup>2</sup>) than for predator species (Table 4).

The densities of mountain hares and mustelids decreased as the distance to tourist destinations increased (Table 5). However, there was no correlation between the distance to a tourist destination and grouse densities or the densities of red foxes and pine martens (Table 5). Among the habitat variables, the densities of adult and juvenile grouses, mountain hares, and mustelids were positively correlated with the amount of mixed forest. The densities of adult and juvenile grouses were positively correlated, while the densities of pine martens and mustelids were negatively correlated with the amount of agricultural land (Table 5). The abundance of red foxes was positively correlated with the density of mountain hares, but the abundances of predators did not affect grouse density (Table 6).

### Discussion

The densities of the studied grouse species were not affected by distance to a tourist destination. However, the densities of mountain hare and mustelids were higher closer to tourist destinations. Based on these findings, it can be concluded that current land use and recreational activities have not had significant negative effects on the wildlife living near the tourist destinations studied.

**Table 3.** Variables describing landscape composition around the wildlife triangles (within a radius of 2.5 km).

Variable	PC1	PC2
Built-up	0.222	0.596
Agricultural	−0.257	<b>0.832</b>
Broad-leaved forest	0.610	0.019
Coniferous forest	−0.841	−0.111
Mixed forest	<b>0.837</b>	0.285
Shrubs/open	−0.013	−0.402
Peat bog	0.012	−0.377
Water	−0.416	0.631
Eigenvalues	2.069	1.844
% of variation explained	25.9	23.0

The component loadings from the PCA analysis are shown, along with the eigenvalues and the proportion of variation explained. The highest component loadings are highlighted in bold.

**Table 4.** Mean ( $\pm$  S.D.) abundances of wildlife species around tourist destinations.

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

N = number of observations. The density unit for grouse is individuals/km<sup>2</sup> in forest land, whereas for mammal species it is crossings/24 h/10 km.

**Table 5.** Results of general linear models for wildlife densities, year, habitat variables, and distance to destination.

Source	B	Std. Error	df	F	t	p
<b>Adult grouse individuals/km<sup>2</sup></b>						
Intercept	10.781	0.870	1, 52.458	73.886	12.391	<0.001
Year			17, 1149	10.110		<0.001
PC1	0.982	0.189	1, 1149	27.018	5.198	<0.001
PC2	0.966	0.180	1, 1149	28.889	5.375	<0.001
Distance	0.010	0.017	1, 1149	0.374	0.612	ns
Destination			9, 1149	17.466		<0.001
<b>Juvenile grouse individuals/km<sup>2</sup></b>						
Intercept	13.858	1.452	1, 112.712	64.200	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	0.300	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
<b>Mountain hare crossings/24 h/10 km</b>						
Intercept	17.856	2.200	1, 78.750	75.534	8.116	<0.001
Year			17, 1003	6.288		<0.001
PC1	2.966	0.540	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	10.400		<0.001
<b>Red fox crossings/24 h/10 km</b>						
Intercept	3.519	0.704	1, 315.504	76.120	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	-0.130	ns
Destination			9, 1003	2.708		<0.01
<b>Pine marten crossings/24 h/10 km</b>						
Intercept	0.700	0.164	1, 394.284	37.506	4.265	<0.001
Year			17, 1003	1.603		ns
PC1	0.011	0.040	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	0.050	-0.223	ns
Destination			9, 1003	3.811		<0.001
<b>Mustelids crossings/24 h/10 km</b>						
Intercept	1.283	0.628	1, 50.848	40.816	2.042	<0.001
Year			17, 1003	10.040		<0.001
PC1	0.435	0.154	1, 1003	7.974	2.824	<0.01
PC2	-0.464	0.151	1, 1003	9.421	-3.069	<0.01
Distance	-0.044	0.013	1, 1003	11.105	-3.332	<0.01
Destination			9, 1003	2.341		<0.05

PC1 = mixed forest habitat; PC2 = agricultural land.

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 wildlife survival (Henttonen 1989; Budela et al. 1998; Newsome and van Eeden

2017). 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 (Hansson and

**Table 6.** Results of general linear models for the densities of prey species, habitat variables and red fox density.

Source	B	Std. Error	df	F	T	p
<b>Mountain hare crossings/24 h/10 km</b>						
Intercept	7.004	1.928	1, 25.326	46.650	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
<b>Adult grouse individuals/km<sup>2</sup></b>						
Intercept	8.030	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
<b>Juvenile grouse individuals/km<sup>2</sup></b>						
Intercept	10.389	1.399	1, 28.375	88.116	7.427	<0.001
Year			17, 843	3.902		<0.001
PC1	-0.040	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

PC1 = mixed forest habitat; PC2 = agricultural land.

Larsson 1978, Aunapuu and Oksanen 2003). These types of food are abundant in gardens, grassy areas, and edge habitats.

The results support the finding of Heikkilä et al. (2007) in the Levi and Ylläs tourist destinations that the density of mountain hares and mustelids was higher in developed areas and campfire sites compared to forest areas in the Pallas-Yllästunturi National Park. 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 use (Hanski et al. 1991).

In this study the presence of agricultural land was 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 was higher in wildlife triangles located near fields (Kurki and Lindén 1995; Kurki et al. 2000). 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 (Kurki and Lindén 1995; Kurki et al. 2000).

The pine marten is a species that is strictly dependent on forests (Storch et al. 1990). In this study, I 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. (1998) found that the negative effect of increasing agricultural land was particularly strong in northern Finland. 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 was positively associated with the populations of mountain hare, adult grouse, and juvenile grouse. Hiltunen et al. (2004) found that hares prefer thickets of willow (*Salix* spp.), downy birch (*Betula pubescens*), and spruce (*Picea abies*) during the summer. Additionally, aspen is known to be an important source of nutrition for hares in their winter diet in Finnish Lapland (Pulliainen and Tunkkari 1987). Dense understories are crucial for mountain hare habitat use, as they provide both food and protection against predators (Hiltunen et al. 2004). 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 (e.g., Seiskari 1962; Pulliainen 1982; Sachot et al. 2003; Åberg et al. 2003).

The density of all species varied among the studied tourist destinations, with most species being more abundant in southern compared to northern destinations. 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 pine marten, also varied between study years. This finding aligns with previous studies (e.g., Siivonen 1954; Lindén 1989) 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.

Landscape data was only available for a year, so how the landscape has changed over the past 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. More information is also needed on the combined ecological impacts of tourism and climate change.

## Conclusion

Overall, the tourist destinations do not have a significant impact on the occurrence and abundance of the studied wildlife species in northern Finland. Species densities were not lower near the studied tourist destinations. In fact, the numbers of mountain hares and mustelids were higher near the tourist destinations compared to areas further away. This suggests that human disturbances and recreational activities are not negatively impacting the species, at least within the spatial scale of this study. The locations 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 studied tourist destinations was relatively small, suggesting that the level of human disturbance was not very high. Additionally, some of the destinations were located in the middle of wilderness areas with a large proportion of old forests. The nearby pristine forest landscape may have offset any harmful effects of the tourist destinations on wildlife populations by providing alternative habitats. However, it is possible that negative impacts of tourism on wildlife populations may occur with a delay. Long-term monitoring is needed to provide information on the effects of tourism on wildlife populations, for example through movement into suboptimal habitats, increased energy expenditure, reduced feeding time, and increased nest predation.

Understanding and predicting the impacts of tourism destinations on species is an important prerequisite for achieving sustainable use of natural resources in tourism destinations. More information is needed to further evaluate the ongoing development of tourist destinations and their surrounding areas. The potential for positive or negative feedback mechanisms in the relationship between tourists and wildlife highlights the importance of finding a balance between conserving biodiversity and ensuring continued recreational opportunities.

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