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Motives for voluntary wildlife monitoring in Finnish hunting teams

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Information about game population states and hunting regulation are important prerequisites in ensuring the sustainability of populations. Voluntary game monitoring has a potential of being an important factor in addition to the monitoring made by professionals. The main method in the monitoring of many game species in Finland is the wildlife triangle scheme (WTS), providing abundance estimates of about 30 species. The WTS is largely carried out by voluntarily participating hunting teams. Regardless of the long traditions in the hunters' monitoring activity and hunting regulation, very little is known about the characteristics of the hunting teams that have been active in the WTS. To gain more insight into the characteristics of the hunting teams at a national and regional scale, we analysed quantitative questionnaire data on various activities of hunting teams collected by the Hunters' Central Organization. A typical team carrying out censuses has a large number of members and large hunting grounds, and its monitoring activity is also associated with the voluntary regulation of the hunting of grouse as well as other management actions. The findings indicate that especially large hunting teams are active in voluntary game monitoring in Finland, but also small groups of motivated individuals can successfully participate in the WTS.

Key words: hunting team, monitoring, motivation, regulation

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Monitoring is an important tool in the management of renewable resources. Monitoring for sustainability of game species is typically based on censuses or other information (e.g. hunting bags and number of hunters; e.g. Sutherland 2001). In many countries, censuses are carried out by professionals, but in Finland the censuses covering the whole country have been largely carried out by hunters on a voluntary basis for > 40 years.

Wildlife censuses carried out by hunters in co-operation with game researchers make up a part of the management system in Finland. It is assumed that the reliability of the censuses is sufficient for monitoring purposes. Census information is utilised by administrators, but also hunters may take advantage of this information in their activities. Even though voluntarily carried out, censuses and hunting regulation are common among Finnish hunting teams (for details see http://www.face-europe.org/huntingineurope/nationalsections_en/finland_en.pdf), the characteristics and motivation of the hunting teams, whose members as a group take voluntarily part in these activities, are almost unknown.

The first hunting team in Finland was founded in 1865 (e.g. Salo 1976), and most of the current 4,300 hunting teams were founded between the 1950s and the 1970s (Vikberg et al. 2002a). Among the reasons for an increasing rate of organisation may be that teamwork made it easier to enter into a lease with a large number of private landowners about the team members' right to hunt and perform other game related activities. In Finland, living game animals are not owned by anyone, but the hunting bag belongs to the hunter (Hunting Act 1993).

Approximately 78% of the Finnish hunters belong to these teams (Vikberg et al. 2002a). The lowest quartile of Finnish hunting teams have < 25 members or 1,900 hectares of hunting area, and the highest quartile has > 85 members or 5,500 hectares. However, these numbers strongly vary at regional and local scales.

Grouse, waterfowl, ungulates and mountain hare *Lepus timidus* are the most popular game animals among Finnish hunters (Ermala & Leinonen 1995a, b). In addition to hunting, the hunting teams have long traditions in other associated activities (Salo 1976). For example, even the first hunting teams in Finland arranged practical training in shooting, provided information and education to their members, and regulated their hunting activity. Nowadays, most hunting teams provide extra food for game animals, especially to mountain hare, moose *Alces alces*, roe deer *Capreolus capreolus* and white-tailed deer *Odocoileus virginianus* (Vikberg et al. 2002c).

Since 1989, the main method for obtaining yearly information on nearly 30 game species in Finnish forests has been the wildlife triangle scheme (later WTS; Lindén et al. 1996). The WTS-censuses in the summer replaced previous route censuses (started in 1963) in the monitoring of four grouse species. Annual route censuses were carried out by 800-900 teams of three hunters (e.g. Rajala & Lindén 1984), and many of these teams may have volunteered or were asked by local game managers to participate in the WTS, in addition to other hunting teams. The WTS-censuses are made on 12-km long permanent, triangular routes. Grouse are visually counted in the summer census, whereas tracks of other (mainly mammal) species crossing the census line are counted in the winter census (Lindén et al. 1996). The total number of wildlife triangles is > 1,600, but currently the summer and winter censuses are carried out in < 800 triangles. Permanent census locations are distributed relatively evenly all over the Finnish forests.

The Finnish Game and Fisheries Research Institute (FGFRI) sends by mail instructions and census forms to the registered participants before each census period (i.e. twice a year). No other encouragements than the promise to get a feedback on the results of their census are made for participants in this contact. Even though one person in winter and three persons in summer can carry out the census, the total number of participants is typically higher.

After the census, the hunters send their census information to the FGFRI who enters it into a database. The teams carrying out the censuses (TCCs) get written feedback, which includes the estimates of the species-specific population states in a census location and in the surrounding area. These estimates can be used to support the decision making regarding hunting regulation in the hunting teams.

In addition to the regulation of hunting at national and regional (game management district) levels (for details see http://www.riista.fi/riistaen), many hunting teams also voluntarily further regulate the activities of their members and hunting guests. According to a questionnaire study made by the Hunters' Central Organization (Vikberg et al. 2002b), the hunting effort is voluntarily regulated by restricting (at least temporarily) the hunting areas or the length of the hunting season, by protecting certain species, setting quotas for the size and other properties of the hunting bag (e.g. age or sex of the individuals), and setting fees for hunting guests.

Indeed, hunting teams may play an important role in game management in addition to their social role in rural communities. Considering the future of game management, it would be interesting to find out, what kind of hunting teams monitor game populations by carrying out the WTS, and what their motivations are. Additional knowledge about the connection between monitoring and regulation would be useful in the management of certain game species and in the management of wildlife richness in general.

The aim of this paper is: 1) to describe the hunting teams participating in the wildlife triangle censuses, and 2) to explore the plausible explanations for the hunting teams' interests in carrying out the WTS. To achieve these goals, we used the available questionnaire information on hunting teams. In addition, we discuss the future of voluntary assistance in the monitoring of game populations and its role in the monitoring of wildlife richness in Finland.

In our exploration of the factors explaining the hunting teams' participation in the WTS, we generated the following predictions that will be tested against numerical data:

1) Considering 'Members': We expect that the WTSs are more common in hunting teams with a large number of members even regardless of the size of the hunting ground. In larger hunting teams more potential participants are available, and logically an increase in the number of participants in the census decreases the effort per participant.
2) Considering 'Area': We expect that the WTSs are more common in hunting teams with a large hunting ground regardless of the number of members. This relates to the assumption that the hunting teams carry out the WTS to utilise the results for their own activities (e.g. regulation of hunting and feeding of game), and thus are more willing to carry out censuses if the obtained information relates to populations on their own hunting grounds. A census line in the form of an equilateral triangle with 4-km sides may easily exceed the borders of a small hunting area, which may decrease the motivation to carry out censuses in teams with smaller hunting areas.
3) Considering 'Regulation': We expect that the activity in the WTS is related to the hunting team's intensity in regulating their hunting effort irrespective of the number of the members and the size of the hunting ground. This relates to the possible need for census information to support the individual member's or hunting team's decision to regulate hunting.
4) Considering 'Management': We expect that the WTSs are more common in hunting teams intensively managing the species being monitored. Census information can be used to support decisions regarding forthcoming management actions, and to monitor results of previous actions (e.g. providing extra food and habitat alterations).

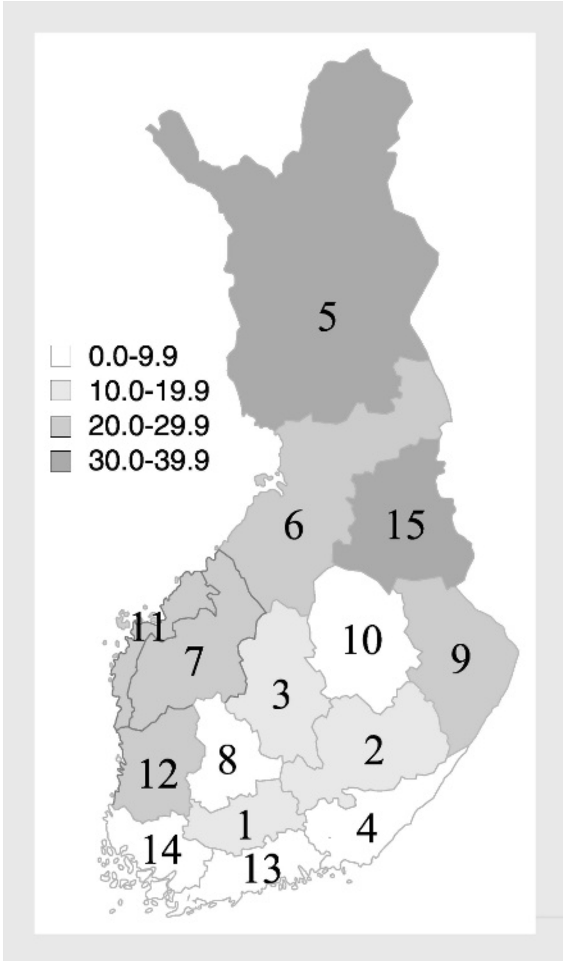

Figure 1. Game management districts (1-15) in Finland. The colours denote the proportion (in %) of the hunting teams carrying out the summer census in each district in 2000 according to the databases. The districts are: 1) Etelä-Häme, 2) Etelä-Savo, 3) Keski-Suomi, 4) Kymi, 5) Lappi, 6) Oulu, 7) Pohjanmaa, 8) Pohjois-Häme, 9) Pohjois-Karjala, 10) Pohjois-Savo, 11) Ruotsinkielinen Pohjanmaa, 12) Satakunta, 13) Uusimaa, 14) Varsinais-Suomi and 15) Kainuu.

Material and methods

We used data from a questionnaire study made by the Hunters' Central Organization in 2001. These data consisted of information obtained from randomly sampled hunting teams and originated from the database covering all hunting teams in Finland, stratified according to 15 administrative units (i.e. game management districts) in Finland (Fig. 1). Questionnaires were sent to contact persons of 1,275 (out of approximately 4,300) hunting teams in Finland of which 889 (70%) were returned. We assume that responses to this questionnaire may be biased towards active hunting teams. To have an indication of the non-responding bias in the sample data, we tested whether the district-specific proportions of the TCCs in our sample differ from the proportions of the TCCs in the national databases. As a result, we found that the sample proportions of the TCCs were higher in all 15 districts than in the national databases, but the 95% confidence intervals of the sample proportions included in every case the proportions of the national databases. The consistently higher proportions may be partly explained by the fact that, in some cases, two or even three hunting teams jointly carry out the census in one location (counted as one TCC in the database), but also by random variation and possible non-response bias. In our analyses we assume that the possible biases are similarly associated in the TCCs and in the other teams, and therefore have a minor effect on our results.

All respondents supplied information about the characteristics of their team. Among the respondents, 839 (94%) also supplied numerical information about their activities during 2000. The statistics include a large number of variables; i.e. information on the hunting bags, censuses, habitat restorations, feeding of wildlife, events and competitions organised as well as hunting and regulation methods used during that year.

Analysis

We analysed how the measured characteristics and activities of the hunting teams were associated with their activity in wildlife monitoring. We tested if there were differences between the TCCs and other teams at the national level. In this analysis, we did not separate data into TCCs for summer and winter, because a major proportion (82%) of the hunting teams in the sample carried out both censuses. We also tested, if there was a relationship between the commitment and the characteristics of the TCCs. The TCCs' commitment was described as a ratio between the number of years without summer censuses and the number of years with summer censuses during the period of the TCC's participating in the WTS. Statistical tests were based on non-parametric Mann-Whitney U-tests and a Spearman Rank correlation test due to some deviations from normality (see Table 1, 'Skewness').

Our hypotheses on the potential factors explaining the participation in the censuses do not handle the factors separately, but within contexts determined by other factors. We separated the summer and winter censuses in these analyses to analyse in more detail the motives for monitoring grouse (in the summer census) and other species (in the winter census).

The model-based tests were made by using binary logistic regression analysis.

First, to test the hypotheses at the general level (i.e. national scale), we removed the effect of districts by including into the model dummy variables identifying the districts (see 'District-model' in Table 2).

We then entered two independent variables 'total number of members in the hunting teams' and 'total area of hunting ground' separately (see 'Members-model' and 'Hunting area-model' in Table 2) as well as at the same time (see 'Members & Area-model' in Table 2). These three alternative procedures enabled us to test the two aspects of the 'Members'-hypothesis and the 'Area'-hypothesis, i.e. the significance of each of the factors both alone and adjusted for the other factor. The latter is especially important as the variables 'total number of members in the hunting teams' and 'total area of hunting ground' are correlated (r_s = 0.70, N = 823, P < 0.001).

After inclusion of the variables relating to the 'Members' and 'Area'-hypotheses, we added the variables relating to 'Regulation' and 'Management'-hypotheses. This was done by using a stepwise method with an inclusion criterion (P < 0.10) and an exclusion criterion (P > 0.10).

In the model regarding the WTS in winter, we added variables that describe hunting interests (relating to the 'Regulation'-hypothesis) of selected species being monitored. First, hunting bags of mountain hare and red fox *Vulpes vulpes* per 1,000 hectares were added to represent hunting intensity, because these species are present and popular game species in every part of Finland.

Next, we added variables relating to another aspect of hunting interest, i.e. hunting regulation. These variables give a general indication of the extent of the intention to regulate hunting in the absence of more detailed information (e.g. quota sizes). The variable group related to the 'Management'-hypothesis included only the variable 'density of feeding locations for mountain hare' (see 'Members, hunting area & feeding-model' in Table 2). Feeding is a popular management activity; hunting teams have nationally more than 35,000 hare feeding locations scattered throughout their hunting areas (Vikberg et al. 2002b).

In the models regarding the summer WTS, the testing of the 'Regulation'-hypothesis was operationalised using the variables 'black grouse *Tetrao tetrix* killed per 1,000 hectares' in hunting area, 'the number of hunting regulation methods in use' and separately all four regulation methods, as well as 'protection of grouse'.

In both of the models regarding summer or winter censuses, the relative importance of the interactions between the explaining variables and the district (a dummy variable) were also tested in order to gain insight into plausible regional differences, which may exist due to differences in e.g. the assemblage and abundance of game species (e.g. Pellikka et al. 2005b), characteristics of hunting teams (see Fig. 1), and landscapes or climate.

All statistical analyses were made using SPSS 10.0 statistical software (SPSS Inc. 1999).

Results

Characteristics connected with monitoring activities in hunting teams

The TCCs differed in many respects from other types of hunting teams. Especially the number of members and the size of the hunting area were larger among the TCCs ($P < 0.001$), and more than double as large as those of other types of teams (Table 1). We also found that the number of members in a TCC was positively associated with the amount of participants (summer census: $R_s = 0.291$, $N = 193$, $P < 0.001$; winter census: $R_s = 0.173$, $N = 193$, $P = 0.016$).

The average amount of foxes killed per space unit (1.64) was significantly higher ($P = 0.038$) among the

Table 1. Selected characteristics of the TCCs and other hunting teams (non-TCCs) with respect to the study questions at national level. Averages, standard deviations (SD) and skewnesses (as background information for model-based analyses) were calculated separately for hunting teams who carried out either the summer or the winter WTS (or both) in 2000, and for other hunting teams. Test statistics were based on Mann-Whitney U-test. * indicates a difference significant at the 0.05 level, ** P < 0.01 and *** P < 0.001; Ns indicates no significant difference.

	TCC			Non-TCC				
Variable families and variables	Average ± SD	N	Skewness	Average ± SD	N	Skewness	z	P
Members of the hunting team								
Total number of members (ind.)	112 ± 128	262	4.41	51.9 ± 51.0	557	3.12	-10.79	***
Active members (%)	62.1 ± 26.2	262	-0.29	67.3 ± 30.3	557	-0.65	-3.15	**
Young (< 25 years old) members (%)	10.4 ± 7.97	266	1.25	8.35 ± 9.69	567	4.50	-4.52	***
Old (> 65 years old) members (%)	12.5 ± 9.19	266	1.49	13.0 ± 11.0	567	1.54	-0.17	Ns
Change in the number of members (1990-2000; ind.)	6.4 ± 21.8	259	3.49	2.39 ± 10.3	562	1.87	-3.26	***
Other characteristics								
Size of the hunting area (ha)	9832 ± 25992	258	10.1	3605 ± 5571	524	11.4	-11	***
Rental area in a hunt (ha)	1739 ± 4423	226	6.28	815 ± 2060	479	10.0	-3.93	***
The time from the founding of the hunting team (years)	40.7 ± 15.4	258	0.27	35.3 ± 17.0	518	0.55	-4.46	***
Hunting activity								
Density of mountain hare in the hunting bag (ind./1,000 ha)	5.54 ± 9.82	258	5.80	6.28 ± 10.6	524	5.57	-1.14	Ns
Density of foxes in the hunting bag (ind./1,000 ha)	1.64 ± 2.03	258	2.89	1.57 ± 2.27	524	3.38	-2.08	*
Guests in mountain hare hunt (days)	16.5 ± 30.6	267	4.78	7.63 ± 12.91	572	3.42	-6.18	***
Density of black grouse in the hunting bag (ind./1,000 ha)	2.36 ± 3.87	240	3.44	2.41 ± 4.08	535	3.37	-0.99	Ns
Voluntary regulating								
Regulation methods in use (0-4)	1.54 ± 1.17	267	0.43	1.16 ± 1.12	572	0.77	-4.51	***
Hunting area restrictions (0/1)	0.37 ± 0.5	267	0.72	0.27 ± 0.45	572	1.13	-2.74	**
Species-specific protection (0/1)	0.48 ± 0.51	267	0.18	0.34 ± 0.48	572	0.77	-3.72	***
Length of hunting season (0/1)	0.13 ± 0.35	267	2.46	0.08 ± 0.27	572	3.49	-2.54	*
Local quota-setting (0/1)	0.56 ± 0.5	267	-0.24	0.47 ± 0.51	572	0.24	-2.43	*
Protection of grouse (0-4 species)	1.72 ± 1.39	267	0.24	1.40 ± 1.31	572	0.51	-3.09	**
Management activities								
Feeding intensity of mountain hare (locations/1,000 ha)	2.44 ± 5.59	258	8.28	2.71 ± 6.96	524	8.02	-1.35	Ns

TCCs than in the other teams (1.57). The average amount of mountain hares and black grouse killed per space unit among the TCCs was lower, but the differences were not significant (P = 0.254 and 0.321, respectively). Among the other indications of hunting intensity, the number of guests in mountain hare hunts was significantly (P < 0.001) greater among the TCCs than among the other teams.

Noteworthy is, that a higher number of hunting regulation methods were used on average in the TCCs (1.54) than in the other teams (1.16), and a positive association between these variables was found in correlative analysis ($R_s = 0.368$, N = 819, P < 0.01). A significant difference between the TCCs and the other teams was also found regarding the proportion of hunting teams restricting their hunting areas, length of the hunting season, species-specific protection and quota setting (P < 0.05 in every case).

The feeding intensity of mountain hare was lower in the TCCs, but it did not differ significantly (P = 0.177) between the TCCs and the other teams. However, this result is difficult to interpret due to a large variation in feeding intensity between districts.

Number of members

The model-based analysis gave more insight into the functioning of the monitoring system and the relationships between motivational dimensions at both national and regional levels. The number of members in the team could significantly explain the probability to carry out both summer censuses (P < 0.001; Fig. 2) and winter censuses (P < 0.001; Table 2) in every context. The odds ratio exceeded value one in every model regarding the summer or the winter censuses, indicating that the number of members in a team has a positive connection to the estimated probability to carry out the censuses. The odds ratios of this variable were the highest (winter = 1.088; summer = 1.111) where the number of members was entered alone after adjusting for district. The odds ratio decreased after inclusion of the hunting area, but was not affected by the inclusion of other variables (i.e. regulations or

Table 2. Effect of selected variables in different contexts (i.e. varying variable sets) in explaining the probability of hunting teams to carry out the WTS in winter 2000. C-prob. indicates the probability that a typical hunting team (with median values of explanatory variables in question) in the district carries out the winter census. The statistically significant deviations (at the 0.05 level) from the odds ratio = 1 or from the reference district category (i.e. district 15) are denoted *; ** P < 0.01; *** P < 0.001.

	District-model	Members-model	Hunting area-model	Members & hunting area-model	Members, hunting area & feeding-model
C-prob. (md) for districts					
1	0.243	0.251	0.266	0.247	0.247
2	0.163**	0.160**	0.158*	0.160*	0.143*
3	0.218*	0.204*	0.213	0.204*	0.198*
4	0.224*	0.197**	0.234	0.203*	0.190*
5	0.447	0.341	0.306	0.294	0.290
6	0.396	0.265	0.259	0.243	0.237
7	0.340	0.172**	0.229	0.163*	0.161*
8	0.208*	0.208*	0.205	0.208	0.203
9	0.352	0.302	0.329	0.299	0.286
10	0.154**	0.130**	0.150*	0.133**	0.105**
11	0.340	0.291	0.287	0.272	0.271
12	0.476	0.396	0.412	0.387	0.385
13	0.180**	0.196*	0.190	0.200	0.197
14	0.234*	0.213*	0.198	0.202*	0.201
15	0.429	0.422	0.352	0.388	0.382
Odds ratio					
Members (10 ind.)		1.088***		1.072***	1.073***
Hunting area (1,000ha)			1.092***	1.038*	1.040*
Feeding (locations/1,000ha)					1.024
Other statistics					
Nagelkerke R^2	0.075	0.158	0.133	0.172	0.177
Correct class. (%)	70.7	73.8	73.7	74.1	74.1
Correct TCC (%)	0	23.2	18.4	24.1	24.6
Hosmer & Lemeshow p-value (large is good)	1	0.824	0.558	0.757	0.347

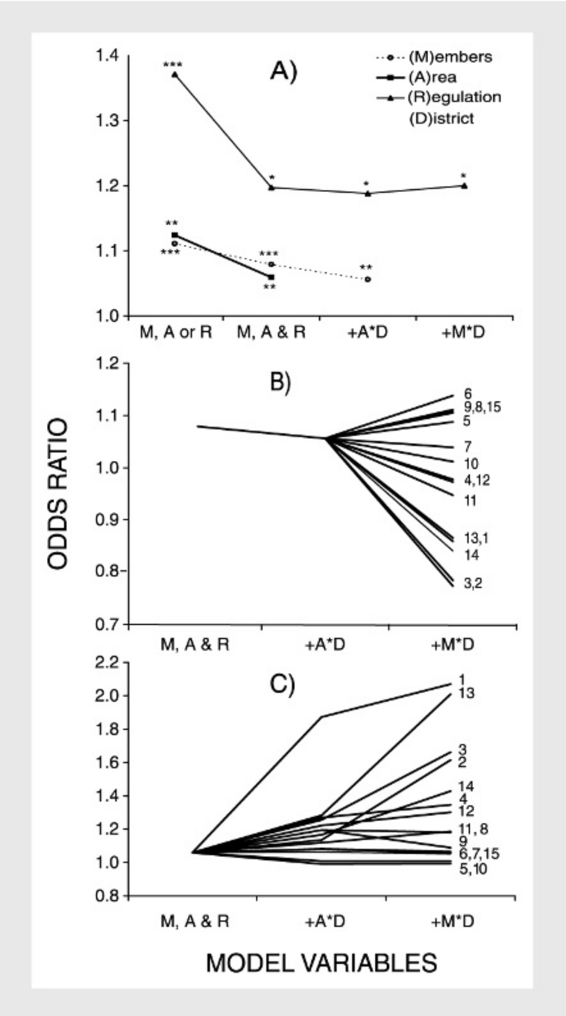

Figure 2. Role of selected variables in explaining the probability of hunting teams carrying out the WTS in the summer. The selected models with the entered variables (number of members (M) and hunting area (A)) and the included variables (denoted with +) are labelled on the x-axes. The values on the y-axes describe the effect of the variables on the rate of change in the probability (odds ratio) of carrying out the WTS. In A) the roles of all of the entered and included variables (i.e. regulation; R) are described at national level, in B) and C) the district-specific role (D) of the number of members (M*D) and hunting area (A*D) are described (i.e. district-specific interactions), respectively (see Fig. 1 for district codes). The statistical significance at the $P < 0.05$ level of the effects are denoted *; ** $P < 0.01$, *** $P < 0.001$.

feeding). The odds ratio regarding the district-specific effect of the number of members (i.e. interaction) reveals that this factor is more strongly connected to the increasing census-probability in northern and eastern Finland than in southern and southwestern Finland.

More than 73% of the hunting teams could be correctly classified as either TCC or non-TCC using only the information of the district level and the number of members (with cutoff $P = 0.5$), However, < 24% of the true TCCs were recognised, indicating that it is easier to classify non-TCCs than TCCs correctly.

Size of hunting area

The size of hunting area was positively and significantly associated with the census probability in every model in winter ($P < 0.001$; see Table 2) as well as in summer ($P < 0.01$; see Fig. 2). The number of members, which was strongly correlated with the size of hunting area, was the only variable that changed the area's role in the study contexts. This means that an increased size of hunting area together with all other associated factors predicts a higher activity in the WTS, and a part of this relationship is due to the fact that a high amount of hunting ground and a high number of members in teams are positively correlated.

The district-specific odds ratios regarding the role of hunting area (i.e. interaction term) in the summer count reveal that the amount of hunting area is most positively connected to the census probability in southern districts. This indicates that hunters having a small hunting area are not very motivated to participate in the censuses. The classification of teams as either TCC or non-TCC performed almost similarly in the cases where either information on the amount of hunting area or on the number of members was used.

Regulations and management

After controlling the effects of the number of members and the area of hunting ground, 'number of different regulation methods in use' was the only variable among the main effects of the alternative variable groups, which had a statistically significant connection ($P < 0.05$; see Fig. 2) to the probability to carry out wildlife triangle censuses in the summer. Its odds ratio (1.197) was higher than the corresponding values of the number of members or of the hunting area, but the inclusion of this variable to a model did not strongly decrease their effects. This indicates that the regulation of hunting in teams is not affected by the number of members or the area of hunting ground in a way that would be reflected in the activity in summer censuses.

In winter censuses, the feeding of mountain hares was the only included variable in the stepwise procedure (see Table 2). However, its effect was nearly significant ($0.05 < P < 0.10$), but it could not improve the classification of teams as either TCC or non-TCC.

District

Even though a high proportion of the TCCs participates in the summer and winter censuses, the probabilities of carrying out the census were higher in summer than in winter in most districts. The range and the differences between the district-specific probabilities were similar in the summer and winter censuses.

Interestingly, two spatially distinct areas were statistically distinguished in respect to the census probability in the summer and winter censuses: the hunting teams in the game management districts in northern, eastern and western Finland had a high probability of carrying out the censuses ($C_p > 0.34$), whereas significantly lower probabilities ($C_p < 0.27$ in the summer, $C_p < 0.25$ in winter) were found in southern and southwestern Finland (see Table 2). The differences between the districts were even more pronounced in the model where the probabilities were adjusted for the effect of the number of members. The district-specific odds ratio for carrying out the censuses decreased strongly in most districts after the inclusion of explaining variables and interaction terms to the models (see Table 2).

Discussion

The hunting teams' participation in the wildlife censuses was associated with many characteristics and activities of the hunting teams at both regional and national levels. The data agreed with our 'Members'-hypothesis predicting a positive association between the number of members and the census probability. This connection may either indicate that the large hunting teams can be seen as a large pool of individuals with varying motivations, or that the willingness of members to participate in the censuses is at least partly related to the amount of work per participant. This interpretation is supported by the finding that the number of members in the teams was positively correlated to the number of participating persons in the census event, and by the finding that the number of members was more strongly connected to the census probability in northern and eastern Finland than in other regions. Especially in the Kainuu district, the average number of members in the teams is relatively small and a higher number of participants may be needed, because carrying out the winter census is demanding due to snow conditions (e.g. snow depth may reach > 70 cm in winter). The weather conditions during the census time period in eastern Finland seem to affect the choice of whether to participate or not in the censuses (Pellikka et al. 2005c), and this may also explain the correlative result that the commitment to the WTSs was only associated with the average amount of mountain hares killed per space unit, which is high in eastern Finland.

The data also supported the 'Area'-hypothesis stating that the WTS is more common in hunting teams, which have large hunting grounds even regardless of the number of members. It was revealed that our first and second hypothesis were related, which is probably explained by the facts that typical criteria for team membership is land-ownership or living within the hunting area, and that the small size of the hunting area can be seen as a reason to reject new membership applications.

In any case, our data supported the expectation that hunting teams may be more motivated to participate in the WTS if their hunting area is large, which usually means that the census route is located largely or entirely within their own hunting area, and the census results are applicable to their own hunting area. The relationship between the size of the hunting area and the census probability was strongest in the southern districts where the forest-dominated hunting areas (i.e. plausible census locations) are typically small due to other land use (e.g. roads and agriculture).

'Regulation' and 'Management'-hypotheses stated that the WTS is associated with hunting regulation and is more common in teams actively managing the species being monitored. Even though the TCCs and other teams clearly differed in this respect, only two of the measured variables could significantly explain the probability of carrying out censuses after controlling the effect of the size of the hunting team on census probability: the number of regulation methods in use regarding the summer WTSs, and the feeding intensity of mountain hare regarding the winter WTSs. The different roles of these variable groups in the descriptive and model-based analyses seem to suggest that hunting regulation partly depends on the size of the hunting team. The hunting effort, for example, may potentially be high in large hunting teams. In that case, the census information can be used to support the decision-making concerning these actions.

Summer counts are mainly made to monitor forest grouse. The variety of hunting regulation methods, which in many cases is directed to regulate grouse hunting in the teams, was associated with the monitoring activity. This may be due to the fact that forest grouse population sizes have decreased during the last four decades, which has increased hunter concerns about the sustainability of forest grouse populations. Even though the hunting teams were active in regulating grouse hunt, the result of the hunting (measured as killed black grouse per area unit) did not differ between the teams. This may either indicate that individual hunters may also regulate their own hunting effort regardless of their respective hunting teams' decisions, or that the local regulation methods are not effective enough.

Our model variables explained and classified relatively poorly the true TCCs, demonstrate the complexity of the phenomenon, and it may have many reasons: First, it may indicate that there are many large hunting teams, which could potentially be TCCs. Second, the result that there were also very small TCCs seems to suggest that also factors other than team characteristics and possible indications of the need for information may explain the participation in the censuses.

One of the plausible factors explaining participation relates to the beginning of the WTS in Finland: The original goal for the monitoring programme was to provide good spatial coverage in every game management district (Lindén et al. 1996). Pellikka et al. (2005c) studied participation in the WTS from a personal point-of-view by making interviews, and found that this goal was interpreted in different ways in different game management districts: At least in one district, all the hunting teams were asked to voluntarily participate even though the teams were small. It is also possible that in other districts only a few TCCs were asked, possibly the locally active teams having a large number of members and many activities. Noteworthy, however, is the fact that many hunting teams stopped participating after a few years, but a relatively large proportion of the recruited hunting teams, and hunting teams in our sample, has continued to carry out censuses for > 15 years with a strong commitment.

Other possible factors, which may explain the probability of carrying out censuses, but which are difficult to put into numbers, are the social settings of the activities. Many of the participating persons in the WTS described the census in a way that can be seen as an indication of tradition or recreational factors motivating to the censuses (Pellikka et al. 2005c): For example, the shared activity together with the company, walking, skiing, orienteering along the census line, enjoyment of seeing animals and tracks, and feeling of responsibility for providing information to the administration and research may be seen as valuable to the participants regardless of the value of the census results.

Reliability of voluntary censuses

The hunters have currently taken an active role in the monitoring of populations and wildlife richness in Finland, and information gathered by hunters is used in many ways in the Finnish game management. The quality of the WTS information provided by voluntarily participating hunters is assumed to be similar from year to year and sufficient for the monitoring purposes. This assumption is based on the following facts: First, in the early years of the WTS, hunters were educated by professionals on how to recognise rare animal tracks (Helle & Wikman 1991). Newman et al. (2003) revealed that a voluntary assistant with very little earlier experience could perform relatively well and improve his skills in monitoring mammals after a brief training. Second, a major proportion of the tracks found in the WTS censuses are made by species, which are very common game animals (ranking order according to amount of tracks in snow in the winter censuses: 1) mountain hare, 2) red fox, 3) red squirrel, 4) moose and 5) stoat). Even though no large-scale experiments have been made to validate these data (e.g. hunters vs professionals), there is some evidence that the results from the grouse censuses made by hunters have been very similar to those reported from the grouse censuses made by bird watchers using the same WTS-method (M. Wikman, pers. obs.). Third, many of the participants in the WTS are very experienced hunters and trackers, and are participating in the censuses year after year (see e.g. Pellikka et al. 2005c).

The quality of the monitoring information can also be evaluated by analysing the statistical properties of the method: The WTS as a triangular application of the line transect method has suboptimal sampling properties compared to the linear transects, but a triangular form is more practical to the voluntary assistants to carry out (Högmander 1995, Högmander & Penttinen 1996). Brittas & Karlbom (1990) analysed the observation bias of grouse censuses in summer, and found that the overall proportion of unobserved birds on the census line was about 20%.

Future of the voluntary wildlife triangle censuses

The cooperation between the hunters, the hunting administration and the game researchers at many spatial and temporal levels may play an important role in ensuring a sustainable use of populations in the future. If the hunters would not be motivated to carry out the WTS regarding such game animals (and species groups), which e.g. are 1) permanently protected due to official or hunting teams' own restrictions, or 2) because the monitoring effort (walking or skiing 12 km at minimum) is regarded as too demanding, it would be difficult and costly to obtain information on the game species. However, our result regarding the summer censuses does not support the assumption that the current hunters' participation in the WTS is only related to their own hunting interest as demonstrated by the fact that hunters also monitor many game species with hunting limited or prohibited in their district (as e.g. grouse hunt in southwestern Finland).

Little information is available to forecast the future trends of the characteristics or activities in Finnish hunting teams (see e.g. Pellikka et al. 2005a). Our numerical results imply that large and growing hun ting teams are the most potential participants in the WTS. Therefore, if other aspects of motivation as well as the attitudes towards censuses remain the same in the future, the ongoing trend towards large hunting teams in Finland may affect positively the WTSs, especially if the participants are recruited efficiently. A prerequisite for improving the recruitment and developing the cooperation is that the factors affecting the motives of voluntary assistants are well understood. Our study can be seen as a starting point in the exploration of the motivation for participating, and further studies may be needed to better understand the most efficient way of affecting the motivation.

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