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Hunter demography, trends and correlates of hunting participation in Sweden

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Jägardemografi, trender och samband till jaktdeltagande inom Sverige

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Keywords: demography, trends, participation, hunting, Sweden, human dimensions, hunter decline, social factors, foreign, harvest, moose, game

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Abstract

The concerning issue of declining number of hunters in North America is also apparent in Europe and Sweden. When the bulk of research found on human dimensions and hunting participation has almost exclusively been done in the United States, this report seeks to add to the needed knowledge on a national level focusing on the causes of hunter declines related to social factors within Sweden. Using hunter data reaching from commune, county to National level, this report describes the correlation between a number of variables and the hunting participation in Sweden.

The typical Swedish hunter lives in an area with low population density, the person usually has higher education, the living situation is stable with no recent moving and there is relatively good access to forest land. Persons with weaker connection to the Swedish culture such as foreign citizens, people with foreign background and people born outside “the Nordic countries” are less likely to start hunt or participate in hunting.

A strong relationship was found between the favorite game, moose (*Alces alces),* and the amount of hunters participating in the hunting. Merged with the quantity of roe deer (*Capreolus capreolus)* and wild boar (*Sus scrofa)* it gives a reliable estimation of the amount of hunters likely to participate in a given year.

Key words: demography, trends, participation, hunting, Sweden, human dimensions, hunter decline, social factors, foreign, harvest, moose, game.

Sammanfattning

Det bekymmersamma faktumet att antalet jägare minskar i Nordamerika är också ett gällande faktum för Europa och Sverige. Då merparten av all forskning gällande jägardemografi och jaktdeltagande är gjord i USA försöker denna rapport att utöka den välbehövda kunskapen inom området med fokus på situationen i Sverige. Med hjälp av data över antalet jägare från kommun-, läns- och nationellnivå belyser rapporten sambandet mellan ett antal variabler och jaktdeltagandet i Sverige.

Den typiske jägaren i Sverige bor i ett område med låg befolkningstäthet, personen har vanligtvis någon form av högre utbildning, boendesituationen är stabil och innefattar inga nyliga omflyttningar och personen har relativt god tillgång till skogsmark. Sannolikheten att börja jaga eller deltaga i jakt är lägre hos personer som har svagare band till den svenska kulturen såsom utländska medborgare, folk med utländsk bakgrund och folk födda utanför norden.

Det finns ett starkt samband mellan det högt uppskattade villebrådet, älg, och antalet jägare som deltar i jakt under ett givet år. Sammanfogade avskjutningsdata av älg, rådjur och vildsvin kan användas som ett relativt tillförlitligt hjälpmedel för att uppskatta antalet jägare under ett givet år.

Introduction

"When you are fed up with the troublesome present, you take your gun, whistle for your dog and go hunting"(Ortega y Gasset 2007). This statement captures the very soul of hunting and is a way of life for many people, especially those living in rural areas (Heberlein and Ericsson 2005).

Several other attempts to describe the essence of hunting and why we hunt can be found going through the literature. One noted report is Kellert's "*Attitudes and characteristics of hunters and antihunters*"(1978), where he more scientifically divides U.S. hunters into three categories of motivation; First the utilitarian/meat hunters accounting for 43.8% of the hunters in his survey. Secondly the nature hunters, which main motivation to hunt are to be in close contact with nature and cause for 17.7% of the people in his survey to hunt. The third group of hunters is the dominionistic/sport hunters serving for 38.5%.

Whatever reasons a person might have to hunt there are several facts that all are true when looking at the hunters as a group. The majority of all hunters are white males, born and raised in rural areas with a father who hunts (Decker et al., 2001, Stedman and Heberlein 2001, Heberlein et al., 2002). The age for a person to be recruited into hunting tend to be low and most are likely to have started to hunt before the age of 20 (Duda et al., 1995, Decker et al., 2001, Stedman and Heberlein 2001). These attributes have repeatedly been found influential, by social scientists who want to explain hunting participation, recruitment, retention and desertion (Enck et al., 2000 Stedman and Heberlein 2001).

The main reason for trying to explain hunting participation is because of its importance as a part in the ecological system. One must realize that for a system to function properly you have to know all variables in the equation. Predator - prey relationship is not a new field of study but I think the human part as a predator, and hunter demography, is too often neglected. Brown et al. (2000) explain that as wildlife populations grow larger, the extent of the human dimensions on wildlife follows. The amount of stake holder groups affected by: collisions with wildlife, damaged crops by grazing, flooding by beavers, parks and golf courses being destroyed by wild boar and ducks and geese soiling the "human habitat" are steadily increasing with the amount of wildlife. Hunting is one of the most direct responses we can use to reduce these wildlife related problems. This is also supported by Heberlein and Thomson (1996) who see maintained hunter populations as a key to maintaining adequate populations of both hunted and non hunted wildlife. In addition, the actions of hunters have a great impact on the environment, not only by harvesting a substantial amount of wildlife, but also by their efforts to improve the habitat of both game and non game species (Heberlein 1987). Furthermore the major part of all funding for wildlife programs in the United States comes from the hunters (Heberlein 1991, Heberlein and Willebrand 1998, Decker et al., 2001). Like Brown et al. (2000) express: "Of all the recreation activities social scientists have studied, hunting may be the most multifaceted in terms of its diverse implications to society and the related dilemmas managers face in regulating it." Brown et al. (2000) also state that "the future of hunting has far broader implications than characteristics of most recreation activities."

Hunting can be viewed in many ways: as a recreational activity, a food resource, a way of life or the primary tool for wildlife management agencies to control game populations (Brown et al., 2000). However you choose to look upon hunting, it is a learned social

behaviour (Heberlein 1987), and hence influenced by changes in socioeconomical factors (Heberlein 1991, Duda et al., 1995). Carefully investigating what social factors that are linked with the hunting participation enables us to better understand the cause of, and if the amount of hunters is going to increase, decrease or remain stable. Furthermore the knowledge allows us to take actions in order to slow or reverse an unwanted trend (Heberlein 1991).

What has been shown, and is causing concern, is that North America is experiencing a decline in the number of hunters (Brown et al., 2000, Enck et al., 2000). A declining hunter population could have serious implications for several reasons. One of which I have mentioned earlier that wildlife management is very dependent on hunting (Muth and Jamison 2000, Zinn 2003).

The major reason for the decline is linked to the ongoing urbanization and our modern lifestyle. Like Kellert (1978) declares, urbanization tends to alienate humans from nature. One consequence of this is that people in general have attitudes based more on feelings than on actual experience and knowledge. Heberlein and Ericsson (2005) also indicate that the urbanization does not bode well for the future of hunting.

Rural upbringing enables hunting opportunities and the very much important social support that can be found there (Heberlein 1987). “81% of US males who grew up in rural areas and had fathers who hunt have hunted at least once in their life” (Heberlein et al., 2002). In every U.S. fish and wildlife service national survey since 1955, it has been reported higher hunting participation in rural than in urban areas (Stedman and Heberlein 2001).This clearly shows the importance of a rural residency on the number of persons that get involved in the activity of hunting.

The rural areas provide a number of important gateways to hunting such as access to game, places to hunt, easier access to hunting land and most importantly a culture very much supportive of hunting. The fact that there is a higher proportion of hunters in rural areas also supports the recruitment of new hunters since hunters is trained by other hunters (Heberlein and Ericsson 2005, Heberlein et al., 2008).

Although, studies done by Heberlein et al. (2002) show that the percentage of the population classified as rural is the strongest and most reliable determinant of hunting participation, there are several other factors found to influence. Geography and gender, age and income but also the amounts of forest land are some examples (Heberlein et al., 2002).

In Texas they have listed 3 factors likely to reduce hunting in their strategic plan for hunting participation: higher lease cost, lack of game and place to hunt (Adams et al., 2004). Manfredo et al. (2003) also support factors like the ones above but add residential stability to the list of factors, while Duda et al. (1995) point out minority race-ethnicity as one important factor having negative effects on hunting participation. This is also explained by Enck et al. (2000) which highlight that low numbers of minorities are hunting, yet the proportion of minority race-ethnicities within the population is growing. Additional to this, the modern life style with more working hours, less leisure time, abundance in alternative leisure activities which compete with hunting are mentioned as threats to both the number of hunters participating in a specific year but also to the recruitment of new hunters (Duda et al., 1995, Heberlein and Thomson 1997, Brown et al., 2000, Heberlein and Ericsson 2005).

Manfredo's example with significance of residential stability is also covered by Duda et al. (1995) who clarifies that hunting is a social activity and that loss of hunting partners for whatever reason, may cause a decline among the others in the group as well. This is also noted when a devoted hunter moves to a new area, where the hunting often does not resume because of lack in social support.

Much of this research found on human dimensions and hunting participation has almost exclusively been done in the United States (Heberlein and Willebrand 1998, Heberlein et al., 2008). However, the trend of declining hunter numbers is also apparent in Europe, not the least in Sweden (Mattsson et al., 2008). This report will therefore seek to add to the needed knowledge on a national level focusing on the causes of hunter declines related to social factors within Sweden.

In Sweden, like in the U.S., money generated by hunting licenses and fees, support management, research and monitoring (Heberlein 1991, Mattson et al., 2008). It is therefore as important as in the U.S., that hunter's demography is carefully followed.
Another risk is that the general decline in the male participants of hunting might reduce the already low numbers of females hunting since there will be fewer males to socialize them into hunting (Heberlein et al., 2008).

Sweden has experienced recolonization of the wolf, *Canis lupus*, population which with increasing population size has created conflict. Moreover wild boar, red deer, fellow deer, moose and carnivores such as brown bear, lynx and wolverine, have gone through immense changes in the last 50 years (Bergström and Danell 2009). This issue will eventually be necessary to control where hunting is one solution (Ericsson et al., 2004). Hence retaining hunters is of importance as well as gaining insight to the knowledge of hunter demography.

The conflicts caused by a higher wolf population have been speculated to be the cause of a decline in hunter numbers in the last years according to the Swedish Association for Hunting and Wildlife Management (2006) and the Swedish hunting association (2007, 2009). Considering moose, the game with the highest hunting value in Sweden, also accountable for the highest number of hunting days by the average hunter in Sweden (Mattsson et al., 2008), changes in the population size of moose can be assumed to have effect on the number of hunters in a given year.

Compared to other countries, Sweden is considered very rural, has a low population density and a strong hunting tradition (Heberlein and Willebrand 1998). You might therefore be misled and believe that hunting participation in Sweden is not threatened by factors as the ones aforementioned e.g. urbanization. Studies' focusing on the attitudes and values of Swedes towards hunting has shown that in 1980 72% were positive and accepted hunting, 2001 this number was 80% (Ericsson and Heberlein 2002). We can therefore dismiss the speculations that a decline in hunter numbers is due to negative attitudes and strong anti-hunting movements gaining ground. Furthermore 84% see hunting as important to keep the balance in nature, 76% see hunting as an important tradition on the countryside and a substantial part of all meat we eat in Sweden comes from moose or other ungulates (Ericsson and Heberlein 2002). Not denying that the attitudes towards hunting affect the future of hunting and how it is performed, the trends of a declining hunter population in Sweden has to be due to some other factors.

This report will in a series of steps, based on the knowledge from previous studies on hunter demography and available data, seek to gain more knowledge about the situation in Sweden. The first step is looking in detail how the circumstances are in all 290 communes of Sweden, in the last hunting year of 2008. By doing this I will find what variables are related to the number of hunters. The second step is to study if I can detect trends in any of these variables linked to the trend experienced within the number of hunters. In this second part the development of the Swedish wolf population will be included as a parameter, trying to find evidence for the speculations mentioned earlier. In the last part of the analysis Sweden's most appreciated game, the moose, complemented with roe deer and wild boar harvest data will be used trying to explain the time trends within the hunter population.

The variables used in my analysis are based on earlier stated key factors, such as the amount of people living in rural areas, residential stability and the amount of minority ethnicities and can be found in more detail under Materials and Methods.

Materials and Methods

My analysis and results are based on a data set consisting of the following parameters: Number of hunters, population size, population density (people/km^2), amount of people aged 65 or older (%), number of people not living in an urban environment (%), amount of people with education 3 years or more after upper secondary school (%), amount of people moving to and within the area (%), amount of people moving from and within the area (%), number of people with foreign background (%), number of people born outside "the Nordic countries" (%), amount of foreign citizens (%), quantity of agricultural land of the whole land area (%), quantity of forest land of the whole land area (%), amount of people with higher income than the average (%), increase in the Swedish wolf population, number of moose harvested, number of roe deer harvested , number of wild boar harvested.

The number of hunters, I assume is equivalent to the amount of people paying for the mandatory state hunting permit. The state hunting permit is valid from 1 July to 30 June and needs to be renewed each year in order to hunt legally. All people aged 18 or who independently handle a firearm needs to carry the state permit when hunting, according to Swedish EPA homepage (2009). This data is collected both from the Swedish Association for Hunting and Wildlife Management and the Swedish environmental protection agency. The hunter data contains numbers of hunters from 1940 to 2008 on national scale, number of hunters from 1999 to 2008 on county level and amount of hunters from 2005 to 2008 in each commune in Sweden.

The major part of the independent variable data I have gathered at Statistics Sweden homepage (www.scb.se) and I have used their definitions and delimitations. However, the data on people not living in an urban environment is collected from the authority the National Rural Development Agency (www.glesbygdsverket.se). This authority has been discontinued since 2009-03-31 and replaced by two new agencies; the Swedish Agency for Economic and Regional Growth (www.tillvaxtverket.se) and the Swedish Agency for Growth Policy Analysis (www.tillvaxtanalys.se) and the original homepage will be closed.

Furthermore the data concerning the Swedish wolf population is found in a report from Viltskadecenter (Aronson and Svensson 2009) and the harvest data is received from the

Swedish Association for Hunting and Wildlife Management section of wildlife surveillance "Viltövervakning".

To be able to compare between different communes and counties I have standardized the independent variables into percent. In cases when the data was not available in this form from Statistics Sweden, I have done the necessary calculations myself.
I have log transformed some variables for normality and that is pointed out in the result part. In some cases data for the current year was not available due to the routines and intervals of sampling or ongoing handling of the data; hence I have used data from the year closest, also this is pointed out in the result part.

When looking at the county level I was forced to summarize the data for the county of Jämtland and Västernorrland into Mittnorrland due to the fact that the hunter data was collected in that format in the past. Another important detail in this analysis at the county level is that from 2007-01-01 Heby commune changed from being part of the county of Västmanlands to now belonging to the county of Uppsala. Hence it is inappropriate to compare data for the two counties to data from previous years. This fact has no major impact on my analysis but should be kept in mind when making conclusions about those two counties.

The selection of wildlife populations to compare to the declining hunter trend has to a large extent been forced by the available data. Only moose harvest data was available on a county level and I therefore decided to perform the analysis on a national level, enabling me to include both roe deer and wild boar harvest data. These three have, however, been chosen with the popularity among the hunters in mind.

For the handling of data I have used Microsoft office excel and for all statistical analyses I have used the program JMP 8. Regression analysis and residual analysis were used to create a model describing the situation of hunters in each commune of Sweden. Some communes plotted have a so called residual, meaning its distance from the trend line. This residual tells that the commune have more hunters than expected, from the size of the population in the commune, if the plot is located above the line. The contrary can be said if the plot is located below the line. The value of the residual enables me to compare the communes with each other and state the reasons for a higher or lower number of hunters than expected. To standardize the value of the residual I divided it with the population size (log) for every single commune.

When I used the generalized linear model or multiple regression I used the Akaike's information criterion (AICc), which is a tool for model selection, to choose the most suitable model. The model giving the lowest AICc is considered being the best.

As an ending to this part I would like to clarify some definitions and give the reader insight in the basis of the data found at Statistics Sweden's database. I will present the information from Statistics Sweden as a list:

- Population size is concerning the situation current for 31 of December for the chosen year.
- Population density is constructed by the population size 31 of December in relation to the land area 1 of January the following year.

- The numerator in the calculation of percent born outside “the Nordic countries” consists of the amount of people born within EU/EFTA excluding “the Nordic countries (Denmark, Finland, Iceland, Norway, Sweden and their associated territories which include the Faroe Islands, Greenland, Svalbard and Åland) and the denominator is population size.
- All areal data concerns the situation current 1 of January for the chosen year.

I have personally made the classification of amount of people with higher income than the average, simply by calculating the average income of 2007 to 211,000 SEK/year and summarizing all with higher income than this level. People not living in an urban environment is the National Rural Development Agency’s definition and is the sum of people living in rural areas and suburban areas or simply population size minus the size of the population living in urban areas.

Results

In 1940 Sweden had 149,588 hunters and this number increased steadily through the years, with some minor fluctuations, until 1994 when it reached its maximum of 322,432 hunters. Since then we have experienced a decline in the hunter numbers leaving us with 267,852 hunters in 2008. The reversed trend has been seen among the female hunters experiencing an increase from 12,024 hunters in 2001 to 14,738 hunters in 2008.
The education of hunter’s shows stable numbers and approximately 9,500 persons/year pass the theoretical exam, based on the last 10 years data from the Swedish Association for Hunting and Wildlife Management and the Hunting register at the Swedish EPA.

To initiate my analysis I look at commune level for the year of 2008 to establish a foundation of how the situation in Sweden appears. My first assumption is that the number of hunters is related to the amount of people, in other words with more people comes more hunters.

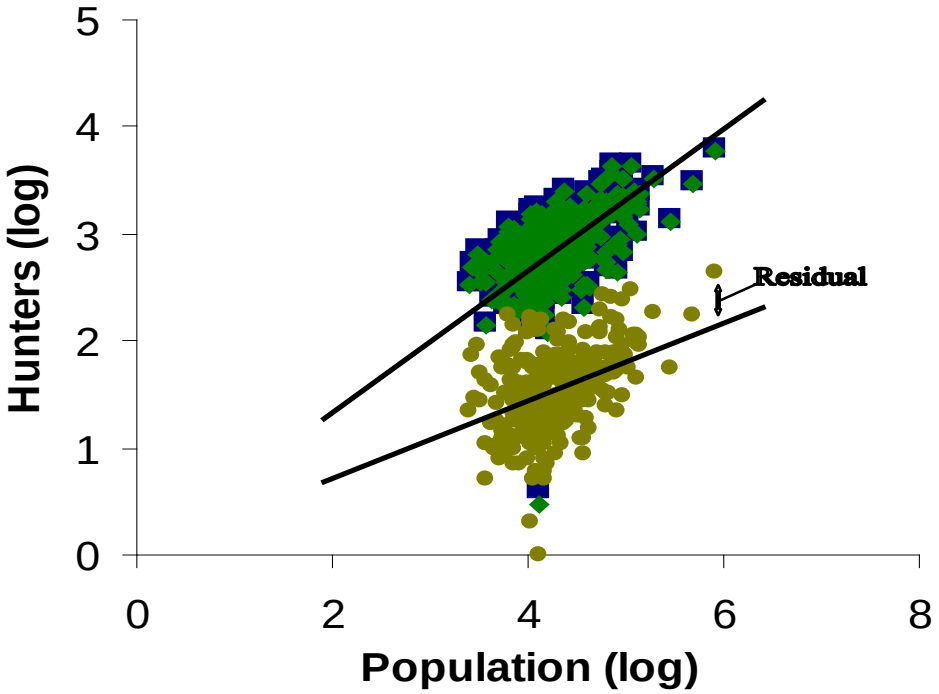

Figure 1. Number of hunters (log) on the x-axis plotted against the population size (log) on the y-axis for all 290 of the Swedish communes, data from 2008. Blue dots illustrate total number of hunters, dark green illustrate male hunters and olive green illustrate the female hunters. The upper line is the trend line for the relationship of total hunter numbers (log) compared to population size (log), whereas the lower line shows the relationship for the female hunters. R^2 is 0.239 for the upper line and R^2 is 0.192 for the lower line.

In Figure 1 a few things are apparent. First, we can note a large difference between the male and the female hunters both in numbers but also in the slope of the trend line (ANOVA, p-value: $< 2.2*e^{-16}$). Secondly it confirms the assumption that with more people comes more hunters.

However, as the scatter indicate the relationship does not fit perfectly to the trend line. R^2 is low for the trend line and indicate that only a little part, of the variation of hunters between the communes, can be explained by the population size. Therefore, the next step is to see how the residual correlates to the independent variables.

Table 1. Zero-order, pair wise correlation between the commune independent variables and the standardized residual of the total hunter numbers for each commune.

Independent variables	**Amount of hunters**
	Residual/log population
Density (log people/km²)	-0.77***
% of the population >= 65 years	0.54***
% of the population not living in an Urban environment	0.49***
% with higher education (log)	-0.34***
% of the inhabitants moving to and within the area (log)	-0.59***
% of the inhabitants moving from and within the area (log)	-0.45***
% with foreign background (log)	-0.49***
% born outside "the Nordic countries" (log)	-0.51***
% foreign citizens (log)	-0.26***
% agricultural land of whole land area (log)	-0.63***
% forest land of whole land area (log)	0.36***
% with higher income than the average (log) (note 2007)	-0.46***

Footnotes: Correlation values with * are significant at ($p<0.05$), ** at ($p<0.01$) and *** at ($p<0.0001$)

Density clearly has a large negative correlation to the amount of hunters a commune have, Table 1. If the density is high the commune will have fewer hunters. The same can be said for almost all of my independent variables except % of the population older than 65, % not living in an urban environment and the % of forest land which all three have positive influence on the hunter numbers.

Some independent variables were also correlated to each other and this makes it difficult to determine the single effect a variable might have on the amount of hunters. Undoubtedly, % with higher education is correlated with the % with high income. To establish the correlation between the independent variables I did one more pair wise correlation.

Below Table 2 illustrates the correlation between the independent variables and makes my next step easier. To be able to isolate the single effect of an independent variable and create a model that best describe how many hunters a commune will have I have used a multiple linear regression approach. Knowing the correlation of the independent variables enables me to sort out those variables which will explain almost the same as another variable.

Table 2. Pair wise correlation between the independent variables.

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
A	1											
B	0.70***	1										
C	0.69***	0.55***	1									
D	0.65***	0.61***	0.52***	1								
E	0.59***	0.58***	0.32***	0.40***	1							
F	0.38***	0.36***	0.13*	0.20**	0.85***	1						
G	0.61***	0.48***	0.51***	0.23***	0.52***	0.37***	1					
H	0.68***	0.52***	0.55***	0.38***	0.53***	0.36***	0.82***	1				
I	0.33***	0.24***	0.27***	0.04	0.45***	0.40***	0.88***	0.66***	1			
J	0.71***	-0.42***	-0.34***	0.32***	0.40***	0.23***	0.31***	0.38***	0.1	1		
K	-0.34***	0.23***	0.22**	-0.25***	-0.30***	-0.17**	-0.22***	-0.27***	-0.15**	-0.26***	1	
L	0.67***	0.68***	0.58***	0.65***	0.32***	0.16**	0.34***	0.39***	0.05	0.26***	-0,07	1

A: Density (log people/km²)
B: % of the population >= 65 years
C: % of the population not living in Urban environment
D: % with higher education (log)
E: % of the inhabitants moving to and within the area (log)
F: % of the inhabitants moving from and within the area (log)
G: % with foreign background (log)
H: % born outside "the Nordic countries" (log)
I: % foreign citizens (log)
J: % agricultural land of whole land area (log) (data 2005)
K: % forest land of whole land area (log) (data 2005)
L: % with higher income than the average (log) (data 2007)

Footnotes: Correlation values with * are significant at ($p<0.05$), ** at ($p<0.01$) and *** at ($p<0.0001$)

Table 3. The model consisting of 4 variables that best describes how many hunters a commune will have. AICc value describes the goodness of fit of the model, the estimate shows the single effect of the independent variable after controlling for all other independent variables and the L-R Chi-square shows how much the variable contributes to the model.
AICc: -1038.627

Variables	Estimate	Std Error	L-R ChiSquare	Prob>ChiSq
Intercept	0.11	0.047	5.0633456	0.0244
Density (log people/km²)	-0.08	0.005	183.77441	<.0001
% with higher education (log)	0.13	0.020	41.338696	<.0001
% of people moving to and within the area (log)	-0.13	0.028	19.908818	<.0001
% forest land of whole land area (log) (data 2005)	0.02	0.006	7.3553375	0.0067

After performing the multiple linear regressions we can see in Table 3 that the variable being most important in determining the number of hunters is Density (log people/km²). Density is negatively correlated to the number of hunters meaning that when the density is low hunter numbers are high. The second variable is % with higher education which is positively correlated with the number of hunters. Note from Table 1 that the univariate correlation between high education and hunters are negatively correlated. However, when density is accounted for, high education level have a positive influence on the amount of hunters. People moving to and within the commune come next in line and have a negative influence on the hunter number. Finally forest has a positive influence on the amount of hunters and with more % forest land comes a higher amount of hunters.

As a next step I have separated the 10 communes with the largest residual and the 10 communes with the lowest residual, meaning more or less hunters than you would expect from the population size. This can be seen in Table 4 and clearly illustrate that the density of people in the commune is a crucial factor in determining how many hunters there will be. The top 10 highest have a mean density of 9 persons per km² compared to 754 persons per km² which is the mean density of the communes with the lowest amount of hunters. The differences between the two groups of extremes are consistent through whole Table 4 but the largest differences are found in density, % not living in urban area, % with foreign background, % born outside “the Nordic countries”, % forest and agricultural land.

Table 4. The 10 communes with the largest respectively lowest residual and the independent variables for each commune.

Commune	Population	% Hunters	A	B	C	D	E	F	G	H	I	J	K	L
Storuman	6304	20.75%	1	26%	100%	7%	4%	5%	5%	2%	3%	0%	40%	25%
Arjeplog	3146	22.92%	0	25%	100%	7%	7%	4%	8%	5%	5%	0%	20%	25%
Härjedalen	10645	16.07%	1	25%	70%	5%	5%	5%	7%	3%	4%	0%	54%	24%
Vilhelmina	7220	16.91%	1	23%	47%	6%	4%	4%	5%	3%	2%	0%	38%	22%
Sorsele	2733	20.38%	0	28%	100%	7%	4%	6%	7%	5%	5%	0%	34%	23%
Älvdalen	7287	16.71%	1	24%	100%	5%	3%	4%	5%	3%	3%	0%	73%	22%
Pajala	6429	17.03%	1	30%	100%	6%	3%	3%	13%	2%	5%	0%	57%	24%
Jokkmokk	5305	17.06%	0	23%	43%	8%	4%	5%	8%	5%	5%	0%	30%	28%
Malung-Sälen	10385	14.71%	3	22%	47%	6%	4%	4%	8%	4%	5%	0%	66%	26%
Strömsund	12532	14.13%	1	25%	66%	6%	4%	4%	7%	5%	5%	0%	56%	23%
Mean	**7199**	**17.67%**	**9**	**25%**	**77%**	**6%**	**4%**	**4%**	**7%**	**4%**	**4%**	**0%**	**47%**	**24%**
Heby	13407	0.03%	11	21%	100%	5%	5%	6%	9%	4%	4%	17%	64%	26%
Burlöv	16230	0.76%	862	17%	0%	9%	9%	8%	33%	22%	10%	37%	0%	27%
Sundbyberg	36079	0.59%	4142	13%	0%	16%	13%	11%	32%	20%	10%	0%	0%	37%
Salem	15177	0.92%	279	14%	0%	12%	6%	6%	20%	10%	6%	13%	47%	36%
Vaxholm	10747	1.27%	185	14%	35%	17%	7%	6%	11%	7%	4%	5%	34%	37%
Åstorp	14533	1.26%	156	16%	13%	5%	9%	7%	24%	14%	9%	62%	14%	26%
Botkyrka	80055	0.59%	411	12%	2%	9%	8%	8%	51%	31%	15%	15%	43%	28%
Tyresö	42332	0.8%	609	14%	7%	12%	6%	6%	19%	10%	6%	2%	19%	37%
Partille	33802	0.92%	591	15%	0%	14%	7%	7%	19%	11%	4%	2%	46%	36%
Landskrona	40860	0.87%	290	19%	14%	8%	7%	6%	30%	20%	11%	75%	1%	26%
Mean	**30322**	**0.8%**	**754**	**16%**	**17%**	**11%**	**8%**	**7%**	**25%**	**15%**	**8%**	**23%**	**27%**	**32%**

A: Density (log people/km²)
B: % of the population >= 65 years
C: % of the population not living in Urban environment
D: % with higher education (log)
E: % of the inhabitants moving to and within the area (log)
F: % of the inhabitants moving from and within the area (log)
G: % with foreign background (log)
H: % born outside "the Nordic countries" (log)
I: % foreign citizens (log)
J: % agricultural land of whole land area (log) (data 2005)
K: % forest land of whole land area (log) (data 2005)
L: % with higher income than the average (log) (data 2007)

Knowing more about the factors affecting hunter numbers in Sweden and the situation for every commune in 2008 opens up for an investigation, on the declining trend of hunters seen since 1994. Using data on county level from 1999 I created the same type of relationship like the one seen in Figure 1, with the exception that I did the analysis on county level and with 10 years data. Also here I used the residual which in this case assured that I was looking at the actual changes in number of hunters as a factor of change in the independent variables and not merely changes in the size of the population.

Looking at Figure 2 we can see that almost all counties have a negative slope looking over the years. However, not all counties indicate a significant negative time trend. Of 20 counties, 17 showed a significant negative time trend. Norrbotten, Stockholms län and Mittnorrland did not have a significant time trend and therefore they were excluded from my analysis. The counties showing the largest decrease in the residual are Värmland, Kronoberg, Kalmar, Gävleborg, Västerbotten and Västmanland.

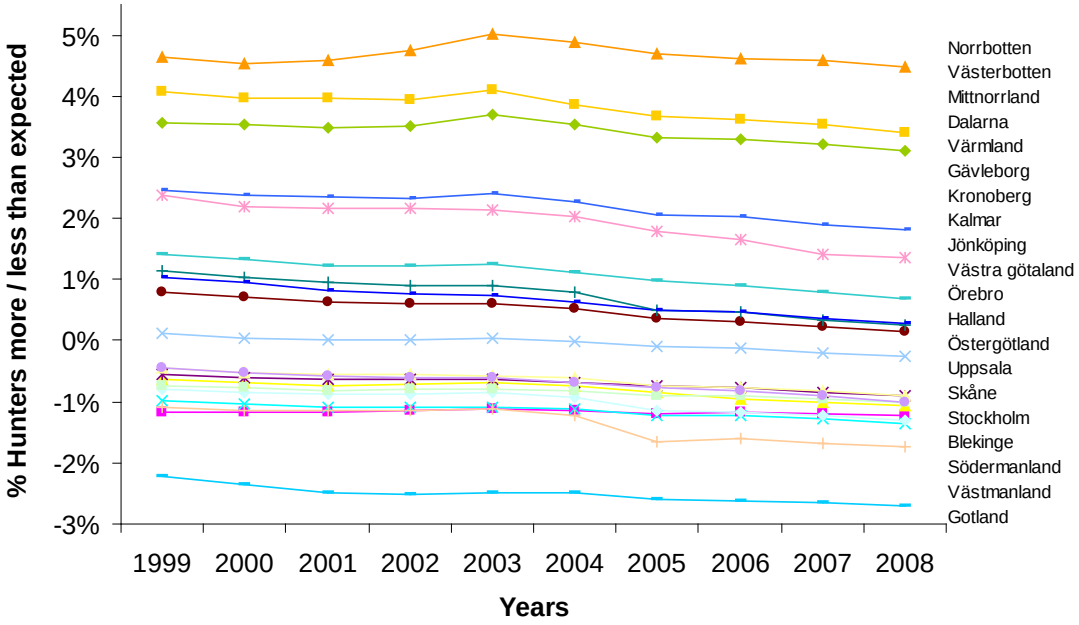

Figure 2. The residual for each county divided with population size expressed as % more/less hunters than expected on the x-axis and the years on the y-axis. Values above 0 indicate a higher number of hunters then expected from population size and below 0 the contrary.

Examining the independent variables over the period of 1999-2008 shows that only four of the variables have a significant time trend. We have had an increase of the % with higher education, % with higher income, % with foreign background and % born outside "the Nordic countries". None of the other independent variables have a significant change over time; hence they can not be the explanation to the changes seen over time for the number of hunters. The development of the Swedish wolf population has been added as a

new variable to investigate if the loss of hunters can be related to the increase of wolf in Sweden.

Table 5. Pair wise correlation of the changes of hunter numbers in each county, with the changes of the independent variables.

County	Increase of Wolf in Sweden	Increase of % with higher education	Increase of % With higher income than the average	Increase of % with foreign background	Increase of % born outside the "Nordic countries"
Uppsala	-0.9488***	-0.7418*	-0.8843**	-0.8835**	-0.962***
Södermanland	-0.9849***	-0.9647***	-0.9677***	-0.9726***	-0.9674***
Östergötland	-0.9818***	-0.9193**	-0.9488**	-0.9825***	-0.9843***
Jönköping	-0.9757***	-0.9685***	-0.9709***	-0.9815***	-0.9799***
Kronoberg	-0.9697***	-0.9581***	-0.9656***	-0.9721***	-0.9655***
Kalmar	-0.9707***	-0.9859***	-0.992***	-0.9861***	-0.9812***
Gotland	-0.9055**	-0.9612***	-0.9323**	-0.9237***	-0.8526**
Blekinge	-0.9461***	-0.8873**	-0.9167**	-0.9619***	-0.9564***
Skåne	-0.9715***	-0.9158**	-0.9267**	-0.9703***	-0.976***
Halland	-0.9744***	-0.957***	-0.9634***	-0.9759***	-0.9686***
Västra götaland	-0.9731***	-0.9286***	-0.9492**	-0.9698***	-0.9725***
Värmland	-0.9668***	-0.9369***	-0.9462**	-0.9726***	-0.9866***
Örebro	-0.9897***	-0.9589***	-0.9798***	-0.9886***	-0.9842***
Västmanland	-0.9134**	-0.8888**	-0.8766**	-0.8658**	-0.9102**
Dalarna	-0.9562***	-0.8998**	-0.9182**	-0.9592***	-0.9618***
Gävleborg	-0.982***	-0.9613***	-0.9664***	-0.9754***	-0.9786***
Västerbotten	-0.9367***	-0.8348**	-0.8904**	-0.9352***	-0.9445***

Footnotes: Correlation values with * are significant at ($p<0.05$), ** at ($p<0.01$) and *** at ($p<0.0001$)

Interesting when looking at Table 5 is that all variables show a strong negative correlation and no remarkable differences can be seen between the different counties. Strong correlation was also found between all independent variables.

As a final step I want to look at changes over a longer time and the only data I found available with complete data set was the national hunter numbers and the game harvest for moose roe deer and wild boar.

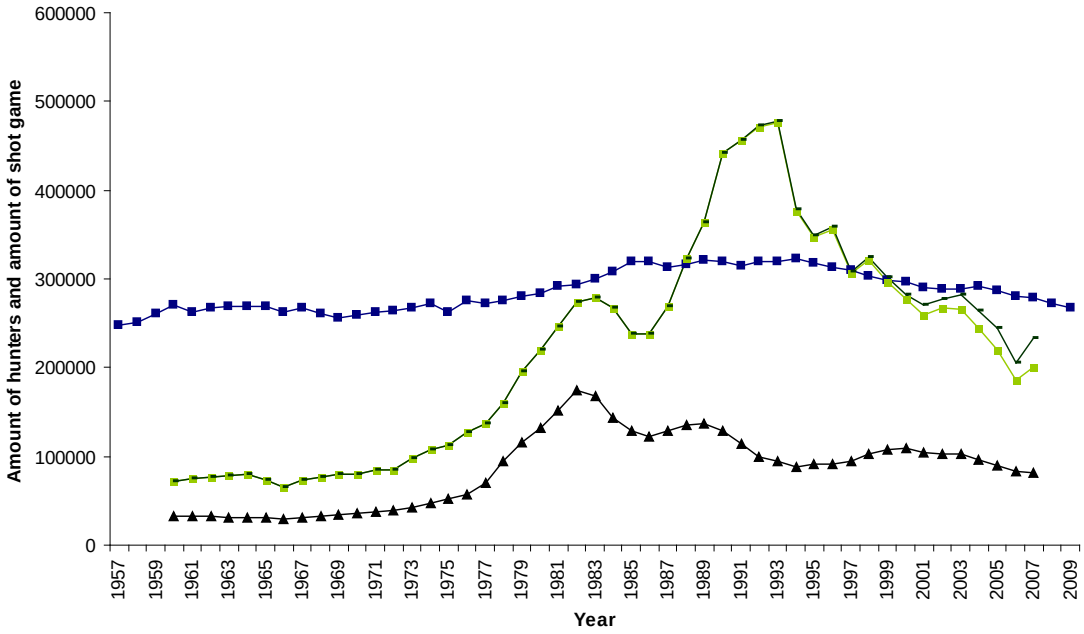

Figure 3. X-axis represents time scale from 1957 to 2009, Y-axis illustrates amount of harvested game and number of hunters. The amount of hunters since 1957 is illustrated by blue line. Moose harvest data since 1960 are illustrated by black line. Sum of harvest data for moose and roe deer is illustrated by light green line. Sum of harvest data for moose, roe deer and wild boar is illustrated by dark green line.

Using Figure 3 we can see that the time trend of the hunters is closely related to the harvest data. Doing a statistical correlation of the different curves gives the result displayed in Table 6. The highest correlation is between the curve of all three harvested species and the amount of hunters with a lag phase of -3, meaning that the response on the number of hunters is lagging behind the curve of the harvest with 3 years.

Table 6. Correlation of the curves in Figure 3 and the lag which gives the highest correlation.

	Number of hunters	
	Correlation	Lag years
Moose harvested	0.865***	-4
Moose+ Roe deer harvested	0.946***	-3
Moose+ Roe deer + Wild boar harvested	0.950***	-3

Footnotes: Correlation values with * are significant at ($p<0.05$), ** at ($p<0.01$) and *** at ($p<0.0001$)

Discussion

The situation in every commune in 2008 confirms the results from previous studies done in U.S. and shows that Sweden is very much alike on several points. Like Heberlein et al. (2002) found the percent of the population classified as rural to be the strongest and most consistent predictor for hunting participation, I found density to be the strongest. I believe that the two concepts are to a large extent the same. In rural areas the density is lower than in urban areas and my results showing a negative correlation with density is evidence of the importance of people in rural areas. Amount of forest land was also proven to be of important for the amount of hunters and also this was found by Heberlein et al. (2002). In many articles, e.g. Heberlein and Thomson (1991) high education has a negative impact on the hunting participation; this is also the case in my study. However, when controlling for the other variables in the model, higher education had a positive effect on the hunter numbers. Heberlein et al. (2008) found this positive effect of higher education, when female hunters in Europe were considered.

I have not distinguished between males and females in my analysis and maybe that result is partly due to that fact. The reason I did not separate the hunter data in to males and females is partly due to the fact that almost all hunters in Sweden are males. Wanting to state the situation in Sweden and try to explain the declining trend of hunters I am obligated not to divide into the two categories. Furthermore the number of female hunters in Sweden has increased through the years and this is not representative for the Swedish hunter population as a whole. In *Female hunting participation in North America and Europe* by Heberlein et al. (2008) the comparison between North America and Europe is done using female hunter numbers and in the European data Sweden is included. That report covers the variables effecting female hunter participation and is another reason why I did not want to look at the two groups separately. I did on the other hand show in Figure 1 that there is a difference between males and female both in absolute amount but also in the slope of the curves which might indicate that the two groups respond differently to the independent variables.

A commune with high residential stability, referring to little movements among the inhabitants, is the fourth parameter of large importance. Similar to what Manfredo et al. (2003) showed it is important with a stable living situation. A stable commune with high amount of hunters provides a social environment that strengthens the values and common interests that has developed within the particular community. When moving it might be hard to find not only the opportunity to hunt but also the social environment and acceptance which are so important for the continuation of hunting.

The independent variables that fall out when building my model to best describe the amount of hunters should not be forgotten. The negative correlation between amount of hunters and the extent of foreign citizens, people with foreign background and people born outside the Nordic countries is a cause for concern. The relationship does not necessarily mean that we should see it as a threat to the continuation of Swedish hunting tradition, rather a fact we should keep in mind when making future decisions in the

politics and handling of people with foreign background and how to integrate them with society. Likely hunting needs more promotion and should be incorporated in the plan of integration for Swedish immigrants if we wish to both help people in need but also preserve the tradition of hunting in Sweden.

The parameters agricultural land and high level of income are two parameters which to some extent are associated with urban areas, or areas with high density of people, and it is not surprising that also these variables are negatively correlated with amount of hunters, making the classic rural/urban antagonism apparent.

The parameter of age is also consistent with previous studies and show that more people over the age of 65 are positively correlated to more hunters. Table 4 summarizes what I have pointed out so far and it gives a clear overview of how each variable differ if comparing a commune with high amount of hunters to a commune with low number of hunters.

In my analysis of the time trend and declining hunter numbers I would like to emphasize the correlation of amount of hunters and harvested game. I believe that the major part of fluctuating hunter populations in Sweden can be explained by the favorite game harvested, in first hand moose but also roe deer and wild boar. It is striking that such a long time series can have so high correlation, not forgetting that the hunters are probably lagging behind with approximately 3 years. Reading *Jakten i Sverige – Ekonomiska värden och attityder jaktåret 2005/06 by* Mattson et al. (2008) gives more credibility to this belief since both moose and roe deer are the games that have the highest hunting value and dominate the amount of hunting days spent in Sweden.

On county level, Table 5, I believe that the time series for the five variables (increase of wolf, increase of % with higher education, increase of % with higher income than average, increase of % with foreign background and increase of % born outside the "Nordic countries") is too short to say to what extent they have affected the decline of hunters. Even though the correlation was higher than 0.95, in most cases, it is to short time series to give a reliable answer. Many variables can be fitted with a high correlation over a 10 year period even though they have no connection to the issue.

However, some conclusions can be made concerning the effects of an increase of the wolf population. With wolf in basically 5 counties in Sweden: Dalarna, Värmland, Gävleborg Västra Götalands län Örebro län (Aronsson and Svensson 2009) one would suspect that correlation would be the highest for those counties. This is however not noticeable in Table 5. Neither has the five counties holding wolf experienced the largest decrease in the residual, Figure 2. This suggests that the decline of hunters is not directly influenced by an increase of wolf. I on the other hand, believe that having access to a longer time series combined with data stating the situation down to commune level would show some effects locally from the impacts of wolf. Many effects can often be hidden depending on what level you do your analysis. There can also be indirect effects e.g. reduced moose abundance which can cause a decline of hunters.

One might suspect the decline to be due to no or low recruitment of hunters, still an average of 9,500 people per year take and pass the theoretical part of the hunting course. Naturally, not all of them take up hunting immediately or ever for that matter, but the recruitment cannot be said to cause a decline.

To be able to make reliable conclusions concerning the declining hunter population in Sweden access to a longer time series of the hunter numbers on a more detailed level than nationally, would have been of importance. It would enable to point out other variables than harvested game to influence the hunter population. This data is however lost in the process of trying to computerize the data collection at the Swedish Association for Hunting and Wildlife Management, a matter revealed during the process of my thesis.

Before I move on to what I see important for the future I would like to address some issues that can be worth having in mind. For instance, the translation of numbers of mandatory state hunting permits sold each year to amount of hunters is an issue that requires some reflection. Are these two synonymous or can there be more hunters than the number of permits sold? In theory the two should be identical since it is required by law to pay the yearly permit in order to hunt. How it looks in reality is a question not easy to answer since it is a matter of an illegal act and hence not likely to be acknowledged. The state permit is however the only measurement available to overview and monitor the whole Swedish hunter population and I feel that in an analysis, like mine, looking for macro explanations for hunting participation it is acceptable to use these numbers.

To some extent the variables I have chosen to examine are determined or limited by accessibility. Nevertheless, I have been able to cover the aspect of opportunity, the cultural aspect and the personal variable aspect which has been used by other scientist when looking at hunting participation.

Like Enck et al. (2000) state, caution must be taken and “interpretations of hunter recruitment and retention trends must take into account dynamic patterns of initiation, cessation and continuation”. Furthermore an idea of active and inactive hunters is good to have in mind. Some hunters might not go out hunting in a given year but should still be included in the pool hunters in which a person can be recruited or retained over a longer time horizon. This fact and some other details like the amount of people likely to give support in different ways is not measured correctly by simply using participation indicators alone. The term hunter is in many ways a matter of a person’s perception of themselves. Many people might identify themselves as a hunter while in a given year not buying the state permit, therefore many important issues goes undetected with participation indicators.

With this in mind I would like to address what I see for the future. I believe that Sweden is experiencing a decline in hunter numbers mainly because of changes in game populations. Maybe including more species than the ones I have examined and probably local differences can exist. Nevertheless, I think that hunter numbers in the future will be more heavily influenced of the social variables I have described as influential. With more people living in cities, higher density of people and more people with weak bonds to the

tradition of hunting, which is a fact of today, we carefully need to follow the trend concerning hunter numbers and make sure to have enough knowledge to take the right preventive measures.

Data today and from 2005, is collected down to commune level divided on male, females and foreign hunters. This is good and should be the least criterion for the data collection. Being able to get the age composition for the Swedish hunters and a distribution chart of this can be a help in trying to see where the sink is. Maybe a supplement to the yearly statistic of hunting permits sold and amount or hunters in a given year could be to every fifth year survey the hunters with a questionnaire. Where questions like; have you been hunting during the last 5 years, if not why?, did you pay the state hunting permit?, do you know anyone who stopped hunting and for what reason?, what would be a strong enough reason for you to stop hunting?, could be asked. The main focus with the questions should be to get the additional information, concerning the hunting participation, which is not covered by the yearly data collection and macro analysis of social factors.

Conclusion

Describing the typical Swedish hunter based on my results tells that the person lives in an area with low population density, the person usually has higher education, the living situation is stable with no recent moving and there is relatively good access to forest land. People with weaker connection to the Swedish culture such as foreign citizens, people with foreign background and people born outside “the Nordic countries” are less likely to start hunt or participate in hunting. These groups can be of importance in the future if we want to preserve the Swedish tradition of hunting.

The strong relationship to the favorite game, moose, is a factor very much regulating the amount of hunters participating in the hunting. Merged with the quantity of roe deer and wild boar it gives a reliable estimation of the amount of hunters likely to participate, three years lag should be used when doing the estimation.

Continued data collection on hunting participation is crucial for the understanding of time trends in the hunter population. Tentatively the lack of information can be gathered by surveying the hunters with a questionnaire every fifth year.

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