Attitudes of hunters and managers toward harvest regulations of willow ptarmigan in Norway

-implications for management

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Innhold

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Tables and figures

Legends to figures and tables:

Sammendrag

Andersen, O. (2008). Jegere og forvalteres holdninger til ulike typer av uttaksbegrensninger for lirype i Norge: konsekvenser for forvaltningen. Masteroppgave i anvendt økologi: 26 s.

Kunnskap om jegernes holdninger til ulike forvaltningsrestriksjoner, slik som tidspunkt for jaktstart og dagskvoter er nyttig informasjon i forvaltningssammenheng. Her rapporterer jeg resultater fra en undersøkelse hvor 2785 rypejegere har svart på spørsmål knyttet til forvaltningsrestriksjoner. Utvalget utgjør om lag 5 % av alle rypejegerne i Norge. Generelt foretrakk jegere en årlig kvote på 15 ryper i året og forbud mot vinterjakt i stedet for dagskvoter. Demografiske variable som bosted (graden av urbanitet) og utdanningsnivå viste ingen signifikant sammenheng med synet på forvaltningsrestriksjonene det ble spurt om i undersøkelsen. Menn var sterkt negative til dagskvoter, mens lokale jegere ga en sterk, positiv sammenheng med en årlig kvote på 15 ryper og ikke vinterjakt. En faktoranalyse (PCA) identifiserte tre dimensjoner som rypejegerne knyttet til "en god jaktopplevelse". Dette var (1) Komfort, (2) Viltkontakt og (3) Tilgjengelighet. Komfortdimensjonen var positivt knyttet til å forby vinterjakt og en årlig kvote på 15 ryper. Dimensjonen viltkontakt var negative til restriksjoner som begrenset uttaket (dagskvoter og årlig kvote). Tilgjengelighetsdimensjonen var positivt relatert til å forby vinterjakt, men negative til alle andre restriksjoner som gikk på uttak, jaktsesongens lengde eller reduksjon i antall jegere. Forvalterne mente at det var en glissen rypebestand ved ca 10 ryper/km^2 og at det var en god bestand ved ca 30 ryper/km^2. Forvalterne foretrakk restriksjoner som er enkle å kontrollere, slik som dagskvote eller forbud mot vinterjakt. For å redusere noe av usikkerheten knyttet til hvilke effekter restriksjonene har på rypebestanden, bør forvaltningen utvikle modeller eller strategier som tar hensyn til variasjoner i bestandstetthet mellom år innen samme område, samtidig som de ivaretar jegernes ønsker og behov. Denne studien har vist at jegerne foretrekker årskvoter, eller kvoter som gjelder for en lengre periode, i stedet for dagskvoter. En terrengkvote-modell som tilbyr jaktkort med en årlig eller fast kvote som kan felles er en slik strategi, selv om dette ennå ikke er vanlig innen småviltforvaltningen i Norge.

Nøkkelord: adaptiv forvaltning, demografi, jegertyper, lirype, spørreundersøkelse.

Abstract

Andersen, O. (2008). Attitudes of hunters and managers toward harvest regulations of willow ptarmigan in Norway: implications for management. Master thesis in applied ecology: 26 pp.

Information on attitudes towards hunting regulations such as season openings and bag limits provide important knowledge for wildlife managers. Herein, I report results from a survey of 2785 willow ptarmigan hunters, comprising an estimated ca. 5% of the total number of ptarmigan hunters in Norway. Hunters were in general more positive to an annual bag of 15 ptarmigan per year and no hunting in winter, than daily bag-limits. Demographic variables such as residence type (degree of urban association) and education showed no significant relationship with attitude to harvest regulations. Males were strongly negative to bag-limits, while locals showed a strong, positive relationship to an annual bag of 15 birds per year and no hunting in winter. Principal component analysis identified three hunter domains related to experiencing a good hunt; (1) Comfort, (2) Game contact and (3) Access. The Comfort domain was positively related to no hunting in winter and an annual bag of 15 birds per year. The Game contact domain was negatively related to harvest regulations that restricted the daily or annual number of bagged game. The Access domain was positively related to no hunting in winter, but negative to all other regulations of bagged game, shortened hunting season or reduction in number of hunters. Managers perceived 10 birds per km^2 in autumn to be a low ptarmigan density, while a good density was perceived to be more than 30 birds per km^2. Managers prefer harvest regulations that are easy to control, such as bag limits or no hunting in winter. To reduce some of the uncertainty related to willow ptarmigan management, managers should develop models or strategies that account for varying densities between years and meet the requirements of different groups of hunters, based on their motivations for hunting willow ptarmigan. This study has shown that hunters prefer quotas (i.e. annual bag), rather than daily bag-limits. A terrain quota model that includes hunting licences with an annual or fixed quota per licence is one such strategy. However, it is not yet commonly applied in Norway.

Key words: adaptive management, demography, human dimensions, hunter types, ptarmigan, survey.

1. Introduction

Population dynamics of willow ptarmigan (*Lagopus lagopus*) are characterized by large annual fluctuations in density among different areas in Norway (Lande *et al.*, 1995; Myrberget & Pedersen, 1993; Aanes *et al.*, 2002). In spite of this, willow ptarmigan is a popular game bird and has been hunted both for subsistence and recreational purposes for more than 150 years in Norway (Barth, 1877). During hunting season 2006/2007, roughly 140 000 persons actually went out hunting. Out of this total number of hunters, 25 per cent hunted for both small and large game, while 40 per cent hunted only large game, and 35 per cent hunted only small game (SSB, 2007). However, the number of ptarmigan hunters and number of birds harvested have declined during recent years, a trend that has persisted since the late – 1980s. During the hunting season 2006/2007 a record low of 312 000 birds shot was recorded. This is a 14 per cent reduction compared to the previous hunting season, and a of 22 percent decline since the 2001/2002 season. The number of ptarmigan hunters in the 2006/2007 season was reduced by 8 percent from the previous year and numbered approximately 54 000. Around 37 300 of these (roughly 70 per cent) reported having shot one or more ptarmigan. The average hunter successfully bags 6 ptarmigan, but around 60 per cent shoot less than this, and only around 10 per cent harvest twenty or more birds in a season (SSB, 2007).

Twenty years ago, a common perception of the impact of hunting on small game species was that hunting mortality was completely compensatory. Hunting off-take was to some degree harvesting of individuals that where likely to die anyway, and that hunting mortality was thought to be compensated by immigration from surrounding areas. Pedersen et al. (2004) have recently shown that there is only weak evidence for compensation in willow ptarmigan in Norway.

Managers introduce regulations to reduce the risk of over-harvesting. I have not found any studies that have examined the effects of harvest regulation on next year's breeding population, which is highly relevant in the harvest regulation decision making processes. Hunting patterns have also changed; two or three decades ago, the hunting pressure was highest in areas near cabins and roads. The main difference today is that remote areas are more available to hunters than before. Road construction, increased use of aircraft and all-terrain vehicles (ATVs) has given the hunters access to areas that were seldom hunted earlier. This reduces the number of undisturbed areas that potentially could act as a source for providing neighbouring hunted areas

with willow ptarmigan. Increased access for hunters, together with a gradual decline in density of willow ptarmigan requires a more active management strategy (Connelly *et al.*, 2005; Strickland *et al.*, 1994). If such a change in management should work, it has to be (1) accepted by the hunters, (2) accepted by the managers and (3) give a measurable, stable or positive effect on the willow ptarmigan population. In this paper, I report attitudes of hunters and mangers to different harvest regulations and I examine how different harvest regulations affect harvest rate with a simple population model.

Management issues

Peek (1986) defined wildlife management as "the art of making the land produce wildlife". This has also been a major concern in wildlife management in Norway and the main focus of willow ptarmigan research has been about understanding the population dynamics (Myrberget, 1989; Myrberget & Pedersen, 1993; Pedersen *et al.*, 2004; Steen *et al.*, 1988; Aanes *et al.*, 2002). A main objective in willow ptarmigan management is to optimize harvest without reducing the reproductive capacity of the population to such an extent that the population level suffers in the long run. Population characteristics of willow ptarmigan require a dynamic and adaptive harvest management strategy. Strickland *et al.* (1994) claimed that harvest management should include the following 3 basic components:

1) Counts of populations size

2) Identification of clear goals for population and harvest, and

3) Development of regulations that allow goals to be met.

Management systems must be in place to measure the outcome of actions in relation to management objectives e.g., population size, growth rate and harvest rates (Connelly *et al.*, 2005). These components are usually part of a harvest management program for big game such as moose (*Alces alces*) and reindeer (*Rangifer tarandus*), but are often missing in management of small game species in Norway.

A modern approach to a dynamic and adaptive willow ptarmigan management should include strategies for harvest rates to meet varying population densities across years (Connelly *et*

al., 2005). In recent decades there has been a greater emphasis on making management decisions, based on knowledge about the effects of harvesting on small game populations in Norway. Despite this, no thresholds of potential concern (TPC) have been defined, specifying the density (or other measures) at which harvest regulations should start. Pedersen and Karlsen (2007) recommended recently the use of such thresholds for willow ptarmigan in Norway. In state land in Sweden, 3-5 accumulated hunter days per square kilometre is used as a TPC (www.smavilt.se). To my knowledge, the concept of TPC has not been applied anywhere in willow ptarmigan management in Norway. Harvest regulations should act to reduce harvest rates or hunting pressure in years with low population density, without reducing the opportunity of the public to hunt. It is therefore appropriate to investigate attitudes of hunters and managers to different harvest regulations. Such an approach with restrictions accepted both from hunters and managers may give a better basis for willow ptarmigan management.

Harvest regulations

Harvest regulations usually implement the following management options; bag-limits or reduced hunting effort. Reduced hunting effort can either be achieved through limits on the numbers of hunters or by reducing the number of days hunting is permitted. Lande et al. (1995) showed that a threshold harvest (closed or unrestricted harvest) strategy would be the most theoretically sustainable option but that a lower threshold with a proportional harvest above this threshold would be more practical (Lande *et al.*, 1995). Source-sink management models have also been proposed, and are now included in an experimental study in several areas in Norway through the Ptarmigan Management Project 2006-2011 (PMP). Willebrand and Hörnell (2001) suggested prohibiting harvesting in part of the total area hunted, as a source-function in relation to hunted areas. Another model suggested by Hörnell-Willebrand (2005) was to set limits for the totally allowable effort within an area. This is in accordance to recommendations given earlier in Norway (Kastdalen, 1992).

Modelling effects of harvest regulations on a population level from one hunting season to the next must deal with considerable epistemic uncertainty (Reagan *et al.*, 2002), due to large interannual variation in demographic rates such as recruitment and survival in willow ptarmigan. Variation in parameters such as harvest rate, winter mortality, chick production and survival to next hunting season and immigration and emigration can vary enormously (Lande *et al.*, 1995).

To further complicate the picture, a negative density-dependence relationship has been observed (Hörnell-Willebrand, 2005; Pedersen *et al.*, 2004). Negative density dependence means that population growth rate decreases when population density increases. This type of negative feedback is stronger in northern parts of Norway and Sweden than further south (Hörnell-Willebrand, 2005). Although a lot of research has been conducted, researchers are far from a complete understanding of these mechanisms.

Research objectives

In Norway, no study has linked the attitude of both hunters and managers to harvest regulations and no studies have linked the effect of the different harvest regulations to population performance. Here, the attitudes of hunters and managers to harvest regulations are compared. Hunters are described in two ways, by using socio-demographic variables and by domains of attributes of a "good hunting experience". The population effects of these harvest regulations are modelled. I pose the following research questions:

- How do preferences for different harvest regulations vary among a sample of willow ptarmigan hunters and managers?
- How do demographic variables such as age, gender, residence, type of hunters and hunter domains affect the attitudes of hunters towards harvest regulations?
- How do different harvest regulations in willow ptarmigan management affect next year's breeding population?

2. Methods

Sample and survey design

Data was collected using a postal structured questionnaire following the Total Design Method (Dilman, 1978). The questionnaire was developed from a combination of experiences with previous studies on attitudes toward recreational fishing, wildlife (Bjerke *et al.*, 2005), ptarmigan hunting (Willebrand & Paulrud, 2004; Aas & Vinsand, 1996) and harvesting in general. The survey measured different aspects of hunter behaviour, preparations and training for hunting, attitudes toward hunting and wildlife management, outcomes and experiences related to ptarmigan hunting, encounters with other hunters, perceptions of game populations and environmental attributes, satisfaction, and demand for different types of hunting related services and products. A draft questionnaire was tested on a small sample before final modifications were made for the main study. 2717 hunters from 23 areas with known willow ptarmigan density received a questionnaire in the beginning of March 2007, following the national closing of willow ptarmigan hunting season. A short reminder was sent out 14 days later, and a second reminder with a similar questionnaire was sent out May 3rd to 1263 respondents who had not responded to the questionnaire. The survey closed June 1st 2007. The data collection resulted in 1876 answers, a total response rate of 69%. After excluding 233 respondents that reported they not had hunted in 2006 and 38 responses without any information, 1605 responses were left. This is an effective response rate of 59%. An identical survey was posted on the Internet. This survey was open for everyone, available from February 22nd to June 1st. At the closing date, the web-survey had 1183 answers, which could be grouped down to municipality level. The web-survey lacked information about ptarmigan density. The web-survey was initially conducted as a convenient sample/control-sample for the reliability of the postal questionnaire. The total number of responses was therefore 2785 (appendix 1). The sample size is around 5% of the total population of ptarmigan hunters in Norway (SSB 2006). Here, both sample sources are pooled.

A total of 194 managers in areas with or without annual line transect counts got an e-mail with a link to a web-questionnaire (for managers) in May 2007. Out of these, 10 respondents replied that they had no willow ptarmigan in their area. A reminder was sent by e-mail on June

15th and a last reminder again on September 10th. The survey closed November 1st. Despite 68 responses (37% response rate), only 24 managers from areas with willow ptarmigan had answered questions related to harvest regulations, and these were selected for further analysis. This gives an effective response rate of 13%. The low response rate could be due to the internet-based survey and that it took some time to complete all answers in the questionnaire. It is probably simpler to fill in a postal questionnaire during a busy day at work.

Main response regulations

Six types of harvest regulations were presented to the hunters and managers:

1. Bag-limit on 2 willow ptarmigan per day
2. Shortened hunting season.
3. Prohibit hunting in winter (from Dec. 23rd).
4. Strongly reduce the number of hunters
5. Divide the season into shorter periods (typically during the first 2-3 weeks of the season).
6. A total quota of 15 ptarmigan for the season.

These management restrictions comprise the modelled response variables, and each response was scored on a scale from 1 (strongly disagree) to 5 (strongly agree). The response variables are treated as continuous variables in the analysis, since they have a logic direction.

Demographic variables used as predictor variables were gender (female=0, male=1), age (grouped into the following age-classes: <= 20 years, 21-39 years, 40-59 years, 60-70 years and >71 years in one-way ANOVA analysis, but continuous in the GLM), education level (cont.), local or non-local hunter and size of the settlement where the respondents live (1= less than 100 inhabitants, 5= more than 40.000 inhabitants).

Harvest regulations

An important objective was to model how different harvest regulations affect the population the following year. To simplify the model as much as possible, I assume additive hunting mortality, no immigration and no emigration. The following equation was used to model the population effect:

$Pop_{t+1}=Pop_t$ *x (1-Harvest rate) x winter survival x chick production* (equation 1)

Where

$$Harvest\ rate\ is\ defined\ as = \frac{\sum Bag}{Pop_t} \qquad \text{(equation 2)}$$

Bag is the total number of bagged game. Pop_t is total population size in august in year t, harvest rate is the estimated proportion of the population which is harvested during the hunting season, winter survival is the survival rate from winter to the next breeding season and chick production is the recruitment of chicks per two adults before the next hunting season (Pop_{t+1}). To reduce uncertainty and to model the effects of harvesting, winter survival is set to 60% (Hannon & Martin, 2006; Steen & Erikstad, 1996) and per capita chick production is set to 3 as an average in years with low production (Hörnell-Willebrand, 2005). The model will then overestimate the effects of hunting in years where chick survival is high, but be more correct in years when chick survival is low, and harvest regulations is needed. All variation in equation 1 will now be in the harvest rate parameter (eqn.2). For regulations limiting the number of hunters or hunting days, which in turn affect harvest rate, 1 ptarmigan shot per day is used as an average, since the data show a daily catch per unit effort (CPUE) of 1.03 birds. The number of hunting days is 8 in the calculations, since the data show an average effort on 7.6 days.

Statistical analysis

Data has been analysed by using SPSS (ver. 14.1.) and SAS (ver. 9.1) computer software. A set of 14 questions (appendix 2) covering various aspects of the hunting activity was used to reveal the underlying dimensions of what hunters perceive to be "a good hunting experience". To describe hunter domains of a good hunting experience, a principal component analysis (PCA) with varimax rotation was used. Eigenvalues were by default set to be greater than 1 (Quinn & Keough, 2003). The initial solution yielded four dimensions, describing 49% of the variation. However, communalities for two of the variables (how well the dog perform and satisfaction with their own shooting) were less than 0,2 so these variables were excluded (Afifi & Clark, 1990). A subsequent PCA with 12 items resulted in four dimensions, explaining 57% of the variance (table 1). Factor scores was generated and used as a measure of how different groups of hunters were placed along the principal component axis. Items included in each dimension extracted from the PCA, were checked by a Reliability analysis. Chronbachs alpha (α) is a model of internal consistency, based on the average inter-item correlation. Chronbachs alpha values higher than 0.6 are considered as reliable (Cronbach, 1951; Nunnally & Bernstein, 1994). The relationship between harvest regulations (response variables), demographic variables and factor scores (predictor variables) was scrutinized by general linear models (GLM). To test for significant differences in factor scores between groups (i.e. gender, hunting technique, local-outsiders), a one-way analysis of variance (ANOVA) was performed (Quinn & Keough, 2003).

3. Results

Background data

I compared the demographic variables and hunting technique from the postal questionnaire and the internet survey to check for dissimilarities. There was no difference between the samples. The pooled hunters sample consisted of 6% females (n= 164) and 94% males (n= 2520), which is identical to the national proportion reported (SSB, 2007). A willow ptarmigan hunter was on average 45 years old (S.E. ± 0.267) and pretty well educated, as an average hunter has completed 14 years of school (S.E. ± 0.107) and education level did not differ significantly (p=0.54) between hunters with and without dogs. 54% of the hunters in this study use dogs, while 32% did not and 14% engaged in hunting both with and without dogs. Hunters without pointing dogs were slightly younger than hunters with dogs, 43.5 and 47 years, respectively, and the difference in age was significant ($F_{1,2303}$=32.41, p=0.001). Hunters without dogs had in average 17 years experience (S.E. ± 0.453), while hunters with dogs had hunted willow ptarmigan for 21 years (S.E. ± 0.338). The difference in experience was significant ($F_{1, 2266}$=52.24, p=0.001). There was also a question related to what hunters considered as a reasonable annual quota. The average was 17 willow ptarmigan (S.E. ± 0.237).

(Table 1 about here)

Effect of hunter domains on attitudes toward harvest regulations

The four hunter types (table 1) were determined from the PCA analysis; (1) Comfort, factor loadings ranged from 0,713 – 0,755(α=0,67), (2) Game contact, factor loadings ranged from 0,694 -0,861 (α=0,71), (3) Access, factor loadings ranged from 0,615-0,728 (α=0,51) and (4) Contentment, factor loadings ranged from 0,405-0,789 (α=0,24). The fourth dimension, "contentment" had two items with low factor loadings and hence a low Chronbachs alpha value indicating unsatisfactory unidimensionality (table 1). This hunter type was therefore dropped in further analyses of the data. The three remaining types, together with demographic variables were compared to attitudes to hunting restrictions (table 2). A significant negative relationship was found between Comfort hunter scores and a reduction in the number of hunters. There was also a strong, positive and significant relationship to prohibiting hunting in winter. An annual bag of 15

birds per year, shorter hunting seasons and splitting up the season into shorter periods were also positively and significant related. Bag-limit was not significant and showed a very weak relationship. Game contact hunters had a strong, negative relationship to bag-limit and a weaker, negative relationship to an annual bag of 15 birds per year. The only weak, positive relationship that was significant was to split up the season into short periods. The Access hunters were significant and negatively related to shorter hunting seasons, a bag-limit and strongly reduced numbers of hunters. A weak, positive and significant relationship was observed for prohibiting hunting in winter.

(table 2 about here)

Effect of hunter demography on attitudes toward harvest regulations

The relationship between the various demographic variables and attitudes to harvest regulations was examined in a GLM with demographic variables as predictors and attitudes to harvest regulations as responses (Table 2). Males were less positive to bag-limits (2 birds per day) than females. Generally, males also had a tendency to be more negative than females with regard to other restrictions such as splitting up the season in short periods, strongly reducing the number of hunters, prohibit hunting in winter and annual bag of 15 birds. There was no difference between sexes in the attitude to shortening the hunting season. Education and degree of urbanisation had no significant effect at all on attitudes to harvest regulations. Age was positively associated to four out of six harvest regulations. There was also a clear difference between local hunters and outsiders on attitudes to regulations. Local hunters were in general much more positive to restrictions such as annual bag of 15 birds, no hunting in winter and to splitting the season into short periods and shorter hunting seasons. A negative and significant relationship was observed for reducing the number of hunters. The same pattern was observed for bag-limits, but this relationship was not significant.

Relationships between demography and hunter types

An analysis of variance (ANOVA) was used to compare socio-demographic variables and hunting technique in relation to factor scores from the first and second principal component axis. Mean scores are plotted in figure 1.

(figure 1 about here)

No significant differences were found between the mean scores on the Comfort (p=0.164) and Game contact (p=0.93) axis for hunters with dogs or hunters without dogs (fig. 1A). Gender showed no significant difference on the comfort (p=0.654) or game contact axis (p=0.428) (fig. 1B). There was a significant difference between local and non-local hunters, where locals had a higher mean score on the comfort axis ($F_{1,2114}$=62.1, p=0.001) (Fig.1 C). Age showed a strong, significant difference in all groups on the comfort axis ($F_{4,2394}$=84,5, p=0.0001). There was a tendency for older hunters to be more comfort oriented while among Game contact hunters there was an increase in scores from hunters below 20 years old to hunters between 21 and 39 years followed by a decrease (fig. 1D).

Managers

I did not split managers into those responsible for public or private land, due to the low sample size. The managers represent areas ranging from 15.5 - 1600 km^2, with an average area of 358.7 km^2 (S.E. ± 87.2). 14 areas (58%) have annual line transect counts, while 10 areas (42%) do not have any counts. Managers considered the ptarmigan population density to be low at around 10 ptarmigan/km^2 (mean 11.67, S.E. ± 0.90), and a good population density to be around 30 ptarmigan/km^2 (mean 30.28, S.E. ± 2.00). This is in accordance with previous research (Steen & Erikstad, 1996) and the density levels used in this survey. Estimated population density before hunting season on public land ranged from 6-40 willow ptarmigan per km^2, with an average of 19.2 (S.E. ± 3.01) birds per km^2. On private land, ptarmigan density ranged from 13-60 willow ptarmigan per km^2, with an average of 28.3 (S.E. ± 5.54). Two managers reported population densities below 20 birds/km^2 and one reported 10 birds/km^2 as a point when a harvest regulation was implemented. Few observations on this question indicate a general lack of defined TPC in willow ptarmigan management. Managers had highest preference score for strongly reduceing the number of hunters, no hunting in winter and daily bag limits (table 3). Shortening the hunting season in the beginning or the end of season, splitting the season into shorter periods and an

annual bag limit of 15 birds per year received the lowest scores (table 3). There was also a question related to selling hunting licenses with a given number of willow ptarmigan that could be bagged. Managers thought, on average, that 7.8 birds per licence (S.E. ± 1.00) was a reasonable quota.

(table 3 about here)

Harvest regulations

In this study, hunters have an average daily catch per unit effort (CPUE) of 1.03 (S.E. ± 0.025) willow ptarmigan and they hunted in average 7.6 days (S.E. ± 0.133). When keeping the number of hunting days constant, and a catch of 2 willow ptarmigan per day, the harvest rate will be doubled and population will decrease. Hunters annually bagged an average of 8,4 willow ptarmigan per year (S.E. ± 0.27), which is 2.4 birds more than the national average reported (SSB, 2007). Again, an annual bag of 15 ptarmigan per hunter will result in an increased harvest rate if hunting effort increases. However, 85.1% of the hunters shot less than 15 willow ptarmigan. Shorter hunting seasons will, if all other factors remain constant, result in a reduced harvest rate and thereby strengthen next years breeding population (table 3). Prohibiting hunting in winter (after December 23rd) will only affect a small proportion of hunters, since the major share of the hunt is in September. A strong reduction in the number of hunters will lead to a reduction in total effort in the area, all other factors being constant. The population is then likely to increase, if daily CPUE or number of hunting days do not change. To split up the hunting season into short periods could increase the total effort. The effect on the population level is most likely negative or, at best, no effect (table 3).

4. Discussion

Response of hunters to harvest regulations

The three types of hunters showed no regular pattern in relation to harvest regulations, but Comfort hunters were negative to reductions in the number of hunters, and positive to all of the other proposed regulations. Game contact hunters were oriented towards no regulations of harvest rate, together with the Access hunters. In addition, Access hunters were negative to reducing the number of hunters and shortening the hunting season. Also, no effect was found of education or place of residence when regressing socio-demographic variables to harvest regulations. Gender, age and if the respondents were a local or non-local hunter, all significantly effected attitudes to harvest regulations. However, the importance to hunters of game contact and harvest success is often neglected in management. Frey et al. (2003) found a strong relationship between harvest success and satisfaction, where harvest success alone explained 27% of the variation in pheasant hunters satisfaction in Utah (Frey *et al.*, 2003). Similar effects on hunter satisfaction are reported for willow ptarmigan hunters in Norway (Faye-Schjøll *et al.*, 2007).

Hunters gave the highest score to an annual bag of 15 ptarmigan per year and no hunting in winter. This means that hunters would like to have the opportunity to hunt as much as they want during a day or a limited period, but accept to cease hunting during winter. One explanation is that only 15% of the hunters in the sample shot more than 15 willow ptarmigan and they hunt on average 7-8 days. Another explanation for the preference to hunt as much as they want is the observed increase in number of hunters with pointing dogs. Surprisingly, 54% of the hunters in this study used dogs. Hunters with dogs are probably more interested in having the opportunity to use the dog as much as possible, rather than shorten the season or limiting the daily number of game they can shoot. Willebrand and Paulrud (2004) studied hunters hunting pattern and attitudes to several aspects related to the hunting experience. They found that how well the dog performed was the main factor for a good hunting experience among hunters. Questions related to the dogs' performance where not included in this paper, but are previously reported (Andersen *et al.*, 2007). However, there are hunters hunting with no dogs, hunters with dogs and hunters who engage in both form of hunting in the survey. Only one study from Norway has studied ptarmigan hunters behaviour and opinion on harvest regulations. This study from the northern part of Norway (Aas

& Vinsand, 1996) found that hunters had higher acceptance levels for postponing the season opening until September 20th, than to introduce a daily bag limit of 3 birds per hunter per day, and a maximum of 15 birds per season. Further, a general reduction in the number of hunters by 25%, a total ban for hunting for 5 years and a shortening of the season from September 10th -24th were not acceptable at all. However, attitudes towards several of the proposed regulations differed significantly among hunter types. They also found that, on average, a hunter spends 12 days hunting per season. As new knowledge about effects of hunting on willow ptarmigan populations has been gained, the attitudes of hunters are likely to change too.

When combining demography, hunting technique and hunter domains, no significant difference were found between hunters with and without dogs or between sexes. There were differences between local and non-local hunters on the comfort axis. Local hunters seem to be more oriented towards a higher degree of comfort than non-local hunters. The most striking result was for hunters' age on the comfort axis. In general there was an increase in comfort score the older the hunter was. In relation to game contact there was an increase in the early stage, from 14-20 year to 21-39, and then game contact decreased with increasing age. One interpretation may be that an inexperienced hunter has fewer expectations as to what the hunt will bring. However, as experience increases, expectations increase in relation to game contact. Similar to the game contact hunter domain here, Willebrand and Paulrud (2004) found that game contact was the second most important factor explaining a good hunting experience. The third factor reported by Willebrand and Paulrud (2004), to hunt without any disturbance from other hunters fell into my analysis up in the hunter domain "contentment" that had too low factor scores and alpha-values to be used further in the analysis (table 1).

Managers and harvest regulations

As regards to perceptions of low and good ptarmigan density there was fair congruence between the responses of the managers and the assumptions used in the questionnaire; in general the mangers regarded a grouse density < 10 birds per km^2 in autumn as low density. Assuming hunting and winter mortality totalling 50% (although hunting mortality can be up to 60% and winter mortality can vary from 40-70% (Pedersen & Karlsen, 2007)), ten birds per km^2 can be translated into 2,5 breeding pairs per km^2 the following breeding season. Autumn densities of more than 30 birds per km^2 were considered good, and can be translated into 7,5 breeding pairs

per km^2 the next spring, given the same mortality rate as mentioned above. There was a discrepancy between the preferences from hunters and managers. The small sample size of managers is likely to affect the results quite a lot and thereby not reflect the overall perception among willow ptarmigan managers. However, the data represents managers from quite large areas. Managers had a higher preference score for bag-limits, no hunting in winter and reducing the number of hunters. To reduce the number of hunters was the harvest regulation with the largest difference in mean score between hunters and managers, followed by an annual bag of 15 willow ptarmigan per year. It is interesting that managers prefer harvest regulations that are connected with substantial uncertainty when it comes to precision of harvest off take, such as daily bag limits. This is probably because bag-limits are easier to control for game keepers. In Norway it is common to set bag-limits from 2-5 birds per day, and the size of the bag-limit can give much variation in relation to a potential harvest rate. Studies of bag statistics in Norway showed that only a small fraction of hunters actually achieved the maximum daily bag (Andersen, 2002), and that hunters in areas with bag-limits were less satisfied compared to hunters that hunted in areas without any restrictions (Faye-Schjøll, 2006; Faye-Schjøll *et al.*, 2007). Shortening the hunting season is usually done by enforcing a closing date in the middle of October or in November. At this time of the year, the ground can be covered in snow, and the number of active hunters is usually much lower than during the first few weeks of the season. However, the hunting can occasionally be excellent during late fall when willow ptarmigan moult into winter plumage.

It has been shown that hunting mortality affects populations of willow ptarmigan in Norway (Pedersen *et al.*, 2004). Use of bag-limits is, because of its imprecise nature, connected with considerable uncertainty when it comes to precision of the harvest off-take. However, an annual quota of 15 birds per year is more difficult to control, unless the design of the game licence becomes more like a punch card or the hunting licences for big game such as moose and reindeer. However, if quotas are connected to a longer time period, it is easier to calculate the total number of birds that can be shot in a hunting terrain. Managers can reduce either the number of birds that can be bagged by each hunter or reduce the number of hunters in relation to the quota. This study has revealed that there is a large difference between what managers (8 birds) and hunters (17 birds) thought could be a reasonable quota connected to hunting licences. Anyway, quotas can be more accurate than bag-limits, if the aim with the harvest regulation is to reduce the risk for overexploitation. Shorter hunting seasons will probably result in a reduced

harvest rate and thereby strengthen next years breeding population. It is important to remember that the major share of the hunt is during the first 2-3 weeks of the hunting season, so the overall effect may even out. Prohibiting hunting in winter (after December 23rd) will only affect a small proportion of hunters, since the major share of the hunt is in September. During winter, the CPUE is assumed to be very low, compared with hunting early in the season. Birds are often more evasive and fly off at greater distances from the hunter. However, Steen and Erikstad (1996) showed that winter mortality is a factor that affects populations as much as hatching success and chick survival. A strong reduction in number of hunters will lead to a reduction in total effort in the area if all other factors constant. In sum, population are likely to increase, if daily CPUE or hunting effort does not change. During the first 2-3 weeks of hunting season on public lands, it is common to divide the season into periods of 5-7 days, as well as restrict the number of hunters that are allowed to hunt in the area. This reduces problems with hunter crowding, and give more hunters access to the hunting area. One problem is that the total effort in the area can increase, since the first group of hunters hunt very intensively i.e. in a period of five days, and when the second group of hunters arrive, they probably do the same.

Hunter crowding can be a problem during the first weeks of the hunting season for willow ptarmigan. Austin et al. (1992) suggested that adoption of several hunter-preferred management options would increase satisfaction, motivation, and success among white-tailed deer hunters in Utah (Austin *et al.*, 1992) and thereby reduce problems related to hunter crowding. Brøseth and Pedersen (2000) fitted GPS receivers on willow ptarmigan hunters during the first 9 days at the start of the hunting season. Willow ptarmigan hunters walked on average 16.2 km daily at a speed of 2.8 km per hour. They hunted for 9 hours each day out of which almost 6 hours was active hunting time. During 50 hunter-days they harvested 20% of the willow ptarmigan population in the study area. The spatial distribution of hunting pressure was strongly dependent on the starting point of the hunters, and areas close to the base cabin were subject to most hunting activity. Areas furthest away, towards the border of the hunting area, experienced little hunting activity, and survival probability of ptarmigan was best predicted by distance from the cabin (Brøseth & Pedersen, 2000).

Harvest management requires knowledge of whether the harvest is sustainable as a result of compensatory mechanisms, such as dispersal and compensatory mortality. Brøseth et al. (2005) studied effects of recreational harvesting on dispersal patterns in willow ptarmigan. They found that a reduction in the population density of willow ptarmigan through harvesting at moderate

densities does not seem to affect the dispersal distances. Thus, if there is little or no difference in the dispersal probability distribution in harvested and non-harvested areas there will be only weak or no compensation for the harvest, given that natural mortality and reproduction are the same in both areas. Thus, erroneously assuming compensation of harvest by immigration into a local population can lead to overharvest (Brøseth *et al.*, 2005; Hörnell-Willebrand, 2005; Willebrand & Hornell, 2001), if not population densities in unharvested areas are not higher.

CPUE is often used as a measure of population abundance in management of willow ptarmigan. The simplest assumption in using CPUE data is that trends in CPUE are linearly related to abundance. Willow ptarmigan density alone is however not a good predictor of the hunters CPUE. Hörnell-Willebrand (2005) showed that the catchability of willow grouse increased as population decreased, indicating a non-linear relationship between density and abundance. Data from PMP showed no significant relationship between estimated density and CPUE, both on an individual level and pooled for each area in the study. The best predictor for CPUE in the PMP was number of willow ptarmigan encounters (Andersen, unpublished data). Similarly, the number of encounters or game seen was the best predictors for harvest success among pheasant hunters in Utah (Frey *et al.*, 2003) and deer hunters (Heberlein *et al.*, 1982). CPUE is not directly linked to abundance, and can have strong seasonal effects in periods when game change behaviour, such as brood break-up, moulting into winter plumage, or in the rutting season. This is also a strong argument to avoid bag-limits and try to develop other harvest regulations.

Management implications

To reduce a lot of the uncertainty related to management of willow ptarmigan, managers should develop models or strategies that account for varying densities between years. Only three managers reported to have defined a TPC when harvest regulations are implemented. A first stage must be to clearly state the management goal (in terms of minimum grouse density, hunter access etc). One such approach is to use a terrain quota strategy, based on density estimates before the hunting season (Pedersen & Karlsen, 2007). A major problem in Norway is that managers on public land sell their hunting permits before they know the density estimates from line-transect counts in August. It is harder to implement harvest regulations after hunting permits are sold. One solution is to adjust the regulations for management of public land in a way that managers are

allowed to delay the sale of hunting permits until the population status is estimated (usually two week before the start of the hunting season) and adjust hunting effort or off-take in relation to what they consider as sustainable. Such an approach seems to be the management practice in very few areas in Norway today. Big game hunters in Norway pay for the number of licences and in some occasions, the slaughter weight of the animals they shoot. If this concept is applied to willow ptarmigan management, it should be possible to calculate the maximum number of willow ptarmigan that can be harvested in a hunting terrain (terrain quota) after population status is estimated prior to the hunting season. Similarly, the hunters should pay for what they shoot. Calculations of sustainable harvest rate should be based on density estimates and chick production (Kastdalen, 1992; Pedersen & Karlsen, 2007). Managers can then sell hunting licences with a fixed quota per licence (i.e. 10 willow ptarmigan) on weekly or seasonal basis. When the quota is bagged, the hunter can buy a new licence, if there are still licences left. This solution will be more sustainable and reduce the risk for overharvesting, without excluding too many hunters in years when production is low. In private areas, managers have a much better possibility of controlling hunting effort and regulating the harvest, than managers on public land. This may underlie the fact that average autumn density of willow ptarmigan on public land is lower (19 birds per km^2) than on private land (28 birds per km^2) in this study. Another explanation for differences in density is that private estates in general are smaller than public land, and often includes more suitable habitats for willow ptarmigan.

A major objective of small game harvest management on public land is to provide hunting opportunities, while at the same time conserving the exploited species. However, there now seems to be a trend of declining hunting participation in many western countries (Heberlein, 2007) and in Norway (SSB, 2007), which can reduce the overall hunting effort in a long-term view. Complicated harvest regulations or restrictions perceived to be meaningless will not have a high degree of legitimacy or acceptance among hunters. Managers must develop harvest regulations and management models that meet the requirements of different groups of hunters, based on their motivations for hunting willow ptarmigan. This study has shown that hunters prefer quotas (i.e. annual bag), rather than daily bag-limits. A terrain quota model that includes hunting licences with a fixed quota per licence is one such a strategy. However, a fixed quota for small game species is not yet commonly applied in Norway.

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6. Appendix 1

N= number of respondents.

Density= estimated willow ptarmigan density from line transects counts before hunting season

Area	N	Density
Web-survey	1183	NR*
Eidfjord statsallmenning	123	7
Engerdal statsallmenning	219	8
Folldal-Elgvasslien	1	33
Rendalen-Nekkjølen	6	39
Oppdal bygdeallmenning B	63	22
Torpa-Gausdal statsallmenning	50	19
Vingelen	33	60
Øv. Numedal statsallmenning	209	21
Øyer statsallmenning	8	33
Folldal statsallmenning	136	24
Eidsfjellet/Ya-gryta	39	13
Kvikne statsallmenning	37	17
Ya-Gryta utmarkslag	20	13
Dovre statsallmenning	86	6
Vang allmenning	27	15
Budal statsallmenning	59	NR*
Nekjådal statsallmenning	24	40
Nordre Raufjellsameiet	2	23
Ringsaker JFO	95	27
Gausdal statsallmenning	135	19
Øvre Haltdal jaktsameie	17	17
Ringebu statsallmenning -felt 1	63	17
Ringebu statsallmenning- felt 2	77	10
Ringebu statsallmenning- felt 3	73	27
Total/mean density	**2785**	**19,12**

* Not reported

7. Appendix 2

The set of question used in the PCA to extract hunter domains (question 24). Note that question c) and k) was excluded from the initial analysis due to low factor scores.

24
I hvilken grad spiller ulike forhold inn på din opplevelse av hvor god jakta er. (Kryss av for hver av påstandene nedenfor)

	Helt uten betydning				Av meget stor betydning
a) Fint vær under jakta	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b) Mye kontakt med vilt (ikke bare antall skuddsjanser)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c) Gode prestasjoner av fuglehunden(-e)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d) Mange skuddsjanser	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
e) Mye felt vilt	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
f) Å få jakte i områder hvor jeg er godt kjent	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
g) Å få jakte på store jaktterreng	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
h)At jaktområdet er lett tilgjengelig fra bilvei	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
i) At husvære for overnatting har en god standard	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
j) Å kunne jakte uten å treffe andre jegere i samme område	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
k) At mine egne skyteferdigheter har vært t ilfredsstillende under jakta (lite bomskudd)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
l) At terrenget er lett å gå i, samt oversiktlig å jakte i	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
m) At naturen i og rundt jaktterrenget er vakker	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
n)At jeg kan jakte her over en lengre periode, uten å føle at jeg må jakte mer intenst når jeg først er på jakt, på grunn av avkorting i jakttiden. (reduksjon i antal dager man kan jakte)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

The set of response variables used (question 33). Note that question f) is excluded from the analysis.

Del 5 Forvaltning og tilrettelegging:

33 **Dersom beskatningen må reduseres på grunn av lav rypebestand, hvilke begrensinger vil du foretrekke?**

	Helt uenig.				Helt enig
a) Dagkvoter på inntil 2 ryper/jeger er nok	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
b) Totalkvote på inntil 15 ryper pr jeger i sesongen er nok	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
c) Lengden på jaktsesongen blir kortere	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
d) Mulighet for vinterjakt på rype fjernes.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
e) Antall jegere som slipper til i terrenget samtidig reduseres kraftig, og det er ikke sikkert at du slipper til i terrenget som følge av dette.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
f) Tilgjengeligheten (mulighet for å kjøpe jaktkort) blir bedre	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
g) Dele jaktsesongen opp i flere kortere perioder, f.eks 5 dager, med færre jegere i terrenget samtidig	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Table 1.

Item	Comfort	Game contact	Access	Contentment
Easy access from road	**.755**	.060	.076	-.077
Cabin with good standard	**.720**	.049	.076	-.011
Easy-walked terrain to hunt in	**.713**	.030	.094	.242
Many chances to shoot game	.092	**.861**	.035	-.018
Much bagged game	.082	**.794**	.114	-.136
Many game encounters	.006	**.694**	.013	.264
Large areas	.004	.158	**.728**	.059
No reduction in hunting season	.023	-.005	**.688**	.172
Hunt in areas I know well	.344	-.041	**.615**	-.063
Beautiful landscape	.113	-.084	.172	**.789**
Nice weather	.482	.191	-.147	**.485**
Hunt without seeing any others	-.247	.202	.347	**.405**
		Factor correlations		
Comfort	1			
Game contact	-0.001	1		
Access	-0.002	-0.007	1	
Contentment	-0.001	0.001	-0.001	1

Table 2.

	Demography						Hunter domains			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Harvest regulation	**Male**	**Age**	**Education**	**Local**	**Rural**	**R^2**	**Comfort**	**Game contact**	**Access**	**R^2**
Bag-limit (2 per day)	-0.521***	0.005*	-0.008	-0.053	-0.124	0.011	0.042	-0.272***	-0.104***	0.045
Annual bag 15 per year	-0.120	0.012***	0.005	0.403***	0.077	0.040	0.171***	-0.092***	-0.040	0.038
Shorter hunting season	0.001	0.005*	0.001	0.267***	0.094	0.012	0.083**	0.057	-0.117***	0.011
No hunting in winter	-0.132	0.028***	-0.007	0.367***	0.064	0.078	0.401***	-0.029	0.067*	0.063
Strongly reduce number of hunters	-0.148	-0.001	-0.006	-0.123*	-0.101	0.004	-0.121***	0.009	-0.061*	0.013
Split up season in short periods	-0.210	0.005	0.008	0.328***	0.047	0.020	0.064*	0.062*	-0.025	0.010

*** $p<0.001$, ** $p< 0.01$, * $p< 0.05$.

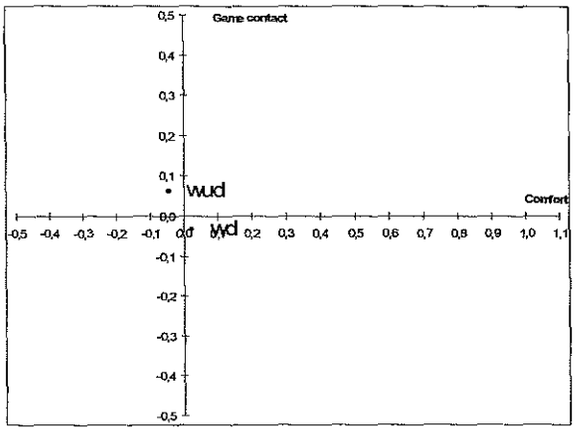
Table 3.

Harvest regulation	Hunters [a] Mean score (S.E.)	Managers [a] Mean score (S.E.)	Score difference (M-H)	Pop. effect (t+1)
Bag-limit (2 birds per day)	3.32 (0.029)	4.1 (0.335)	0.78	-
Annual bag 15 per year	3.80 (0.028)	2.56 (0.465)	-1.24	-/0
Shorter hunting season	2.46 (0.030)	2.35[b] - 2.53[c] (0.342[b]-0.385[c])	-0.11 and 0.07	+
No hunting in winter	3.28 (0.034)	4.2 (0.338)	0.92	+
Strongly reduce number of hunters	2.88 (0.027)	4.26 (0.323)	1.38	+
Split up season in short periods	3.20 (0.028)	2.41 (0.438)	-0.79	-/0

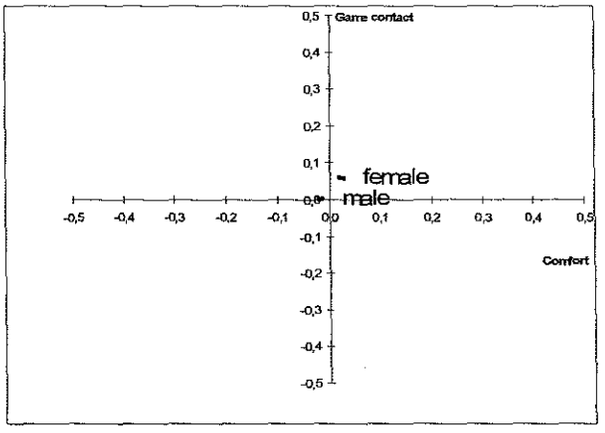
[a] Scale hunters: 1: Strongly disagree, 5: Agree very much.
[a] Scale managers: 1: seldom used, 5: often used
[b] In the start of hunting season
[c] In the end of hunting season

Figure 1.

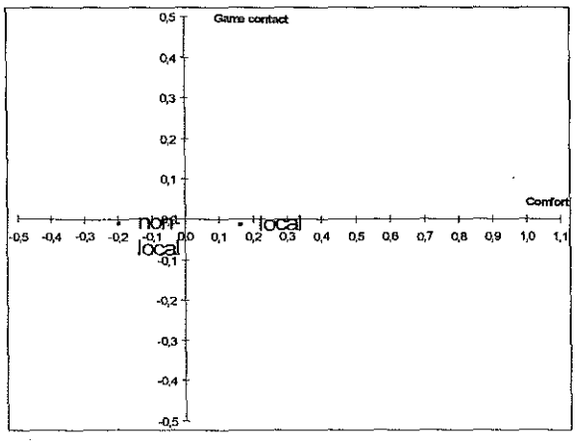
A)



B)



C)



D)