Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Faculty of Natural Resources and Agricultural Sciences
Department of Ecology
Grimsö Wildlife Research Station

Greylag geese (*Anser anser*) – crop selection and spatial distribution around Sörfjärden, Södermanland

Grågäss (*Anser anser*) - grödoval och rumslig fördelning vid Sörfjärden, Södermanland

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Even if the world would end tomorrow I would still plant a tree today.

Martin Luther King, Jr.

Abstract

A rapid population growth in Greylag geese (*Anser anser*) has led to a conflict between geese and farmers due to the foraging geese in agricultural fields which causes damage to crops by trampling and grazing. Culling cannot always be used as a management tool due to protection of the species and temporal restrictions of hunting seasons. Therefore, non-lethal methods such as different scaring techniques and alternative reserved feeding areas, i.e. accommodation fields, have been developed to try to push them away from agricultural fields and pull them to these reserved feeding areas. To enhance the non-lethal management, more knowledge was needed about the geese such as crop selection and distribution patterns e.g. the selection of fields in relation to distance to roost sites. In this study the geese crop selection was estimated by compositional analyses over a three year period (March-October in 2010-2012) around Sörfjärden, Sweden. Moreover, the distribution of geese in relation to distance to roost sites was studied. The compositional analysis showed that the geese selected the acommodation field and grassland more than expected for 2010 and 2011, but that wheat was the top ranked crop in 2012. However, the selection of the accomodation field and grassland was more pronounced during early summer and the selection of grass fields´ declined during late summer. The geese shifted to cereals such as wheat (*Triticum spp.*), barley (*Hordeum vulgare*) and pea (*Pisum spp.*) in late summer, probably because of higher availability due to the harvest and waist grains on the stubble fields. No significant results were found on geese distribution of distance to roost site, due to clumped distances to roost sites in the study area. In conclusion, accommodation fields are a good non-lethal method to ease the grazing pressure on agriculture fields especially during early summer in Sörfjärden.

Contents

Introduction

During the past 30 years the number of Greylag geese (*Anser anser*) has shown a positive long-term increase throughout Europe (Fox et al. 2010). At least three interacting factors have been suggested as drivers for this increase, namely; i) land-use changes since 1950´s, which opened wide agricultural lands that provided enormous amounts of food for foraging geese (Fox et al. 2005; Jefferies et al. 2003; Fox et al. 2010), ii) regulated hunting and protection of species (Anon. 1987; Anon. 1979) and hunting effort have declined in proportion to the increasing flocks of geese (Nilsson and Persson 1991), and iii) wetland restorations which has improved nesting and staging sites (Anon. 1974).

The increase in geese abundance has led to conflicts between farmers and geese due to the damages caused by grazing and trampling on the agricultural fields where geese forage. The problems are especially pronounced in areas where the birds aggregate in large numbers such as nesting, resting and moulting sites (Kleijn et al. 2012; Percival and Houston 1992; Paterson 1991). In areas with intense grazing the losses in crop yield can be extensive (Percival and Houston 1992; Vickery and Gill 1999; Rehfisch 2002; Musgrove et al. 2011) but even small losses can be significant for small scale farmers (Paterson 1991).

In an attempt to minimize the damages and to mitigate the conflict in Sweden, the County Administration board in association with NGO's, Wildlife Damage Center, scientists and farmers have initiated counteractions (Hake et al. 2010). For decades culling has been used as a main management strategy to control and minimize the damages. However, culling cannot always be used as a management strategy since some damaging species are protected by the International Union for Conservation of Nature and Natural Resources (IUCN) red list of endangered species or due to hunting regulations (Anon. 1987). Therefore, alternative methods to culling have been developed. The general non-lethal methods to decrease damage is to scare the birds within damage prone areas and try to pull them in to certain areas by creating preferred areas such as grasslands or specific agriculture fields where the birds are allowed to graze undisturbed i.e. accommodation fields (Tombre et al. 2013; Vickery and Gill 1999). To increase the success rates of such counteractions we need increased knowledge about the geese and how they respond to measures taken. Especially when establishing accommodation fields it is necessary to know; what crop they prefer and how far from roost sites they are prepared to forage.

Crop selection can be studied by analyzing the relative use of resources by an animal in relation to the relative availability of the resources (Aebischer et al. 1993). Moreover, the selection can be studied over different spatial scales, from distribution patterns (first order selection) to the selection of certain feeding patches (fourth order selection, Johnson 1980). Although there are studies concerning Greylag geese and the impact on and selection of agricultural fields, these aspects are poorly understood because patterns of selection vary between seasons and specific areas (Patterson et al. 1989; Vickery and Gill 1999). Such knowledge is however of high value for the management since the information could be used to; i) be able take precaution on highly preferred field's e.g. scaring and culling, ii) predict which crops are more likely to suffer greater damage, iii) select seed mixes for the

accommodation field to increase their attraction, iv) decide where, in relation to roost sites, to establish an accommodation field and how to manage it to get the highest selection and v) achieve better understanding of seasonal variations in selection patterns.

Aim

This study aims to investigate crop selection by Greylag geese, paying particular attention to the selection of a recently established accommodation field in relation to the available agriculture fields and crops within the damage prone area (i.e. third order selection; Johnson 1980) in Sörfjärden Sweden. Seasonal patterns will also be analyzed to further define the role of the accommodation field in the area. Moreover, this study aims at describing the distribution of Greylag geese in relation to distance to roost site.

Methods

Study area

The study area Sörfjärden (Fig.1) is located in south-central Sweden (WGS 84; 59.42983, 16.78314) and consists of agricultural areas, bank areas, dense reed areas and open water (of which shallow water comprises an area of 25km^2). Sörfjärden is protected by the RAMSAR convention since 2001 (Anon. 1974), and holds both a number of nature reserves and Natura 2000 sites which comprises both the Bird Directive (Anon. 1979) and the Habitat Directive (Anon. 1992) which make it a perfect waterfowl habitat.

Sörfjärden and its surroundings has for some time been an important resting and nesting place for several species of water fowls, such as Greylag geese (*Anser anser*), Eurasian Bittern (*Botaurus stellaris*) and Greater Scaup (*Aythya marila*) (Broberg 2012). The number of Greylag geese in Sörfjärden has during the past five years (2007-2012) varied between 1200-5000 (mean 4060) according to counts conducted in September (Ödman et al. 2013). This accounts for 25% of the total number of geese in the county of Södermanland. The number of breeding pairs per year, in Sörfjärden was estimated to about 175 in a three year survey (2007-2009) (Ödman et al. 2013).

During the past five years (2007-2012) the mean yearly temperature for the area were 6.5º C, during summer the temperatures average were approximately +16 º C, and during winter around +2º C. The lake is usually covered with ice and snow from January to mid-March or early April. Yearly rainfall range between 600 and 800 mm, but the lake water levels are regulated with dams so the surroundings are less likely to be affected by heavy rainfall. (Swedish Meteorological and Hydrological Institute, www.SMHI.se)

In 2010, an accommodation field was established in the area of Sörfjärden. The field was set off and managed by mowing to attract geese in order to decrease the damages caused by geese on other agricultural fields. The seed mix that was used consisted of; 25% alfalfa (*Medicago sativa*), 23% timothy (*Phleum pratense*), 15% *Lotus corniculatus,* 12% meadow fescue (*Festuca pratensis*), 10% white clover (*Trifolium repens*), 10% chicory (*Cichorium intybus*),

5% caraway (*Carum carvi*). The accommodation field was managed to keep the grass sward height low (>.5m, Vulink et al. 2010), since they prefer plants that are short and brittle. (Ödman et al. 2013)

Data collection

Greylag geese survey

The survey was conducted in 2010-2012 between March and October, with a four week gap during midsummer (i.e. during moult when most birds are unable to fly). The number of geese was surveyed from a total of 22 survey points distributed over the study area (Fig.1). One point was later excluded due to missing data, i.e. 21 of these were used in this study. The points were chosen so that several fields could be monitored at the same time without leaving the vehicle and thereby avoiding disturbance to the geese whilst counted. The observations were conducted on a weekly basis, one visit per week at each survey point between sunrise and noon, by volunteers from the Swedish Ornithology association (SOF) in association with the Swedish Society for Nature Conservation (SSNC).

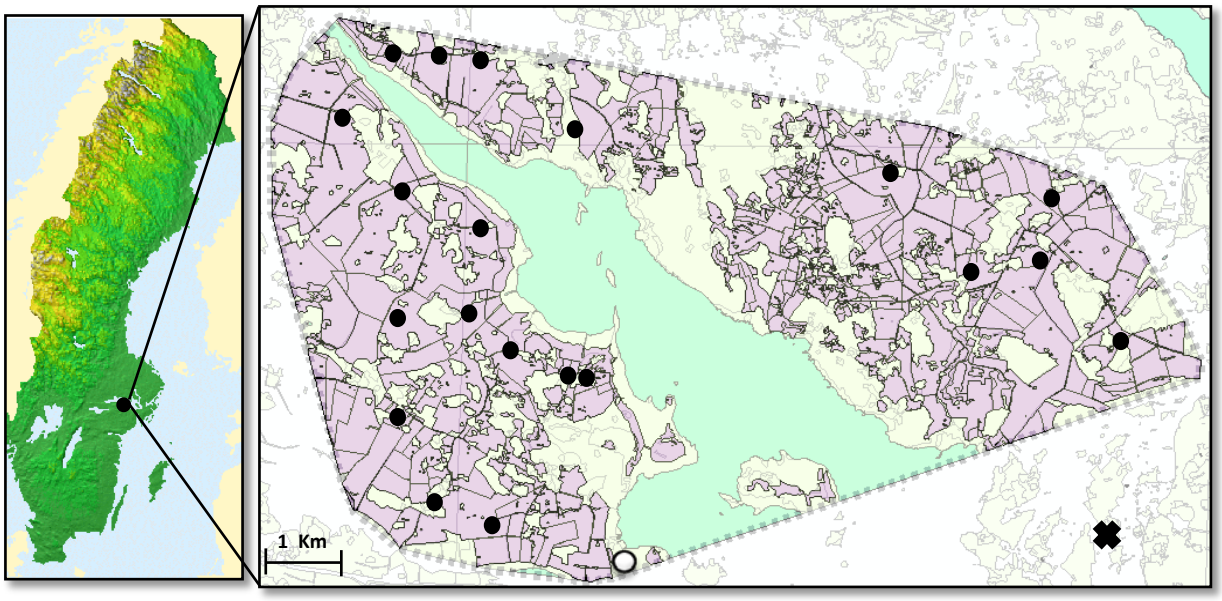

Fig.1. The locations of the survey points for the Greylag geese survey on agricultural fields in Sörfjärden, Sweden (2010-2012). The study area are defined by the dashed line. The minimum convex polygon (MCP) is defined by outer edges of the surveyed fields (convex hull). The black dots show the survey points (the hollow one is the accommodation field) and the x marks the point that was deleted due to missing data.

Field and crop data

Sixty six agricultural fields were surveyed and the number of fields ranged from 1-6 at each survey point. Out of these fields 48 were used for the analysis (18 were excluded due to missing data on crop type and size of the field). Crop type was obtained from the register of fields and crop types (block-data) provided by the County Administration board, but not all fields were included in the register and therefore had to be excluded from this study. The crop composition varied between years. The block-data contains; the field ID number, the size of the fields and the crop on each field per year.

Crops that were present in the study area but not in the survey fields have been excluded. Some crops have been merged together into categories of crop types such as for potatoes and linseed the category “other” was created. Both categories “pasture land” and “grassland” includes several different types’ of pasture- and grasslands. Land set aside was defined as agricultural fields that are not used for farming for one or several years.

Since the study only comprised a sample of all fields within the area, a convex hull was created by the function minimum convex polygon (MCP) in ArcGIS 10.1 (ESRI, New York 2013) to define the study area. A total of 326 fields (5711ha) were included in the total study area. By comparing the composition of crop types (proportion based on area) on the surveyed fields in relation to the total study area, it was possible to see if the survey fields were representative in crop composition within the study area.

Distance to roost site

The distance to water edge (roost site) was calculated from the midpoint of the fields to the nearest edge of Sörfjärden, using the near-function in ArcGIS 10.1. For this analyses, information from the topographical map of Sweden (“Gröna Kartan”, 1:50 000 Lantmäteriet) was used. The distribution of geese in relation to field size and distance to roost sites were plotted in Fig.4.

Seasonal differences

Different crops mature and are harvested at different times. Thus, determine the effectiveness of the accommodation field, the seasonal variations in crop selection had to be included in this study. No harvest data was included in the observations, why the period of the geese´s moulting period was used to define the seasons. They were defined as “early summer” from March to early June and “late summer” from mid-July to October.

Statistics

A compositional analyses (Aebischer et al. 1993) was used to analyze the third-order habitat selection of Greylag geese. Third-order selection compares the selected habitats within the defined home range with the available habitats in the same home range. The weekly counts of number of geese observed at certain crop types were used as the independent observations. The composition of crops was constant over the seasons within each year. All analyses was conducted in R 3.0.1 (R Development Core Team 2011) for the compositional analyses the adehabitat library was used. The expected number of geese was calculated by multiplying the proportion of the available crop type with the total number of geese counted during the three year survey (Neu et al. 1974).

Results

Overall patterns

The agricultural field within the total study area (n=326), had an average size of 5.8 ha (±6.8 SD), whereas the size of the fields included in the survey (n=48) had an average area of 13.5 ha (±9.3 SD), the size of the accommodation field was 5.75 ha. The mean distance from the roost sites to the midpoints of the survey fields for the entire study area was 1248 m (±1182.7 SD); whilst for the surveyed fields the mean distance was 1839 m (±1772.3 SD) and the accommodation field was located 475 m from the roost site. The surveyed fields proved to be representative regarding the area of the specific crop types for all the years combined.

Most geese were found on wheat (*Triticum spp.*), which also was the most common crop type in the study area (majority of the area), followed by the accommodation field, which comprised the least area (Table 1). The accommodation field (accom. field) was selected more than expected for all the years combined, followed by wheat and grasslands (Table 2). Although crop types such as the accommodation field, grassland, barley (*Hordeum vulgare*) and pea (*Pisum spp.*) displayed a higher selection than expected in relation to availbility (Fig. 2), no significant difference in selection was found for barley or pea when looking at the whole study period. Although wheat did not show high number of geese in relation to its availability, it was significantly more selected than all the other crops except for the accommodation field and grassland (Fig. 2).

Table 1. The observed number of Greylag geese on every crop type in the study area around Sörfjärden Sweden, divided into; year, season and in total for all three years and expected number of geese on each crop based on the size of the survey fields for all three years combined (2010-2012). Also the mean area for the survey fields.

Crop type	2010	2011	2012	Early summer	Late summer	Total no of geese for all years	Expected no geese	Mean area of survey fields (ha)
Accom. field	646	867	635	1334	814	2148	131	5.8
Pasture land	113	46	265	197	227	424	1190	52.5
Grassland	886	320	151	703	654	1357	334	14.7
Oats	358	3	228	47	542	589	562	24.8
Barley	413	721	694	52	1776	1828	1385	61.1
Rape	219	48	70	220	117	337	2018	89.0
Rye	102	223	3	75	253	328	469	20.7
Land set aside	65	127	0	122	70	192	238	10.5
Wheat	1269	4103	1479	2722	4129	6851	7027	310.0
Pea	585	0	0	50	535	585	304	13.4
Other	229	0	0	106	123	229	1212	53.5

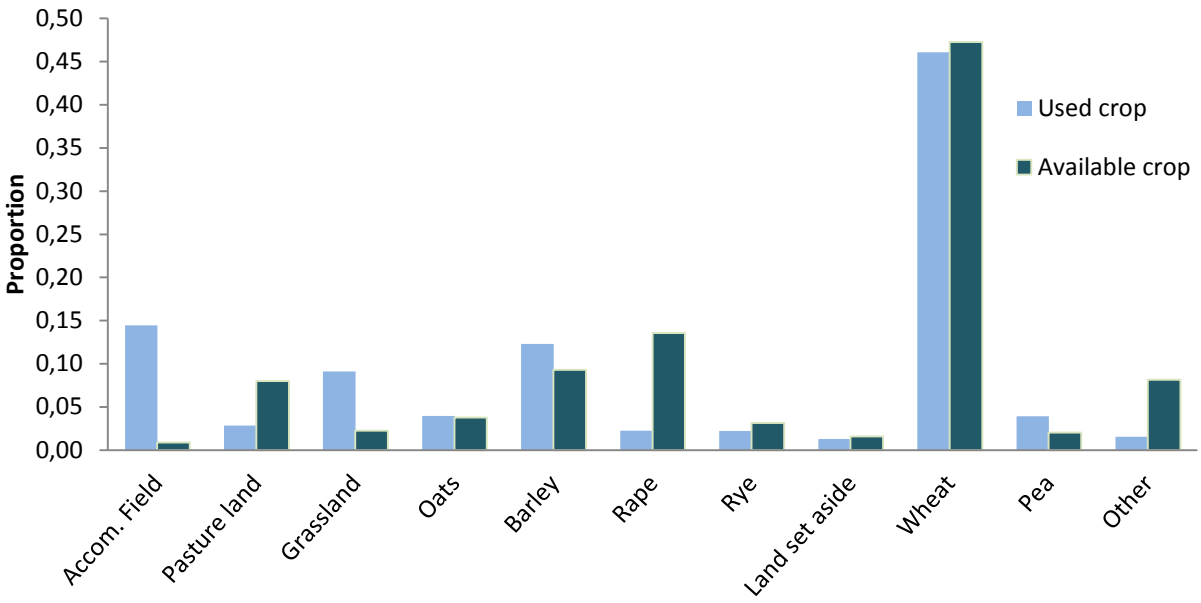

Fig. 2. Proportion of geese observed in the different crops in the study area around Sörfjärden Sweden in 2010-2012 at the different crop types and the proportion of available crop (area based), within the survey fields for all three years combined.

Table 2. A matrix for the years 2010-2012 for Greylag geese around Sörfjärden, third-order habitat selection i.e., detailed view of the relative resource selection among crops with *t* values p< .05 in bold. A lower rank indicates a higher selection.

Crop type	Accom. field	Pasture land	Grassland	Oats	Barley	Rape	Rye	Land set aside	Wheat	Pea	Other	Rank
Accom. field	-											1
Pasture land	**-6.349**	-										10
Grassland	**-2.215**	**4.515**	-									3
Oats	**-3.474**	0.727	**-2.744**	-								4
Barley	**-3.981**	-0.377	**-3.269**	-1.234	-							6
Rape	**-6.291**	-0.692	**-5.071**	-1.237	-0.066	-						9
Rye	**-5.554**	-0.251	**-3.576**	-0.865	0.199	0.291	-					8
Land set aside	**-5.284**	0.357	**-3.959**	-0.384	0.706	1.192	0.587	-				7
Wheat	-2.047	**3.066**	-0.385	**2.164**	**3.086**	**3.432**	**3.995**	**3.648**	-			2
Pea	**-3.57**	0.733	**-2.095**	0.052	1.065	1.211	0.987	0.484	**-2.463**	-		5
Other	**-7.09**	-1.438	**-5.528**	**-2.139**	-1.085	-1.292	-1.328	**-2.044**	**-4.971**	-1.956	-	11

Interannual patterns

There are some interannual variations in the crop selection, i.e. the crops are selected slightly different by geese from one year to another. However, the accommodation field was always top ranked independently of year, followed by grassland in (2010 and 2012), and followed by wheat in 2011 (no significant difference to accommodation field). In 2012 wheat drops down from being ranked as three to seven. The crop types pea and other were not available during 2011 and 2012, and by that the composition of crops was slightly different from 2010 (Table 3b, c). However, 2010 when pea was available it was ranked as number four but was not significantly more selected than any other crop. However, the accomodation field was significantly more selected (Table 3a). Over all there was an increase in selection for different types of grass in 2012 and as a result the selection of cereals declined.

Table 3. Third-order habitat selection i.e., a detailed viewof the relative resource selection among crops with *t* values p< .05 in bold. a) matrix for 2010. b) matrix for 2011. c) matrix for 2012. na = not accessible. A lower rank indicates higher selection.

Crop type	Accom. field	Pasture land	Grassland	Oats	Barley	Rape	Rye	Land set aside	Wheat	Pea	Other	Rank
a,												
Accom. field	-											1
Pasture land	**-4.042**	-										8
Grassland	-0.434	**5.251**	-									2
Oats	**-2.708**	0.842	**-2.687**	-								5
Barley	**-3.177**	-0.072	**-2.812**	-0.959	-							6
Rape	**-4.030**	-0.189	**-3.921**	-1.011	-0.062	-						9
Rye	**-3.387**	1.777	**-2.246**	0.598	1.667	1.695	-					7
Land set aside	**-4.186**	-0.229	**-4.192**	-1.232	-0.154	-0.067	**-2.134**	-				10
Wheat	-1.572	**2.306**	-1.721	1.023	**2.100**	**2.038**	0.453	**2.301**	-			3
Pea	**-2.437**	1.041	-1.698	0.305	1.215	1.025	-0.176	1.377	-0.420	-		4
Other	**-4.898**	-1.084	**-4.234**	-1.997	-1.154	-1.411	**-2.896**	-1.369	**-2.989**	-1.847	-	11
b,												
Accom. field	-											1
Pasture land	**-7.443**	-										9
Grassland	**-2.769**	**4.585**	-									3
Oats	**-5.426**	0.941	**-3.586**	-								7
Barley	**-3.992**	0.858	**-2.488**	0.382	-							5
Rape	**-6.917**	**-2.286**	**-5.466**	**-4.244**	**-2.696**	-						8
Rye	**-4.916**	0.516	**-3.201**	-0.088	-0.385	**2.459**	-					6
Land set aside	**-3.746**	**3.306**	-1.710	**2.368**	1.317	**6.917**	1.768	-				4
Wheat	-1.596	**3.872**	0.175	**3.726**	**2.220**	**5.876**	**3.019**	1.715	-			2
Pea	na	na	na	na	na	na	na	na	na	-		
Other	na	na	na	na	na	na	na	na	na	na	-	
c,												
Accom. field	-											1
Pasture land	**-3.446**	-										5
Grassland	-1.010	**2.749**	-									2
Oats	**-3.407**	-0.189	**-2.799**	-								4
Barley	**-3.824**	-1.040	**-3.112**	-1.026	-							6
Rape	**-5.030**	-1.974	**-4.519**	-1.762	-0.250	-						9
Rye	**-4.749**	-1.250	**-5.111**	-1.069	0.037	0.508	-					8
Land set aside	**-3.030**	1.429	**-2.281**	1.676	**2.791**	**7.089**	**6.036**	-				3
Wheat	**-3.928**	0.332	**-2.668**	0.464	1.192	1.601	1.532	-0.618	-			7
Pea	na	na	na	na	na	na	na	na	na	-		
Other	na	na	na	na	na	na	na	na	na	na	-	

Seasonal patterns

When divided into early and late summer the results changes between the seasons. During early summer the accommodation field was the top ranked crop type and significantly more selected than all other crops, grassland and wheat were ranked as number 2 and 3 respectively (Fig 3a, b & Table 4a). During late summer wheat was top ranked and the accommodation field was ranked as second and only significantly selected over five other crops (pastureland, rape, rye and land set aside and other), i.e. the selection for the accommodation field has decreased. Pea was ranked as number three in late summer (Table 4b). The selection for pea increased from early to late summer, and moreover the selection for it did not differ from the

selection of the accommodation field any longer (Fig. 3 & Table 4b). Overall there was a decline in selection for the different grass crops whilst there was an increase in use of the cereal crops between the two seasons.

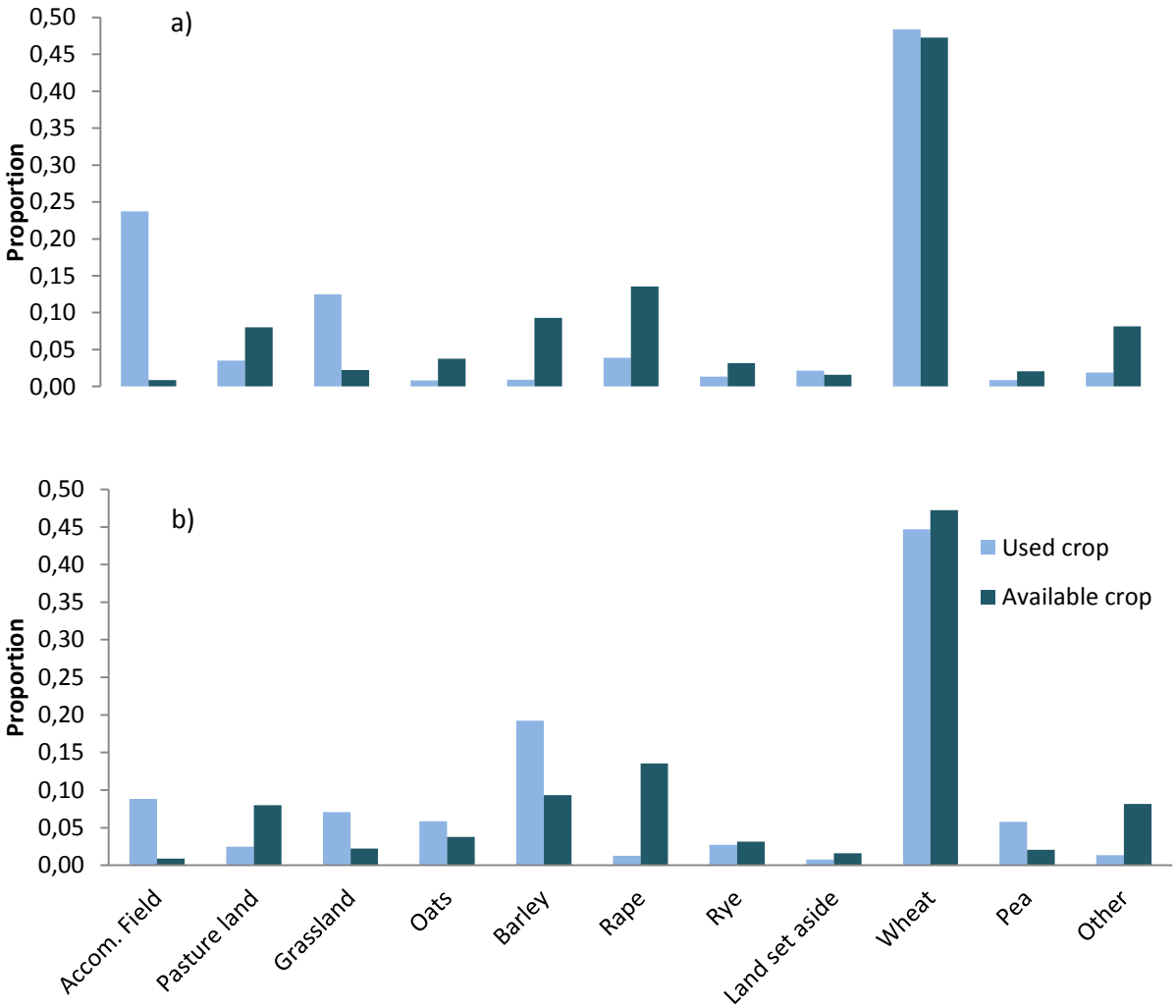

Fig. 3. Proportion of geese within the different crop types and the proportion of crop availability within the survey fields for: a) early summer and b) late summer, in the study area around Sörfjärden Sweden 2010-2012.

Table 4. Third-order habitat selection i.e., a detailed view the relative resource selection among crops with *t* values p< .05 in bold for two seasons in the study area around Sörfjärden Sweden in 2010-2012. a) matrix for early summer, before moult. b) matrix for late summer, after moult. A lower rank indicates a higher selection.

Crop type	Accom. field	Pasture land	Grassland	Oats	Barley	Rape	Rye	Land set aside	Wheat	Pea	Other	Rank
a,												
Accom. field	-											1
Pasture land	**-5.963**	-										4
Grassland	**-5.358**	**5.05**	-									2
Oats	**-6.715**	-0.428	**-6.17**	-								6
Barley	**-8.675**	-1.442	**-6.338**	-1.401	-							9
Rape	**-8.931**	0.372	**-4.97**	0.894	**2.936**	-						10
Rye	**-7.17**	-0.909	**-5.612**	-0.645	0.799	-1.254	-					7
Land set aside	**-6.661**	-0.089	**-4.278**	0.316	1.889	-0.578	0.91	-				5
Wheat	**-5.456**	1.249	**-3.264**	1.244	**2.374**	0.657	**2.673**	1.36	-			3
Pea	**-10.869**	-1.782	**-7.786**	-1.346	0.17	**-2.823**	-1.009	**-2.265**	**-3.475**	-		11
Other	**-7.344**	-0.899	**-5.298**	-0.819	0.855	**-2.185**	-0.185	-1.017	-1.914	0.515	-	8
b,												
Accom. field	-											2
Pasture land	**-3.652**	-										10
Grassland	-1.202	**2.268**	-									4
Oats	-1.226	1.331	-0.561	-								5
Barley	-1.36	0.839	-0.784	-0.369	-							6
Rape	**-3.585**	-1.519	**-3.085**	**-2.294**	-1.749	-						9
Rye	**-2.638**	0.552	-1.267	-0.612	-0.398	1.69	-					8
Land set aside	**-2.582**	0.627	-1.848	-0.74	-0.411	**2.403**	-0.024	-				7
Wheat	0.152	**2.929**	1.332	1.725	1.964	**4.28**	**2.97**	**3.773**	-			1
Pea	-0.573	**2.857**	0.427	1.014	1.137	**4.251**	1.711	**2.141**	-0.8	-		3
Other	**-3.96**	-1.152	**-3.082**	-2.041	-2.035	0.093	-1.843	-1.916	**-5.806**	**-3.183**	-	11

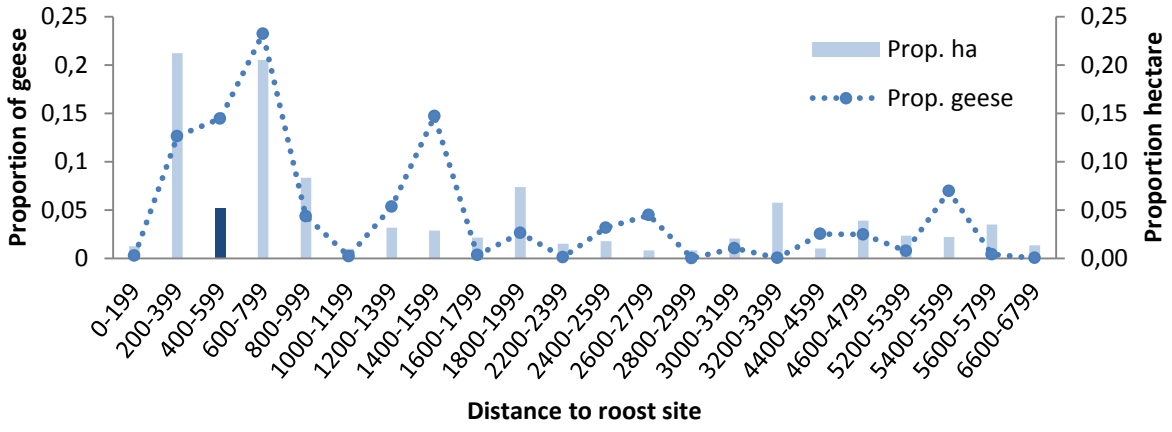

Fig.4. The proportion of Greylag geese and the proportion of surveyed area and their distribution within the study area around Sörfjärden Sweden in 2010-2012, in relation to the distance to roost site. The darker bar show the accommodation field.

During the survey a total of 78% of the geese were observed within a 2 km radius from the roost site. However, the same distribution was observed for the area surveyed and it geese therefore seem to use the fields by random i.e geese do not select fields closer to roost site more than expected (Fig.4).

Discussion

This study showed that Greylag geese do not select available crops at random, rather they selected the accommodation field significantly more than other crops. Furthermore, the study shows a variation in crop selection both between years (Table 3) and seasons (Table 4). Both the accommodation field and grassland were top ranked in most of the analyses. Since the two crop types are similar to one another in composition, so the reason why the accommodation field was selected in larger extent could derive from the fact that it had been managed to attract geese with slightly different seed mix and repeated mowing (Vickery and Gill 1999), and that the geese were undisturbed on that field (no scaring and culling).

Although a previous study (Wallgärd 2010), on Greylag geese have shown a preference for agricultural fields with an average size of 24 ha, the small accommodation field in this study was still selected eventhough it only comprised 5.75 ha (Table 3a, b, c), which further indicate a high selection of that field.

Establishment of an accomodation field seem to be a rather good solution to mitigate geese grazing problems (Lauresen 2002; McKay 2001). This was also supported by a questionnaire sent out by the County Administration board to local farmers around Sörfjärden, which showed that the general impression was that the accommodation field had relieved some of the grazing pressure by the geese on their agricultural fields, especially in spring and early summer. Through this experience several farmers have shown an interest in establishing an accomodation field on their land. However, the accomodation field is not a complete solution since there still were a lot of geese on other fields. Moreover, the effectiviness differ between seasons and years. The attractivness of an accommodation field might not only be due to how it is managed. The crops on the surrounding fields could also have an effect, since the selection may be influenced by density of geese in the area. According to Fretwell and Lucas (1970), birds will always feed in the best habitat, but as more and more birds are entering the avaliable first choice habitat the suitability declines until it is as high as the second best habitat and the birds will start to select the second choice aswell as the first (Baveco et al. 2011). By planting crops that are low in preference for the birds on surrounding fields, the accommodation field may be even more selected and the risk of birds wandering into the closest surrounding fields will be lower. Thus, when establishing an accommodation field the area around it should also be considered and included in the management of the accommodation field. For example regarding to when the crops get sown, when they mature and are harvested. By establishing more accommodation fields in the same area the effect may also be improved.

There were some differences in the selection of the accommodation field between years. This may partly be explained by the fact that the accommodation field was established in 2010, the establishment of some crops might not have been optimal the first year and the field was partially flooded in 2012. Nevertheless it was still highly selected all years (Table 3). The second in rank was grassland for 2010 and 2012, but in 2011 wheat was ranked top two (Table 3). The area of wheat more than trippled from 2010 to 2011, whilst grasslands decreased with ca.50% in the same period. The vast increase in area of wheat in combination

with the theories of Fretwell and Lucas (1970) and Baveco et al. (2011) may explain why wheat was selected more then grassland in 2011. The increse in selection of cereals between 2010-2011 and the decrease of it between 2011-2012, whilst the grass crops decreased between 2010-2011 and increased between 2011-2012 could be explaind by the weather. In 2012 there was heavy rain which postponed the harvest and since some fields were flooded the biomass was less available that year.

My results may be applied in other damage prone areas and for other geese species. However, since the problems and conditions vary, generalisations should be made with caution. In my study area, farmers reported that they have the greatest yield losses during spring and early summer. The timing of the grazing has shown to be of importance for the amount of lost yield (Abduljalil and Patterson 1989) and also for the food preferences as the geese tend to change diet between seasons and stages of life (Fox and Kahlert 1998; Aebischer et al. 1993). When the data in this study were divided into early and late summer, it became clear that the accommodation field has the strongest effect during early summer which makes it a good solution within Sörfjärden. These preferences shift in the late summer towards fields with cereals (Table 4) and most likely stubble fields and waist grain from harvest, which might be indicated by the increased selection of wheat which is ranked as number 1 in late summer, peas and barley (Axelsson and Modin 2006). If it was a selection for waist grain or if there was some other crop such as grass on this fields´ have not been investigated in this study. There is a decline in the selection of grass sprouts crops, such as pasture land between early and late summer, and pasture land is low ranked in all other analyses as well. Since the pasture land is grazed by livestock, leaving the sward heights low, and consisting of grass geese should be able to benefit from it all summer, since they prefers sward heights lesser than 0.5m (Vulink et al. 2010) and grasslands (Vickery and Gill 1999). But yet they do not select it here. This might be interesting to evaluate further. Since the accommodation field was selected to lesser extent during late summer, areas with more pronounced problems during that period will be in need of alternative counter-measures. For example during late summer in damage prone areas, it could be a good idea to use supplemental feeding on land set aside or stubble fields to increase their attractiveness as temporary accommodation fields. Supplemental feeding could also be used on accommodation fields´ in late summer when its attractivness decreases in an attempt to gather more birds on such fields. It would be interesting to include more types of accomodation fields (other crop or management) to study whether the effect may be sustained independent of seasons. For example, Axelsson and Modin (2006) showed that fields´ with vegetables (carrots) were highly prefered after harvest by the geese in late summer time. Land set aside in the rotation cycle could also be used as accommodation fields, since a lot of plants used as nitrogen absorbers are included in the geese diets (Owen et al. 1977). The composition of them could however be slightly changed to be even more beneficial both for farmers and geese every year, since it is ranked as 4 in 2011 and 3 in 2012, but as soon as there are other crops available (as there were in 2010), the ranking drops to number 10.

In my study the variation in distance to surveyed fields from roost sites was very restricted and most fields were placed within 2 km to the roost site (Fig.4). Moreover, 78% of all geese in the survey was found within this range. Thus, based on my study it is not possible to

conclude wether the distance to roost sites is of importance or not when the geese choose foraging sites. However, within my study area it seems that the risk of damage as well as success of accomodation fields is highest within the range of 2 km, since the majority of birds are found there. A more widespread distribution of the fields´ would be prefferable to get a more precise description of the geese crop selection in the landscape and distance to roost sites. Which would be in line with previous studies that successfully have shown that the geese prefer to graze on agricultural fields close to roost sites (less than 1000 m; Vickery and Gill 1999; Wallgärd 2010).

Greylag geese around Sörfjärden do not select crops in relation to their avaliability. The accomodation field was the top ranked crop type and significintly more selected than most of the other crops within the area, especially during early summer. However, to increase the proportion of geese using accomodation field´s it may be necessary to increase the total area of available accomodation fields´, and increase the intensity of scaring and/or culling on other fields. Eventhough the accommodation field was top ranked many geese still foraged on other fields, especially during late summer. Thus, further studies and management action are needed and since this study only comprises one area it is not possible to generalize. The seasonal division is based on the geese moulting time in Sörfjärden and could be changed from one year to another and in different areas since changes in climate may delay the moult but also the arrival time of the birds. An accommodation field is a rather costly measure, but is probably necessary to be able to succeed with measures such as scaring, which otherwise only may push the birds to other fields where they cause damage if areas where they can forage undisturbed are missing. Grasslands, including the accommodation field, are important foraging sites for Greylag geese around Sörfjärden. Knowledge about crop selection composed in this study can be used to take precaution on highly damage prone field’s, enhance the accommodation field attractiveness through seed mixes and distances as well as shift the measures taken against damages caused by geese by adapting to seasonal variation in crop selection.

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