ORNIS SVECICA 1:81 – 92, 1991 https://doi.org/10.34080/os.v1.23086

Selection and exploitation of feeding areas by staging and wintering geese in southernmost Sweden

LEIF NILSSON & HAKON PERSSON

Abstract

Bean Geese and Canada Geese preferred high-energy food (spilled grain, sugar-beet spill, potatoes and carrots) in autumn. When harvested fields were ploughed or when the ground was frozen, the geese grazed winter cereals. During periods with deep snow most of the Canada Geese utilized rape sticking up through the snow. In spring, both species fed on sprouting grass on permanent pastures. Such pastures were also heavily utilized by Bean Geese during mild periods in late winter. White-fronted Geese primarily used winter cereals and grassland. Marked changes in agricultural practices have occurred in southern Sweden contemporarily with the population increase in the Bean Goose. Mechanical harvesting has provided abundant spill of sugar beet, potatoes and carrots, serving as a high-rated food source for geese in autumn. Distance to the roost was also an important factor influencing field choice. Flying distances of up to 14 km were noted both for Bean and Canada Geese, although mean distances were much shorter. SW Skåne could probably support larger staging populations. During the last 10 years only a small proportion of suitable areas (36 % of 1 × 1 km squares within flying distance of 14 km of a roost) was used by feeding Bean Geese.

L. Nilsson & H. Persson, Department of Ecology, Ecology Building, S-223 62 Lund, Sweden

Introduction

During recent decades the goose populations of Sweden and other parts of Europe have increased markedly (e. g. Ogilvie 1978, Owen 1980, Madsen 1987, Rutschke 1987). For example, the number of Bean Geese *Anser fabalis* (Latham) staging in southern Sweden during autumn increased from about 20 000 in the late fifties and early sixties to about 60 000 in the late seventies (Nilsson & Persson 1984, Nilsson 1988). Similarly, the White-fronted Goose *Anser albifrons* (Scopoli) increased in southernmost Sweden in parallel with the European winter population. During the same period the breeding population of the Greylag Goose *Anser anser* (L.) in southern Sweden increased from 200 – 300 pairs in the early sixties to about 2 000 pairs in the early eighties (Nilsson 1982), and the Canada Goose *Branta canadensis* (L.), introduced into Sweden about 1930, reached about 3 000 breeding pairs in 1982 (Fabricius 1983).

All European goose species except the Greylag and the introduced Canada Goose breed in the far north, where no noticeable habitat changes have occurred in recent years. Therefore explanations for the marked increase in goose populations have been sought in the staging and wintering areas in southern and western Europe, where the Greylag and Canada Geese also are to be found. This marked increase in goose populations has generally been ascribed to changes in agricultural methods and to a decrease in hunting intensity.

By analysing ringing data for three goose populations wintering in western Europe, Ebbinge (1985) was able to document that a marked decrease in mortality was associated with the increase in numbers. In the Baltic-North Sea population of the White-fronted Goose and a population of the Dark-bellied Brent Goose *Branta b. bernicla* (L.) the increases coincided with marked hunting restrictions. The situation was less clear in the British-Icelandic population of the Pink-footed Goose *Anser brachyrhynchus* (Baillon) where decreased mortality was suggested to be partly due to improved feeding conditions during winter (Fox et al. 1989).

An improvement of the feeding conditions on agricultural land in the staging and wintering areas has been suggested as being one of the reasons for the marked increases in goose populations. A number of studies

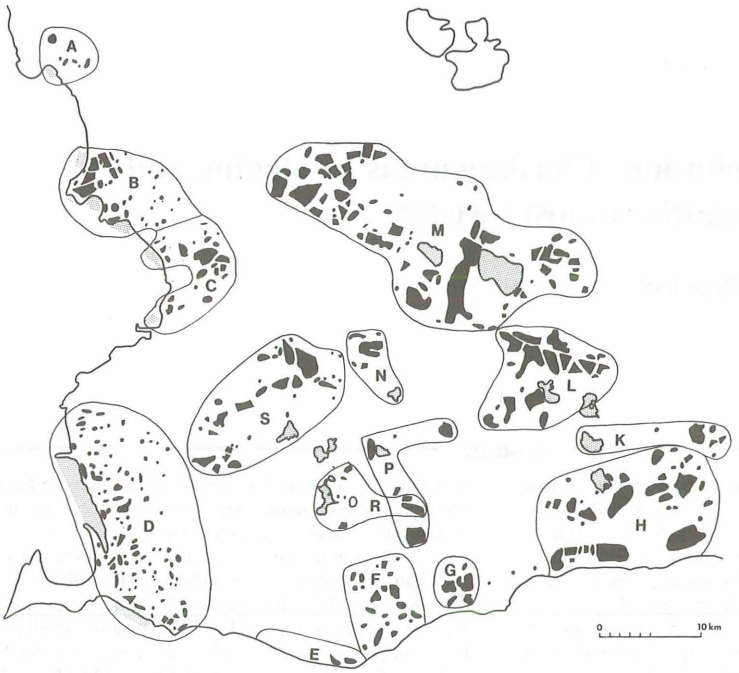

Fig. 1. Distribution of feeding areas (black) and roosts (stippled) used by staging and wintering geese in SW Skåne, southernmost Sweden during 1977/78–1986/87. The division into subareas (associated with specific roosts) is also shown.

Fourageringsområden (svart) och sovplatser (prickat) utnyttjade av rastande och övervintrande gäss i SV Skåne 1977/78–1986/87. Dessutom visas indelningen i delområden (i anslutning till sovplatserna).

have also been undertaken to analyse the exploitation of food resources by geese in different European countries (for summaries see Ogilvie 1978, Owen 1980, Rutschke 1987 and references below). The situation in south Sweden was studied by Markgren (1963) in the fifties but marked changes in both goose numbers and agricultural practices have occurred during the twenty years between our studies.

In this study we have examined how agricultural areas in southern Sweden function as staging and wintering habitats for Bean Geese, White-fronted Geese and Canada Geese. More specifically we (1) compared the field choices of the different species, (2) quantified the use of different field types by geese, (3) evaluated the importance of various factors assumed to be involved in feeding area selection in each of the species, (4) determined the extent to which the agricultural areas in southern Sweden can support increasing numbers of geese, and (5) against this background tried to determine if changes in agricultural practices could influence the goose populations.

Study area

The study was undertaken in SW Skåne, the southernmost province of Sweden, with extensive surveys covering the entire area used by staging and wintering geese (Fig. 1).

SW Skåne is an agricultural area characterized by large fields. Although clay soils predominate, sandy soils are also present in some important goose areas. The main crops grown are cereals, oilseed species (mainly rape) and, in some districts, sugar beet. A large proportion of the cereals (both wheat and rye) are sown in autumn, providing sprouting shoots for the geese. Oilseed crops are also autumn-sown to a large extent. Potatoes and carrots are grown on areas with sandy soils. Larger areas of permanent grassland occur around some lakes and along the coast at Foteviken (subarea D).

Staging and wintering geese arrive in SW Skåne after the cereal harvest at which time fields of stubble are available temporarily before being ploughed under later during autumn. In October root crops are harvested, and during November the harvested fields of sugar beet become available. By this time winter cereals and rape have started growing. Most of the sugar beet fields have been ploughed under by mid-December. The main field types remaining for the rest of the season are winter cereals, rape, perennial grassland and ploughed fields. The proportions of the total area represented by each of the field types in the two special study areas are shown in Tables 5 and 6.

Several small and medium-sized lakes in SW Skåne are suitable as roosting sites. Most of them are within

the daily flight range of suitable feeding areas. The sea along the west coast is shallow, and the coast south of Malmö as well as some bays further north in the Öresund offer protected roosting sites.

Material and methods

The local distributions and field choices of staging and wintering geese were determined in connection with extensive mid-monthly counts in October–March 1977/78–1986/87. All areas known to be frequented by geese in SW Skåne were covered. During these surveys all goose flocks located were counted and recorded on field maps together with information of the field types used. After the main roosts had been located, morning and evening flights were observed to ascertain whether all feeding areas had been found.

In addition, intensive studies were undertaken in two areas (Fig. 1): an inland area centered around the lakes Vombsjön and Krankesjön (subarea M, mainly 1977/78–1980/81) and a coastal area at Öresund (subarea B–C, 1985/86 and 1986/87). The special study areas were thoroughly surveyed about twice a week during the season and the goose flocks recorded on large-scale field maps. At the beginning of the season the available field types were mapped, and any agriculturally related changes were noted.

Staging and wintering populations

Three species occurred in considerable numbers in SW Skåne during the staging and wintering period: the Bean Goose, the White-fronted Goose and the Canada Goose. Moreover, the Greylag Goose was common in the area during early autumn, but left in early October as the other species arrived (L. Nilsson and H. Persson, unpubl.).

The Bean Goose, which was the most common of the species, arrived in early October and stayed until late March or early April. Maximum numbers during the study reached as high as 24 000 individuals. Numbers varied depending on the severity of the winter with most geese leaving during the coldest periods. Over the study period (1977–1986), October populations in SW Skåne showed a significant and steady decrease (Spearman $r = -0.72$, $P < 0.001$, cf. Nilsson 1988), whereas populations in the other months merely fluctuated. This decrease in October is probably related to the corresponding increase recorded at staging areas further north in Sweden, especially at Lake Tåkern (Nilsson 1988).

Numbers of White-fronted Geese during October and November generally peaked at around 2 000. Unusually high numbers were recorded in the autumn of 1982.

The Canada Goose, on the other hand, was a typical winter visitor in SW Skåne, arriving in November and

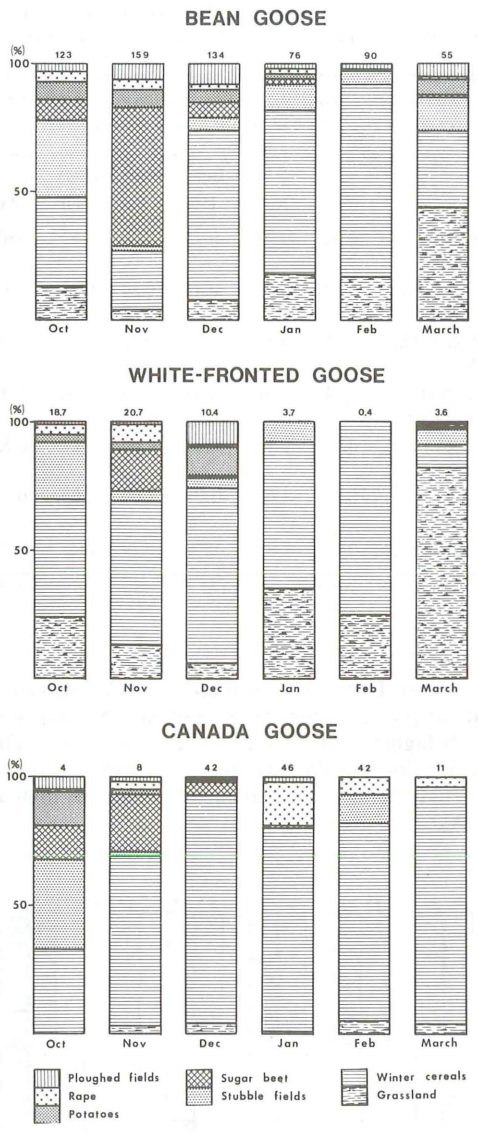

Fig. 2. Field choice of Bean Geese, White-fronted Geese and Canada Geese in SW Skåne. Estimates are based on data obtained in midmonthly counts from 1977/78–1986/87. Values for field type were calculated on the basis of its proportional contribution to the total count each month. Accumulated totals of geese (in thousands) are given above the columns for each month.

Fältval för sädgäss, blässgäss och kanadagäss i SV Skåne baserat på mittmånadsinventeringar 1977/78–1986/87. Värdena för de olika fälttyperna baseras på deras andel i summan för de olika månaderna. Ackumulerade totalsummor (i tusental) för de olika arterna anges över varje kolumn.

Table 1. Field-type preferences of Bean and White-fronted Geese in the Vomb area (M, Fig. 1) 1977/78–1980/81 according to Jacobs' index (Jacobs 1974): D = (r-p)/(r+p-2rp), where r is the proportion of geese in a given habitat type, and p is the proportion of the total area consisting of that habitat type. The index ranges from -1 (total avoidance) to +1 (only one habitat selected).

Sädgässens och bläsgässens fälttypspreferenser i Vombområdet (M, Fig. 1) 1977/78–1980/81 enligt Jacobs index (Jacobs 1974): D = (r-p)/(5+p-2rp), där r är andelen gäss i ett givet habitat och p är andelen av hela området som består av det habitatet. Indexet sträcker sig från -1 (totalt undvikande) till +1 (endast ett habitat utnyttjas).

	Bean Goose *Sädgås*							White-fronted Goose *Bläsgås*						
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Grassland *Gräsmark*	0.27	−0.79	−0.72	−0.28	0.62	0.62	0.79	0.47	−0.08	−0.40	−0.86	0.93	0.84	0.93
Winter cereals *Höstsäd*	0.14	0.21	0.67	0.54	−0.75	0.32	−0.92	0.45	0.64	0.85	0.48	−1.00	0.03	−0.89
Stubble fields *Stubb*	0.11	0.31	−0.27	0.78	−1.00	−0.18	−0.79	−0.36	0.10	−0.99	0.94	−1.00	−0.88	−1.00
Sugar beet *Sockerbetor*	0.14	0.91	−1.00	−1.00	−1.00	−1.00	–	−0.82	−0.10	−1.00	−1.00	−1.00	−1.00	–
Potatoes *Potatis*	0.47	0.18	0.84	0.66	0.87	0.52	0.55	−0.29	−0.21	0.76	−1.00	−1.00	−0.65	−1.00
Rape fields *Raps*	−0.80	−1.00	−1.00	−1.00	−1.00	−0.97	−0.97	−0.53	0.18	−1.00	−1.00	−1.00	−1.00	−1.00
Ploughed fields *Plöje*	−0.76	−0.39	−0.48	−0.79	−0.28	−0.93	−0.46	−0.88	−0.90	−0.95	−0.99	−0.78	−1.00	−0.81

December. During hard winters some Canada Geese left the province, but the proportion remaining was much higher compared with the Bean Goose. The Canada Goose in SW Skåne increased markedly during the study period with maximum numbers as high as 16 900.

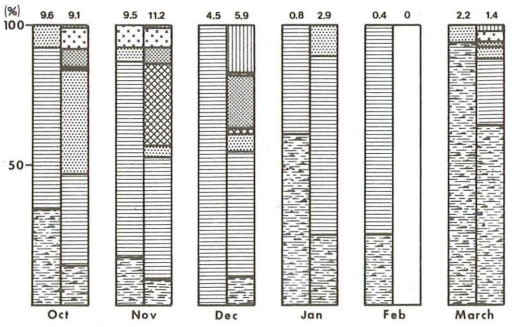

Fig. 3. Field choice of White-fronted Geese in homogenous flocks (left column in each pair) and in flocks mixed with Bean Geese (right column), based on mid-monthly counts in SW Skåne in 1977/78–1986/87. For a further explanation, see Fig. 2.

Fältval för bläsgäss i homogena flockar (vänstra kolumnen i varje par) och i blandflockar med sädgäss (högra kolumnen) baserat på mittmånadsinventeringar i SV Skåne 1877/78–1986/87. Se vidare Fig. 2.

Results

Field choice

The field types chosen by Bean Geese in southwest Skåne varied markedly over the season (Fig. 2). In October, stubble fields, winter cereals and grasslands were the most frequented field types. In November, in connection with the sugar beet harvest most Bean Geese moved to beet fields. Local concentrations of geese were observed in potato fields. In the two carrot growing areas, carrot fields were frequently visited. Winter cereals were occasionally used during this period, especially by geese that had temporarily left the sugar-beet fields in response to a disturbance. Later in the autumn, when the harvested fields were ploughed or when they became unavailable due to frost, the Bean Geese grazed winter cereals (wheat and rye), wheat generally being the most commonly grown cereal. Rape was used only on a few occasions, especially during periods of hard weather in winter. On the other hand Bean Geese were sometimes seen on rape fields in autumn, feeding on sprouting seed that had been spilled during harvesting of the former crop. In spring they turned their attention to sprouting grass on permanent pastures. Such pastures were also heavily utilized during mild periods in late winter.

White-fronted Geese were found primarily on winter cereals and grassland (Fig. 2), with the former field type prevailing except in March, when the vast majority of the Whitefronts were found on permanent pasture.

Tab. 2. Field-type preferences of Bean and Canada Geese in the Öresund area (B-C, Fig. 1) in 1985/86 and 1986/87 according to Jacobs' index. See Tab. 1 for further explanation.

Sädgässens och kanadagässens fälttypspreferenser i Öresundsområdet (B-C, Fig. 1) 1985/86 och 1986/87 enligt Jacobs index. Se Tab. 1 för ytterligare förklaringar (Carrots = morötter).

	Bean Goose *Sädgås*					Canada Goose *Kanadagås*				
	Nov	Dec	Jan	Feb	Mar	Nov	Dec	Jan	Feb	Mar
1985/86										
Grassland	–1.00	–1.00	0.45	0.72	0.97	–1.00	–0.85	–0.10	0.29	0.42
Winter cereals	–0.42	–0.37	0.69	0.82	–0.12	0.13	0.49	0.71	0.75	0.46
Stubble fields	0.70	–0.14	0.77	–1.00	–1.00	–0.31	–1.00	–0.23	–1.00	–1.00
Sugar beet	0.96	0.98	–	–	–	0.93	0.90	–	–	–
Potatoes	0.39	–1.00	–1.00	–1.00	0.12	0.54	–1.00	–1.00	–1.00	0.91
Rape fields	0.14	–0.36	–0.08	–0.82	–1.00	0.39	0.22	0.60	0.48	0.08
Ploughed fields	–1.00	–1.00	–0.95	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
1986/87										
Grassland	–0.81	–1.00	–1.00	–1.00	–1.00	–1.00	0.09	–1.00	–1.00	–0.74
Winter cereals	0.32	0.88	0.98	1.00	1.00	0.79	0.94	0.72	0.97	0.97
Stubble fields	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00
Sugar beet	0.91	0.04	–	–	–	0.73	–0.77	–	–	–
Carrots	0.70	0.97	–	–	–	–1.00	–1.00	–	–	–
Potatoes	0.73	0.76	–	–	–	–1.00	–1.00	–	–	–
Rape fields	–1.00	–1.00	–0.57	–1.00	–1.00	–1.00	–0.42	0.66	–0.45	–0.51
Ploughed fields	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00	–1.00

For homogeneous flocks of Whitefronts these two field types dominated even more markedly, whereas Whitefronts occurring in flocks of Bean Geese showed almost the same field choice as the latter species (Fig. 3).

In early autumn the few Canada Geese present primarily exploited newly harvested fields. As soon as the winter cereals had sprouted, however, they changed to this field type, which was preferred throughout late autumn and winter (Fig. 2). During periods with deep snow most of the Canada Geese utilized rape sticking up through the snow. During periods of hard weather in winter the Canada Geese remained on the sea until about midday feeding at times on *Zostera* meadows.

Field-type preferences

In the Vomb area, Bean Geese showed no marked preferences for any specific field type in October (Tab. 1), although the preference index was highest for potatoes, an important root crop in this area (Nilsson & Persson 1984). Sugar beet fields were preferred in November. In addition to potatoes, winter cereals were selected in December and January. Preferences varied according to weather conditions, potatoes not being available during periods when the ground was frozen. The preference indices for winter cereals decreased between January and February, with grassland being highly preferred during late winter in mild years and in spring. On the other hand, grassland was generally not preferred by Bean Geese during November and December. Rape was not used by Bean Geese, whereas the preference indices for stubble fields varied between months.

In the Öresund area (Table 2), Bean Geese also showed a strong preference for sugar beet fields in late autumn. Although potatoes and carrots were also selected in 1986, potatoes were only subject to marginal use in 1985. During January and February winter cereals were the most preferred field type, with stubble fields also being selected in January 1986. The change from sugar beet fields to winter cereals occurred earlier in 1986/87 than in 1985/86 owing to the colder weather during the latter period. As in the Vomb area the preference shifted from winter cereals to grassland for the few remaining Bean Geese in March 1986, whereas Bean Geese continued to prefer winter cereals throughout the colder winter of 1987. Rape fields were generally ignored in the Öresund area as well, but not to the extent observed in the Vomb area some years earlier.

The field preferences of the White-fronted Goose were much different from those of the Bean Goose in the Vomb area (Table 1). Grassland was used to a certain degree in October and was highly preferred in February–April, but was ignored completely during November–January, when winter cereals were preferred. The other field types were generally characterized by highly negative values with the exception of potatoes in December and stubble fields in January.

Tab. 3. Exploitation (goosedays/ha) of different field types in the Vomb area (M, Fig. 1) in 1977/78 –1980/81 by Bean and White-fronted Geese. Exploitation values are based on those fields of each field type used by geese.

Sädgässens och blässgässens utnyttjande (gåsdagar/ha) av olika fälttyper i Vombområdet (M, Fig. 1) 1977/78 –1980/81. Utnyttjandegraden har beräknats på de fält av varje fälttyp som gässen verkligen utnyttjade.

	Goosedays/ha *gåsdagar/ha*							
	Bean Goose *Sädgås*				White-fronted Goose *Blässgås*			
	77/78	78/79	79/80	80/81	77/78	78/79	79/80	80/81
Grassland	165	170	364	157	54	40	94	121
Winter cereals	441	234	583	683	149	184	223	154
Stubble fields	190	314	434	166	4	75	136	25
Sugar beet	589	1778	398	45	16	188	2	0
Potatoes	580	290	167	599	7	58	14	302
Rape fields	47	258	0	0	0	196	0	0
Total goosedays	429 000	307 200	355 800	215 000	53 000	46 300	77 500	72 000

Canada Geese in the Öresund area (Table 2), like Bean Geese showed a strong preference for sugar beet in November–December. Although winter cereals were generally selected in winter, rape was also a relatively popular food during the winter months.

Exploitation of feeding areas

Although sugar beet was subjected to the highest overall exploitation rate during 1978/79, between-year variation was marked, and winter cereals had higher rates of exploitation in other years (Table 3). In the Öresund area the relative degrees of exploitation of the various field types also differed between years (Table 4). Sugar

Tab. 4. Exploitation (goosedays/ha) of different field types in the Öresund area (B–C, Fig. 1) in 1985/86 and 1986/87 by Bean and Canada Geese. Exploitation values are based on those fields of each type used by geese.

Sädgässens och kanadagässens utnyttjande (gåsdagar/ha) av olika fälttyper i Öresundsområdet (B–C, Fig. 1) 1985/86 och 1986/87. Utnyttjandegraden har beräknats på de fält av varje fälttyp som gässen verkligen utnyttjade. Winter wheat = höstvete, winter rye = höstråg.

	Goosedays/ha			
	Bean Goose		Canada Goose	
	85/86	86/87	85/86	86/87
Grassland	43	7	95	36
Winter wheat	62	66	109	103
Winter rye	28	535	331	368
Stubble fields	155	0	14	0
Sugar beet	497	189	154	7
Potatoes	32	218	97	0
Carrots	–	1160	–	0
Rape fields	48	8	176	149
Total goosedays	158 300	148 300	239 900	120 600

Tab. 5. Percentage of the total area of each of the field types in the Vomb area (M, Fig. 1) used by feeding geese in different years. Total area of various field types (ha) shown in brackets.

Procentandelen av den totala arealen av olika fälttyper i Vombområdet (M, Fig. 1) som har utnyttjats av gässen för födosök under olika vintrar. Inom parentes anges för varje fälttyp totalarealen (ha).

	77/78	78/79	79/80	80/81
Grassland	90 (530)	76 (530)	81 (530)	75 (530)
Winter cereals	70 (454)	40 (540)	35 (570)	16 (496)
Stubble fields	44 (496)	51 (350)	49 (201)	21 (484)
Sugar beet	79 (62)	37 (109)	100 (23)	18 (128)
Potatoes	65 (174)	39 (161)	100 (117)	67 (148)
Rape fields	26 (170)	8 (145)	0 (298)	0 (241)
Total area (ha)	1886	1835	1737	2037

Tab. 6. Percentage of the total area of each of the field types in the Öresund area (B–C, Fig. 1) used by feeding geese in different years. Total area of various field types (ha) shown in brackets.

Procentandelen av den totala arealen av olika fälttyper i Öresundsområdet (B–C, Fig. 1) som har utnyttjats av gässen för födosök under respektive vinter. Inom parentes anges för varje fälttyp totalarealen (ha).

	85/86	86/87
Grassland	52 (360)	20 (234)
Winter wheat	66 (795)	62 (590)
Winter rye	75 (276)	84 (157)
Stubble fields	79 (108)	0 (122)
Sugar beet	100 (167)	91 (238)
Potatoes	100 (26)	100 (38)
Carrots	–	100 (3)
Rape fields	60 (505)	22 (415)
Total area (ha)	2255	1797

Tab. 7. Per cent of 1 × 1 km squares of potential goose feeding area (i.e. open fields) within flying distance (14 km radius) of different roost sites in SW Skåne, in which feeding goose flocks were seen during the mid-monthly counts in 1977/78 – 1986/87. Squares falling within the radius of more than one roost site were allocated to the nearest roost. Roost site locations are shown in Fig. 1.

Procentandelen 1 × 1 km kvadrater, som utgjorde potentiella födosöksområden för gäss (d v s öppna fält) inom flygavstånd (14 km radie) från olika sovplatser i SV Skåne, i vilka födosökande gåsflockar setts under mittmånadsinventeringarna 1977/78 – 1986/87. Kvadrater som ligger inom radien för mer än en sovplats har förts till den närmaste sovplatsen. Sovplatsernas läge framgår av Fig. 1.

Roosts	Total number of 1 × 1 km squares	Per cent used by feeding geese
Sovplatser	*Totala antalet 1 × 1 km kvadrater*	*Procentandelen som har utnyttjats av födosökande gäss*
A – C	208	43.3
D – G	332	42.4
H – K	222	40.5
L	106	48.1
M	299	34.7
N – S	407	23.3
Total	1574	36.2

Tab. 8. Relationship between degree of field exploitation by Bean and Canada Geese and distance to the Öresund roost for winter cereals in 1985/86.

Sädgässens respektive kanadagässens fördelning av födosöket på höstsädesfält på olika avstånd från sovplatsen i Öresund vintern 1985/86.

Distance (km) *Avstånd*	Per cent goosedays Bean Goose *Sädgås*	Canada Goose *Kanadagås*
0 – 2	4.9	38.7
2 – 4	12.3	24.5
4 – 6	8.8	26.7
6 – 8	0.2	10.1
8 – 10	4.1	0
10 – 12	22.8	0
12 – 14	46.9	0
Total goosedays	38 000	125 690

beet had the highest mean exploitation rates in both study areas. Exploitation rates for Bean Geese on sugar beet and winter cereals were higher in the Vomb area than in the Öresund area.

The utilized proportion of the available area of a given field type varied markedly between field types and years (Tables 5 and 6). Whereas nearly all fields with root crops in the Öresund area were used to some extent, a considerable proportion of such fields in the Vomb area was not used, especially in 1978/79 and 1980/81.

The proportions of winter cereal fields used in the two study areas were similar. In contrast, grassland was used to a greater extent in the Vomb area than in the Öresund area. Generally only a small proportion of rape fields was used by feeding geese.

It was not possible to measure the degree of exploitation of feeding areas outside the two special study areas because the number of observations was insufficient (monthly counts) and data on the actual crops grown were lacking. To make a rough estimate of the amount of feeding areas available to geese from different roosts we calculated the number of 1 x 1 km squares of open ground available as potential feeding grounds within a radius of 14 km from each roost, 14 km generally being the maximum distance that geese will fly between their roosts and feeding areas in SW Skåne. Squares falling within the 14-km radius of two roosts were assigned to the nearest roost. Only one third of potential squares was found to be visited by feeding goose flocks (with at least 100 individuals) at least once during the period concerned (Table 7).

Factors affecting the degree of field exploitation

The maximum distance between roosts and feeding areas in the Öresund study area in 1985/86 was 8 km for the Canada Geese, whereas no less than 74 % of the Bean Geese used fields with winter cereals at a distance of 8 to 14 km from the roost (Table 8). Distances between feeding areas and roosts in other parts of SW Skåne without Canada Goose flocks were generally shorter (Nilsson & Persson 1984). Flocks of Canada Geese and Bean Geese of more than 100 individuals were rarely seen in the same fields.

For sugar beet fields used earlier in the season, i. e. before the main arrival of Canada Geese, the situation was different. The five sugar beet fields in subarea B, which were 1–3 km distant from the roost, were subjected to a mean exploitation rate of 429 ± 178 goosedays/ha, whereas the mean exploitation rate for the three sugar beet fields in subarea C, where the distance to the roost was 10–13 km, was 88 ± 38 goosedays/ha. The sugar beet fields of area C were mostly used when the geese were disturbed in area B.

The size of a field affects its attractiveness to geese; fields with rape or winter cereals used by the geese for feeding were significantly larger than fields of corresponding type not utilized by geese (Table 9). There was, however, no correlation between the rate of exploitation, in goosedays/ha, and field size, the correlation coefficients for Bean and Canada Geese on winter cereals being –0.23 and 0.14, respectively. Neverthe-

Tab. 9.Mean size (± SE), in ha, of fields utilized by feeding geese in the Öresund area in 1985/86 and 1986/87 compared with the mean size of fields of corresponding types not used by geese. N = number of fields.

De av gässen för födosök utnyttjade fältens medelstorlek uttryckt i hektar (±SE) i Öresundsområdet vintrarna 1985/86 och 1986/87 jämfört med medelstorleken för de fält av motsvarande fälttyp vilka ej utnyttjats av gässen. Mean = medelvärde, Range = storleksintervall, N = antalet fält.

	Fields used by geese *Fält utnyttjade av gäss*				Fields not used by geese *Fält ej utnyttjade av gäss*				P for difference
	Mean	SE	Range	N	Mean	SE	Range	N	
Winter cereals									
1985/86	15.0	1.5	4–66	49	6.1	0.6	2–24	64	<0.001
1986/87	29.4	6.3	5–94	17	7.2	1.3	6–29	32	<0.001
Rape fields									
1985/86	25.7	8.3	4–94	11	6.5	0.7	4–19	31	<0.001
1986/87	17.3	3.8	6–29	6	9.5	1.2	2–33	34	<0.001

less the smallest fields were ignored. In 1985/86 fields with a size of up to 5 ha accounted for 14 % of the total area with winter cereals but only 3 % and 2 % of the total of goosedays for Bean and Canada Geese, respectively. A similar comparision could not be made for sugar beet because all fields were large, and all were utilized to some extent by the geese.

Discussion

Choice of feeding areas

Goose species differ in bill morphology, which suggests that they are adapted to different types of food (e. g. Owen 1980). However, during the breeding season many species share the same feeding areas, i. e. short grasses and sedges (references in Owen 1980). Therefore the differentiation in bill structure probably occurs in response to the food situation in staging and wintering areas.

The larger races of the Canada Goose have rather long, narrow bills. Hanson (1965) proposed that this shape is an adaption that facilitates the stripping of seeds from standing grass and sedges. This type of bill is also suitable for probing in soft marshes and for grazing rather tall vegetation. Among the other goose species occurring in Sweden, the Bean Goose has a bill similar to that of the larger Canada Geese that were introduced into Sweden. The Greylag Goose also has a hard, heavy bill, suitable for digging, whereas the White-fronted Goose has a smaller bill that is more suitable for grazing and seed stripping (Owen 1980).

Of the European goose species the Greylag Goose still uses *Scirpus* rhizomes, its natural food, to a considerable extent during the winter in many areas (Loosjes 1974, Amat 1986), but like other goose species it mainly frequents agricultural areas during the rest of the non-breeding season (L. Nilsson and H. Persson, unpubl.).

Even if the staging and wintering geese were originally adapted to non-agricultural habitats they are nevertheless adapted to deal with the sort of food made available in large quantities by farming practices. The two larger species considered in this study have continued to utilize roots rich in starch during the autumn (mainly sugar beet but also potatoes and carrots), changing to winter cereals once the root crops have become unavailable as a result of ploughing and/or ground frost. Bean Geese staging and wintering in other parts of Europe show food preferences similar to those observed in SW Skåne (Leisler 1969, Schröder 1969, Sterbetz 1971, Gerdes et al. 1978, Mooij 1979, 1984, Van Impe 1980, Gerdes and Reepmeyer 1983). For the Canada Goose comparable data from Europe are lacking, but in extensive studies in North America the Canada Geese fed on a variety of crops (e. g. Hanson 1965, Bell & Klimstra 1970, Bellrose 1976, Reed et al. 1977). The situations in Europe and North America are however not comparable. In the latter region crops are grown especially for geese (Bellrose 1976, Raveling 1978).

Canada and Bean Geese showed similar field choices during autumn and winter in SW Skåne. Canada Geese were, however, seen on rape fields more often than Bean Geese, possibly because in face of hard weather Bean Geese were more prone to leave the country than Canada Geese. The remaining Canada Geese then had to feed on rape, which was the only plant available during periods with deep snow. Bean and Canada Geese usually fed in different fields in the Öresund area; the Bean Geese normally moved longer distances to their feeding areas than the Canada Geese. This indicates that competition might occur between these two species in winter.

The smaller White-fronted Goose still grazes, although it now uses winter cereals for a large part of the season. They showed a marked preference for grazing on grass or winter cereals when occurring in homoge-

neous flocks, whereas their field choice was similar to that of the Bean Goose when occurring together with this species. In most parts of Europe grassland is the most important feeding habitat for White-fronted Geese (Markgren 1963, Kuyken 1969, Leisler 1969, Owen 1971, 1972a, 1972b, Philippona 1972, Gerdes & Reepmeyer 1983, Ysebaert et al. 1988) although other crops, such as potatoes and sugar beet, have some importance locally (Philippona 1972). Grassland was highly preferred before the sprouting of winter cereals in autumn. They shifted to the less preferred winter cereals once the grass had stopped growing in winter (Kuyken 1969, Owen 1971, Ysebaert et al. 1988) but shifted back again when grass began sprouting in spring.

The shift from grassland to winter cereals by White-fronted Geese in autumn is probably triggered by the sprouting of the cereals, which offer a food rich in proteins at a time when the grass stops growing (Kear 1963). The preferences of all three species changed to protein-rich sprouting grass in spring. Although the Canada Geese left the study areas in SW Skåne early, on other staging areas they moved to grassland in spring, like the other species (pers. obs.).

Digestibility presumably is an important factor influencing food selection in geese, especially during autumn, when they are building up reserves for the winter (Raveling 1979b). Accordingly, the two larger species showed a marked preference for root crops rich in starch. The content of secondary metabolites in the plants might also influence food choice (Buchsbaum et al. 1984, 1986). Apart from periods of hard weather, the general avoidance of rape by geese should probably be viewed in this context. For grazing geese the proportion of the sward consisting of dead material is a factor of importance (Owen 1971).

Distance to the roost was also found to be an important factor influencing field choice (cf. also Nilsson & Persson 1984). Flying distances of up to 14 km were noted both for Bean and Canada Geese, although mean distances were much shorter (cf. Nilsson & Persson 1984). Similar distances have been reported for Bean Geese from other countries (Gerdes et al. 1978, Sterbetz 1979, Gerdes & Reepmeyer 1983), whereas flying distances of up to 10–20 km have been reported for the White-fronted Goose (Philippona 1972, Sterbetz 1979). Even though geese can cover long distances to reach profitable feeding sites (cf. Davis et al. 1989), areas close to the roost were used earlier and more intensively than equally good areas at larger distances (cf. Raveling 1969, 1978, 1979a).

Field size also influences the choice of feeding areas: fields used by geese were considerably larger than fields not used by geese. The importance of disturbance as a factor restricting the use of fields by geese was studied by Bélanger & Bédard (1989), Forshaw (1983), Karlsson et al. (1978), Madsen (1985), Markgren (1963), Norris & Wilson (1988), Owen (1972 a,b) and Owens (1977).

Crop exploitation

Few studies have attempted to establish the carrying capacities of various field types for geese. Owen (1977) calculated that well managed grasslands could sustain a grazing pressure of 1900 goosedays/ha by Greylag Geese. For Greylag Geese feeding on *Scirpus*, Zwarts (1972) found that 3 000–4 000 goosedays/ha affected future production, whereas 1 500–2 500 goosedays/ha had no such effect. For winter cereals there are no data available.

The highest exploitation pressure on a field of winter cereals found in the present study was 5 100 goosedays/ha (one small field), whereas sugar beet and potato fields were subjected to exploitation pressures up to 2 200 goosedays/ha. Most fields were much less exploited, grazing pressures being considerably lower than the calculated values from Britain. Van Impe (1980) reported 230–1 030 goosedays/ha for fields exploited by Bean Geese in the Netherlands, whereas for White-fronted Geese, grazing pressure on grass in Belgium and England generally was between 600 and 900 goosedays/ha (Kuyken 1969, Owen 1972b). Exploitation pressure by Greylag Geese in Scotland ranged between 640–1 350 goosedays/ha for individual fields (Newton & Campbell 1973). Madsen (1980) reported annual exploitation rates for Pink-footed Geese on grass to range between 290 and 710 goosedays/ha, whereas Lorenzen & Madsen (1985) reported maximum grazing pressures of 800–1 200 goosedays/ha for different areas.

Agricultural areas as goose habitats

Marked changes have been undertaken in agricultural practices during recent years. Changes having an important impact on geese include the increase in field size and the mechanization of harvesting routines.

Harvest mechanization has probably had more impact than the increase in field size. Sugar beet has long been an important root crop in Skåne, but when manually harvested little spill was left for the geese (Markgren 1963). In the seventies and eighties, however, mechanical harvesting has provided abundant spill, serving as a high-rated food source for geese in autumn. For Bean Geese sugar beet accounted for approximately 50 % of the total goosedays from harvest time until freezing or ploughing in some districts, and sugar beet was also important for Canada Geese. Sugar beet has also been reported as an important food source for geese in other European countries (references cited

above). Similarly the spill left after the mechanical harvesting of potatoes and carrots, which was not available earlier, has become a high-rated food source for Bean Geese. The emergence of potato feeding has also been documented in Scotland (Kear 1963).

Other changes in the feeding habits of wintering geese in south Sweden have also taken place in recent decades. Markgren (1963) made an extensive study of Bean and White-fronted Geese in southwest Skåne during the late fifties. His study area was regularly surveyed in our monthly counts, the field choice of the geese here being similar to the overall results reported in this study. For both species Markgren reported a marked dominance for meadows and pastures. In the Bean Goose no less than 58 % were seen on this field type compared to only 8 % for winter cereals, whereas winter cereals was the most important field type in our study for periods when root crops were not available. White-fronted Geese still feed to a large extent on grassland but in contrast to the fifties winter cereals now dominate the field choice for important periods in winter. The differences between our study and Markgren's (1963) probably to a great extent relate to changes in agricultural practices, high quality grasslands being rare nowadays (Gerell 1988).

Thus radical changes in agricultural practices have occurred in southern Sweden contemporaneously with the population increase in the Bean Goose. The general increase in field size and the change to mechanical harvesting, with increased amounts of spill, provide the geese with energy-rich food during a period after the autumn migration, when they have to build up their energy reserves for the winter (cf. Raveling 1979b). This could in turn enhance winter survival and future breeding results.

SW Skåne could probably support staging goose populations larger than those presently using the area; several fields within the study areas were not used by feeding geese. In southern Sweden as a whole there are many localities that could function as staging areas in autumn, but which have not yet been used. This is illustrated by the rapid change in the early autumn distribution of the Bean Goose that has occurred during the last decade, with the establishment of new staging areas in several regions and a great increase in the population at Lake Tåkern (Nilsson 1988).

Geese that can find sufficient resources for the winter in the agricultural districts of southern Sweden and other parts of Sweden still need areas with fresh sprouting grass to build up reserves for the breeding season (cf. e.g. Ankney & McInnes 1978, Raveling 1979b, McLandress & Raveling 1981). Grassland is a habitat type in short supply in SW Skåne and has also decreased markedly in other parts of southern Sweden in recent years (Gerell 1988).

Acknowledgements

Financial support for the study during 1985/86–1987/88 was obtained from the National Swedish Environmental Protection Board. Observations made in the Vomb area in 1977/78–1980/81 were financed by the Nordic Council for Wildlife Research.

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Sammanfattning

Val och utnyttjande av furageringsområden av rastande och övervintrande gäss i sydligaste Sverige

Under senare år har gåsbestånden i Sverige och angränsande områden i Europa ökat högst markant (Owen 1980, Madsen

1987, Rutschke 1987, Nilsson 1988). Alla europeiska gåsarter med undantag för grågåsen och den inplanterade kanadagåsen häckar i nordliga trakter, där några biotopförändringar ej konstaterats. Man har därför antagit att orsakerna till gåsbeståndens expansion är att finna i rast- och vinterområdena. De viktigaste orsakerna anses vara förändringar inom jordbruket, samt lägre dödlighet till följd av minskat jakttryck.

I denna undersökning studerar vi hur jordbruksområdena i Sydsverige fungerar som rast- och vinterområden för sädgäss, bläsgäss och kanadagäss: 1) fältval för de olika arterna, 2) de olika arternas exploatering av olika fälttyper, 3) betydelsen av olika faktorer för valet av furageringsområden, 4) hur jordbruksområdena i södra Sverige kan härbärgera de ökande gåsbestånden och 5) förändringar i gässens fältval.

Undersökningarna genomfördes i SV Skåne (Fig. 1) i samband med månatliga gåsinventeringar 1977/78–1986/87 samt vid intensivstudier i Vombområdet 1977/78–1980/81 och Öresundsområdet vid Barsebäck–Lomma 1985/86 och 1986/87.

Resultat

Sädgåsens fältval varierade markant under säsongen (Fig. 2, Tabell 1 och 2). Vid ankomsten utnyttjades stubbåkrar, gräsmarker och sädesfält. Efter betskörden dominerade sockerbetsfälten starkt, varefter gässen när dessa plöjdes eller frös till flyttade över till höstsäd. Lokalt var skördade fält med potatis och morötter viktiga. Under senare delen av vintern och våren föredrog gässen gräsmarker framför höstsädesfält. Kanadagåsens fältval liknade sädgåsens, men till skillnad från sädgåsen utnyttjade den ibland raps under vintern, vilket endast sällan konstaterades för sädgåsen.

Bläsgässen furagerade i huvudsak på gräsmarker och höstsädesfält (Fig. 2, Tabell 1). Bläsgäss som sökte föda tillsammans med sädgäss liknade dock dessa i sitt fältval (Fig. 3). Under den tidiga hösten föredrog bläsgässen gräsmarker, men skiftade sedan till höstsäd för att skifta tillbaka till gräsmarker på våren.

Utnyttjandegraden av olika fälttyper varierade starkt mellan olika år (Tabell 3 och 4). Detsamma gällde den andel av den totala arealen av olika grödor i undersökningsområdena som utnyttjades av gässen (Tabell 5 och 6). Det högsta antalet gåsdagar/ha noterades för sockerbetor.

Andelen utnyttjade fält med höstsäd var densamma i båda undersökningsområdena. Däremot utnyttjades gräsmarker i betydligt större utsträckning i Vombområdet. Rapsfält utnyttjades i tämligen ringa omfattning.

För att få en grov uppfattning om gässens tillgång på furageringsområden beräknades antalet 1 × 1 km rutor med potentiella gåsområden inom en radie av 14 km (maximal normal flygsträcka mellan sovsjö och furageringsområde) från de olika sovsjöarna. Totalt noterades gåsflockar om minst hundra individer endast inom en tredjedel av rutorna (Tabell 7).

Avståndet till furageringsområdena kan också vara en faktor av betydelse för gässens fältval. I Öresundsområdet noterades i medeltal 429 gåsdagar/ha för sockerbetsfält belägna 1–3 km från sovplatserna, medan endast 88 gåsdagar/ha noterades i ett område 10–13 km från sovplatserna. I Öresundsområdet utnyttjade sädgässen längre bort liggande höstsädesfält, från sovplatserna räknat, i betydligt högre grad än kanadagässen (Tabell 8), en effekt av konkurrens? Fältens storlek var en annan faktor av betydelse för gässens val av furageringsområde (Tabell 9).

Diskussion

De svenska gässens fältval jämförs med motsvarande undersökningar i andra länder, varvid betydande överensstämmelser konstateras. Av speciellt intresse är kanske att jämföra denna undersökning med Markgrens (1963) studier från slutet av femtiotalet. Hans studier genomfördes i Sövdeområdet som utgör ett av våra delområden. Vid tiden för Markgrens studier förekom inte sockerbetor bland de utnyttjade fälttyperna, medan de dominerade bilden 20 år senare. Orsakerna kan sökas i den maskinella skörden som lämnar betydande mängder spill för de näringssökande gässen. En annan skillnad mellan Markgrens och våra studier återspeglas i sädgässens utnyttjade av höstsädesfält. Dessa besöktes i tämligen ringa omfattning på 50-talet, medan de nu är den dominerande fälttypen under vintern. Å andra sidan förekommer endast ringa utnyttjande av gräsmarker, en effekt av ändrad markanvändning och minskad förekomst av för gässen lämpliga gräsmarker.

Sammanfattningsvis konstateras att de förändringar som skett i jordbruket under senare decennier varit gynnsamma för gåsbestånden i Sverige och övriga Europa. Vidare konstateras att sydsveriges jordbruksområden torde kunna härbärgera betydligt större gåsbestånd än vad som är fallet idag.