Seasonal changes in habitat use of White-fronted Geese near Antwerp, Belgium

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Introduction

Wild geese apparently have a very inefficient digestive system (Owen 1972a). It is, therefore, very important for these animals to select a diet that meets their feeding demands both quantitatively and qualitatively.

When feeding, wild geese not only choose between vegetation zones (Owen 1971 and 1972b) or habitats (Ebbinge *et al.* 1975; Derksen *et al.* 1982; Boudewijn 1984; Madsen 1985; Amat 1986), but they also select certain plant species (Owen 1976; Owen *et al.* 1977; Ydenberg and Prins 1981; Drent and Prins 1987). However, most of these studies are concerned with seasonal patterns, or deal with habitat shifts during winter or spring migration. Little is known about the temporal patterns in goose usage within a single macrohabitat, such as a grassland complex.

In this paper, which is part of a study on the feeding ecology of the European White-fronted Goose *Anser albifrons albifrons* in Flanders, use of a heterogeneous grassland area was investigated.

Study Area

The study was carried out on the BASF-grounds at 'Zandvliet' in the north of the Antwerp industrial area. The area used to be part of the Antwerp polder landscape, but, as a result of industrialisation, the area was raised by infilling in the late sixties.

The study area comprises about 300 ha of poorly drained grassland. It is crossed by a few roads, railways and drains, but on the whole it suffers low disturbance from people. Part of the grassland is periodically flooded by rain during autumn and winter with four or five bigger pools remaining throughout the year. During the summer the pastures are grazed by cattle and sheep, whereas in winter only some of them are used for grazing.

Before the raising of the site the whole polder was a traditional winter haunt. The geese wintering in the Antwerp polder are part of a larger population, most of which roost on the mudflats of the River Scheldt, but some stay on the study area. There is sometimes interchange between the geese of the study area and neighbouring haunts on the left bank of the River Scheldt and on the Dutch polders.

Methods

Geese were counted on average three times a week, both on the BASF-grounds and in the surrounding polder.

Scattered over the whole study area, 78 plots of 2x2 m were placed at random. The plots were widely spaced within each pasture and were marked with one peg, to which a square of portable, telescopic plastic pipes (2x2 m) was added when studying it.

Samples were made in each plot at the end of November. This late date for vegetation analysis provided information on the vegetation on which the geese actually foraged, but made the determination of different plant species more difficult. Therefore, bents *Agrostis* spp. were lumped together as were meadow-grasses *Poa* spp. The occurrence and abundance of species were recorded using the 'Tansley scale' (Tansley 1946). These abundance-estimations were later transformed into numerical values (Table 1) and inserted into the vegetation matrix. Estimations were added into the vegetation matrix of the amount of dead material in the vegetation (three classes: >60%; 20–60%; <20% coverage) and of the total cover (three classes: dense; intermediate; open). To classify the

Table 1. Abundance-classes used in the description of the vegetation together with the numerical value allocated.

Dominant	10
Co-dominant	9
Abundant (a)	8
Between (a and f)	7
Frequent (f)	6
Between (f and o)	5
Occasional (o)	4
Between (o and r)	3
Rare (r)	2
Sporadic	1

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samples into distinct groups, the 'Two-Way Indicator Species Analysis' or 'TWINSPAN' was used. TWINSPAN is a complex, polythetic and divisive clustermethod (Hill *et al.* 1975; Hill 1979; Gauch 1982).

In order to determine how the geese use the different feeding sites, goose droppings were counted regularly in the plots. Since the density of droppings is such that counting over small areas is adequate, and since digestion by geese is very inefficient, with a very short throughput time, it can be assumed that the droppings found are from geese feeding at that location (Owen 1975a). Dropping counts are often employed in the assessment of goose usage of various habitats in order to determine seasonal and spatial patterns (Ebbinge *et al.* 1975; Ydenberg and Prins 1981; Derksen *et al.* 1982). They can be subject to bias, due to the attitude of the observer, number of observers, size and shape of the plot, effects of dropping density, and effects of weather and dropping disintegration (Bédard and Gauthier 1984). To make reliable counts, all counts were done by TJY, always in the same crouched position. The small plots (2x2 m) allowed a complete overview. The droppings were removed from the plots after counting. Only single droppings produced by grazing geese were included in the analysis, piles of three or more droppings produced by resting geese were excluded.

Droppings were counted on 7 occasions. Due to the weather conditions (i.e. frost), the periods were unequal: 1: 14 November – 5 December; 2: 6–19 December; 3: 20–30 December; 4: 31 December – 26 January; 5: 27 January – 28 February; 6: 1–17 March; 7: 18 March – 4 April.

Results

Seasonal variation in numbers

The number of geese in the study area (in relation to the average daily temperature) during the winter 1986–87 is given in Figure 1.

In November, numbers increased slowly. At the end of December, when the temperature fell below 0°C, up to 5,000 White-fronted Geese arrived, but most of them

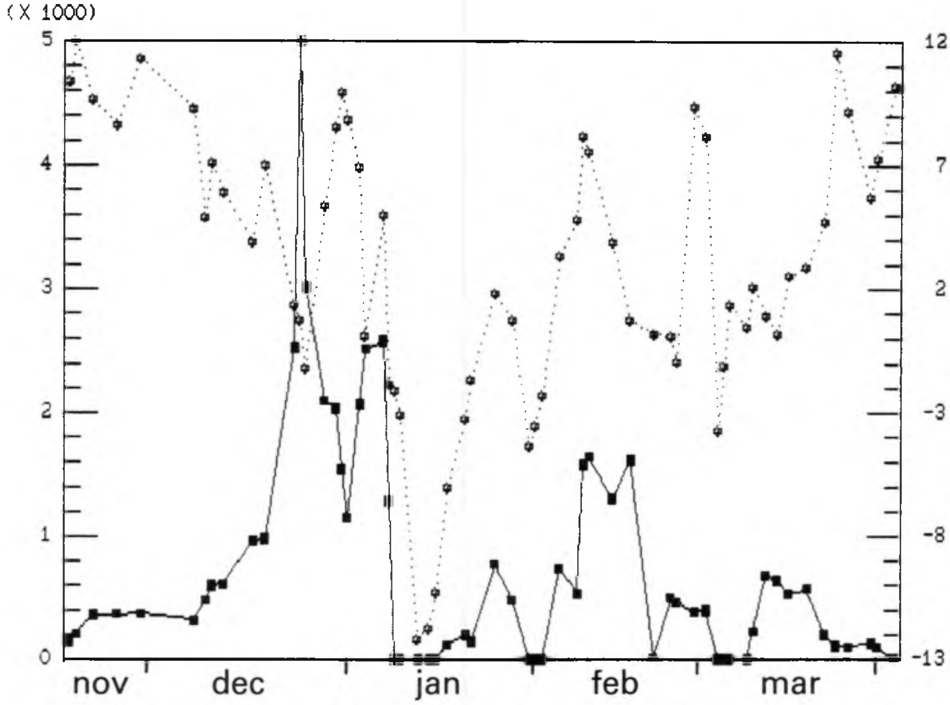

Figure 1. Number of White-fronted Geese (full line) in relation to average daily temperature (broken line) on the study site during the winter 1986–87.

left very rapidly. During the rest of the winter numbers fluctuated largely in parallel with the temperature. During the cold spells (often with snow-fall) geese left the area and went to the surrounding polder, where they mainly foraged on winter cereals and stubble fields, sometimes together with Bean Geese *Anser fabalis*. Early in April the last goose left.

Vegetation

The study area is dominated by a few cultivated grass species: meadow-grass, *Poa* sp.; bent, *Agrostis* sp.; cocksfoot, *Dactylis glomerata*. Because of the nature of the soil (a raised site), many species typical of waste places also appear, such as chickweed, *Stellaria media*; common mouse-ear chickweed, *Cerastium fontanum*; yarrow, *Achillea millefolium*. The grassland on the BASF-grounds is therefore probably a rather marginal feeding ground compared with the surrounding polder.

The TWINSPAN resulted in a distinction between the two main groups (Figure 2). Group 1 comprises 49 plots, subdivided into 5 subgroups (1a–1e), and is characterised by a high diversity, and a high abundance of grasses, *Poa* sp.; *D. glomerata*; red fescue, *Festuca rubra*, but also with many pioneer species, e.g. *S. Media*; *C. fontanum*; white clover, *Trifolium repens*; *A. millefolium*. Group 2 comprises 29 plots, subdivided into 3 subgroups (2a–2c), and is characterised by a low diversity, and a very high abundance of only a few grass species, *Poa* sp.; *Agrostis* sp.; marsh foxtail, *Alopecurus geniculatus*; perennial ryegrass, *Lolium perenne*.

The occurrence of the most abundant species in each subgroup is summarised in Figure 3. The differences in vegetation composition are due to abiotic factors (Table 2). One of the most important is clearly the humidity gradient. Others are the nature of the soil and its manuring. These factors together with the species composition determine the structure and cover of the vegetation (Table 2).

Goose usage

The number of droppings per plot per period varied between 0 and 135. The number of droppings per vegetation subgroup, expressed as a percentage of the total number of the droppings per period,

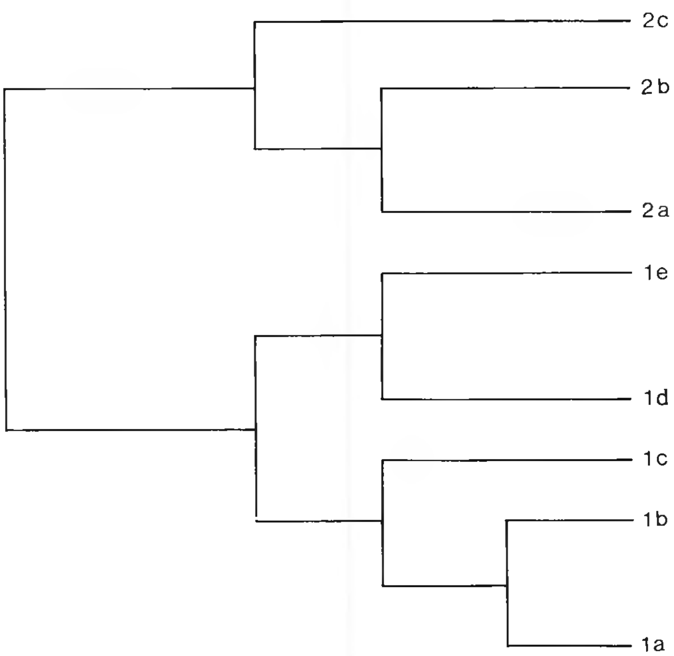

Figure 2. Dendrogram showing the different vegetation groups as determined by a TWINSPAN-analysis.

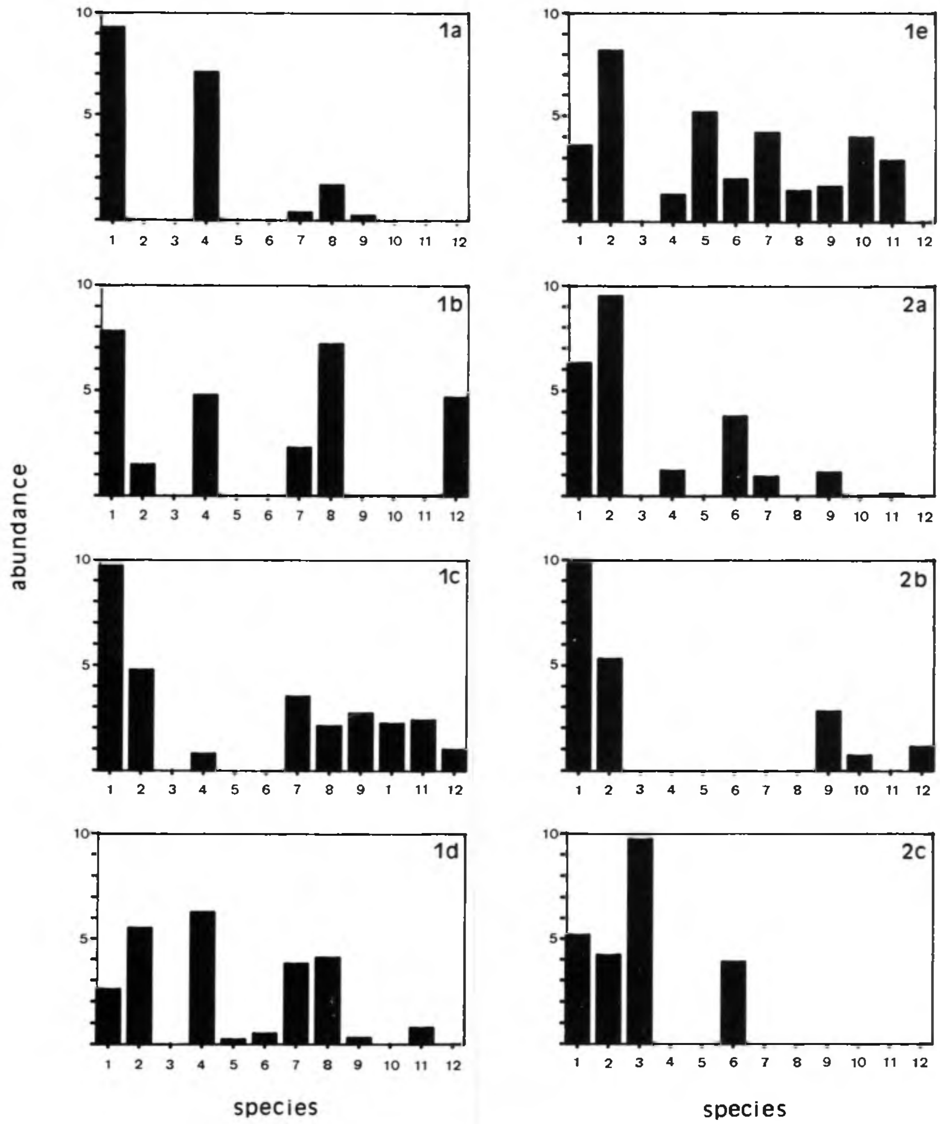

Figure 3. Average abundance of some common plant species in each subgroup.

1 = *Poa* sp.; 2 = *Agrostis* sp.; 3 = *Alopecurus geniculatus*;
4 = *Dactylis glomerata*; 5 = *Festuca rubra*; 6 = *Lolium perenne*;
7 = *Cerastium fontanum*; 8 = *Stellaria media*; 9 = *Trifolium repens*;
10 = *Achillea millefolium*; 11 = *Taraxacum officinale*; 12 = *Moss*

is shown in Figure 4. For each subgroup (except subgroup 1e), the average number of droppings per plot per day was found to differ significantly between the seven periods (Kruskal-Wallis test, Table 3). The lack of significance in subgroup 1e is due to the very low dropping densities.

For each period (except period 7), the average number of droppings per plot per day was found to differ significantly between the 8 vegetation subgroups (Kruskal-Wallis test, Table 4). The lack of significance during period 7 is again due to the very low dropping densities.

During period 1, mainly the plots of group 2 (especially 2c) were used. The same

Table 2. Characteristics of the vegetation for each subgroup by the TWINSPAN-analysis.

	H	M	S	C	D
1a	2	2	1	3	2
1b	1	3	2	2	2–3
1c	2	2	3	3	1–2
1d	1	2–3	2	1–2	2
1e	1	1–2	1–2	2	2–3
2a	3	2	2	2–3	1
2b	3	2	3	3	1–2
2c	3	3	3	3	1–2

H (Humidity)	1 = dry	3 = wet
M (Manuring)	1 = low	3 = high
S (Structure)	1 = rough	3 = fine
C (Cover)	1 = open	3 = dense
D (Dead material)	1 = less	3 = much

trend was found during period 2, but subgroup 1c also became an important feeding site. Thus, early in winter, when numbers are still low, there is a selection towards the wetter and more manured plots. The vegetation of these plots consisted mostly of cultivated grasses and had a fine structure and a dense cover with less dead material (Table 2).

During period 3 (when large numbers of geese arrived on the study area) and period 4, a decline in the use of group 2 was seen, with a positive change towards subgroups 1a and 1b. Subgroup 1c remained as important as it was during the first two periods. The decline in use of the wetter plots of group 2 (especially 2c) was partly due to the average temperature often falling below zero, and resulting in the freezing of some of the wetter plots. This made them unsuitable for foraging, so the selection was then for the drier plots, where birds were able to find more unfrosted grass. The preferred plots still had a high state of manuring and a dense cover.

During periods 5 and 6, vegetation subgroup 1c and to a lesser extent 1a were the most preferred.

Period 7 was difficult to interpret, because of the very low dropping densities. However, there were indications that the plots of group 2 were used again.

By calculating the Spearman Rank correlation coefficients for the number of droppings per plot between the 7 periods (Table 5) we see that the geese shift sequentially between feeding sites. Indeed, period 1 is strongly correlated with period 2, so the goose usage is similar during these two periods. We find similar significant correlations between periods 2 and 3, between periods 3 and 4, between periods 4, 5 and 6, and between periods 5, 6 and 7.

Discussion

In general, in the Antwerp polder the European White-fronted Goose fed mainly on cultivated grassland and poorly drained pastures. Only during cold periods did the geese shift towards stubble and winter cereal fields. A similar attraction to relatively wet and mostly cultivated grassland has been observed in Sweden (Markgren

Table 3. Differences in the number of droppings per plot between each vegetation subgroup for each period.

Period	1	2	3	4	5	6	7
N=78	19.92 **	22.89 **	21.93 **	29.52 ***	16.93 *	14.05 *	4.12 ns

Kruskal-Wallis: Chi-square + significance ***= P<0.001 **= P<0.01 *= P<0.05 ns = not significant

Table 4. Differences in the number of droppings per plot between each period for the 8 vegetation subgroups.

Subgroup	1a	1b	1c	1d	1e	2a	2b	2c
	N=70 31.7 ***	N=63 27.9 ***	N=56 20.3 **	N=105 26.3 ***	N=49 10.8 ns	N=89 29.4 ***	N=42 19.7 **	N=63 35.8 ***

Kruskal-Wallis: Chi-square + significance ***= P<0.001 **= P<0.01 *= P<0.05 ns = not significant

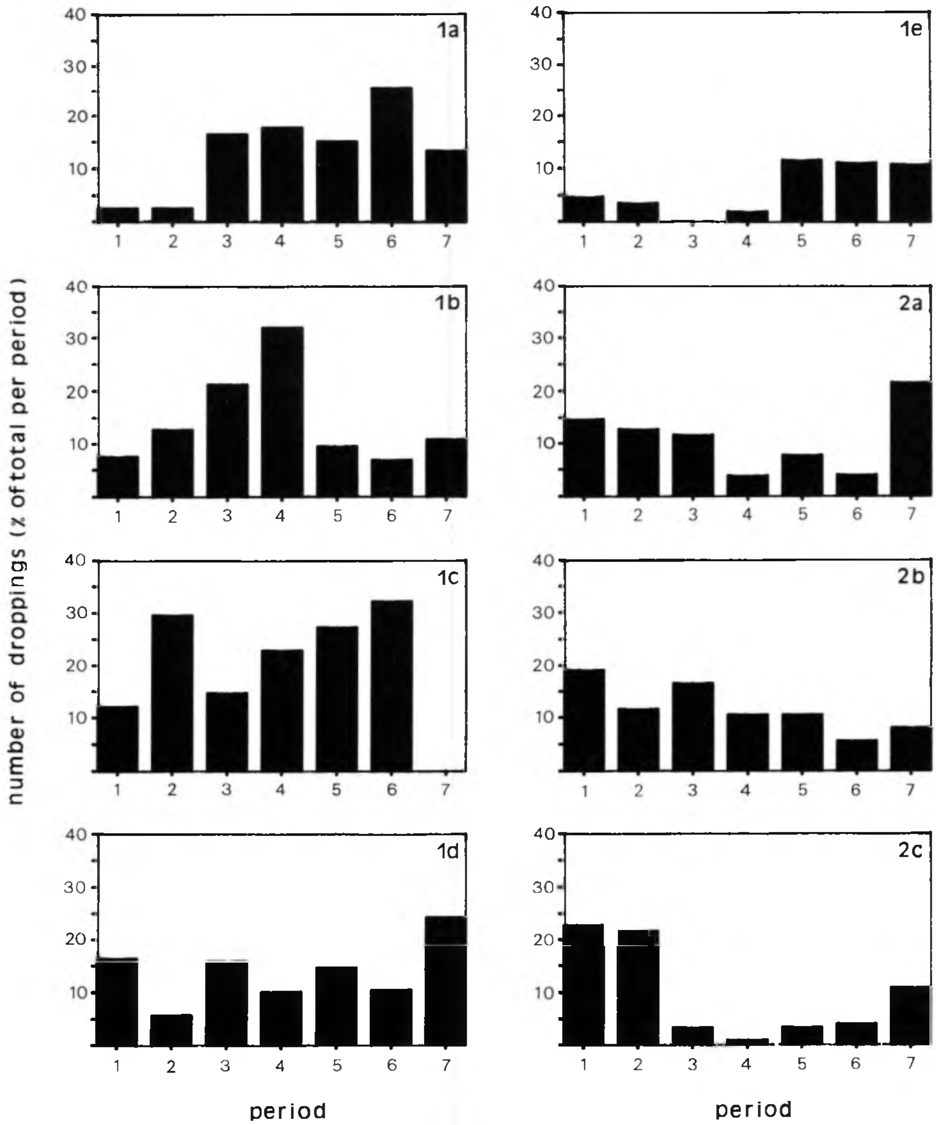

Figure 4. Average number of droppings per vegetation subgroup in each period, expressed as percentage of the total number of droppings in that period.

1963), in Belgium (Kuijken 1969), in the Netherlands (Lebret *et al.* 1976), and in England (Owen 1971). Winter grain fields, clover fields, stubble fields with waste grain, ploughed or harrowed fields were rarely used. However, nowadays many pastures and grasslands are transformed into arable land, forcing geese to feed on these fields.

The basis for habitat selection in wild geese is very complex. Small herbivores, such as geese, require more nutritious and digestible foods than large herbivores, because of their limited ability to digest fibre and cellulose (Buchsbaum *et al.* 1986). Geese have very low digestibility coefficients in contrast to their metabolic needs. It is therefore necessary for them to select a relatively high-quality diet. However, feeding selection is constrained by the need to avoid plants with high levels of secondary metabolites (Buchsbaum *et al.* 1984). The important characteristic of the vegetation is the energy which can be metabolised per unit weight ingested. This

Table 5. Spearman rank correlation coefficients (+ significance) between the different periods, based on the number of droppings per plot per period.

Period	1	2	3	4	5	6	7
1	/	–	–	–	–	–	–
2	0.64 ***	/	–	–	–	–	–
3	0.19 ns	0.34 **	/	–	–	–	–
4	0.10 ns	0.16 ns	0.55 ***	/	–	–	–
5	0.20 ns	0.12 ns	0.20 ns	0.39 ***	/	–	–
6	0.04 ns	0.09 ns	0.19 ns	0.38 ***	0.47 ***	/	–
7	0.13 ns	0.06 ns	0.03 ns	0.05 ns	0.24 **	0.11 ns	/

***= $P<0.001$ **= $P<0.01$ ns = not significant N = 78

energy is determined by the nutritive value (Owen 1975b and 1979; Ydenberg and Prins 1981), and the digestibility of the plant species (Ebbinge *et al.* 1975; Drent *et al.* 1979; Madsen 1985). These are in turn determined by the species composition of the vegetation and its state of growth, and by the fertility of the soil.

During cold spells, the geese leave the main study site (the BASF-grounds) for the surrounding polder to forage on stubble fields and winter cereals. Apparently, energy intake on the BASF-grounds is insufficient at such times. Nevertheless, under normal conditions geese prefer the BASF-grounds. From this it appears that feeding preferences are also influenced by factors such as isolation from disturbance (Newton and Campbell 1973; Owen 1979; Kuijken and Meire 1987), distance from a roost, and weather conditions (Owen 1971). The BASF-grounds not only serve as feeding grounds but also as a roost; the disturbance is low as compared to that on the polder, where shooting and farmers' activity is high.

The geese also show a temporal and spatial preference for distinct vegetation subgroups within a grassland complex. Moreover, there are indications that geese shift feeding sites sequentially during winter. However, this selection is not absolute. Although the vegetation is often similar over larger areas, quite important changes can occur in a short distance. Consequently, while geese are moving during foraging (on average 20 steps/min), they can cross several vegetation subgroups. However, the time spent in each vegetation subgroup can differ. Especially when large numbers are present, the geese are feeding over the whole study area and make use of most of the plots.

The geese seem to select for a vegetation with low amounts of dead material (Owen 1971) and with a dense cover and a fine structure. This vegetation is found on more manured soils with a high humidity. Furthermore, the species composition of the vegetation is also important. Some plant species are preferred, others are avoided. In this study a significant positive correlation is found between the number of droppings per plot and the abundance of *Poa* sp. for period 3 (r_s:0.35 $P<0.01$), period 4 (r_s:0.36 $P<0.001$), and period 6 (r_s:0.26 $P<0.01$); the abundance of *T. repens* for period 2 (r_s:0.24 $P<0.05$) and period 5 (r_s:0.26 $P<0.05$); and the abundance of *A. geniculatus* for period 1 (r_s:0.35 $P<0.01$) and period 2 (r_s:0.25 $P<0.05$). A negative correlation is found with the abundance of *Agrostis* sp. for period 3 (r_s:–0.27 $P<0.05$), and for period 4 (r_s:–0.35 $P<0.01$). Faecal analysis could confirm these correlations. Indeed, it was shown in the other studies that wild geese do select for distinct plant species.

The exploitation of preferred food sources by grazing wild geese results often in their depletion to a level beyond which exploitation is no longer profitable. The utilisation of seed crops of *Agrostis stolonifera* by Greylag Geese *Anser anser* in summer is one example of such a finite food supply. On the other hand, Brent Geese

Branta bernicla were able to visit a saltmarsh every 3–5 days, resulting in a removal of the whole harvestable fraction of the food stock, because the food source, *Plantago maritima*, shows regrowth in spring (Drent and Prins 1987).

In the present study the geese shifted towards other (less preferred) vegetation subgroups during winter. Possibly, the preferred vegetation was depleted because regrowth was very slow in winter. Weather conditions seem to have accelerated the shift towards other vegetation subgroups because of the freezing over of some of the wetter plots. In a mild winter the geese would forage for longer on these plots. When grass growth starts (March), there are indications that the geese shift back to the vegetation subgroups first used.

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Summary

Distribution and habitat use of European White-fronted Goose *Anser albifrons albifrons* in winter were studied in relation to habitat selection near Antwerp (Belgium). Geese were counted on average three times a week. The vegetation was analysed in 78 plots, placed at random. Eight vegetation subgroups were distinguished, based on a TWINSPAN program. Goose usage was determined by counting droppings in the plots in 7 periods throughout the winter.

Geese shifted from the study area towards the surrounding polder during cold spells. Geese also showed a temporal and spatial preference for distinct vegetation subgroups within the study area. Moreover, there are indications that they shifted feeding sites sequentially during winter.

The different use of feeding sites was explained by the fact that the geese probably had to deal with finite food supplies of different qualities, and often with severe weather conditions and disturbance.

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