The winter grazing of saltmarsh vegetation by Dark-bellied Brent Geese

K. CHARMAN and A. MACEY

Introduction

In this country Dark-bellied Brent Geese *Branta bernicla bernicla* winter mainly on coastal sand and mud flats and eat the seagrass *Zostera* and the green alga *Enteromorpha*. In addition certain areas of high saltings are grazed and in recent years agricultural land has also been utilized. The diet of Brent Geese foraging on saltmarshes has been little studied. This paper describes studies of diet and feeding behaviour at two locations on the east coast of England where geese regularly feed on saltmarshes. It also suggests ways in which saltings at present unsuitable as goose grazing could be improved.

Methods

Most of the study was carried out on a section of the north Norfolk coast at Morston about two kilometres west of Blakeney (Figure 1) where 600–1,000 geese graze the saltings from December until their departure in April. Some work was also carried out on the Geedon Saltings, Fingringhoe, Essex (Figure 1) where 1,000–1,500 geese feed. Both areas were similar botanically, being mature high saltmarshes characterised by flat open areas of a close short turf dominated by *Limonium vulgare*. These 'greens' are interspersed with longer rank vegetation of *Puccinellia maritima* and *Halimione portulacoides*. The saltings are flooded only on high spring tides.

We used three methods to study the feeding of Brent Geese on a small section of marsh at Morston during the winter 1973–1974.

(*i*) *Faecal analysis*

Microscopic examination of droppings can be used to indicate the type of food eaten by wildfowl and other groups of animals (Owen 1975a). At fortnightly intervals throughout the winter samples of 200 fresh droppings were collected at random from within the study area and deep frozen. The thawed samples were mixed with water until a thick fluid consistency was obtained. A subsample was taken from the mixture, placed on a microscope slide and fragments of vegetable material identified by comparing their cuticle pattern with those of a series of reference slides. The plant fragments at each of a systematic series of stop points (intersections on a 5 × 5 mm grid) were identified until one hundred identifications had been made. The point quadrat sampling method can give accurate estimates of the proportion of different species ingested on a leaf area basis provided differential fragmentation is taken into account (Owen 1975a and 1976). This fact was allowed for by recording two 'hits' for fragments with both leaf surfaces intact.

(*ii*) *Dropping counts*

The numbers and distribution of goose droppings can indicate the usage of different vegetation types (Owen 1971). Four transects 50 m × 1 m were marked out in an area used by geese so that the major vegetational types (Table 1) were represented approximately in the proportion they occurred on the 'greens'. Tall stands of *Agropyron pungens* and *Halimione* were under represented in the transects but were not used to any extent by geese. Each square metre along the transects was classified as belonging to one of seven vegetational categories (Table 1) depending on the height and abundance of certain key species. The numbers of droppings occurring in each square metre of transect were counted and removed fortnightly one or two days before the first spring tides flooded the marsh.

(*iii*) *Exclosures*

Comparison of protected areas inside exclosures with grazed areas outside can be used to indicate the species eaten by geese (Owen 1971). In addition information on species abundance within the sward can be related to food selection. Estimates of plant biomass prior to grazing by Brent Geese (November) were obtained by removing and weighing the above ground vegetation in ten 25 cm × 25 cm quadrats placed randomly along each of two 20 m sample lines. Two 3 × 3 m exclosures were erected using wooden posts and a 'cat's cradle' of string at 15 cm and 30 cm above ground level. These structures were effective in excluding grazing geese. Goose droppings were only found within exclosures when they had been

Wildfowl 29 (1978): 153–62

washed in by spring tides. Ten random samples were removed from each sample line and from within each exclosure in the spring (March) when the majority of Brent Geese had stopped grazing the saltmarsh. Samples were later sorted into live and dead material of each of the component species. The samples were weighed after oven drying at 90°C to constant weight.

No rabbits *Oryctolagus cuniculus* or hares *Lepus capensis* or their faeces were seen in the study area. The frequent flooding of the marsh and the presence of a large creek to the landward of the study area was probably sufficient to exclude them. Both Mallard *Anas platyrhynchos* and Wigeon *Anas*

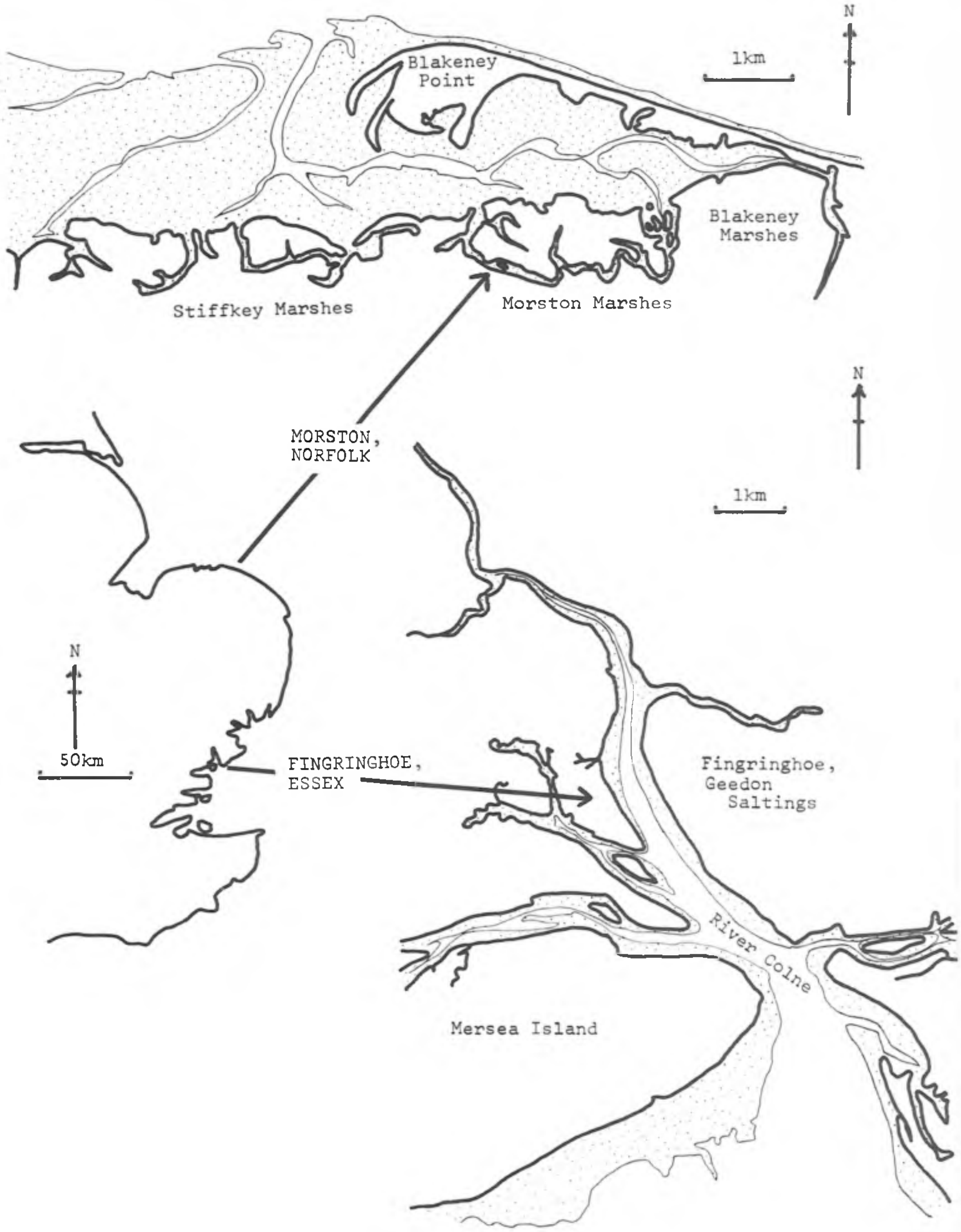

Figure 1. The study areas.

penelope were seen in low numbers near to the study area, but it was thought that any grazing by them was insufficient to influence the results significantly.

Usage of intertidal and saltmarsh areas

Regular surveys of the coast from Wells to Blakeney were carried out during the winter of 1974–1975 to investigate the relative importance of saltmarsh and intertidal food sources to Brent Geese. The numbers, activity and location of flocks were noted in relation to the distribution of *Zostera, Enteromorpha* and saltmarsh vegetation.

Results

Faecal analysis

The number of cuticle fragments from different species of plant identified from droppings are shown in Figure 2. During December, January and February *Puccinellia* and *Spergularia media* were the main food items although *Triglochin maritima* was important in early December. During March, when new growth was taking place, the variety of species eaten increased markedly and the contribution of *Puccinellia* and *Spergularia* to the diet declined. A sample of droppings collected in Essex on the Geedon Saltings conformed to this pattern. The presence of small quantities of intertidal food in droppings is consistent with the movement of birds between coastal flats and saltmarsh and the time which food takes to pass through the gut (Ranwell & Downing 1959).

Dropping counts

The percentage of droppings found on each vegetation type is shown in Figure 3. Wet areas (C) covered with short vegetation of *Limonium, Puccinellia, Triglochin* and *Salicornia europaea* were used initially but *Puccinellia* and *Triglochin* on the edges of pans (E) and creeks (B_2) became more important towards the middle of the winter. Dry areas on the 'greens' (D) were used increasingly as the new growing season approached in spring.

Exclosures

The mean biomass of individual species contained in the sample cuts from the 'greens' in November are given in Appendix 1, together with values for grazed and ungrazed areas in March. A summary of the differences in biomass on the two sample dates and between grazed and ungrazed samples is shown in Table 2.

The quantity of live *Triglochin, Spergularia* and seedlings increased significantly ($p < 0{\cdot}05$) between November and March in the ungrazed plots. In contrast the amount of live *Spergularia* and *Puc-*

Table 1. Descriptions of the major saltmarsh communities found at Morston, Norfolk.

Vegetation type	Description of communities and the approximate percentage cover of key species
A	Tall rank growth of *Halimione* (80%) and *Agropyron* (20%)
B_1	Tall rank growth of *Halimione* (75%) and *Puccinellia* (25%)
B_2	Tall creek side vegetation of *Festuca* (50%) *Halimione* (25%) and *Puccinellia* (25%)
B_3	Pure stands of *Festuca* (100%)
C	Short vegetation on wet areas. Bare ground (25%) *Limonium* (15%) *Puccinellia* (15%) *Salicornia* (15%) *Plantago* (10%) *Triglochin* (10%) and other species (10%)
D	Short vegetation on dry areas. *Limonium* (25%) *Triglochin* (20%) *Plantago* (15%) *Armeria* (10%) *Puccinellia* (10%) other species (10%) and bare ground (10%)
E	Tall vegetation on edge of pans. *Triglochin* (20%) *Plantago* (15%) *Salicornia* (15%) *Limonium* (10%) *Puccinellia* (10%) other species (20%) and bare ground (10%)

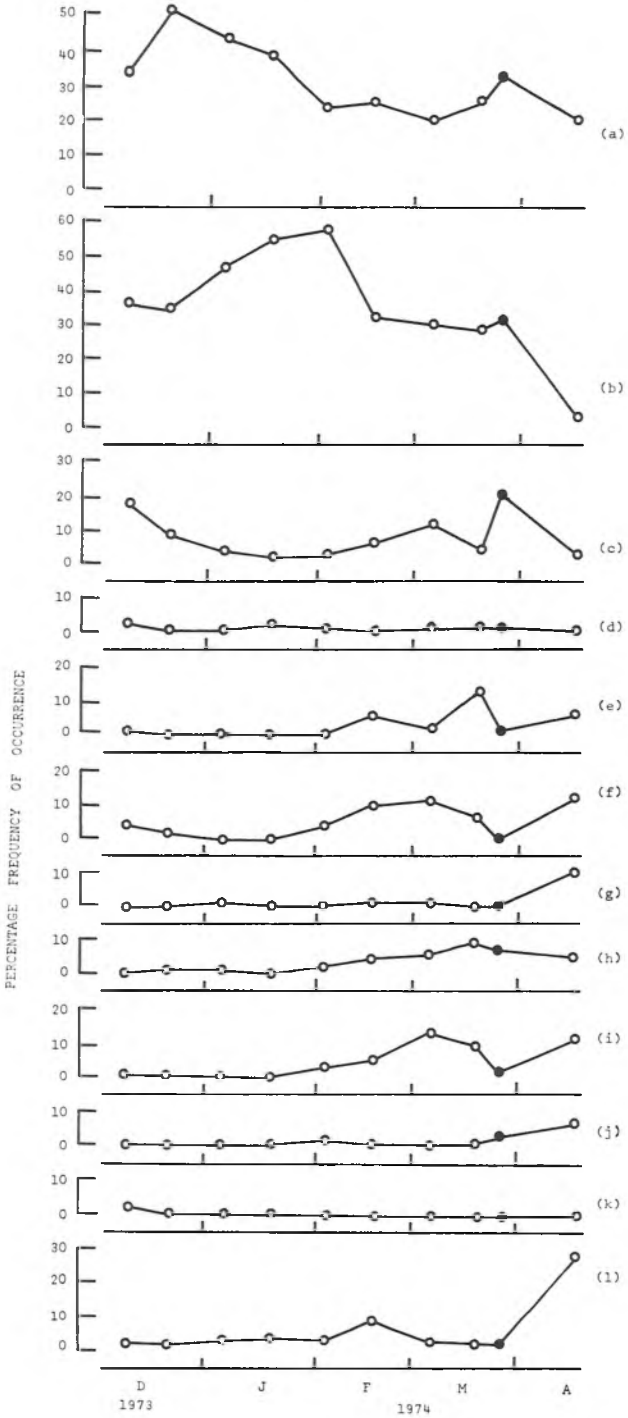

Figure 2. Seasonal changes in the percentage frequency of occurrence of fragments of different plant species found in the droppings of Brent Geese at Morston, Norfolk (open circles) and Fingringhoe, Essex (solid circles). (a) *Spergularia*; (b) *Puccinellia*; (c) *Triglochin*; (d) *Festuca*; (e) *Halimione*; (f) *Aster*; (g) *Armeria*; (h) *Plantago*; (i) *Limonium*; (j) *Salicornia*; (k) *Zostera*; (l) *Enteromorpha*.

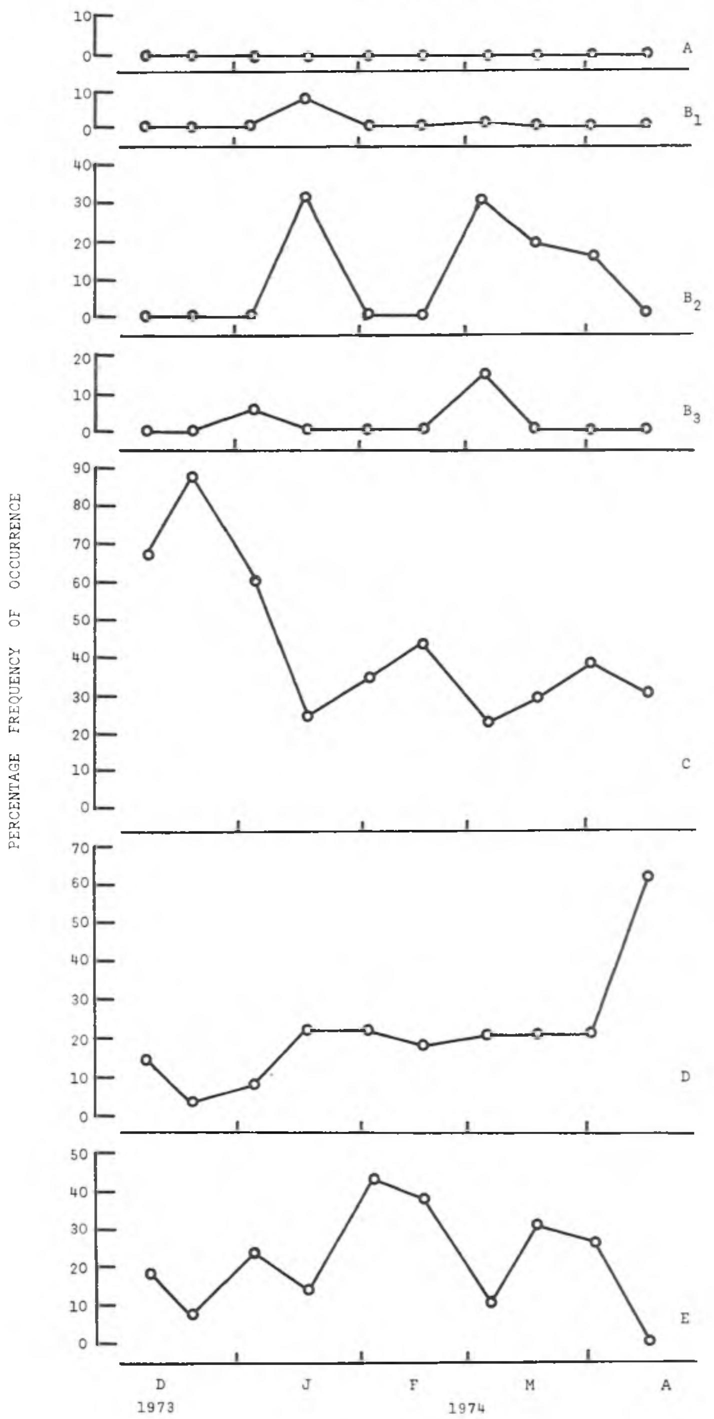

Figure 3. Seasonal changes in the percentage frequency of occurrence of droppings on different salt-marsh communities at Morston, Norfolk. For description of communities see Table 1.

cinellia decreased on grazed areas ($p < 0{\cdot}05$). Dead *Aster tripolium* and *Armeria maritima* declined over the winter ($p < 0{\cdot}05$) on both grazed and ungrazed areas, dead material probably being washed out by high spring tides. More dead *Salicornia* persisted through the winter on ungrazed plots than grazed plots ($p < 0{\cdot}05$). This could have been caused by goose grazing but the low occurrence of this species in the droppings (0·8%) suggests that trampling may have been responsible.

Changes in the biomass of saltmarsh plants directly attributable to grazing occurred in *Spergularia, Triglochin* and seedlings ($p < 0{\cdot}05$) and *Puccinellia* ($p < 0{\cdot}10$).

Food selection

Forage ratios (Jacobs 1974) were calculated for each plant species by comparing the percentage frequency of occurrence of the species in the diet and the percentage contribution of that species to the total biomass in the sward. The results of the faecal analysis of December and January samples have been related to biomass in November and those from February, March and April to the biomass in March. Forage ratios larger than one indicate a positive selection, those below, an avoidance.

The results (Table 3) suggest that selection for *Spergularia, Puccinellia* and *Triglochin* took place in winter and spring but that *Aster* and *Plantago maritima* were only selected in spring.

General survey

On arrival in autumn Brent Geese concentrated their feeding on the *Zostera* bed at Wells (Figure 4). Because of the small size of the bed, stocks were soon depleted and an increasing proportion of birds ate *Enteromorpha*. The *Enteromorpha* stocks were in turn reduced and from the second half of December onwards the geese grazed the saltings. Geese only fed in the longer vegetation surrounding the 'greens' in late January and early February when they appeared hardest pressed for food before spring regrowth had begun.

Discussion

Of the three methods used in this study faecal analysis gave the most direct measure of the contribution of different species to the diet. The distribution of birds and of their

Table 2. A summary of the differences in biomass of saltmarsh plants cut from grazed and ungrazed plots at Morston, Norfolk in November 1973 and March 1974. N = November 1973; M = March 1974; U = ungrazed; G = grazed; n.d. = no detectable difference; significant differences shown at the 95% (**) and 90% (*) level.

	Alive material	Dead material
Armeria	n.d.	NU > MU(**), NU > MG(**)
Aster	n.d.	NU > MU(**), NU > MG(**)
Halimione	n.d.	n.d.
Limonium	n.d.	n.d.
Plantago	n.d.	n.d.
Puccinellia	NU > MG(**), MU > MG(*)	n.d.
Salicornia	MU > MG(**)	n.d.
Spergularia	MU > NU(**), NU > MG(**), MU > NU(**)	n.d.
Triglochin	MU > NU(**), MU > MG(**)	NU > MU(**), NU > MG(**)
Seedlings	MU > NU(**), MG > NU(**), MU > MG(**)	n.d.

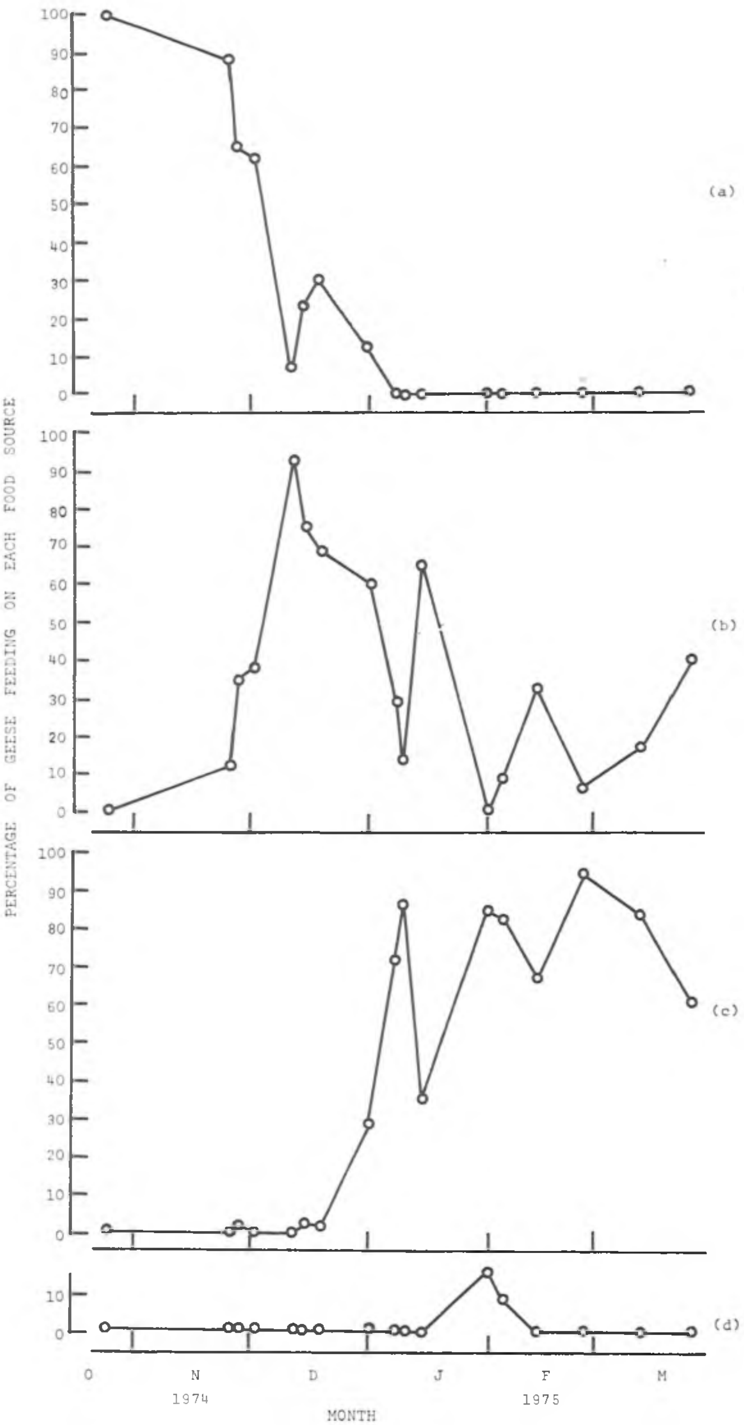

Figure 4. The percentage of Brent Geese feeding between Wells and Blakeney, Norfolk on each of the four major food types during the winter 1974–1975. (a) *Zostera*; (b) *Enteromorpha*; (c) Saltmarsh 'greens'; (d) Long saltmarsh vegetation.

Table 3. The forage ratios for Brent Geese feeding in late winter and early spring on the saltmarsh at Morston, Norfolk. The percentage frequency of occurence of a species in the diet divided by the percentage contribution of that species to the total biomass in the sward. Figures larger than one indicate positive selection, those below, an avoidance.

	December to January	February to April
Armeria	0·04	0·95
Aster	0·34	13·33
Halimione	0·02	0·37
Limonium	0·00	0·19
Plantago	0·23	96·0
Puccinellia	3·53	1·89
Salicornia	0·00	0·14
Spergularia	20·23	21·89
Triglochin	2·30	6·83

droppings suggested ways in which changes in the diet might be brought about by the use of different sections of the habitat.

Vegetation clips are a very time consuming method and can only give a true indication of the diet of a species if natural growth and dieback are taken into account. Even when grazed and ungrazed plots are compared, problems may be encountered in interpreting the results solely in terms of grazing. Both trampling and the presence of droppings may well have important effects on vegetation.

Two types of investigation appear to warrant the extra time and effort needed for vegetation clips. These are: (a) in long term studies to investigate the effect of grazing on subsequent vegetation growth and structure; (b) when a measure of the relative abundance of different food items is required in order to study the degree of selection for particular species. Although a species contributes little in terms of percentage occurrence to the diet, if that species occurs less frequently in the habitat then it may be being strongly selected.

The methods used in this study indicated that *Spergularia, Triglochin* and *Puccinellia* formed the major part of the diet of Brent Geese feeding on saltings. The same species were also eaten at Scolt Head (Ranwell & Downing 1959) although direct comparison with Ranwell and Downing's results are difficult. Their sampling procedure was designed to study the overall feeding pattern, including the use of intertidal resources.

Whilst feeding on saltings, Brent Geese appeared to select *Spergularia, Puccinellia,* and *Triglochin* in the winter and spring, and *Aster* and *Plantago* in the spring. Wigeon and White-fronted Geese *Anser albifrons* also take *Puccinellia* in preference to other plant species (Leisler 1969; Owen 1971).

The reasons behind food selection in the Brent Goose are unknown but several factors could be of importance. Brent Geese may select for the most nutritious components of the saltmarsh sward. Preference for vegetation high in nitrogen has been shown in other species of geese (Harwood 1975; Owen 1975b). Similarly both the degree to which a species can be ground up in the gizzard or the salt content of a species could be important factors in determining its ultimate value to the goose. Further speculation on the reasons for food selection would be unjustified without detailed nutritional analyses.

Conservation and management

In recent years the population of the Dark-bellied Brent Goose has increased markedly (Ogilvie & St Joseph 1976) and there is evidence (Charman, in press) that the early depletion of *Zostera* and *Enteromorpha* stocks has forced Brent Geese to feed inland on winter cereals. This situation is unlikely to be tolerated by farmers for very long. The extensive creation of *Zostera* beds is both technically difficult and expensive (Ranwell *et al.* 1974). Increases in *Enteromorpha* frequently indicate high levels of nitrogen in estuaries which may be undesirable for other reasons.

Large areas of saltmarsh fringe the coast of south-east England but Brent Geese fed consistently only on one or two areas, these areas were of a particular saltmarsh type. It may be possible to increase the area of saltings at present suitable for goose grazing.

The improvement of saltings as Wigeon feeding grounds has been undertaken using mowing followed by sheep grazing (Cadwalladr & Morley 1973). The conversion of previously unsuitable areas of saltmarsh, with rank, tussocky growth of *Puccinellia,* to short cropped 'greens' using mowing or grazing might be feasible. An increase in the number of sites where saltmarsh feeding could take place within the present wintering grounds of the Dark-bellied Brent Goose would both ease the pressure on existing intertidal food stocks and allow higher population levels to be maintained without interfering with agricultural interests.

Acknowledgements

We should like to acknowledge Mr D. F. Musson of the National Trust for permission to carry out work on land in north Norfolk. We are also grateful to Drs L. A. Boorman, J. D. Goss-Custard, D. Jenkins, D. G. Kay, M. Owen and D. S. Ranwell for useful comments on earlier drafts of this paper.

The studies described in this paper were financed by the Department of the Environment under Research Contract DGR 205/2.

Summary

1. This paper describes studies of the diet and feeding behaviour of the Dark-bellied Brent Goose *Branta bernicla bernicla,* at two locations on the east coast of England where geese regularly feed on saltmarshes. A number of methods were used to investigate different aspects of saltmarsh feeding.

2. During December, January and February *Puccinellia* and *Spergularia* were the main food items. During March, when new growth was taking place, the variety of species eaten increased.

3. Wet areas covered with short vegetation were used initially but the edges of pans and creeks became important towards the middle of winter. Dry areas were used increasingly as spring approached.

4. Between November and March changes in biomass of saltmarsh plants directly attributable to grazing occurred in *Spergularia, Triglochin, Puccinellia* and seedlings.

5. Geese fed selectively on *Spergularia, Puccinellia* and *Triglochin* throughout the winter and spring and on *Aster* and *Plantago* in the spring.

6. The grazing of saltmarsh 'greens' by geese took place from late December through to late March after the *Zostera* and *Enteromorpha* stocks had been heavily grazed. Long saltmarsh vegetation was only used in late January and early February when the geese appeared to be hardest pressed for food.

7. Ways are suggested for improving saltings at present unsuitable as goose grazing and thus reducing the pressure on agricultural land.

References

Caldwalladr, D. A. & Morley, J. M. 1973. Sheep grazing preferences on a salting at Bridgewater Bay National Nature Reserve, and their significance for Wigeon conservation. *J. of British Grassland Association* 28: 235–42.

Charman, K. (in press). Feeding ecology and energetics of the dark-bellied brent goose in Essex and Kent. Proceedings of the *First European Ecological Symposium; Ecological Processes in Coastal Environments* (Ed by R. L. Jefferies & A. J. Davy).

Harwood, J. 1975. Grazing strategies of blue geese, *Anser caerulescens.* Ph.D. Thesis, University of Western Ontario.

Jacobs, J. 1974. Quantitative measurement of food selection. *Oecologia* 14: 413–17.

Leisler, B. 1969. Beiträge zur kenntnis der okologie der Anatiden des Seewinkels (Burgenland). *Egretta* 12: 1–64.

Ogilvie, M. A. & St Joseph, A. K. M. 1976. The dark-bellied brent goose in Britain and Europe, 1955–76. *Brit. Birds* 65: 422–39.

Owen, M. 1971. The selection of feeding site by white-fronted geese in winter. *J. Appl. Ecol.* 8: 905–17.

Owen, M. 1975a. An assessment of faecal analysis technique in waterfowl feeding studies. *J. Wildl. Mgmt.* 39: 271–9.

Owen, M. 1975b. Cutting and fertilizing grassland for winter goose management. *J. Wildl. Mgmt.* 39: 163–7.

Owen, M. 1976. The selection of winter food by white-fronted geese. *J. Appl. Ecol.* 13: 715–29.

Ranwell, D. S. & Downing, B. M. 1959. Brent goose winter feeding pattern and *Zostera* resources at Scolt Head Island, Norfolk. *Anim. Behav.* 7: 42–56.

Ranwell, D. S., Weyer, D. W., Boorman, L. A., Pizzey, J. M. & Waters, R. J. 1974. *Zostera* transplants in Norfolk and Suffolk, Great Britain. *Aquaculture* 4: 185–98.

Appendix 1. The mean weight in grams (and Standard Error) of alive and dead plant material cut from within 25 cm × 25 cm quadrats (n = 20) on grazed and ungrazed plots at Morston, Norfolk in November 1973 and March 1974.

		22.11.73 Ungrazed		21.3.74 Grazed		21.3.74 Ungrazed	
		Mean	S.E.	Mean	S.E.	Mean	S.E.
Armeria	Alive	0·48	0·27	0·20	0·18	0·21	0·14
	Dead	0·20	0·11	0·00	—	0·01	0·01
Aster	Alive	0·14	0·12	0·05	0·02	0·11	0·06
	Dead	0·29	0·18	0·01	0·01	0·00	—
Halimione	Alive	0·69	0·21	0·41	0·17	1·95	0·70
	Dead	0·60	0·24	0·76	0·57	1·02	0·61
Limonium	Alive	0·43	0·10	0·35	0·08	0·44	0·07
	Dead	5·27	1·37	3·14	0·67	3·68	0·49
Plantago	Alive	0·01	0·01	0·01	0·01	0·04	0·04
	Dead	0·26	0·23	0·00	—	0·00	—
Puccinellia	Alive	0·86	0·16	0·49	0·10	1·00	0·32
	Dead	0·59	0·15	0·82	0·08	0·95	0·21
Salicornia	Alive	0·00	—	0·00	—	0·00	—
	Dead	1·22	0·18	0·81	0·21	1·48	0·22
Spergularia	Alive	0·22	0·06	0·09	0·02	0·57	0·17
	Dead	0·03	0·03	0·00	—	0·00	—
Triglochin	Alive	0·06	0·02	0·04	0·01	0·13	0·02
	Dead	0·36	0·12	0·02	0·01	0·01	0·01
Seedlings	Alive	0·00	—	0·04	0·01	0·18	0·07
	Dead	—	—	—	—	—	—

Dr K. Charman* & A. Macey†, Institute of Terrestrial Ecology, Colney Research Station, Norwich, Norfolk, NR7 4UD.

* Present address: Nature Conservancy Council, 70 Castlegate, Grantham, Lincolnshire, NG31 6SH.
† Present address: RR 1, Chemin Lamarche, Pte Gatineau, Quebec J8T 4Y6, Canada.