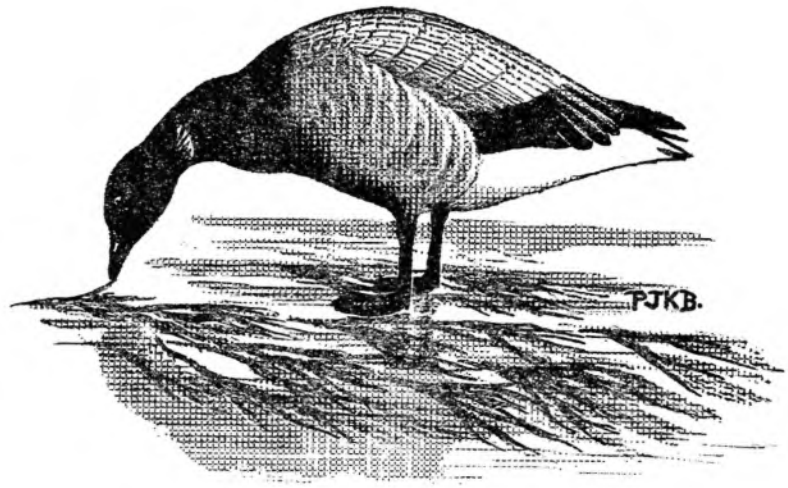


THE BRENT GOOSE AND ITS FOOD SUPPLY IN ESSEX

P. J. K. Burton

Summary

SURVEYS have been made of food supplies in the wintering areas of Brent Geese in Essex. The tidal distribution and productivity of the three species of *Zostera* is discussed, and results of surveys at Foulness and Osea Island are given. *Z. noltii* is the commonest species, and *Z. marina* is absent. Brent do not fully utilise all available supplies of *Zostera*. The behaviour of Brent in Essex is contrasted with areas where *Z. marina* is abundant.

Enteromorpha is the commonest algal food. Important supplies are found at Dengie, Ray Sands and Goldhanger. Results of surveys at Goldhanger are given. More Brent eat *Enteromorpha* later in the winter; and in some areas Brent move between *Enteromorpha* and *Zostera* beds with the tide. Higher plants and animal foods are sometimes taken, and the ingestion of sand is discussed.

Calculations of feeding rate based on measurement of grazing at Foulness suggest that food supplies in the main wintering haunts are more than adequate for the numbers of Brent recorded up to 1959-60. A reserve of food exists in other areas, and in theory could support considerably more; in practice, competition and the need for space to move about in would limit numbers. It is suggested that the highest winter average which would be comfortably maintained would be about 6000.

Introduction

The relationship between the Brent Goose *Branta bernicla* (L) and its food supply has attracted attention since the 1930's, when one of its most important food plants, *Zostera marina,* died out over large areas of the North Atlantic seaboard. The decline in numbers which followed aroused a conservational interest in the species which still persists. At the time of writing, the Brent Goose is given total legal protection in Great Britain and several other European Countries.

One of the chief wintering haunts of the Dark-bellied race of this species (*B. b. bernicla*) is the Essex coast. This paper sets out the results of surveys of food supply made in the county during the past four years, and an attempt is made to assess the value of food as a limiting factor on Brent numbers in this region.

Methods

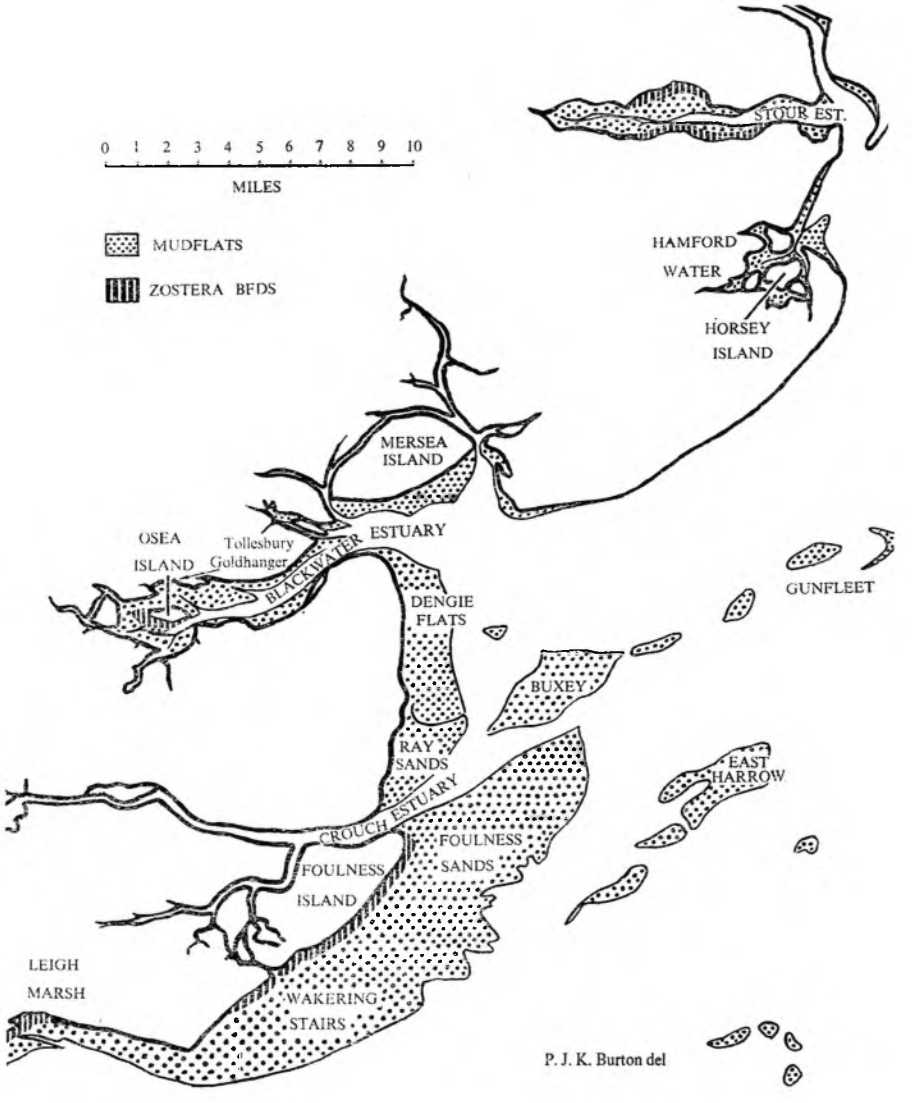
The methods employed for assessing the productivity of plants growing on mudflats are essentially the same as those described by Ranwell and Downing (1959). A large number of quadrat throws are made on the mud, and for each, an estimate of percentage cover is made by eye. These estimates are then related to weight by collecting and weighing a number of samples of the amount enclosed by a quadrat at the different estimated percentages. From these data, a reasonable figure can be arrived at for weight per unit area, and given the area covered by the food plant, the total weight of the crop can be calculated. Areas have been estimated by surveying tidal ranges with a home-made theodolite, and plotting the results on 2½″ Ordnance Survey maps. The areas most thoroughly surveyed have been Foulness Flats, Wakering Stairs and the Goldhanger-Osea Island area of the Blackwater estuary. Many other parts of the coast have been visited and the extent of cover estimated by pacing. Assessments of crop density have been made by examining the thickness of the growth, and estimating visually the percentage cover, drawing on the experience of surveying Foulness and Osea. The account which follows gives the results of surveys for different types of food, and aspects of Brent behaviour which affect the amount taken are mentioned.

Zostera

Dandy (1958) recognizes three species of *Zostera*. *Zostera marina* is the largest form, with leaves up to 1 cm. broad and 120 cm. long. *Z. angustifolia* (=*Z. hornemanniana* (Tutin)) is smaller, with leaves up to 4 mm. broad, and 30 cm. long. *Z. noltii* (=*Z. nana* (Roth.)) is a very small species, only 1-2 mm. broad and up to 20 cm. long.

The distribution of these plants in relation to tidal levels is not clear, and probably varies according to local conditions of shelter, substratum, salinity, etc., where these are such as to affect the nutritional balance (Butcher, 1935). However, true *Z. marina* appears to be most abundant at low tide levels and in sublittoral regions, while the two narrow-leaved species occur higher up the shore. *Z. noltii* seems characteristic of high levels; in Essex it does not extend below about mid-tide level, and in North Norfolk (Ranwell & Downing, *loc. cit.*) it may remain exposed during high water neap tides. *Z. angustifolia* growing in Essex occurs almost entirely in pools of standing water formed in depressions; at Osea Island, such depressions are only found high up the shore, and *Z. angustifolia* is therefore limited to high levels. At Leigh-on-Sea, pools are plentiful about mid-tide level, and *Z. angustifolia* is therefore found at the seaward end of the *Z. noltii*.

Productivity figures are available for the various forms of *Zostera*. Ranwell & Downing (*loc. cit.*) estimated the yield of *Z. nana* green parts in autumn at Scolt Head, North Norfolk as 2800 kg./ha., and using the same methods in Essex, the writer obtained exactly the same figure. Mörzer Bruijns and Tanis (1955) record a productivity at Terschelling, Holland, of 8000 kg./ha.; this includes both the autumn and the heavier spring crops, together with the rhizomes, and indicates a somewhat greater yield than in Essex. In Norfolk and Essex *Z. angustifolia* has a patchy distribution; though it is a larger plant than *Z. noltii*, Ranwell & Downing obtained a figure for it of only 1260 kg./ha. For *Z. marina*, Boysen-Jensen (1915) gives


0 1 2 3 4 5 6 7 8 9 10
MILES
MUDFLATS
ZOSTERA BEDS
STOUR EST.
HAMFORD WATER
HORSEY ISLAND
MERSEA ISLAND
OSEA ISLAND
Tollesbury
Goldhanger
BLACKWATER ESTUARY
DENGIE FLATS
GUNFLEET
BUXEY
RAY SANDS
EAST HARROW
CROUCH ESTUARY
FOULNESS SANDS
FOULNESS ISLAND
LEIGH MARSH
WAKERING STAIRS
P. J. K. Burton del

a yield of between 1700 and 6000 gm./sq.m., commonly about 3500 gm./sq.m. This corresponds to 35,000 kg./ha. Such a high figure is evidently due to the fact that the samples were sublittoral ones; where continually submerged *Z. marina* forms a dense uniform cover, the buoyant leaves standing upright in the water.

The present distribution of *Zostera* in Essex is shown in Fig. 1. The greatest amount is at Foulness and Wakering, where *Z. noltii* extends for more than 6½ miles down the coast in a zone 300 to 350 yards wide. The total area is some 800 acres or 320 hectares, and the total crop of *Zostera* shoots in autumn some 900 metric tons. A few *Z. angustifolia* plants have been found at Wakering.

The *Zostera* at Osea Island, including a good deal of *Z. angustifolia* at high levels, is of much smaller extent. It extends 50 to 150 yards out for 1½ miles along the south shore, covering about 25-30 hectares. The crop weight is about 70 metric tons. The total crop for both Foulness and Osea is thus of the order of 1000 metric tons. In addition there are extensive beds of *Z. noltii* on the Stour estuary (with a little *Z. angustifolia*) and at Leigh-on-Sea (where *Z. angustifolia* is plentiful, though patchy); comparatively few Brent winter in these two areas. Traces of *Z. noltii* have recently been found in the Dengie area and at Tollesbury, perhaps indicating the start of recolonisation. *Z. marina* is apparently extinct on the Essex coast, though at one time recorded from Osea and Mersea Islands, and on the Dengie coastline.

All three species of *Zostera* were found on Hamford Water, south of Horsey Island, in the 1930's (Butcher 1934). *Spartina townsendii* was introduced around the island about this time and has spread rapidly; returning in 1955, Butcher (pers. comm.) only found drift *Zostera* debris here, and on a visit in September 1958, the writer saw none at all. Evidently the *Spartina* has increased silt deposition in this landlocked bay, making it unsuitable for *Zostera.*

Brent Geese most often feed close to the tide edge; hence, where *Z. angustifolia* grows mainly at high tide levels as at Osea and Norfolk, it only forms a small proportion of the birds' diet. In Norfolk, Ranwell & Downing (*loc. cit.*) found no evidence that any was taken, though birds at Osea are sometimes seen feeding close inshore, and a stomach from this area contained 70% *Z. angustifolia* (analysis by D. S. Ranwell). Also, the densest part of the *Z. noltii* is concentrated at a high level, and is therefore not fully utilised by the geese.

At Foulness, the Brent do not feed uniformly along the whole coastline, but congregate largely in one area throughout the winter. A different area is chosen each winter. This is fortunate since, while the region in use is subjected to heavy grazing pressure, in other regions the spread of rhizomes can continue with little hindrance.

The habits of Brent in Essex and other areas where *Z. noltii* is the dominant form differ from those in areas where *Z. marina* is more abundant. *Z. marina* produces large quantities of drift, especially in autumn when disturbance by seasonal gales detaches leaves. At this time of year, Brent often spend much time offshore eating this floating débris (Russell 1890). During the winter, leaves loosened from the mud by feeding geese replenish this driftweed "larder." Such drift is negligible where *Z. noltii* is the dominant plant, as it is insufficiently dense, and its short leaves do not bind

together so tightly, so that the floating masses are easily broken up by the sea. Owing to this, and to the higher zonation of *Z. noltii,* Brent in areas where it is the common form spend much less time offshore than in areas where *Z. marina* abounds.

Where *Z. marina* is available, it constitutes the major part of the diet throughout the winter—Cottam *et al* (*loc. cit.*) estimated 85%. In areas where the geese subsist on *Z. noltii* there is characteristically a shift later in the year to other foods, especially green algae.

Algae

Second in importance to *Zostera* as a food are the green algae, notably *Enteromorpha* and *Ulva. Enteromorpha* is more abundant in most regions and hence is taken in greater quantity. There seem to be no preferences for particular species of either genus. The species of Ulva most often recorded are *U. lactuca* and *U. latissima,* evidently because they are most common. Campbell (1946) found that *Enteromorphae* from Brent stomachs were all of fine species; however, this too may be merely because they were the more abundant in the areas studied. Brent in Essex have been recorded as taking *Enteromorphae* of widely varying growth form—species identified have been *E. clathrata, intestinalis, prolifera* and *ramulosa.*

Enteromorpha and *Ulva* occur on a variety of substrata. They are least dense on pure sand. Rocks and boulders may be thickly covered, often with red algae associated. *Ulva* thrives on rocks, while *Enteromorpha* reaches maximum density on mud. They occupy the area down to about mid-tide level, and are densest at high levels. This distribution is simi'ar to that of *Z. noltii* and the habits of Brent are similar in both *Z. noltii* and *Enteromorpha* regions. *Enteromorpha* however has a somewhat wider range, and in Essex a sparse growth is found for about 50-100 yards seaward of the *Z. noltii.* Landward of the *Zostera* at Foulness is a zone occupied by the green alga *Cladophora. Enteromorpha* is found on all parts of the Essex coast, especially where *Zostera* is absent, and has colonised areas from which *Zostera* has disappeared. It is better able than *Zostera* to exist on an unstable surface or in regions of rapid silt deposition as at Hamford Water.

Important stretches of green algae in Essex are at Dengie, the Ray Sands, Goldhanger and the Tollesbury-Mersea area. The beds of algae in the Goldhanger area are probably the most dense in the county. A cover of up to 80% extends 50-100 yards out from the saltings, and a band of about 20% cover continues for another 50 yards to about mid-tide level. The predominant species are *E. prolifera* and *ramulosa,* which form a mat some 3″ thick in autumn. The mean productivity is about 8500 kg./ha. and the total mass in the area on the north shore of the Blackwater estuary between Heybridge Basin and Gore Saltings is estimated at 3-400 metric tons. Elsewhere in the estuary, and on Hamford Water, the crop is very sparse indeed, with a productivity of probably not more than 1000 kg./ha. At Dengie, a density of 2000 kg./ha. is estimated; this would be greater were the surface of the mud not broken up extensively by runnels.

Mörzer Bruijns & Tanis (*loc. cit.*) observed that Brent at Terschelling fed mainly on *Z. noltii* up to November or December, but after this, moved increasingly to the *Enteromorpha* beds. In Norfolk, *Zostera* and *Enteromorpha* are eaten in the first half of the winter and *Enteromorpha* alone later in the

season. The majority of Essex Brent change during the winter from a diet of pure *Z. nana* to a mixed diet of *Zostera* and algae, but many subsist throughout the winter on *Zostera* alone. When a mixed diet is taken, the birds move with the tide between different feeding areas, usually taking *Zostera* on the flood and *Enteromorpha* on the ebb. Such an alternation is well seen in the Osea Island area and also at the mouth of the Crouch and on the Stour.

There is evidence that algae are less nutritious than *Zostera;* Ranwell and Downing (*loc. cit.*) give analyses suggesting that fresh *Z. noltii* leaves are about three times as rich in protein as fresh *Enteromorpha* thalli, and also contain a good deal more carbohydrate. Cottam *et al* (*loc. cit.*) found that American Brant which had been feeding on algae were unusually thin, and reasoned that this was due to nutritional inadequacy of the algae. However, another explanation may be that this was because the large population of Brant had been thrown suddenly upon a less abundant food source, and had quickly exhausted it. Brent certainly seem to support themselves on algae in other areas, and observations in Essex show no difference in the time spent feeding on the two types of food. Many factors, such as the size of mouthfuls taken, the amount of energy spent in grazing the two types of food, the greater fibre content of *Zostera* and so on, may obscure the effects of the differences in composition of the two foods. It is not thought unduly inaccurate to regard *Zostera* as equivalent to *Enteromorpha* in the assessment of food resources in Essex, since the figures available are in any case only rough approximations.

Green algae other than *Enteromorpha* and *Ulva* are usually only recorded in trace amounts from stomach or dropping samples, though colonial diatoms sometimes appear in quantity. *Cladophora* is fairly abundant in Essex, but occurs at high tide levels not much frequented by the geese, and little is therefore taken. Brown and red algae are eaten at times in small amounts. Sixteen genera of algae have so far been identified in Brent food samples.

Other plants

Higher plants other than *Zostera* spp. are at times taken in considerable quantities. Two especially favoured are the glasswort, *Salicornia,* growing at the seaward edge of the saltings, and the grass *Puccinellia,* found abundantly on the saltings. Others often eaten are *Spartina, Festuca rubra, Triglochin maritima* and *Aster tripolium.* In Essex these plants may be taken at any spring tide, when high water floods the saltings, but in many areas a seasonal factor also plays a clear part. Thus Mörzer Bruijns and Tanis (*loc. cit.*) found that Brent in the Terschelling area foraged on the saltings to some extent during the early part of the winter, and again in the spring. A tendency to visit the higher marsh late in the winter was also noted in Norfolk (Ranwell and Downing, *loc. cit.*).

Foraging on saltings or inland meadows has in the past been correlated with Zostera scarcity; such behaviour was noted after the disappearance of *Z. marina* in the 1930's, both in Europe and North America. It is possible that a tendency towards land feeding late in the winter is a normal feature which may become emphasised when *Zostera* is scarce. Bolin and Webbe (unpublished) quote a report that before the 1914-18 war so many used to come ashore in spring to feed on the island of Föhr that they could be heard

all over the island on a calm evening. Factors other than food scarcity on the mudflats that could play a part are the renewed growth of land and salting plants, producing new tender shoots, and the impending change to a land habitat for the breeding season. As a direct cause of land foraging at Tipperne, Denmark, Lind (1956) has suggested that strong spring winds may result in overland flights by the geese revealing the foraging possibilities to them.

Animal Food

Small quantities of animal matter are regularly found in stomach and dropping samples, which must be ingested with other food. *Zostera* is particularly rich in animal associates, and samples of *Z. noltii* collected at Foulness contained about 2% by weight of animal matter (excluding *Littorina* spp.). Most of this material consisted of the amphipod *Corophium,* which was abundant among the leaves of *Zostera* and must be taken with them by feeding Brent. Hydroids occur quite often in food samples. Many other animals including molluscs, crustaceans, annelids, fish fry, protozoans and even insects, are recorded.

Brent are occasionally recorded taking animal food deliberately, and at Foulness, Essex, Brent Geese have quite often been observed pattering on the mud with their feet like gulls to bring up lugworms *Arenicola marina* which were then eaten.

Sand and Mud

A good deal of sand and mud is ingested by Brent, both deliberately and with food plants. More mud and sand is mixed up with *Enteromorpha* than *Zostera,* and this may be a reason why Cottam *et al* (*loc. cit.*) found more gravel in the stomachs of birds which had been feeding on green algae, though hunger may have played a part. In Essex, at low tide, the geese commonly resort to stretches of mud distant from the sea wall. In these areas they may be seen feeding on what appears to be mud, since nothing grows at these low levels, and the only abundant animal is the gastropod *Hydrobia ulvae,* which is only occasionally found in stomach and dropping analyses.

Discussion

There has been much speculation in the past regarding the extent to which *Zostera* supply limits the population of Dark-bellied Brent in Northern Europe. Recent opinion has tended to suggest that its importance has been exaggerated. For Essex at least it is possible to give some indication of an answer to this problem.

It is necessary first to attempt an assessment of the amount of food taken by a Brent in a day. Some clue is given by data for other birds. Drinnan (1958) estimated that Oystercatchers *Haematopus ostralegus* took 17.5% of their body weight per day in dry weight of food, and quotes figures for other animal feeders in the range 12-25%, varying inversely with the size of the bird. At Foulness, surveys indicated that some 650 metric tons of *Z. noltii* were removed during the winter of 1957-58. The Brent is the only species abundant at Foulness which eats *Zostera,* and an estimate of feeding rate

was made by dividing this quantity by the average number of birds counted throughout the winter—some 2300. This gives a figure of about 350-400 gm. dry weight of *Zostera* per day, equivalent to about 20-25% of the body weight per day. This seems high compared to the figures mentioned, but since these all concerned animal foods, different results might be expected. Also, some *Zostera* may have been removed by storms, frosts, etc. However, an underestimate of *Zostera* supply is to be preferred to an overestimate, and the figure of 375 gm. dry weight (=approx. 2400 gm. fresh weight) is therefore used in the calculations which follow.

From the surveys made of Foulness, Wakering, Osea Island and Goldhanger, it is possible to make cautious assessments of the bulk of food present in other areas of Essex, based on relative extent and density of cover. The estimated figures are shown in Table 1 below:—

Table 1: Estimates of the annual crop of Brent food plants at the less important haunts on the Essex coast.

Locality	Area (Hectares)	Plant	Density estimated (in kg./ha.)	Total crop estimated (metric tons)
Stour	150	*Zostera*	2500	400
Leigh-on-Sea	60	*Zostera*	3000	200
Dengie	350	*Enteromorpha*	2000	700
North Blackwater (other than Goldhanger) ..	100	*Enteromorpha*	500-1000	50-100
South Blackwater	100	*Enteromorpha*	500-1000	50-100
Hamford Water	200	*Enteromorpha*	500-1000	100-200

Adding these figures to those for the area surveyed, a figure for the whole county is arrived at of some 3000-3500 metric tons. This would be sufficient for about 12,000 Brent throughout the winter. Wildfowl counts show that the average number present throughout the past six winters has been 3300.

The figure of 12,000 would be impossible to maintain in practice for various reasons. In the first place, a considerable amount of the available food must be taken by other birds, of which Wigeon *Anas penelope* and Mute Swan *Cygnus olor* are the most important. Both species are abundant on the Stour, and Wigeon are numerous in the Blackwater and on the Dengie coastline, though scarce at Foulness and Wakering. Furthermore, Brent need a good deal of space to move about in, and it is characteristic that they should not make use of all the available feeding grounds. Thus, at Foulness, only part of the expanse of *Zostera* is usually grazed during any one winter.

It seems improbable, then, that a very high proportion of the coastline could be fully used without in effect overcrowding the birds, and it is suggested that the highest winter average which could be comfortably maintained would be in the region of 6000. Even during the last century the comparable figure may not have been so much more, for considerations of space would still have been important; although further large numbers may have been maintained at sea by the drift then available from *Z. marina*. During exceptionally hard winters in the past, very large numbers indeed seem

to have collected for a time in some areas, and would temporarily have overcrowded them. This may occur again, but need not affect the general conclusion that Brent numbers in Essex are not far below the maximum possible, the ultimate limit being imposed by space, competition and food supply.

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