Food and feeding habits of the Common Eider at Seafield, Edinburgh, in winter

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Introduction

The Common Eider *Somateria m. mollissima* is mainly a winter visitor to Seafield, on the Firth of Forth at Edinburgh, arriving at the beginning of October and leaving in the middle of May, although a few may be seen during the summer months. Seafield, as an Eider wintering area, has slowly grown in importance over the last decade. A maximum of 270 birds was recorded in 1959 but in 1967, 2,900 were to be found (D. G. Andrew, pers. com.), a figure which was exceptional at this time. However, at present 2,000 birds are resident for most of the winter, with numbers occasionally reaching 2,900 (Player 1970).

From observations and ringing returns it appears that most of the birds wintering here come from East Lothian and the Farne Islands, two important breeding centres, but some may come from further north. It is possible, although unlikely, that the population is boosted by Continental birds. This occurs in south-east England, but the distances involved are smaller and Eiders tend to restrict their movements to within 200 km. of their birthplace.

Description of the area

Over 90% of the diving ducks wintering on the south shore of the Firth of Forth occur between the shipping entrance to Leith Docks (Grid ref. NT 263787) and Portobello Power Station (Grid ref. NT 316744) (see map Figure 1).

In this area there are five discharges into the sea, of which two are purely industrial—Portobello Power Station discharging cooling water and Scottish Agricultural Industries (S.A.I.) discharging gypsum. The other three pipes send out both industrial and domestic sewage. These are the east and west Water of Leith sewers, and Seafield sewer.

Of these five pipes, Seafield is the only one to have any form of treatment before entry to the sea. Here there is detritus screening and maceration while the others exude untreated matter.

In 1969 approximately 30.5 million gallons per day of effluent entered the sea. Actual figures are not available as there are no gauging stations on the sewers.

The industrial effluents are from paper mills, breweries, distilleries, chemical plants, electrical engineering plants, maltings, and a slaughter house (Anon 1962).

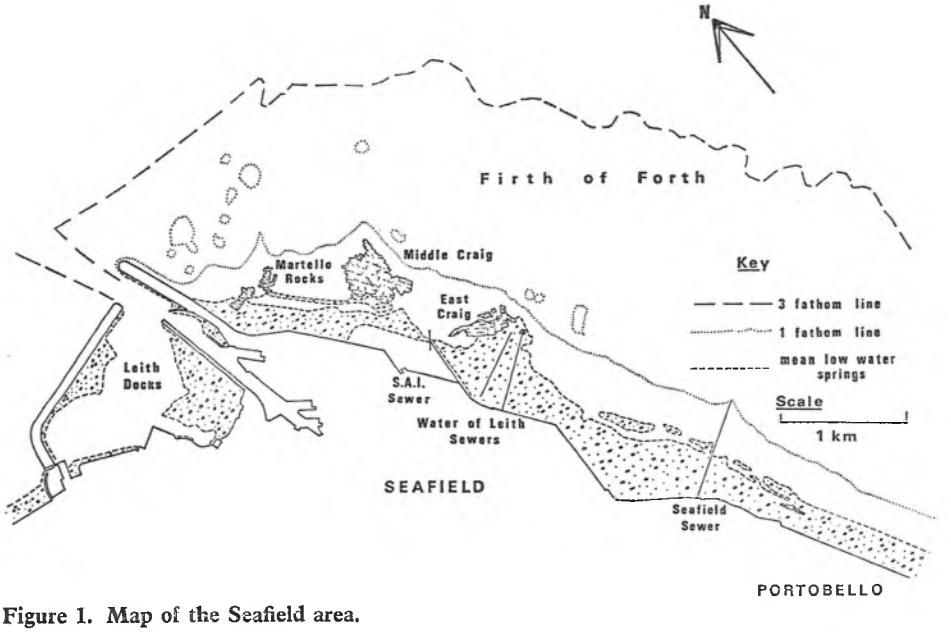

Figure 1. Map of the Seafield area.

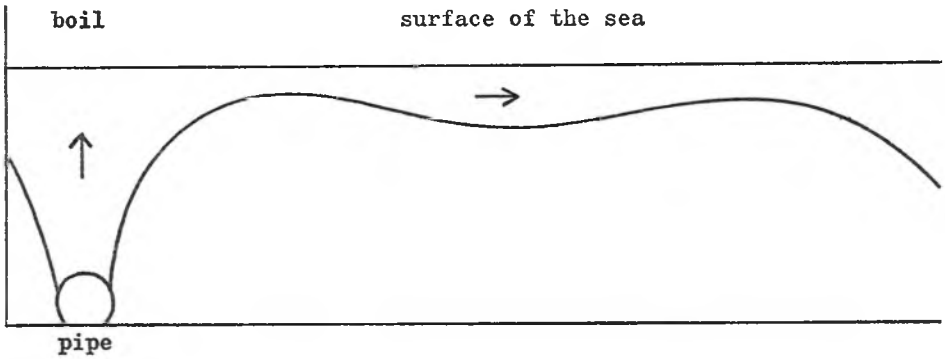

Figure 2. Profile of a sewage slick.

These effluents form a slick, which on a calm day can be seen for several miles out to sea. Figure 2 shows a profile of a sewage slick. As fresh water is less dense than sea water it rises to the surface to form a slick. This slick swings east and west with the tide. The fresh water on the surface has a calming effect similar to, but less distinct from, that of oil.

However, wind is the main factor which affects wave height. It has been found that the sea remains calm if the wind comes from the west to south-east sector, even though it may be blowing at 40 k.p.h. This is due to the protection given by the hill Arthur's Seat (height 250 m.) and by the Leith Dock industrial complex. Table I shows that the wind comes from this sector, or is calm, for over three-quarters of the duck wintering period October to April. It may be that ducks are attracted both by the calm sea and by the large amounts of waste material which enter the Forth every day.

Table I. The direction of the wind from October to April, expressed as per cent.

NW	6		SE	8
N	4		S	11
NE	6		SW	19
E	7		W	25
		Calm 14		

The maximum numbers of each species of duck recorded are: Eider 2,900, Long-tailed Duck *Clangula hyemalis* 762, Goldeneye *Bucephala clangula* 4,000, Scaup *Aythya marila* 35,000, and Pochard *Aythya ferina* 1,000, although it is believed that the entire wintering flock of Pochard at Duddingston Loch 2.5 km. inland (4,000-8,000 birds) come down to feed at night. The greatest number of ducks recorded on the area is 40,000, in January 1970 (D. G. Andrew, pers. com.).

Methods

The methods of analysis of stomach (= gullet + proventriculus + gizzard) contents have been described in detail by Olney (1963, 1970). Eiders were collected when they were feeding. Even so many had only small amounts of food in their stomachs. These were removed in the laboratory a few miles away and placed in formo-saline solution. The various species of food were identified and the number of stomachs in which a species occurred was listed as its 'frequency'. The amount of alcohol which each food species displaced gave its 'volume'. Food items vary in their resistance to the chemical and mechanical processes of digestion. This is especially so in carnivorous birds. For instance, hard crab claws remain for a long time, while the flesh of molluscs rapidly passes into the intestine. Therefore in the present case, and following Madsen (1954), more reliance is placed on the frequency with which food items occur than on their volume.

Results

Fifty birds were collected over the period November 1969-March 1970 consisting of 22 adult males, 8 juvenile males, 10 adult females, and 10 juvenile females, all of which contained food.

The number of different food species observed is plotted against the number of birds examined in Figure 3. With an increase in the number of specimens examined, fewer new food species appear and the curve approaches a horizontal line. New food species are found for

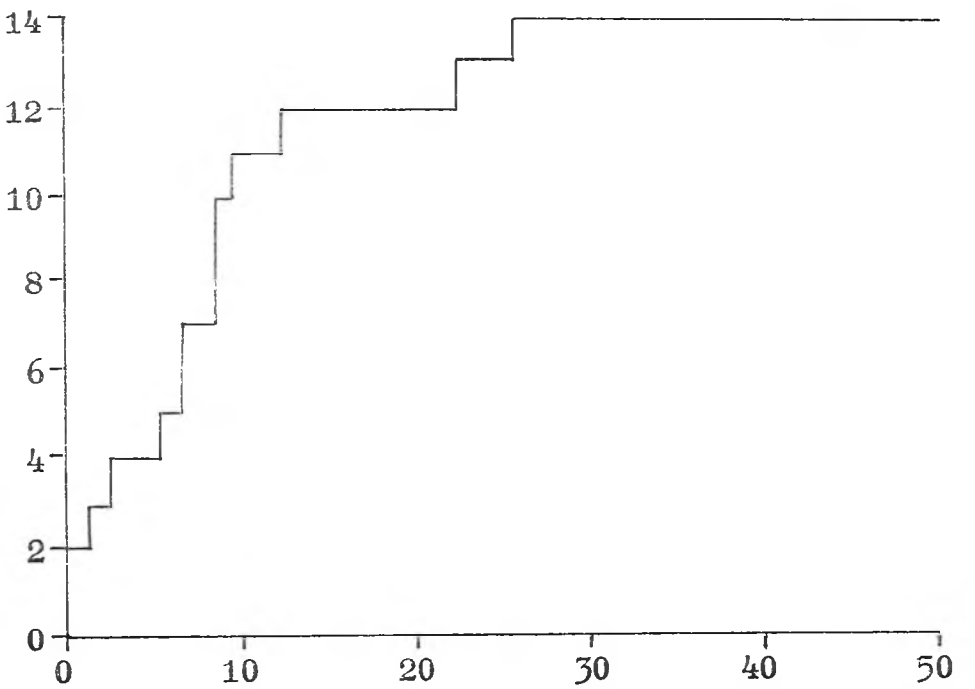

Figure 3. The total number of different food species found (vertical scale) for each additional bird in the sample examined (horizontal scale).

about the first 20 birds examined, after which new items appear infrequently. Hence, the total sample would appear to be large enough to give reliable results on the food of the Eider at Seafield.

Pethon (1967) found a sample of 20 Eiders to be sufficient, but his birds were eating 27 food species compared to the Seafield Eiders' 14. Likewise, Geramisova and Baranova (1960) found 25 food species. The difference may be partially accounted for in that the Norwegian and White Sea samples were collected in the summer when food organisms are more plentiful.

The complete list of food items is shown in Table II.

Molluscs, mainly the Blue Mussel

Table II. Stomach contents of 50 Eiders.

	Frequency	*Frequency %*	*Volume (ml.)*	*Volume %*
ANIMAL MATERIAL				
Mollusca - Bivalvia				
Mytilis edulis	47	94	531.0	70.8
Cardium edule	1	2	—	—
Mollusca — Gastropoda				
Littorina littorea	5	10	2.4	0.3
Buccinum undatum	3	6	1.0	0.1
Crustacea				
Carcinus maenas	12	24	146.6	19.6
Portunus depurator	4	8	38.0	5.1
Hyas araneus	2	4	16.5	2.2
Balanus spp.	2	4	13.0	1.7
Nematoda				
Spirurida spp.	3	6	—	—
Annelida				
Nereis spp.	2	4	—	—
PLANT MATERIAL				
Barley	3	6	0.8	0.1

Mytilis edulis, constituted the principal food of the Eiders in the Forth. They were taken by 47 (94%) of the birds examined and made up the bulk of the stomach contents. 30 stomachs (60%) contained *Mytilis edulis* alone. The size of mussel eaten varied from 1 to 41 mm. Figure 4 shows the size distribution of mussels in the stomachs of the Forth Eiders. The two peaks 4-7 mm. and 10-13 mm. are not due to selection by the birds, but represent two age classes (either separate years or spring and autumn settlement). Prior to the last sample in March the histogram was skewed in favour of mussels of 16 mm. upwards, reaching a peak at 28-31 mm. Of the mussels available on the rocks 65% were over 40 mm. in length. Hence there is selection for the smaller sizes under 30 mm.

The number of mussels in the stomach contents varies and was usually difficult to estimate because some shells were crushed. However, one bird was found to contain 239 mussels ranging in size from 2-24 mm. Madsen (1954) found one Eider had eaten 1,600 mussels varying in size from 3-20 mm. plus 15 Shore Crabs *Carcinus maenas* of up to 20 mm. carapace breadth, and the remains of six small Common Sea Stars *Asterias rubens*. The only other bivalve found in the Scottish sample was the Common Edible Cockle *Cardium edule* which occurred in a single bird.

Periwinkles *Littorina littorea* had been consumed by five birds (10%). Usually, only a single or a few individuals were present in these stomachs. Their size ranged between 12 and 15 mm. The Common Whelk *Buccinum undatum* was taken by three birds (6%) and varied in size from 20 to 38 mm.

Crustaceans were present in 34% of the birds; the commonest being the Shore Crab which had been taken by 24%. The size of this crab ranged from a carapace breadth of 31 to 52 mm.; one bird contained three of size 50, 49 and 43 mm. Other crabs eaten were the Swimming Crab *Portunus depurator* 8%, and the Spider Crab *Hyas araneus* 4%. Crabs were found in nine out of ten birds in the November sample and only three more times in the later birds.

Barnacles *Balanus* spp. were found in two of the stomachs (4%) but had probably been taken in with the mussels on which they live. Nematodes and errant polychaete worms were found in 6% of the birds, probably those feeding near the Middle Craig (Figure 3). Barley husks were taken by 6% of the sample. This was the only vegetable consumed and originated from the sewage.

Gravel and small stones 5 mm. or less in size were found in 31% of all the specimens examined, being present in every bird feeding mainly on crustaceans but in only 60% of those eating molluscs.

Feeding behaviour

The feeding grounds during the winter are on and around the rocks near Leith Docks. The most important is the Middle

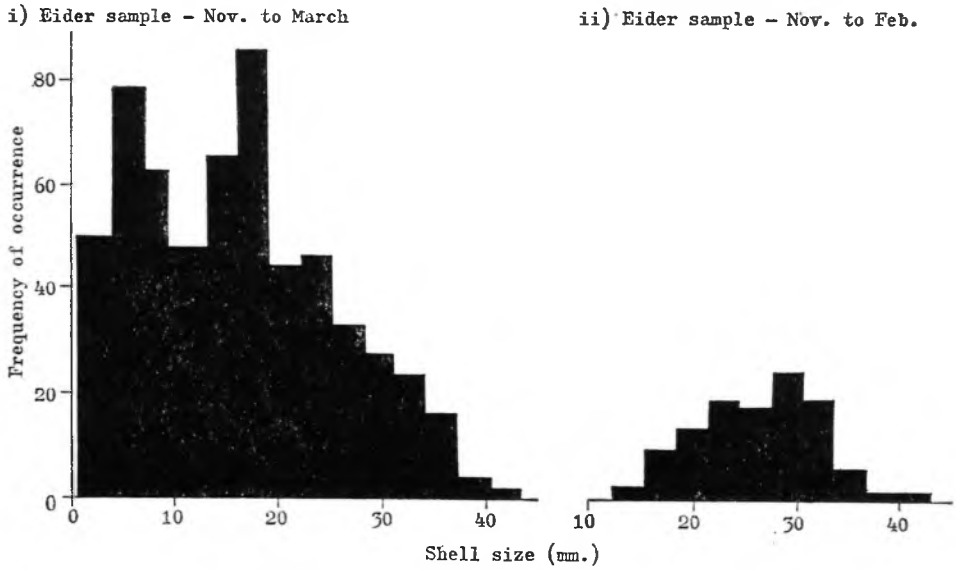

Figure 4. The size distribution of *Mytilus edulis* in the stomachs of Eider Ducks.

Craig where up to 1,500 Eiders may be found feeding over the rocks or resting 100 metres further out.

On a typical day, 6th April 1970 at 06.50 G.M.T. when the tide was going out there were 465 birds feeding in the channel between Middle Craig and the Martello rocks, where 480 were feeding. The channel feeders seemed to prefer about 15 cm. of water where they could dip or up-end like dabbling ducks. Table III gives an estimation of invertebrates has been observed at all states of the tide. The preferred depth is 2-3 metres. When in large parties (over 50 birds) the Eiders do not seem to dive for food, it is usually restricted to groups of 20 or fewer birds. Unlike Pochard, Scaup and Goldeneye, the Eider does not make an initial jump when diving but simply put its head into the water and half opens its wings just before it passes beneath the surface. Millais (1913) found that Eiders swim under the water with their necks slightly

Table III. The invertebrate population in the channel at Middle Craig.

Species	*Depth*	
	0-10 cm.	*10-20 cm.*
	No./1000 cc.	*No./1000 cc.*
Spirurida spp.	600	11,000
Nereis spp.	150	240
Capitella capitella	75	30

on the bottom there, mainly polychate and nematode worms.

When the Eider has eaten many of the invertebrates in the upper layers of the substrate by up-ending or dipping, it digs a crater and thus exposes the richest concentrations. This is done by 'sitting' fairly upright in the water and pushing the dead mussel shells aside with its feet like a hen scratching for insects. The bird then explores with its beak the hole it has just made and continues scratching and searching until it has found sufficient, or until the invertebrates within easy reach have been eaten. In this 'cratering' method of food exploration the bird will often move in a circle around the 'crater'. As the tide ebbs the Eiders move with it, 15 cm. of water seeming the preferred depth (Plate Vb, p. 56).

This method of feeding, so far as I know, has not been recorded before. It is possible that Seafield Eiders alone have evolved this behaviour for feeding on these invertebrates which are plentiful only landward of the Middle Craig and Martello Rocks. However, since wintering birds come from the Farnes and East Lothian, one could expect the behaviour to spread rapidly as happened with Blue Tits *Parus caeruleus* and milk bottles. It has been found that the Eiders nesting around the estuary of the Lothian Tyne show similar behaviour in June when in the company of young, searching for food in mud near the river bank.

It appears that crater feeding, up-ending and dipping are preferred to diving, possibly since less energy is required for such dabbling around. Diving takes place mostly on the open sea and usually at low tide, although it curved and inclined backwards, the wings still half open but not in use, and the feet working alternately.

Daily activity

Pethon (1967) observed Eiders 24 hours a day during the summer months in Norway. He found that the birds spent the night ashore and started feeding at daybreak. Most of his birds fed for about four hours after they had gone to sea. Feeding then slowed down for several hours, usually 09.00-16.00 G.M.T. when half the birds were resting ashore. In the last five hours of daylight some feeding again took place. As the amount of daylight decreased, the midday rest also decreased so that in the winter there might be only one peak feeding period. Hence from this study it may be concluded that the majority of Eider feed once a day at dawn and to a lesser extent at dusk.

In Norway, however, the difference between high and low tide is very small, whereas at Seafield the difference varies between 2.7 and 5.5 metres. The Seafield Eiders prefer to feed at low tide when less effort is required in searching for food. Bent (1926) found Eiders preferred low tide, but when the rising tide forced too great an exertion in diving, they move off to some other feeding ground or rested and played until the tide was favourable once more. He found them resorting to the same rocks every day at certain stages of the tide, as long as the food lasted. Bent suggested that the reason why Eiders do not feed at night was because, unlike other ducks, they were not disturbed on their feeding grounds.

Few birds were found feeding at Seafield at midday even when the tide was out. They do not feed at dusk either, but flight out to sea in a north-easterly direction, returning at dawn. Their feeding cycle is controlled by the tide and the time of day. With a favourable tide Eiders begin feeding at sunrise, cease by 10.00 G.M.T., commence again by 13.00 G.M.T. and leave for the open sea at sunset (Table IV). At high tide during the day, long lines of Eiders, of which only a few are feeding, may be seen 1 km. offshore.

Table IV. The percentage of Eiders feeding during the day (4th May 1970).

Time	*No. of Eiders present on the study area*	*% Eiders feeding*
Before 05.30	0	0
06.00-07.00	551	100
08.00-09.00	621	38
10.00-11.00	834	5
13.00-14.00	653	36
18.00-19.00	712	96
After 19.15	0	0

Low tide at 07.14 and 19.45. Sunrise 05.41. Sunset 19.00 GMT.

Dementiev *et al.* (1952) described how Eiders fed four times daily, at high and low tides, in the summer months in Arctic Russia. However, Mackay (1890) told of a similar situation in America to that at Seafield. He found that the birds flew out to sea after an evening meal and returned before daylight, alighting outside the rocks and swimming in as a compact body. The Seafield Eiders also prefer to alight on the sea and swim in, rather than land on the rocks. This is probably due to the legs of an Eider being situated posteriorly and so making landings on a hard surface more difficult.

During the morning influx 95% of the birds come from the north-east and to a certain extent follow the coastline, so that when approaching the rocks they are coming from an easterly direction. The other 5% come from the west-north-west, probably having spent the night in the sheltered waters of Inchkeith.

Discussion

No attempt at the quantitative analysis of the Eider's winter food in Britain has been made, other than the inadequate study of Collinge (1924). There have been some qualitative accounts such as those of Evans (1909), Robinson (1909) and Florence (1912). However, detailed quantitative studies have been made in Europe and (with the very similar races *S. m. dresseri* and *S. m. borealis*) in North America. Madsen (1954) summarised his own examination of 296 stomachs, together with the results of earlier workers, such as Collinge (1924), Schiøler (1925), Cottam (1939) and Soot-Ryen (1939). He found general agreement that molluscs form the principal food of the Eider and that, in marine habitats, *Mytilus edulis* is the prominent item, constituting between 30% and 60% of the total. Later studies have confirmed Madsen's conclusions. Thus Gerasimova and Baranova (1960) in the Soviet White Sea found the mussel comprising 36-61% of Eider food; McGilvrey (1967) in the NE. United States, 70% (by volume); Pethon (1967) in Norway, 29%; Nilsson (1970) in S. Sweden, 87%. The results of the present study fit in the upper end of the range.

The previous studies also agree with the present one in according second place to crustaceans, especially crabs, but also amphipods. Pethon (1967) reports a seasonal change in diet from mainly *Mytilus* in spring and summer to mainly crustaceans in August to October. The Soviet studies in particular have indicated dietary changes when birds are in the breeding quarters and especially when accompanying young. However, it is not the purpose of this paper to attempt a complete review of the literature. This has recently been done by Bauer and Glutz (1969).

Conclusions

Unlike the majority of studies on the food and feeding habits of birds, this paper investigates such activities in a strongly man-modified environment. The effects of sewage have increased the numbers of food organisms available but reduced their diversity. Molluscs, crustaceans, annelids and nematodes are the beneficiaries of pollution.

So huge is the available food supply that the area holds one of the largest duck

concentrations in Western Europe. However, such a population could easily be wiped out by an accidental oil spillage. In December 1969 between 100 and 200 ducks were killed by an oil slick on the Forth estuary. Fortunately, the slick only affected the eastern end of the Seafield flock; otherwise there would have been a catastrophe. Within the next ten years Edinburgh sewage will be treated before discharge and this is likely to reduce the amount of food available and hence the numbers of ducks to be found in the area.

Acknowledgements

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Summary

The food and feeding habits of the Common Eider *Somateria m. mollissima* are described, based on stomach analyses of 50 birds collected between November 1969 and March 1970 from Seafield, Edinburgh. A maximum of 40,000 diving ducks and 2,900 Eiders have been recorded there, attracted by a plentiful food supply and a calm sea. The main foods of the Eiders are molluscs and crustaceans, obtained by diving, up-ending, dipping and scratching out craters. Their feeding cycle is controlled by the time of day and by the tide.

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