The utilisation of urban resources by the herring gull (larus arqentatus)

Patricia Monaghan

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THE UTILISATION OF URBAN RESOURCES BY THE HERRING GULL (*Larus argentatus*)

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ABSTRACT

The utilisation of urban resources by the Herring Gull was studied between 1973 and 1976 in Northeast England. This involved a study of refuse tips as a winter food supply, and the use of inhabited buildings as nesting sites. The local breeding population is small, and there is an influx of gulls from east Scottish and Norwegian colonies into Northeast England during the winter months. Herring Gulls caught during winter could be sexed by bill depth alone; wing length was used as an indicator of geographical origin. Gulls fed at refuse tips in the study area throughout the winter months. There was a predominance of adults over immatures at refuse tips in winter, while immatures predominated over adults around inshore fishing vessels in the same area. There was considerable fluctuation in the number of gulls present at tips on different days, related to weather factors and feeding conditions elsewhere. Immature Herring Gulls were less constant to a particular feeding area than adults, and adult females less so than adult males. Individual Herring Gulls did not feed at refuse tips every day, and refuse did not constitute the major or necessarily the only food source for these birds in winter. There were two different feeding areas used by gulls on the refuse tips which differed in the abundance and availability of food: individual birds consistently used one or other area, and proportionally more adult females than males used the secondary area. The number of nesting pairs/

pairs and nest sites used by Herring Gulls nesting on buildings in Sunderland and South Shields were monitored. Their breeding success was higher than in more "natural" colonies, possibly due to the nature of the nesting sites. A national census of gulls nesting on buildings in Britain and Ireland was organised in 1976, to measure the growth and spread of rooftop nesting: the number of Herring Gulls nesting on buildings was found to be doubling within 5 years, and the number of Lesser Black-backs within 3 years. The potential public health hazard presented by gulls nesting on buildings was reviewed.

CHAPTER 1

INTRODUCTION

Gulls in general, and Herring Gulls in particular, are characterised by a lack of specialisation (Tinbergen, 1953). Neither herbivores nor carnivores, neither pelagic nor terrestrial, they are omnifarious both in diet and in habitat. In relation to their environment, they are adaptable and opportunistic. This thesis is essentially a study of this adaptability, demonstrated by the ability of Herring Gulls to exploit resources provided by man; that is the utilisation of refuse as a food supply, and the utilisation of inhabited buildings as nesting sites.

Throughout this century, there has been an increase in the numbers of several gull and other seabird species, but none so marked as that of the Herring Gull. In 1969 the Herring Gull was recorded as the second most numerous gull nesting in the British Isles, with more than 330,000 pairs breeding along almost the entire coastline of Britain and Ireland (Cramp et al, 1974). Its recent rate of increase has been such that the population will have doubled since then, and the Herring Gull is in all probability the most numerous gull nesting in Britain at the present time. The increase in the large gulls has been documented by Parslow (1967) and while there has been spectacular growth in certain areas due to high immigration (Brown, 1967), the increase in the Herring Gull in Britain is not a localised phenomenon. Harris (1970) recorded a 10% annual increase in the number of Herring Gulls nesting in the Bristol Channel region, since at least 1948, and Parsons (1971) recorded/

recorded a 13.5% annual increase on the Isle of May in the Firth of Forth since the island was first colonised by a single pair of Herring Gulls in 1907 (Baxter and Rintoul, 1953). Chabrzyk and Coulson (1976), using data collected during "Operation Seafarer" (a census of seabirds nesting in the British Isles in 1969 - 70), calculated that since at least 1930, a 12 - 13% annual increase has been typical of this species in the British Isles overall. Substantial increases in Herring Gull numbers have been recorded elsewhere in Europe, for example in Denmark (Salomonsen, 1963), in Sweden (Curry-Lindahl, 1961), in Germany (Goethe, 1964), in the Netherlands (Bruyns, 1958, Voous, 1960) and in Finland (Bergman and Koskimies, 1958). In Western Norway, on the other hand, the Herring Gull is not increasing (Johansen, 1977). Kadlec and Drury (1968) found the Herring Gull population in New England to have been doubling every 12 - 15 years between the early 1900s and 1965, though it is now undergoing a regional decline in certain areas (Nisbet, 1977). The increase in the number of Herring Gulls in Britain has been reflected in an increase in the number wintering inland since the habit was first noted in the late 19th century (Hickling, 1963). While still predominantly a coastal nester in Britain, an increasing tendency to nest inland has also been noted, particularly in the Irish wetlands, though also in Great Britain (Parslow, 1967, Kennedy et al, 1954 and Sharrock, 1976). Similarly in Sweden, Herring Gulls have shown an extension of their breeding range from coastal to inland areas (Lindroth, 1946, Olsson, 1958). The adaptability of this species is demonstrated by the variety of nesting sites utilised, which range from rocky skerries and islands, cliff ledges and sea/

sea stacks to moorlands and a variety of man-made structures.

Though Herring and Great Black-backed Gulls were found to have no serious deleterious effects on either agriculture or wildlife in the Grand Mannan archipelago, New Brunswick (Pimlott, 1952), the expansion of the Herring Gull population in Britain has resulted in its being lately regarded as a pest species. Gulls roosting on water storage reservoirs cause pollution problems (Fennel et al, 1974), and Herring Gulls have been implicated in the spread of infection to livestock (Williams et al, 1976 and Brough 1969). Large numbers of gulls can also be hazardous to aircraft (Stables and New, 1968, Brough 1968, Grant, 1969, Drury and Nisbet, 1969) and have been reported to have harmful effects on other nesting birds (Amadon, 1958, Drury, 1965 and Thomas, 1972).

A population increase such as has occurred in the Herring Gull is brought about through a decrease in selection pressure, effecting a decrease in mortality. An understanding of the cause of a population increase requires an understanding of the factors which previously limited population growth. Several different reasons have been put forward to explain the recent increase in the numbers of gulls, such as climatic factors, increasing food supplies and reduced predation. Lack (1966) held that

> "Starvation outside the breeding season is much the most important density dependant factor in wild birds".

generally taking the view that birds are commonly short of food in their natural environment; this view is opposed by others (eg/

(e.g. Ashmole, 1963 and Pearson, 1968). It has been suggested that an increased amount of waste food material provided by man has effected the population increase in the Herring Gull, by providing an abundant winter food supply. However, the fact that gulls feed on easily obtainable refuse is not evidence for a shortage of alternative feeding areas. Using a similar logic, it could be argued that since the number of gulls nesting on buildings has increased this century, the population increase has been effected by an increase in the number of buildings.

The aim of this study has been to gain some information on the extent to which, and with what success, gulls make use of the resources provided in and around urban areas for feeding and breeding purposes. Extensive exploitation of urban areas as nesting places is a relatively recent trend in gull species, and the rate of increase and breeding biology of gulls in these areas as compared with more traditional colonies is largely undocumented. With the notable exceptions of Spaans (1971) and Kilhman and Larsson (1974) in the Netherlands, surprisingly few studies have been made on the exploitation of refuse by gulls and the extent to which they are dependant upon this food source in winter. An attempt was therefore made to evaluate the role of urban waste as a food supply for gulls during the winter months.

CHAPTER 2

MATERIALS AND METHODS

1. STUDY AREAS

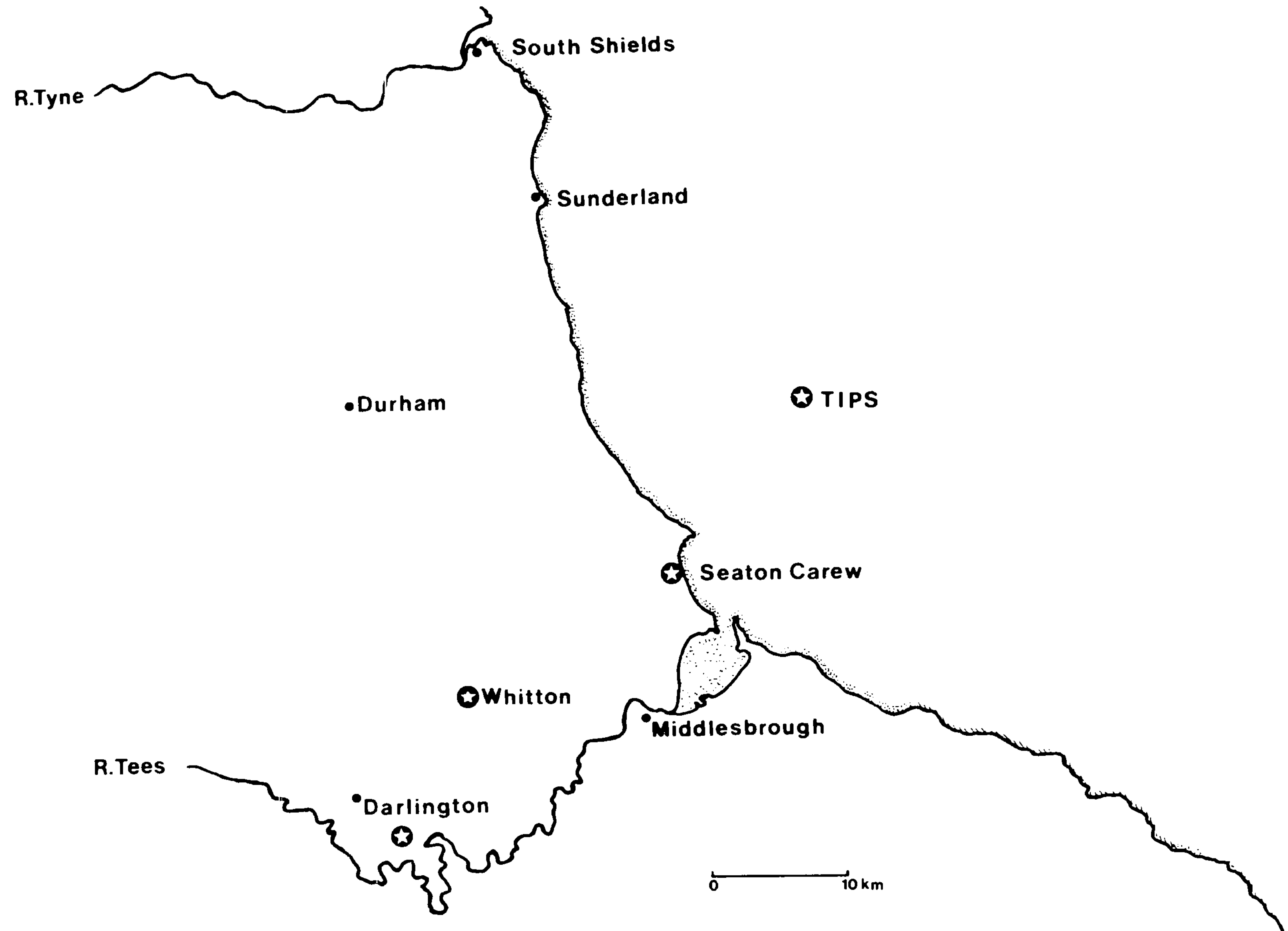
The study was centred in Northeast England, in the area shown in Figure 1, involving the administrative counties of Tyne and Wear, Durham and Cleveland.

(1) Refuse Tips

Studies of the utilisation of refuse tips by gulls were conducted in the area inland and around the Teesmouth estuary. Birds feeding in this area roosted at night in the estuary itself. There were three large domestic refuse tips in this area, serving Darlington and the Teesmouth conurbation (human populations 85,120 and 390,310 respectively); these tips were used by gulls throughout the winter months. They were located as follows:

(a) Whitton tip, situated 17 kilometres inland (Figure 1). In the winter of 1973 this tip was situated at Thorpe Thewles ($54^{\circ}36'$N, $1^{\circ}25'$W). In January 1974, the tip moved from Thorpe Thewles to Whitton, and the transition was completed within 3 days. These two tips are treated as one site, and referred to as Whitton tip. Some 10,000 tonnes of domestic refuse were dumped annually at this site, using a landfill tipping method. Dumping of refuse was rotated around the tip and terraces of consolidated refuse material were levelled out and covered with earth; thus at any one time, dumping activities centred on only a small area of the tip. Throughout the day, heaps of refuse were levelled out/

Figure 1: The area of Northeast England on which this study was centred, involving the administrative counties of Tyne and Wear, Durham and Cleveland.



South Shields
R.Tyne
Sunderland
Durham
TIPS
Seaton Carew
Whitton
Middlesbrough
R.Tees
Darlington
0
10 km

out by bulldozing, and exposed refuse was covered with earth generally only after dumping had ceased in the late afternoon. Large pools of water present on the tip were used by gulls for bathing, and fields adjacent to the tip were used as temporary roost sites throughout the day. This tip closed in January, 1976.

(b) Darlington tip (Figure 1), situated at Neasham quarry, 27 kilometres inland (54°28'N, 2°30'W). This tip was operative throughout the study, and 10,000 tonnes of domestic refuse were dumped annually at this site. The tipping procedure was similar to that used at Whitton tip.

(c) Seaton Carew tip (Figure 1), situated directly on the sea-front (54°40'N, 1°12'W). This tip, also operative throughout the study, was the largest of the three tips, 25,000 tonnes of domestic refuse being dumped per annum. The pattern of tipping did however differ from that used at the other two sites. Refuse at Seaton Carew was employed as part of a land reclamation and landscaping project; it was not levelled out in terraces, but dumped in high ridges, later to be covered with soil and seeded with grass. Much of the refuse dumped at this tip was left exposed for several days. Flocks of gulls roosted during the day on previously reclaimed grass areas close to the tip, and also on the shore and sea surface.

Dumping took place at all three tips between 09.00 and 15.30 GMT on weekdays and 09.00 and noon on Saturdays; no dumping took place on Sundays. Observations at these tips were made from a landrover, which essentially served as a mobile hide. (This could/

could be driven very close to the birds without causing disturbance; gulls on the tip were startled by any person on foot other than the regular tip employees.) When necessary, 10 x 50 binoculars and a 60 x 60 zoom telescope were used. Observations on individual gulls were made with the aid of a portable cassette tape recorder. Counts made at tips were of all gulls in the tip area, including roosting flocks in open areas adjacent to the tips.

(2) Towns

Three towns in the study area supported rooftop nesting gulls; these were Sunderland, South Shields and Hartlepool. (Gulls were also nesting on buildings on the north side of the River Tyne in North Shields, Tynemouth and Newcastle upon Tyne.) The largest colonies were present in Sunderland (human population 214,820) and South Shields (human population 96,900) (Figure 1); detailed studies of gulls nesting in both these towns were made during the 1974, 1975 and 1976 breeding seasons. Observations were made using 10 x 50 binoculars and a 60 x 60 zoom telescope from suitable vantage points; rooftops with nesting gulls were visited where access was possible. Culling procedures were carried out in South Shields in 1975 and 1976, and in Sunderland in 1976 only; gull corpses obtained from these culls were measured, anatomically sexed and subjected to pathological examinations. A number of gull corpses obtained from the Scarborough area were similarly treated.

2. MARKING OF INDIVIDUAL BIRDS

(1) Catching methods

A total of 312 Herring and Great Black-backed Gulls were caught at tips in the study area, the majority being caught at the Whitton site. This was largely done using narcotic baits, under licence from the Nature Conservancy Council. These baits consisted of approximately 2cm square bread "sandwiches", spread with a mixture of margarine and a-chloralose. The dosage used was 0.27mg of a-chloralose per bait; this is considerably lower than the dosage levels used elsewhere (Murton et al, 1963 and Cornwell, 1966). Baited bread squares were mixed with equal amounts of similar unbaited squares, consisting only of bread and margarine. This, coupled with the low dosage level, minimised the risk of a lethal overdose, since most birds tended to eat more than one bait. Baits had generally to be placed on the loafing areas in order to avoid any interference with tipping activities. Though placed in a conspicuous heap, there was often a considerable time lag between the baits being put down and their being consumed by gulls in proximity to them. This was partly due to the attention of those birds not sleeping or preening on the loafing area being directed towards the tipping area, the baits initially going unnoticed. Nevertheless, even when a group of gulls had collected around the food pile, the birds still showed a reluctance to feed while on the loafing areas. (When baits could be placed on the tipping areas, they were consumed immediately.) Feeding on baits on the loafing areas was usually preceded by individual gulls darting/

darting backwards and forwards in the direction of the food, in what appeared to be a conflict between approaching the food source, and withdrawl from food presented under unusual circumstances. The first bird to take a piece of bread was most usually a Black-headed Gull or an immature Herring Gull. As soon as one bird started to feed on the pile, it was followed immediately by a large rush of gulls; all baits were consumed within a few minutes of the first having been taken. Between 45 minutes and 1 hour after feeding on baits, anaesthetised gulls were picked up on the tip and in the fields close to the tip: all undigested baits were removed from the crop. Anaesthesia lasted between 1 and 12 hours. The birds were kept overnight in warm conditions and released when fully recovered.

Due to the proximity of the shore, it was not possible to use this method at Seaton Carew, since anaesthetised gulls roosting on the sea surface would have been in danger of drowning. Gulls were caught at this tip on only one occasion and a cannon-net was used for this purpose. In addition, a number of gulls were also caught for ringing and marking purposes at Burniston refuse tip, Scarborough (54°18'N, 1°27'W): measurements made on these birds were used for comparisons with gulls caught elsewhere.

(2) Ringing methods

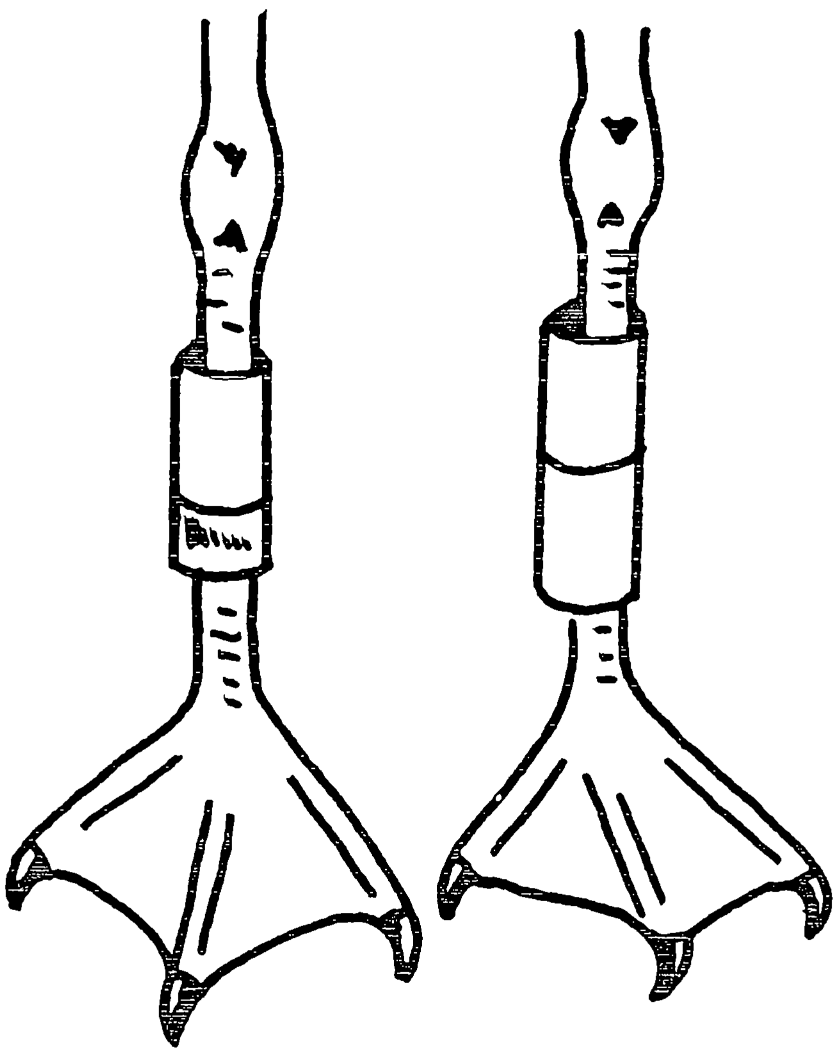
The majority of gulls caught at the tips were weighed, and wing and beak measurements recorded. Each bird was given a unique colour-ring combination, plus a British Trust for Ornithology numbered monel ring. Seven different coloured darvic rings, 20mm in/

in height, were used; a colour-ring plus the monel ring was put on one leg of each bird, and two colour-rings on the other leg (Figure 2). Interchanging the colours and positions of the darvic rings gave a large number of combinations. These colour-rings were readily visible under field conditions.

In Sunderland and South Shields a total of 160 young Herring Gulls were ringed at nest sites. Individual colour combinations were employed in 1974, using 10mm darvic rings. White and black 20mm colour-rings were used in 1975 and 1976 respectively.

Throughout this study, the majority of observations related to the Herring Gull, though comparable information on Great Black-backed and Lesser Black-backed Gulls was collected when possible.

Figure 2. Colour and metal ring combinations used on Herring Gulls during the present study. Interchanging the colours and relative positions of the three colour-rings and the metal ring gave a variety of unique combinations.



CHAPTER 3

SEASONAL MOVEMENTS OF GULLS IN NORTHEAST ENGLAND

A total of 147 adult and 104 immature Herring Gulls from refuse tips in the Teesmouth area of Northeast England were individually colour-ringed during the autumn and winter months of 1973, 1974 and 1975, and during January and February of 1976. Forty four adult and 17 immature Great Black-backed Gulls were similarly ringed and released. During the 1974 - 1976 breeding seasons, 160 young Herring Gulls were colour-ringed at nests in Sunderland and South Shields (p.11). A number of these gulls have since been reported through the British Trust for Ornithology ringing scheme; this information, coupled with sightings of individual birds, has given some insight into the seasonal movements of gulls in Northeast England. (This latter is taken here as being the administrative counties of Northumberland, Tyne and Wear, Durham and Cleveland.)

1. HERRING GULLS

(1) Winter adult population

No adult Herring Gulls ringed on refuse tips in winter during this study have yet been recovered dead between September and early February, that is, outside of the breeding season. Two adult Herring Gulls, colour-ringed at Whitton tip in winter 1974 were observed feeding at a refuse tip in Scarborough (North Yorks) in January and September, 1976; though not all adult gulls colour-ringed and released were seen again at refuse tips in the Teesmouth area, no/

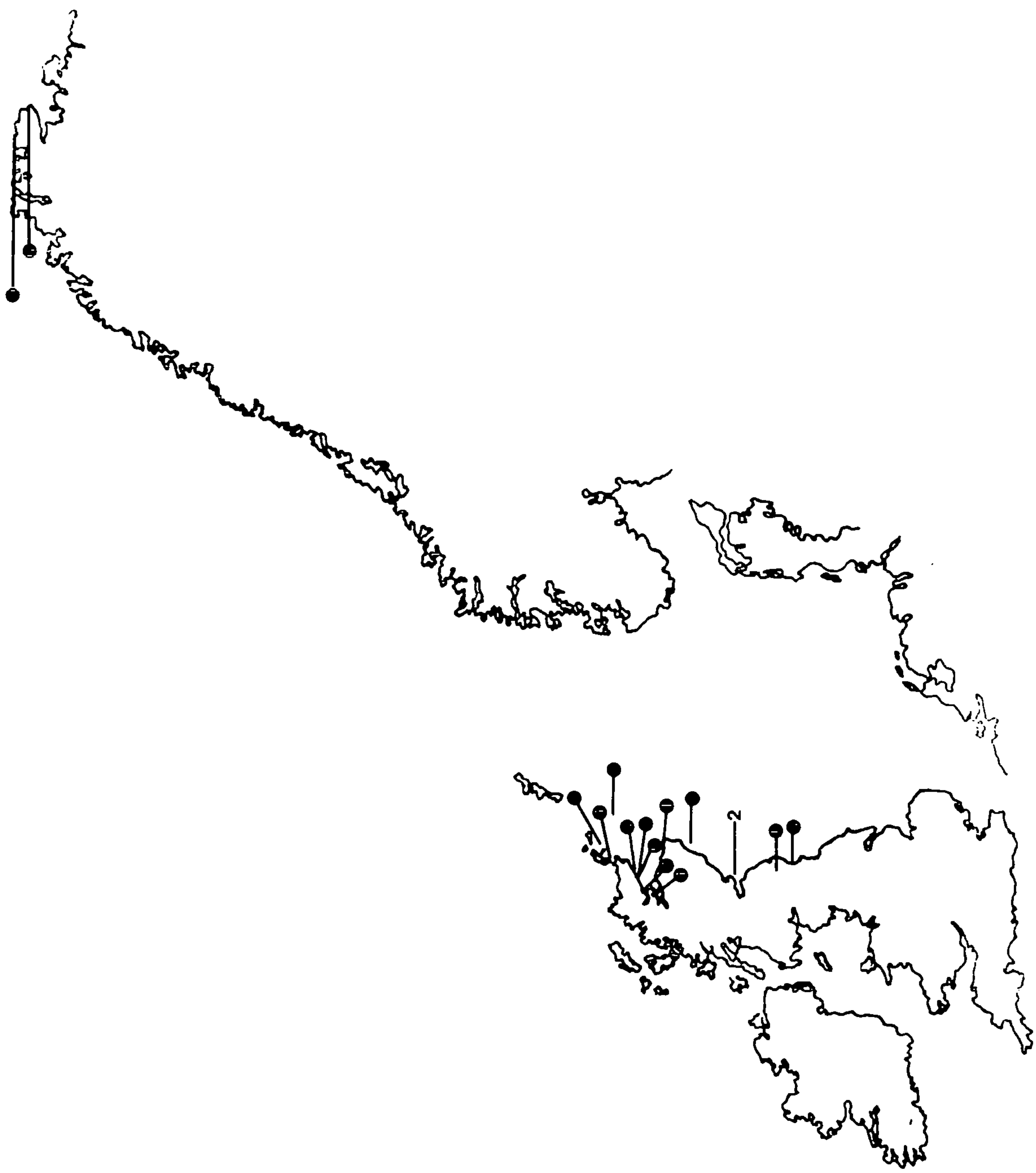
no other sightings outside the study areas have been reported during autumn and winter.

Sixteen of these colour-ringed adults have been recovered dead or sighted between late February and August, giving some indication of their breeding locations. Areas where the birds were reported are shown on Figure 1. Twelve of these birds were reported north of the 57^{o} latitude line, two of which were recovered in Finnmark, Norway, more than 70^{o} north. All of the British records were on the east coast of the country. Though extensive searches were made, no adult Herring Gulls ringed on refuse tips in Northeast England were recorded breeding in this region, or in North Yorkshire. Two were recorded breeding on the Isle of May, in the Firth of Forth. Throughout this study Herring Gulls wearing colour-rings indicating the year of fledging from the Isle of May, Firth of Forth (Parsons, 1971) were sighted feeding at refuse tips in the Teesmouth area during autumn and winter; juvenile Herring Gulls fledged from this colony were sighted feeding at these tips as early as September of the year of fledging. Northeast England is a wintering area for Firth of Forth Herring Gulls, both breeding adults and immatures (Parsons, 1971) (Figs. 2 and 4).

Though adults known to have fledged from the Isle of May were sighted at the tips outside the breeding season, it is not known what proportion of these gulls had returned to the Isle of May as breeding birds.

From the distribution on Figure 1, it appears that adult Herring/

Figure 1: Areas where adult Herring Gulls, ringed at refuse tips in the Teesmouth area, were reported between late February and August. This gives some indication of their breeding locations.

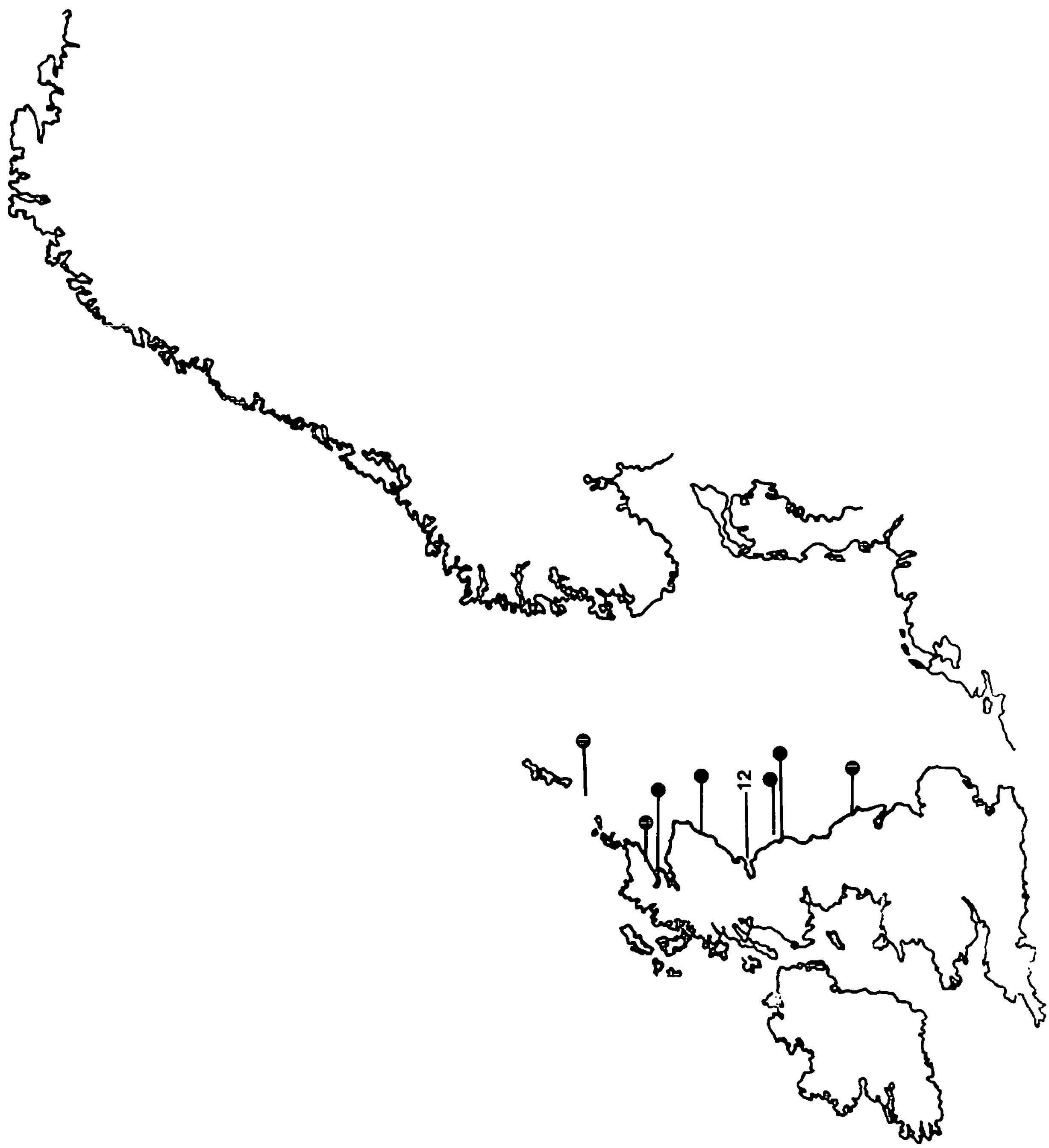


Herring Gulls overwintering in Northeast England breed north and east of this area, as far north as Finnmark, Norway. Though not breeding in Northeast England, the majority of these gulls returned to this area in consecutive years (p.86). To obtain additional information, the B.T.O. Herring Gull recovery records from 1953 - 1975 were consulted. Very little ringing of Herring Gulls in autumn and winter has taken place in Northeast England, and no data were obtained to supplement Figure 1. Figure 2 shows the natal areas of all adult Herring Gulls ringed as young and recovered in Northeast England in autumn and winter months, from 1953 - 1975. Less than 50% of young Herring Gulls surviving to breeding age return to the natal colony to breed, and some take up nesting in the wintering area (Chabrzyk and Coulson, 1976). Some of the birds recovered in winter will therefore breed in areas other than their fledging area. The high numbers of gulls recovered from the Forth area is in part due to the intensive ringing programme on the Isle of May between 1966 and 1970 (Parsons, 1971). However, it is evident that the majority of adult gulls present in Northeast England in winter breed in colonies north and northeast of this area.

(2) Breeding population

Northeast England supports relatively few Herring Gull colonies other than those on rooftops (Appendices 4 and 5), on the Farne Islands, Coquet Island and on sea stacks at South Shields; the total breeding population is of the order of 1,000 pairs. No gulls/

Figure 2: The natal areas of Herring Gulls, ringed as young and recovered in Northeast England as adults in autumn and winter months, from 1953 - 1975.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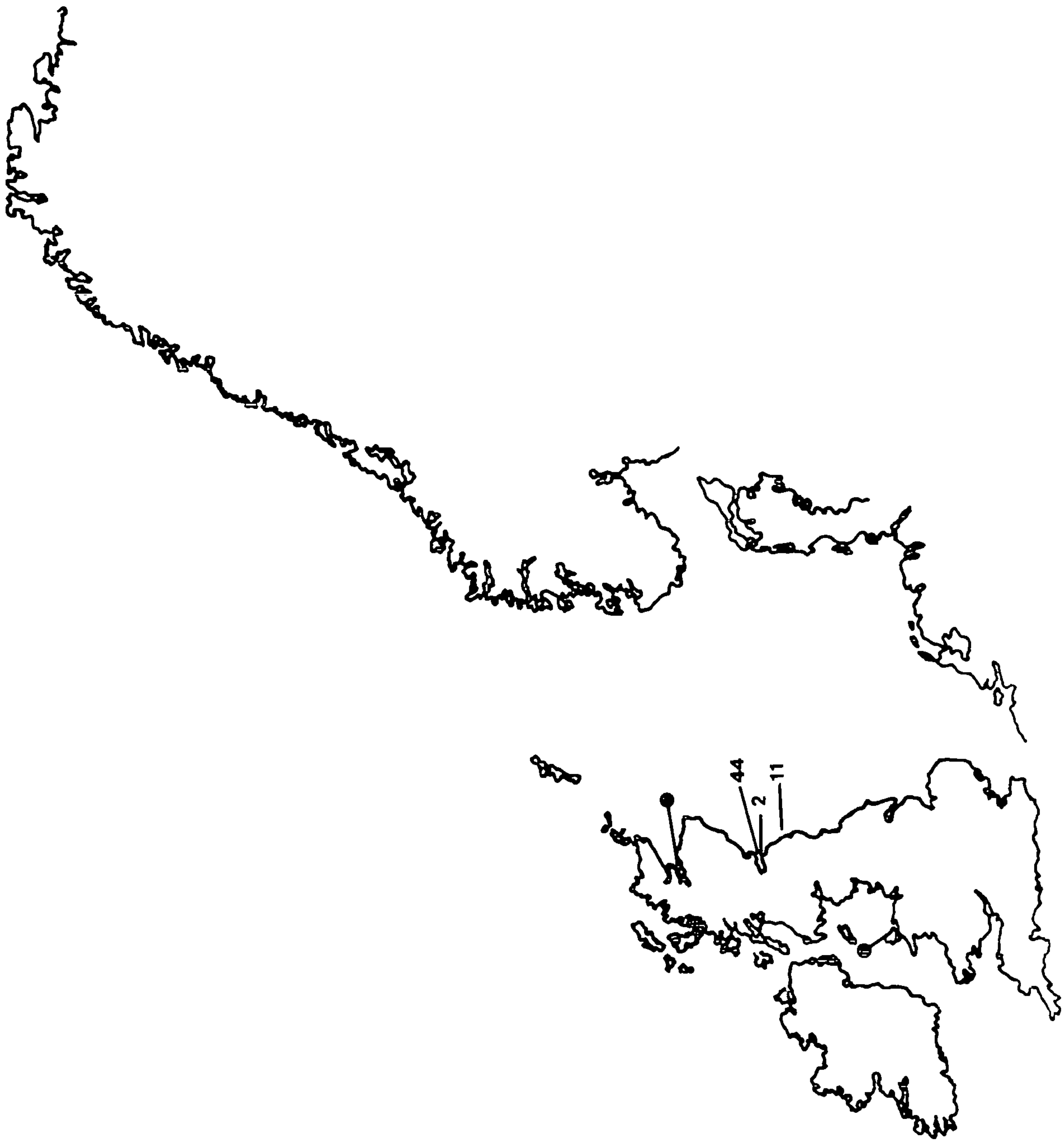
gulls ringed in winter during this study were found to be local breeding birds. Twenty-three adult Herring Gulls, fledged from the Isle of May, were found breeding on rooftops in South Shields and Sunderland. A number of Herring Gulls fledged from the Forth area have thus taken up nesting in the wintering area (p.128). Figure 3 shows the natal areas of all adult Herring Gulls ringed as young, and recovered in Northeast England during the breeding season from 1953 until 1975, (as obtained from B.T.O. ringing records). Though this does reflect ringing effort, the Forth Islands and colonies in east Scotland are a major source of recruits into gull colonies in Northeast England. The data obtained from the B.T.O. records and from this study suggest that there is a movement of adult Herring Gulls from Norwegian and eastern Scottish breeding colonies down the east coast of Britain during the autumn and winter months; these birds return to their breeding colonies in early spring.

There is thus a seasonal influx of adult Herring Gulls, which breed in northeast Britain and Norway into Northeast England during the winter months. The local breeding population of Herring Gulls in Northeast England is small, and the majority of adult Herring Gulls present in winter are not local breeding birds.

(3) Immatures

Three reports of immature Herring Gulls ringed at refuse tips in the Teesmouth area during autumn and winter months were received from/

Figure 3: The natal areas of Herring Gulls ringed as young and recovered in Northeast England as adults during the breeding season, from 1953 - 1975.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from areas outside the ringing area. An immature was sighted at Scunthorpe, Lincolnshire in December, 1974, another sighted feeding at a refuse tip in South Wales in January, 1976, and the third was found dying on Coquet Island, Northumberland, in July, 1976. Nine of the young Herring Gulls ringed in towns within the study area (p.6) have since been recovered dead. Five of these were recovered between August and October of their first year of life; similarly Harris (1964) analysing a much larger number of recoveries (734), found that 50% of first year recoveries occurred at this time. Two of these 5 birds were recovered in South Shields, 2 in South Yorkshire and one in Northamptonshire. The remaining 4 immatures were recovered during their second year of life; 2 in Cleveland, 1 in Tyne and Wear and the fourth in Northumberland. In addition, colour-ringed young fledged from Sunderland and South Shields were observed feeding in winter around fishing boats in the Tyne-Tees area, and at refuse tips in the Teesmouth area (p.17). Thus a number of young fledged from local colonies remained in Northeast England throughout the winter months, while others dispersed south of this area. The B.T.O. recovery records provided additional information with respect to immature Herring Gulls in Northeast England between 1953 and 1975. These data are shown on Figures 4 and 5, indicating the fledging area of immature Herring Gulls recovered in Northeast England in autumn/winter and spring/summer periods respectively. Though this again will reflect ringing intensity, young gulls overwintering in Northeast England originate from colonies to the north/

Figure 4: Fledging areas of immature Herring Gulls recovered in Northeast England in autumn and winter, from 1953 - 1975.

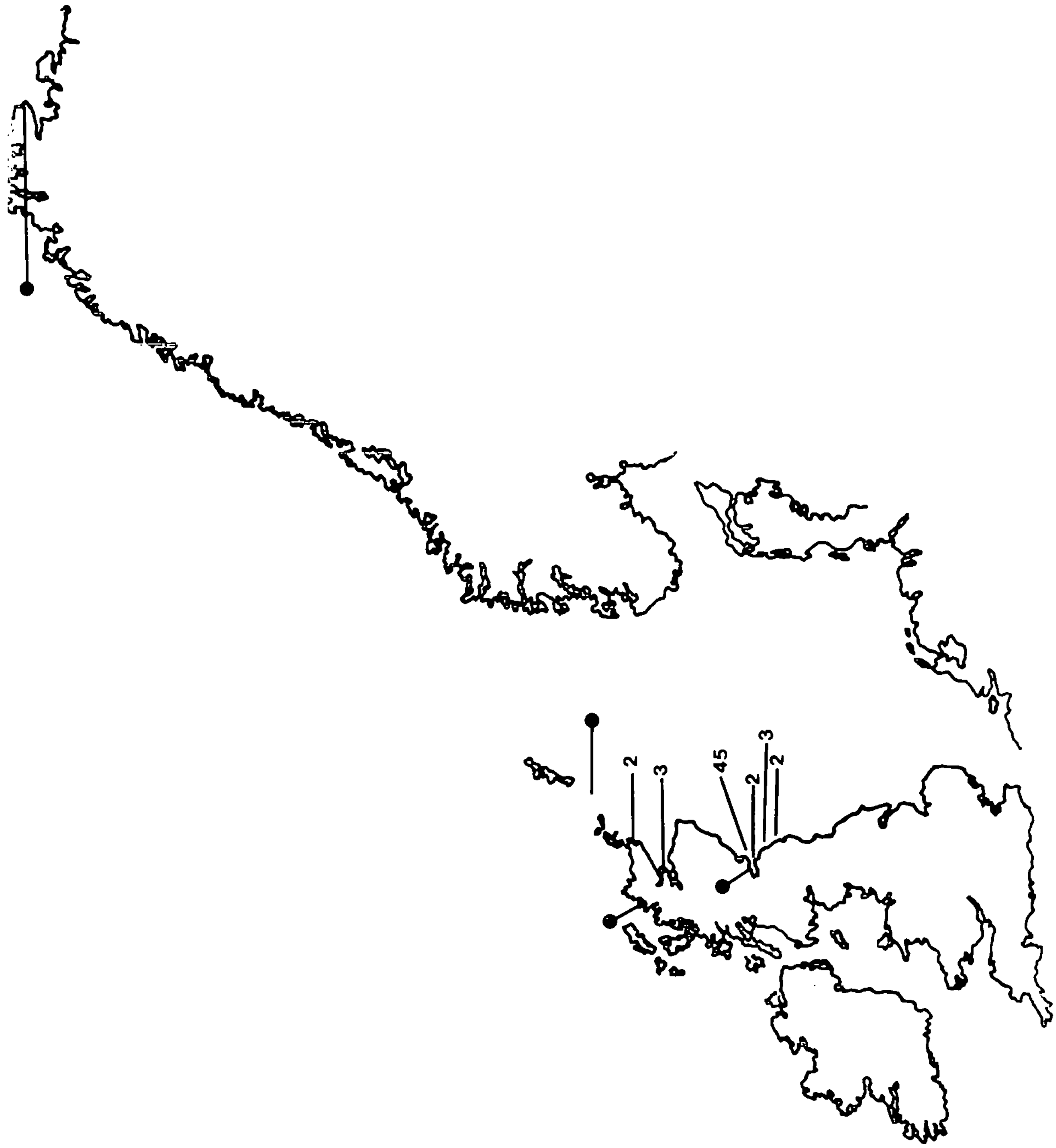
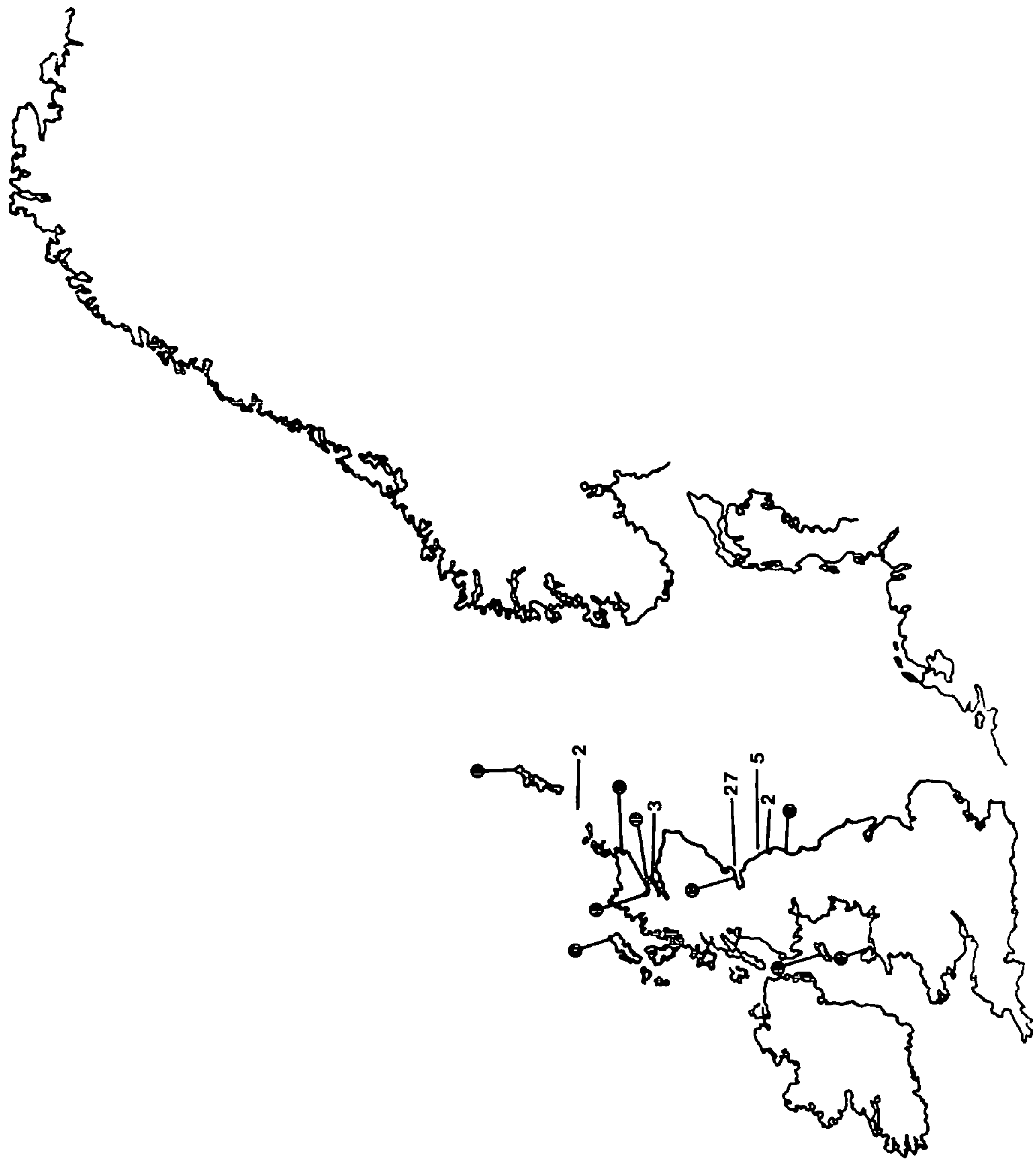

2
3
45
2
3
2

Figure 5: Fledging areas of immature Herring Gulls recovered in Northeast England in spring and summer, from 1953 - 1975.


2
3
27
5
2

north and northeast of this area, as far north as Finnmark, as shown in Figure 4. This parallels data from Figure 1, adult Herring Gulls overwintering in the Northeast breeding as far north as Finnmark. In spring/summer, as shown in Figure 5, the origin of young gulls shows a similar predominance of birds fledged from northern areas. This may in part be representative of those immatures which remain and take up nesting in the wintering areas, as reported for Isle of May Herring Gulls (p129). Since the local breeding population is small, the majority of immatures present in Northeast England originate from colonies north of this area. Thus the population of immature Herring Gulls present in Northeast England in both summer and winter months is made up of birds fledged from east Scottish and Norwegian colonies, and a proportion fledged from local colonies.

(4) Conclusion

The natal areas of birds recovered in the Northeast of England and recoveries of birds ringed in this area suggest that adult and juvenile Herring Gulls from North British and Scandinavian colonies overwinter in Northeast England. The population of adult Herring Gulls present in Northeast England in winter are, in the main, not local breeding birds. Some of the immatures fledged from other colonies remain in the Northeast throughout the year; young fledged from the Isle of May are known to take up breeding in the wintering area. A proportion of young fledged from local colonies disperse south in winter while others remain in the natal area.

2. <u>GREAT BLACK-BACKED GULLS</u>

Four adult Great Black-backed Gulls ringed in this study have since been recovered. Two were recovered during the breeding season in Norway, (71°04'N, 28°12'E and 63°03'N, 9°12'E). The remaining two were recovered in autumn/winter, one in Rye (Sussex) and the other locally at Teesmouth. In addition, one immature Great Black-back, caught at a Durham refuse tip in winter 1974, was ringed as a pullus in a Norwegian colony in July 1974. These recoveries suggest an overwintering of Scandinavian Great Black-backed Gulls in Northeast England. Movements of Scandinavian Great Black Backs into Britain has been well documented (Report on Bird Ringing, 1972).

CHAPTER 4

DISTINGUISHING BETWEEN, AND SEXING, BRITISH AND SCANDINAVIAN HERRING GULLS

INTRODUCTION

Ringing recoveries show that there is a winter influx of Scandinavian Herring and Great Black-backed Gulls into Britain during the autumn and winter months. The populations of these gulls overwintering in the study area are made up of both British and Scandinavian birds. A proportion of the Herring Gulls ringed on refuse tips in winter during the course of this study are not British breeding birds. The problem thus arises of identifying these individuals, and of correctly sexing all gulls caught on the basis of external characters.

Barth (1967) has given details of the body dimensions of male and female Scandinavian Herring Gulls from a series of locations and has shown them to be significantly larger than his British sample. Indeed he has used size, in addition to mantle colour, and more recently moult, as a basis for a taxonomic distinction between two subspecies of Herring Gull, *Larus argentatus argentatus*, the Fennoscandian form, being the larger, darker bird, and *Larus argentatus argenteus*, the British form (Barth, 1975). However the British population in Barth's (1967) comparison was represented by only 7 birds, and these from northern Scotland. Since then, further biometric data on British breeding Herring Gulls have become available; that of Harris and Hope Jones for Pembrokeshire and Anglesey,/

Anglesey, from the Isle of May during culling measures (Neil Duncan, in preparation), and also from Scarborough and South Shields during the present study. This enables comparisons of variability within the British population itself and further comparisons with Barth's data for Norway.

Male Herring Gulls are significantly larger than females from the same breeding locality, though there is a degree of overlap between the two (Goethe, 1961, Barth, 1967; Harris and Hope Jones, 1969 and Ingolfsson, 1969). Since both British and Norwegian Herring Gulls were caught during the present study, an extensive size overlap between Scandinavian females and British males could cause confusion in the sexing of birds based on body dimensions. To overcome this difficulty a means of sexing gulls independant of overall body size is required; size can then be used as an indicator of geographical origin.

METHODS

In the course of the present study a number of live Herring Gulls were examined in both summer and winter and details of weight, wing length, bill length and bill depth recorded; in addition, prior to dissection for bacteriological examination, a number of breeding birds from Scarborough and South Shields were similarly measured and sexed internally. Condition of moult was examined in birds from both groups. All measurements taken on these gulls were made by or in the presence of the author, and were made on freshly dead or living birds.

The/

The measurements taken were as follows:

WEIGHT: Recorded to the nearest 1 gram.

WING LENGTH: Maximum chord of the right wing, measured in millimetres.

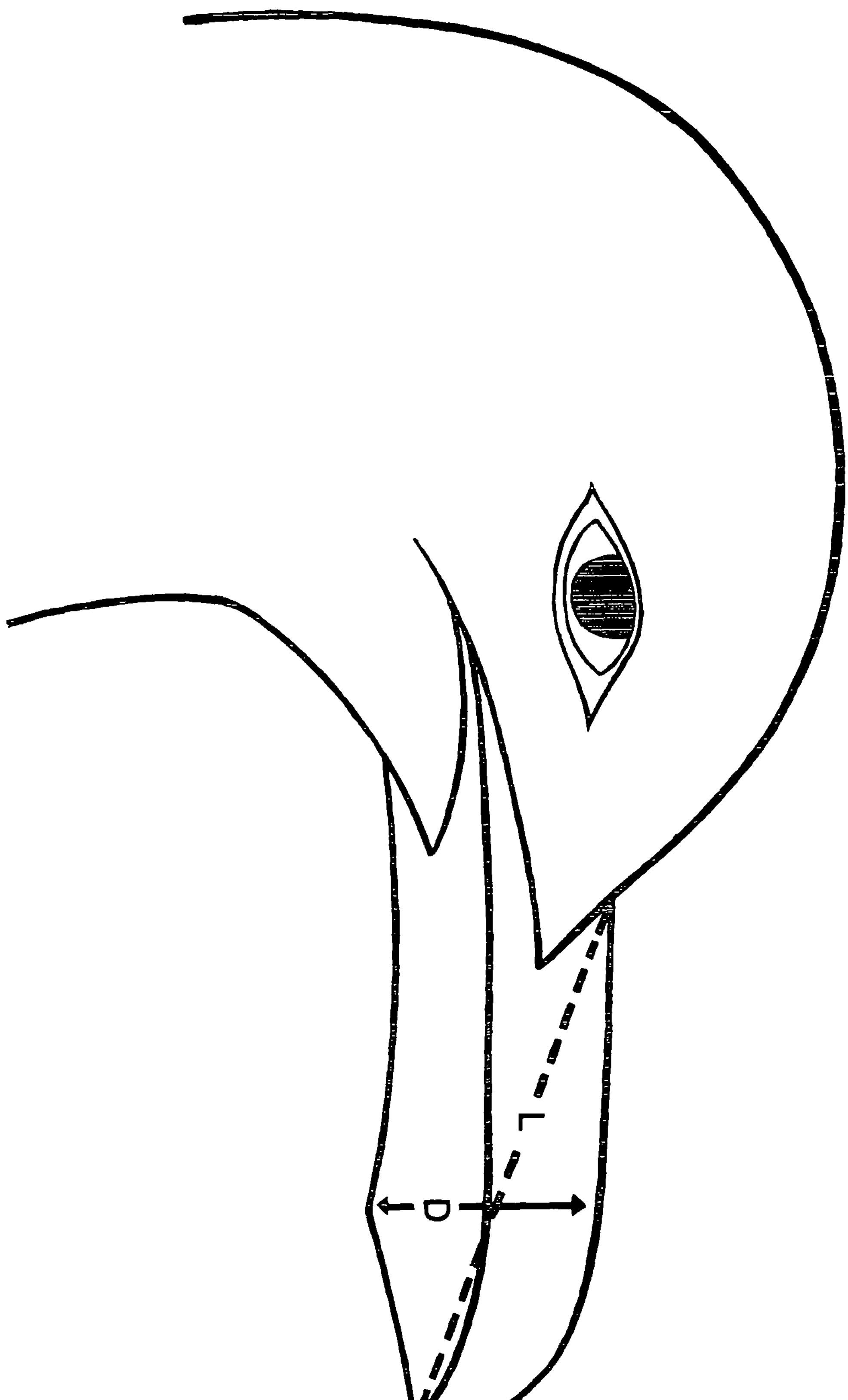
BILL LENGTH: Chord of the exposed culmen, from the tip of the upper mandible to where the feathers cease to hide its natural position (Fig. 1), measured in millimetres.

BILL DEPTH: Maximum depth from the gonys to the ridge of the culmen vertically above (Fig. 1), measured in millimetres.

BILL INDEX: Bill length/bill depth = bill index.

Birds from Scarborough were measured in May and June, 1976, from South Shields between March and May 1975 and 1976, and from refuse tips in the Teesmouth area throughout the autumn and winter months of 1973, 1974 and 1975. Additional data used in the following analyses were obtained from the Isle of May (Neil Duncan, in preparation), that published by Harris and Hope Jones (1969) for Pembrokeshire and Anglesey and that of Barth (1967) for the Scandinavian regions. Unless otherwise stated, the data treated in this section refer to adult (i.e. $>$ 4 yrs) Herring Gulls. The material from both Pembrokeshire and Anglesey and the Isle of May was fresh. Barth introduces a correction factor to account for shrinkage where his material consisted of museum skins; the dead specimens were on average smaller by 5.2mm in wing length, 0.52mm in bill length and 0.50mm in bill depth. However the majority of his measurements were also made on fresh material.

Figure 1: Bill measurements taken: Bill length (L) = the chord of the exposed culmen, measured from the tip of the upper mandible to where the feathers cease to hide its natural position. Bill depth (D) = maximum depth from the gonys to the ridge of the culmen vertically above.


L
D

1. VARIATION WITHIN THE BRITISH POPULATION

The biometric data obtained from anatomically sexed birds taken from breeding populations in the Scarborough area and from South Shields, were compared with those from Pembrokeshire/Anglesey and from the Isle of May; these areas are shown in Fig.2. The data from these groups are presented in Table 1 alongside that of Barth (1967) for the whole of Norway. For all parts measured the difference between the sexes was highly significant for each locality; the largest females exceed the smallest males and the separation between the sexes is not complete.

Between the 4 British groups there was nevertheless some variation in body size and this is considered below in further detail for each parameter measured.

(1) Weight

With the exception of bill depth in Isle of May males, the greatest relative variance was found in the weight of the birds, and there was no significant difference in the coefficient of variation (CV) between groups or sexes for this parameter. Males were significantly heavier than females in all cases ($p < 0.01$). Though weight will to some extent represent variations in linear dimensions (Amadon, 1943) and thus reflects overall greater size, it is an unstable character. Individual variation, sex, the amount of food in the crop, time of day, season and temperature all produce fluctuations. Baldwin and Kendeigh (1938) and Barth (1967) concluded that a very large number of records are required and that time of collection must be known for a meaningful analysis.

Weight/

Figure 2: Areas within the British Isles from which biometric data were obtained from anatomically sexed Herring Gulls during the breeding season.


Isle of May
South Shields
Scarborough
Anglesey
Pembrokeshire

Table 1

Measurements of anatomically sexed adult male and female Herring Gulls, taken during the breeding season, in different areas of the British Isles and Norway. The years during which the measurements were made are given in brackets

	$\bar{x}$	S	n	SE	Range	CV
Scarborough (1976)						
Female						
Weight (gm)	906.5	81.6	88	8.64	740 - 1150	9.0
Bill length (mm)	49.5	2.4	88	0.26	476 - 548	4.9
Bill depth (mm)	17.6	0.6	88	0.06	15.6 - 18.9	3.4
Wing length (mm)	408	10.4	88	1.11	382 - 431	2.5
Male						
Weight (gm)	1092.8	86.7	124	7.79	943 - 1283	7.9
Bill length (mm)	53.9	2.1	124	0.19	48.9 - 58.9	3.9
Bill depth (mm)	19.2	0.8	124	0.07	17.8 - 21.5	4.2
Wing length (mm)	426	11.8	124	1.06	403 - 458	2.8
I. May (1974 - 76)						
Female						
Weight (gm)	851.8	78.1	432	3.76	710 - 991	9.2
Bill length (mm)	48.5	2.3	432	0.11	44.4 - 54.1	4.7
Bill depth (mm)	17.7	0.1	432	0.03	15.1 - 18.9	1.0
Wing length (mm)	406	10.2	432	0.5	390 - 4 36	2.5
Male						
Weight (gm)	1026.1	91.4	550	3.90	890 - 1295	8.9
Bill length (mm)	53.3	2.5	550	0.11	18.1 - 61.1	4.8
Bill depth (mm)	19.7	1.8	550	0.08	19.9 - 21.9	9.3
Wing length (mm)	425	15.3	550	0.65	405 - 459	3.6

Table 1 (Contd.)

Pembrokeshire and Anglesey (1961 - 65)	$\bar{x}$	S	n	SE	Range	CV
Female						
Weight (gm)	813.0	69.0	32	12.20	690 - 940	8.0
Bill Length(mm)	50.0	2.5	130	0.22	43.0 - 56.2	5.0
Bill Depth (mm)	17.1	0.9	130	0.08	14.8 - 20.9	5.0
Wing Length(mm)	406	9.4	116	0.87	382 - 427	2.0
Male						
Weight (gm)	977.1	68.0	36	11.33	750 - 1150	7.0
Bill Length(mm)	54.6	3.0	148	0.25	49.0 - 64.4	5.5
Bill Depth (mm)	19.0	0.6	148	0.05	16.9 - 21.4	3.2
Wing Length (mm)	426	9.1	129	0.80	399 - 455	2.1

South Shields (1975)	$\bar{x}$	S	n	SE	Range	CV
Female						
Weight (gm)	891.2	99.3	32	17.50	696 - 1179	11.1
Bill Length(mm)	49.8	2.3	32	0.41	46.2 - 53.2	4.6
Bill Depth (mm)	17.6	0.6	32	0.12	15.9 - 18.3	3.9
Wing Length (mm)	409	10.1	32	1.78	397 - 434	2.5
Male						
Weight (gm)	1023.1	59.7	27	11.50	906 - 1182	5.8
Bill Length(mm)	53.8	2.8	27	0.55	48.4 - 56.2	5.3
Bill Depth (mm)	19.0	0.9	27	0.19	18.7 - 22.0	5.2
Wing Length(mm)	429	10.2	27	1.96	412 - 447	2.4

Norway (1942-64)	$\bar{x}$	S	n	SE	Range	CV
Female						
Weight (gm)	944.0	64.0	115	6.00	795 - 1100	6.8
Bill Length(mm)	52.7	1.9	115	0.20	48.0 - 58.0	3.6
Bill Depth (mm)	18.1	0.6	89	0.07	17.5 - 20.0	3.6
Wing Length(mm)	429	11.1	115	1.00	401 - 458	2.6
Male						
Weight (gm)	1177.0	86.4	138	7.40	900 - 1440	7.3
Bill Length(mm)	57.9	2.3	140	0.20	53.7 - 65.2	3.9
Bill Depth (mm)	20.1	0.8	102	0.08	18.3 - 22.1	4.1
Wing Length(mm)	453	11.2	140	0.90	428 - 480	2.5

$\bar{x}$ = mean
S = Standard deviation
n = Sample size

S.E. = Standard Error
C.V. = Coefficient of Variation

Weight alone is unsuitable for sexing gulls or for distinguishing between those from different localities, since relative fluctuations are largely undocumented.

Table 1 gives mean weights (plus standard deviations and standard errors) for both males and females from the 4 British Herring Gull groups.

Using comparisons based on students t-test, town females (Scarborough and South Shields) were heavier than each of the other two groups. Males from the Scarborough area were the heaviest overall in the British sample; only males from South Shields and the Isle of May however were not significantly different ($p < 0.05$ in all significant cases).

(2) Wing length

When comparing wings measured at different times of year, wing length must be treated with some caution since wear on the primary wing feathers and stage of moult must be taken into account (Nisbet, 1967; Prater, 1970; Bourne, 1971; Grant, 1971 and Pienkowski and Minton, 1973). Age of birds also has some bearing on wing length (Stewart, 1963), and this may be particularly important with respect to wear on the wing mirrors in gulls (Neil Duncan, in preparation). However provided the time of measuring is known, comparisons can be made between birds measured at the same time of year.

The mean wing length of British males differed significantly from females from the same locality in all cases ($p < 0.01$). In all samples other than for the Isle of May, the relative variance as/

as measured by the CV was similar and did not differ significantly between sexes or geographical groups (Table 1). Isle of May males were significantly more variable than any other males or females. There were no significant differences between the 4 British groups in wing length for either males or females. Thus within the British population as represented here, wing length does not show a high degree of variation either within or between localities.

Where locality is known, wing length presents a useful sexing criterion; alternatively, where sex is known, it could be used as a means of distinguishing between British and Norwegian Herring Gulls.

(3) Bill length

Differences in measured bill length must also be treated with caution, as there is no truly standardised method of taking this measurement. As Barth (1967) states, it is "unavoidable that the inner point or base of the bill is somewhat arbitrary".

The mean bill length in British males differed highly significantly from females from the same locality ($p < 0.01$), though there was some variability within the British population, (Table 1). Isle of May gulls in particular had shorter bills than those from elsewhere. (Isle of May males differed significantly from those of the other three groups; Isle of May females differed significantly from those of Scarborough and South Shields; $p < 0.05$ in all cases.) To some extent however, these differences will be due to differencesin measuring techniques.

(4) Bill depth

Bill depth is undoubtedly a more standardised measure of the bill than is length, the measuring point being more consistent and the measurement less ambiguous. As with the other parameters, males differed significantly from females ($p < 0.01$). Again there was some variability amongst the British groups as shown in Table 1: this was particularly true of the females, the differences in bill depths being significant between all groups other than those from Scarborough and South Shields ($p < 0.05$ in all significant cases).

(5) Conclusions

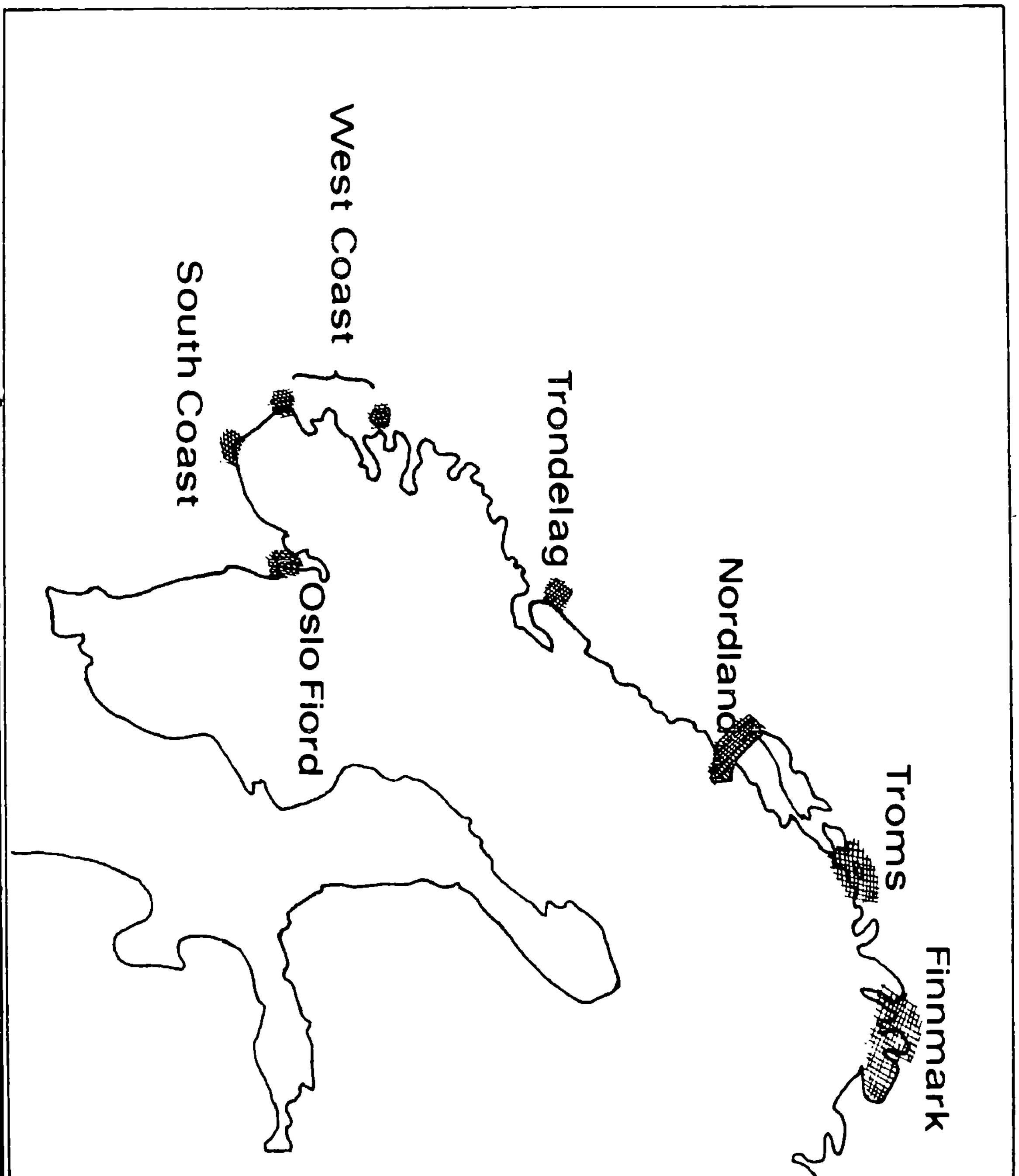
From these data it is evident that there is considerable variation in external characters within the British population of Herring Gulls, wing length being the least so and weight the most variable. Isle of May Herring Gulls of both sexes appear to have shorter, deeper bills than those from elsewhere.

2. COMPARISONS BETWEEN BRITISH AND NORWEGIAN HERRING GULLS

(1) Differences in body dimensions

The 4 British Herring Gull groups were compared with the data presented by Barth (1967) for the whole of Norway (Table 1). The localities represented in Barth's sample are shown in Fig. 3. In weight, wing length, bill length and bill depth British females differed significantly from Norwegian females ($p < 0.01$), and British males differed significantly from Norwegian males in all four parameters ($p < 0.05$). The British population as represented here/

Figure 3: Areas within Norway from which Barth (1967) obtained biometric data from anatomically sexed Norwegian Herring Gulls during the breeding season.


West Coast
South Coast
Trondelag
Oslo Fiord
Nordland
Troms
Finnmark

here is clearly defined from that of Norway, British Herring Gulls being of a smaller overall size. This supports the findings of Barth (1967) which were based on a small British sample from Northern Scotland, and agree with his conclusion that, "the short bills, and short wing lengths of the British population,.... typify this as a separate form".

(2) <u>Overlap between British males and Norwegian females</u>

British Herring Gulls of both sexes are significantly smaller than their Norwegian counterparts in size. There is an overlap in size between British males and Norwegian females. Norwegian females as measured by Barth are lighter than British males in weight ($p < 0.01$); this is however based on summer measurements and it is not known if this difference holds in the winter season. The wing lengths of Norwegian females overlap with those of British males to such an extent that wing length will not separate the two (Table 1). With respect to bill length, Isle of May and South Shields males were found not to differ significantly from Norwegian females though the bills of males from Scarborough and Pembrokeshire/ Anglesey were longer ($p < 0.01$). Bill length will not separate British males from Norwegian females in the Herring Gulls caught at refuse tips during this study. Bill depth on the other hand differed highly significantly between all British males and the Norwegian females, the females having overall shallower bills. Thus British males and Norwegian females do overlap in size, but not in bill depth and, in summer at least, not in weight.

3. SEX DISCRIMINATION

On the basis of external characters, female Herring Gulls are significantly smaller than males from the same locality, though the larger females are greater than the smaller males. Bill measurements are generally taken as the most reliable indicator of sex. Drost (1938), Dunnet and Anderson (1961), Harris (1964), Harris and Hope Jones (1969) and Barth (1967) point out methods of sexing living Herring Gulls, Fulmars, Greater Black-backed Gulls, Herring and Lesser Black-backed Gulls and Herring Gulls respectively, based on the ratio of bill length to depth. Using birds of known sex from Scarborough, bill length was plotted against bill depth for both males and females, shown in Fig. 4. These data were analysed by means of a "discrimination analysis" (Appendix 10), calculating the discriminant function which produced the best separation. The equation obtained for the discriminant function was:

$$\text{D.F.} = (\text{BILL LENGTH} \times 0.01625) + (\text{BILL DEPTH} \times 0.05195) - 18.12852$$

$$\text{male} > -0.134 < \text{female}$$

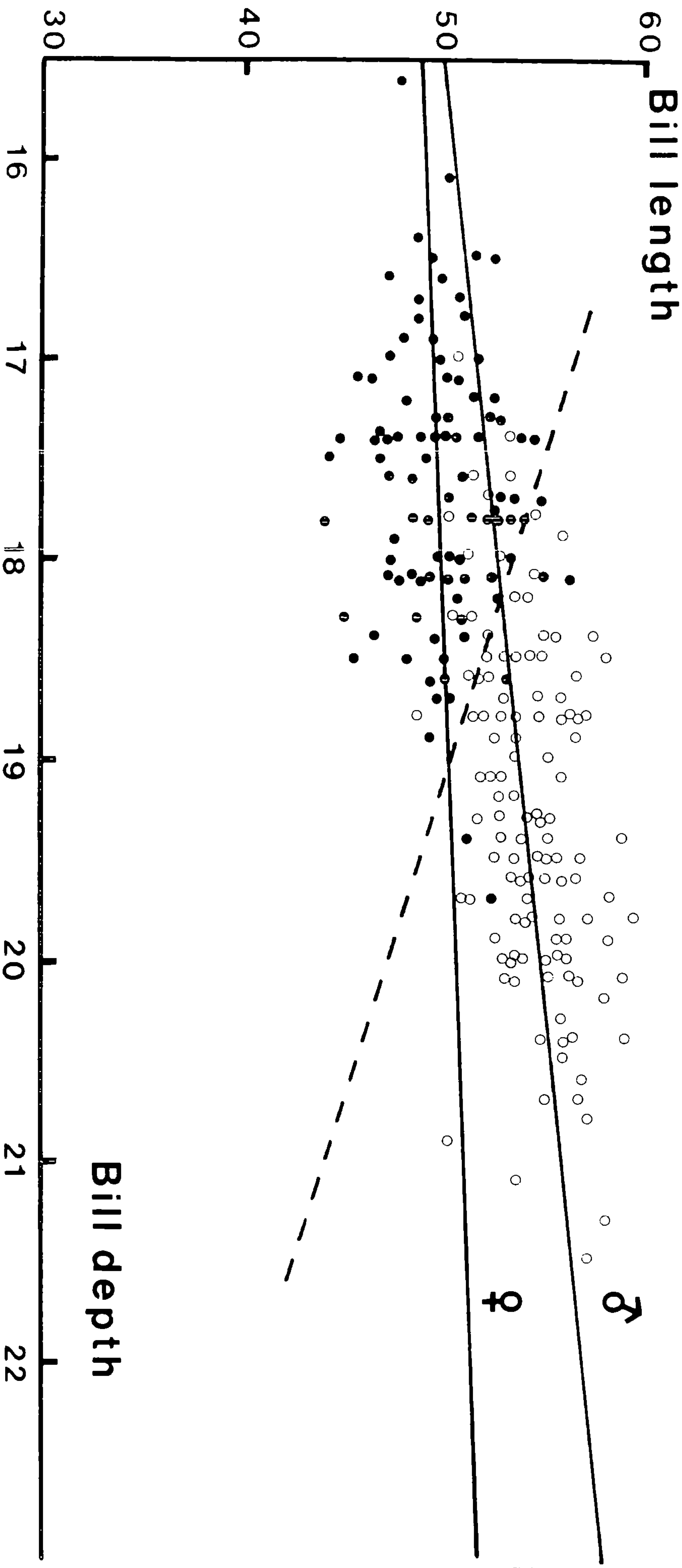
This separation line was drawn as indicated in Figure 4. The predicted results are given in Table 2.1. The level of accuracy in sexing using these parameters was 90.1% correctly predicted. Several other combinations of measurements were used in discrimination analyses, but failed to provide any appreciable improvement over that using bill length and depth (Table 2).

Figure 4: Bill length plotted against bill depth for Herring Gulls of known sex from Scarborough. Open circles are males, closed circles females. The regression lines for males and females are as follows:

males $Y = 0.99x + 34.7$

females $Y = 0.29x + 44.4$

The dotted line is the separation line as based on the discriminant analysis (see text).



Bill length
60
50
40
30
Bill depth
16
17
18
19
20
21
22
♂
♀

Table 2

Discrimination analyses based on 88 female and 124 male anatomically sexed Herring Gulls from Scarborough, using parameters as indicated in 1 - 9

Variables	Actual Sex	Predicted Female	Predicted Male	% Grouped Correctly Classified
1. Bill length and bill depth	Female Male	83 (94.3%) 16 (12.9%)	5 (5.7%) 108 (87.1%)	90.1%
2. Bill length, bill depth and wing length	Female Male	80 (90.9 %) 9 (7.3%)	8 (9.1 %) 115 (92.7%)	91.9%
3. Bill length, bill depth, wing length and weight	Female Male	83 (94.3%) 10 (8.1%)	5 (5.7%) 114 (91.9%)	92.9 %
4. Weight, wing length and bill index	Female Male	81 (92.0%) 8 (6.5%)	7 (8.0%) 116 (93.5%	92.9%
5. Wing length and bill index	Female Male	68 (77.3%) 22 (17.7%)	20 (22.7%) 102 (82.3%)	80.1%
6. Bill depth	Female Male	78 (88.6%) 12 (9.7%)	10 (11.4%) 112 (90.3%)	89.6%
7. Wing length	Female Male	72 (81.8%) 13 (10.5%)	16 (18.2%) 111 (89.5%)	86.3%
8. Bill length	Female Male	72 (81.8%) 20 (16.1%)	16 (18.2%) 104 (83.9%)	83.0%
9. Weight	Female Male	86 (97.7%) 32 (25.8%)	2 (2.3%) 92 (74.2%)	83.9%

Though weight does improve the accuracy of prediction (Table 2.2) this is unsuitable for comparisons over differing time periods. Thus, as found by previous workers, the most suitable criteria for sexing gulls from a known locality, in this case Scarborough, are the bill measurements.

Since there was some uncertainty as to the locality of the winter birds, size overlap between Norwegian females and British males in bill length renders the method of sexing based upon both bill measurements unsuitable. A means of sexing adult Herring Gulls independant of overall body size was therefore required. As can be seen from Figure 4, the scatter of bill measurements in females is very large, and, while the bill parameters were significantly correlated in males ($r = +0.40$, d.f. = 122), this was not so for females ($r = +0.08$, d.f. = 86). The correlation coefficients were compared using the Fisher conversion to z (Fisher 1921) as outlined by Snedecor and Cochran (1971) for use in a significance test between two sample values of r, the null hypothesis being that the two values of r were drawn at random from the same population. They were found to differ significantly ($P < 0.025$), and the null hypothesis rejected. The relationship between bill length and depth differs between males and females in that, independant of bill length, females tend to have relatively shallow bills; in males, bill length is positively correlated with bill depth. Males tend to have larger bills than females; thus a bill of equal length, if short will be shallow in both sexes, but if long will remain shallow only in the female./

female. Though there is overlap in bill length between British males and Norwegian females, this is not so for bill depth, the female bill remaining significantly shallower. As a single criterion, bill depth provided the best separation between the sexes, using a discrimination analysis (Table 2.6). Therefore, bill depth alone is the most useful criterion for sexing gulls from an unknown locality, females being identified by virtue of their relatively shallow bills. When used singly in discrimination analysis (Table 2.6), bill depth correctly predicted sex in 89.6% of cases.

4. SEPARATION OF BRITISH AND NORWEGIAN INDIVIDUALS

The bill depth of Norwegian females is shallower than that of British males ($p < 0.01$), and for all localities covered by Barth, (see Barth, 1967, Table 4), only females from Bornholm Island (Baltic Sea), having a mean bill depth of 19.0mm, would cause confusion here. On the basis of 80 male and 80 female Herring Gulls obtained from the German North Sea coast, Goethe (1961) gives mean bill depths of 20.2mm and 18.4mm respectively; these females thus also have shallow bills though deeper than the British or Norwegian females. Ringing recoveries however suggest that the main winter influx into Britain is of Norwegian Herring Gulls (p.16).

Table 3 gives the 99% confidence limits obtained for bill depths of British males and Norwegian females. Using these limite, a Herring gull with a bill depth less than 18.4mm would be classified as a female.

Table 3

Bill depths of British and Norwegian anatomically sexed adult Herring Gulls. Mean ($\bar{x}$) and 99% confidence limits. Bill depth<18.4 classified as female

Sex	Breeding Locality	$\bar{x}$ (mm)	99% C. Limits
Male	Scarborough	19.2	18.97 - 19.43
Male	I. May	19.7	19.40 - 20.00
Male	Pembroke	19.0	18.80 - 19.20
Male	S. Shields	19.0	18.40 - 19.60
Female	Norway	18.1	17.90 - 18.30

Table 4

Mean bill depths of Herring Gulls, sexed using this measurement, caught at refuse tips in the Tessmouth area

Sex	n	$\bar{x}$ (mm)	s
Male	53	19.3	0.5
Female	55	17.3	0.6

$\bar{x}$ = mean
s = standard deviation
n = sample size

Data from 108 adult Herring Gulls captured during winter were then examined, and the birds sexed using bill depth. This gave 53 males and 55 females. (Table 4 gives the mean bill depths obtained for each sex plus standard deviations.) As previously stated (p.34), wing length is a reliable criterion for distinguishing between British and Norwegian Herring Gulls where sex is known: it was employed here in this context. Table 5 gives 99% confidence limits for wing lengths of British birds of both sexes and for Norwegian females. Using these limits, females with wing lengths greater than 415 mm would be classified "not British" and similarly with male wing lengths to greater than 435 mm. The sexed winter adults were thus classified. This gave 15 Norwegian and 40 British females and 4 and 49 males respectively. (Means and standard deviations are given in Table 6, plus details of available wing lengths and weights.) The British classified birds do not differ significantly from the British population in Table 1 and the "non British"birds, albeit a small sample, do lie within the limits given by Barth (1967) for the Norwegian localities.

5. PRIMARY FEATHER MOULT

In addition to the recording of biometric data, a large number of gulls were examined in both summer and winter for details of the condition of the primary feather moult. Whitherby et al, (1958) state that the full moult of the Herring Gull lasts from May until/

Table 5

Mean wing lengths ($\bar{x}$) + 99% confidence limits of anatomically sexed Herring Gulls breeding in the localities indicated

Sex	Breeding Locality	$\bar{x}$ (mm)	99% C. limits
Male	Scarborough	426	422 - 430
Male	S. Shields	429	422 - 435
Male	Pembroke	426	423 - 429
Male	I. May	425	422 - 428
Female	Scarborough	408	404 - 412
Female	S.Shields	409	403 - 415
Female	Pembroke	406	403 - 409
Female	I. May	406	404 - 408
Female	Norway	429	425 - 433

Female wing length > 415mm classified "non-British"
Male wing length $\geq$ 435mm classified "non-British"

Table 6

Measurements of Herring Gulls caught at refuse tips in the Teesmouth area in winter. These birds have been sexed using bill depth and classified as British or non-British breeding birds using wing length.

Sex	Locality	n	$\bar{x}$	s
Wing length (mm)				
Male	Brit.	49	423	7.9
Male	Non Brit.	4	441	4.5
Female	Brit.	38	404	7.7
Female	Non Brit.	15	421	7.0
Weight (gm)				
Male	Brit.	42	1004	82.6
Male	Non Brit.	4	1023	56.9
Female	Brit.	30	843	69.0
Female	Non Brit.	12	890	69.0
Bill Length (mm)				
Male	Brit.	49	51.8	3.1
Male	Non Brit.	4	54.5	3.0
Female	Brit.	41	49.2	2.1
Female	Non Brit.	11	50.2	3.3

n = sample size
x = mean
s = standard deviation

until October. Ramsey (1913), using data based on feathers collected on a Scottish beach, suggested that adult Herring Gulls began the primary feather moult in late July.

Harris (1971) stated that Herring Gulls in Pembrokeshire start the primary moult in late June or early July, "when they are feeding large young". Barth (1975) used this latter information as representative of the timing of moult in British Herring Gulls, a feature with which he supports his distinction between *Larus argentatus argentatus*, the Fennoscandian form, and *Larus argentatus argenteus*, the British form. He states that the former commences moult in May. However, birds examined in this study were also found to have commenced the primary feather moult in May; on the basis of internally sexed birds, males were found to begin moult prior to females. Table 7 shows the number of females in primary moult on 25.May, 1976 compared with males examined at the same time. The difference was found to be significant, the onset of primary moult being earlier in males. These birds were from a breeding population in Scarborough.

Table 7

Difference in onset of primary feather moult between fully mature male and female Herring Gulls, examined on 25 May, 1976, $\chi^2_1 = 4.83$

Sex	In moult	Not in moult	Total
Male	32	11	43
Female	25	25	50

In Pembrokeshire Harris examined 275 Herring Gulls shot during May, but found no trace of primary feather moult. Timing of breeding may be an important factor here (Barth, 1975) and thus non-breeding birds could complicate the issue. Those birds detailed in Table 7 were in full breeding condition, as measured by the condition of the gonads and presence of brood patches.

Table 8 gives details of birds whose primary feather moult was examined at various times during the year, giving numbers, age and sex details for adults. These data are based on anatomically and externally sexed birds. Birds classified on biometric details as of Norwegian origins were not included. The average moult scores are given in Table 8; moult scores were obtained from the right wing using the method outlined by Snow (1967) and Harris (1971), i.e. a score from 1 - 5 on each new feather; a fully moulted Herring Gull, having 10 freshly grown large primaries, would thus score 50. Primary feather moult was found to span over 6 months, similar to the period reported by Barth for Fennoscandian birds. All birds caught on 9 December 1975 had completed the primary feather moult. Males maintained an advance over females, other than data obtained from Scarborough in September, 1976, where equal values were obtained for both sexes. Moult in gulls undergoing their first primary moult was most advanced (1st summer/2nd winter birds) and that of intermediates (3rd and 4th year gulls), was also in advance of the adults. The average moult scores can be seen in Fig. 5 for the different age classes. The scores were not/

Table 8

Mean moult scores obtained for British Herring Gulls examined during 1975 and 1976

Date	Age/Sex	Mean Moult Score	No. of Birds Examined	S. Deviation
25.5.76	Adult, Male	1.0	42	1.0
	Adult Female	1.0	47	1.4
	3/4 years	3.6	4	-
	1st Summer	11.0	24	3.1
21.6.76	Adult Male	9.5	11	4.3
	Adult Female	7.2	13	4.2
	3/4 year	14.3	4	-
	1st Summer	25.8	4	-
23.7.75	Adult Male	15.0	18	4.6
	Adult Female	12.3	12	5.6
	3/4 year	23.8	2	-
	1st Summer	-	-	-
25.8.75	Adult Male	25.7	19	11.4
	Adule Female	23.6	18	4.7
	3/4 year	37.0	5	2.1
	1st Summer	42.7	6	2.0
20.9.76	Adult Male	36.0	35	6.2
	Adult Female	36.7	22	2.8
	3/4 year	44.0	18	3.4
	2nd winter	49.0	6	1.1
22.10.75	Adult Male	47.0	4	-
	Adult Female	44.0	1	-
	3/4 year	48.0	2	-
	2nd Winter	50.0	4	-
24.11.75	Adult Male	-	-	-
	Adult Female	48.5	2	-
	3/4 year	-	-	-
	2nd Winter	50	1	-
9.12.75	Adult male	50	6	-
	Adult Female	50	6	-
	3/4 year	50	1	-
	2nd Winter	50	5	-

Figure 5: Average moult scores, based on data in Table 8, plus that of Barth (1975), for Herring Gulls examined in different months. (Month on the horizontal axis).

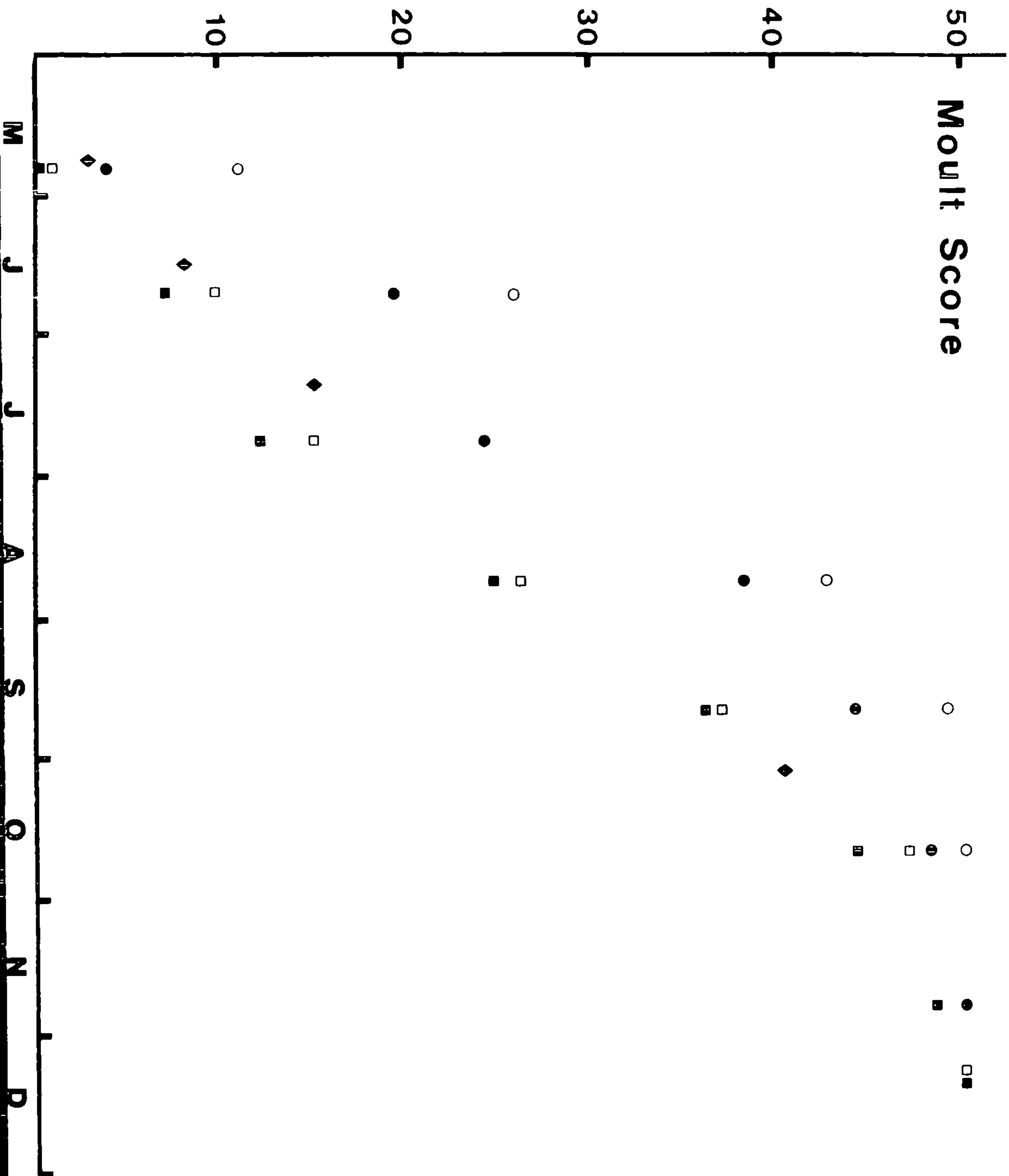
Legend: □ adult males

□ adult females

⊜ 3/4th year

○ 1st summer/2nd winter.

◆ Norwegian


Moult Score
10
20
30
40
50
M
J
J
A
S
O
N
D

not treated as having a straight line relationship with time as suggested by Harris (1971), but rather as a sigmoid curve, due to the flattening effects of the upper and lower score limits of 0 and 50. The data given by Barth (1975) for gulls from Oslo, Norway, were plotted also on this graph. The sex of these adults is unknown, but they do not differ appreciably from the British birds examined in this study.

Thus, it is not the case that the British population of Herring Gulls as a whole beginsthe primary moult in late June, early July, as suggested by Harris (1971) for Pembrokeshire. It is of course possible that the timing of the moult alters in different years as Harris (1971) suggests, but the breeding season varies little. Sex and age of the birds are however very important. Timing of moult therefore does not contribute to the taxonomic distinctions as suggested by Barth (1975). Nevertheless, other information on mantle colour (Barth, 1966) and body measurements (Barth, 1967) do support this distinction. Additional data obtained in this study confirm that distinction between L. argentatus argenteus and L. argentatus argentatus on a size basis (Barth, 1967), the latter being a significantly larger bird overall: to what extent this is merely part of a cline however, it is not possible to ascertain from the present data.

6. CONCLUSIONS

On the basis of external parameters, it is possible to sex living Herring Gulls independant of overall body size. Thus, where/

where birds from more than one breeding population are involved and there is a size overlap between sexes, it is possible to distinguish between individuals from the two populations. This was done for Herring Gulls caught at refuse tips in the Teesmouth area during winter, when both British and Norwegian breeding birds were known to be present. Of 108 adult Herring Gulls ringed and released in the Durham area during winter months, 6% of males and 27% of females were identified as being probable Norwegian birds. British breeding Herring Gulls were found to commence the primary feather moult in May and this lasted until late November. The timing of moult in British breeding Herring Gulls did not differ from that reported in Norwegian breeding birds by Barth (1975).

A smaller number of measurements were made on Greater black-backed Gulls caught at refuse tips during the winter months. These, plus available moult scores, are given in Appendix 1.

CHAPTER 5

THE USE OF REFUSE TIPS BY GULLS IN THE TEESMOUTH AREA

INTRODUCTION

It has frequently been suggested that an increased food supply in the form of human waste products, such as fish offal and the material found at refuse tips, has been an important causative factor in the rapid increase of the Herring Gull during this century. There are two main ways in which refuse is thought to have effected the population increase.

(1) By enabling adults to rear more or better quality young during the breeding season (Andersson, 1970). Two studies have suggested that adults which feed their young on refuse material, in addition to natural foods, fledge more young than those which do not use refuse (Spaans, 1971, Davis, 1974). However, it is not clear from these studies to what extent the increased fledging success is due to the quality of the adult birds themselves, whose utilisation of refuse in feeding their young may represent an overall more efficient foraging technique. It is possible that, even if refuse were not available, these individuals would still rear more young than their non refuse-feeding counterparts.

(2) Fisher (1952), referring to the Fulmar, pointed out that young birds are probably more vulnerable to any deficit in the external environment than are older birds. It has been suggested that refuse enhances the survival of both adult and young Herring Gulls outwith the breeding season, acting as a major food source

(e.g./

(e.g. Spaark, 1951, Drost, 1958, Bergman and Koskimies, 1958, Bruyns, 1958, Lack, 1966, McRoberts and McRoberts, 1970, Grant, 1969) or by acting as a reserve food supply when conditions elsewhere have deteriorated (Kilhman and Larsson, 1974). This does make the assumption that other food sources are limiting during the winter months.

It is with this latter situation, the use of refuse tips by Herring Gulls outwith the breeding season, that this study has been concerned. Changes in the numbers of Herring Gulls frequenting a particular tip during the autumn and winter months have been monitored, as has the differential use of the tip by adult and immature birds; the behaviour of marked individuals has also been studied. From these data, it has been possible to evaluate to some extent the role of refuse tips as a winter food supply for Herring Gulls. The majority of observations relate to the tip at Whitton, Co. Durham, and most particularly to the autumn and winter season 1974 - 75. This is the only season over which this tip was operative continuously. A total of 221 Herring Gulls were caught, individually colour-ringed and released at Whitton tip during the course of this study, of which 136 were adult birds, and 85 4 years old and under. Unless otherwise stated, the term immature will here refer to birds which have not yet aquired full breeding plumage; that is birds up to 4 years old. Details of the criteria used to age birds are given in Appendix 2.

SPECIES FEEDING AT TIPS IN THE TEESMOUTH AREA

Several different bird species were observed to feed regularly at tips in the study area, including crows, jackdaws, starlings/

starlings and pied wagtails. Three gull species were regularly present, the Herring Gull, the Great Black-backed Gull and the Black-headed Gull, with only occasional records of Common Gulls, Lesser Black-backed Gulls and Glaucous Gulls. The most numerous species of gull at the two inland tips, Whitton and Darlington, was the Herring Gull, followed by the Great Black-backed Gull; the ratios of Herring to Great Black-backed Gulls at these dumps were generally 4:1 at Whitton and 6:1 at Darlington. At Seaton Carew, where the tip was in very close proximity to the shoreline, this ratio was generally 2:1. On occasion however, Great Black-backed Gulls were equal in number to, or outnumbered, Herring Gulls at Seaton Carew. This was never recorded at either of the two inland tips.

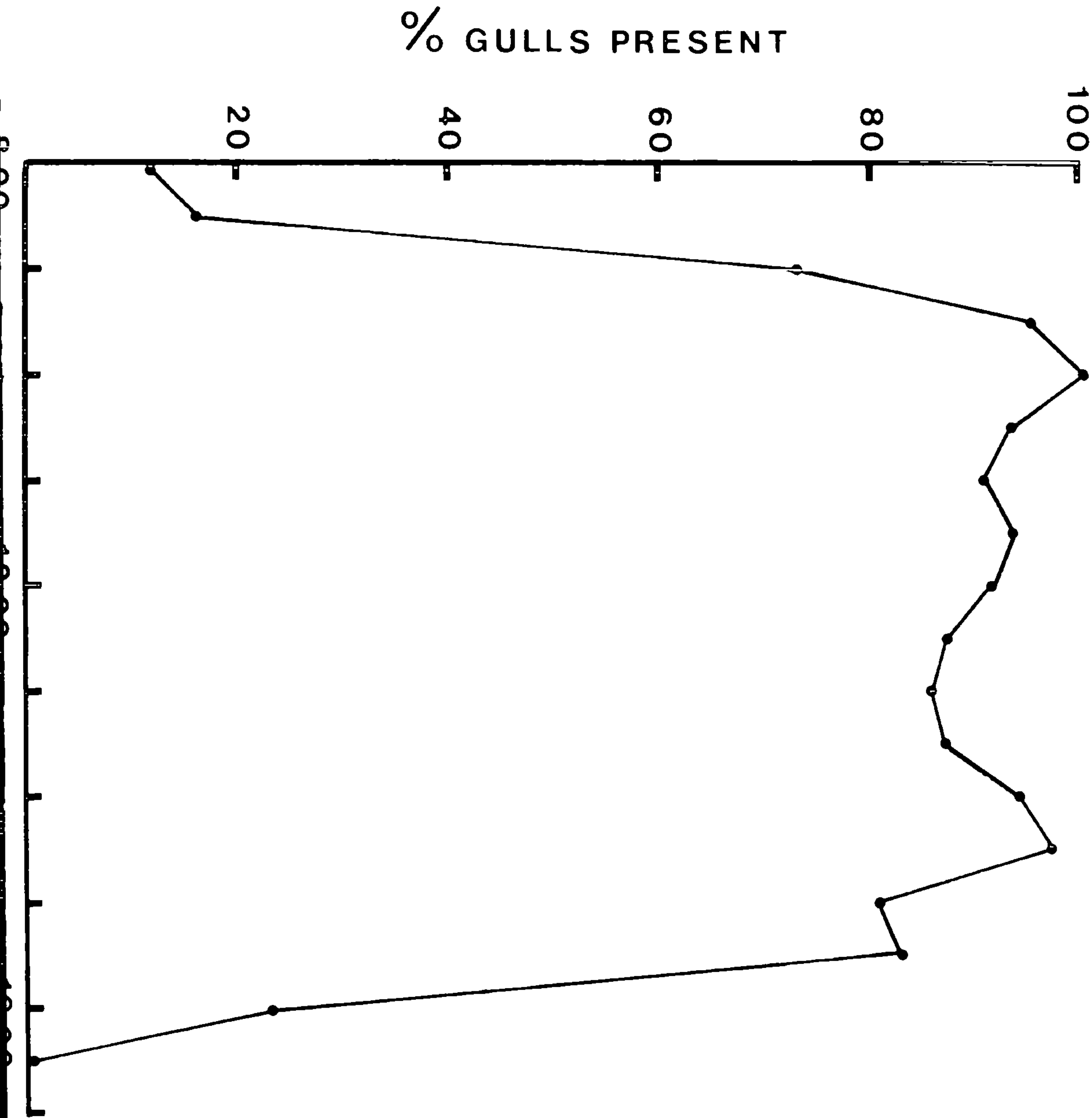
From the ratios observed at these tips, Great Black-backed Gulls were less common at inland than at coastal sites.

PART 1. VARIATIONS IN THE NUMBER OF GULLS FEEDING AT TIPS

1. VARIATIONS IN THE NUMBER OF GULLS THROUGHOUT THE DAY

Regular counts of all gulls in the area of Whitton tip were made at approximately $\frac{1}{2}$ hr intervals throughout the course of 8 separate feeding days (p.71) in November and December 1973. Figure 1, based on a summation of these data, shows the number of gulls present in the tip area throughout the feeding day, expressed as a percentage of the maximum number recorded. The number of gulls reached a peak between 09.00 - 10.30 G.M.T. in the winter months and there was little variation in the numbers present during the course/

Figure 1: The number of gulls present in the area of Whitton tip throughout the feeding day, expressed as a percentage of the maximum number recorded. (Based on a summation of counts at $\frac{1}{2}$ hr intervals throughout 8 feeding days.)


% GULLS PRESENT
20
40
60
80
100

course of any one day. The first gulls departed for the roosting areas in the Tees estuary between 15.00 and 16.30 GMT, when either the light began to fade or the supply of refuse was terminated. In addition, colour-ringed individuals were on many occasions seen at the tip both in the morning and afternoon of the same day. There was no evidence of flocks of gulls arriving or departing from the tip other than at times specified above. Gulls did not commute to and fro between the tip and the coast throughout the day. Rather, gulls coming to feed at the tip did so early in the day, remaining there until their departure to the roosting grounds in the late afternoon. A similar situation was reported by Spaans (1971). He found that the number of gulls feeding at tips in the Netherlands province of Friesland was complete by 09.30 - 10.00 (Central European time) in winter, the first gulls departing for the roosting areas at 15.00 or 16.00 hours. On the basis of a positive correlation between morning and afternoon counts at several tips visited in a fixed sequence, Spaans suggested that,

> "the gulls resorting from the flats to the dumps do so early in the day (thus in many cases long before the flats are exposed) and not in the course of the day."

This pattern differed at weekends. On Saturdays Whitton tip closed at noon, prior to which all exposed refuse was covered with a layer of soil; the tip remained closed until Monday morning. Gulls dispersed from the tip area on Saturdays between 14.30 and 15.30/

15.30 GMT. The number of gulls recorded at the tip was consistently very low on Sundays throughout the study period (p.71).

2. SEASONAL VARIATIONS

Figure 2 shows the number of adult Herring Gulls present at Whitton tip on 46 week days on which accurate counts were made between 09.00 and 10.30 GMT, from September 1974 to March 1975. This does not include counts made on Sundays, which did not constitute a feeding day (p.71). The number of adults frequenting this tip varied considerably throughout this period. There was however a rapid decline in late January and early February, which represents the departure of the adults from the area with the onset of the breeding season. The adult gulls frequenting the tip in winter are not local breeding birds (p.16). Throughout the summer months very few adult Herring Gulls feed at tips in the Teesmouth area, and the numbers reach their winter levels in late August and early September. Similarly, Spaans (1971) found that the lowest numbers of gulls were recorded at refuse tips in Friesland during the breeding season, and the winter level was reached in October. Figure 3 shows, for the same days as in Figure 2, the number of immature gulls present at Whitton tip. There is no decline in the number of immature gulls with the onset of the breeding season. However, at the coastal tip at Seaton Carew, the number of immatures frequenting the tip did in fact increase from a level of ca. 100 individuals to more than 200 in February.

Figure/

Figure 2: The number of adult Herring Gulls present at Whitton tip on 46 weekdays on which accurate counts were made, between September, 1974 and March, 1975. (Month on the horizontal axis)

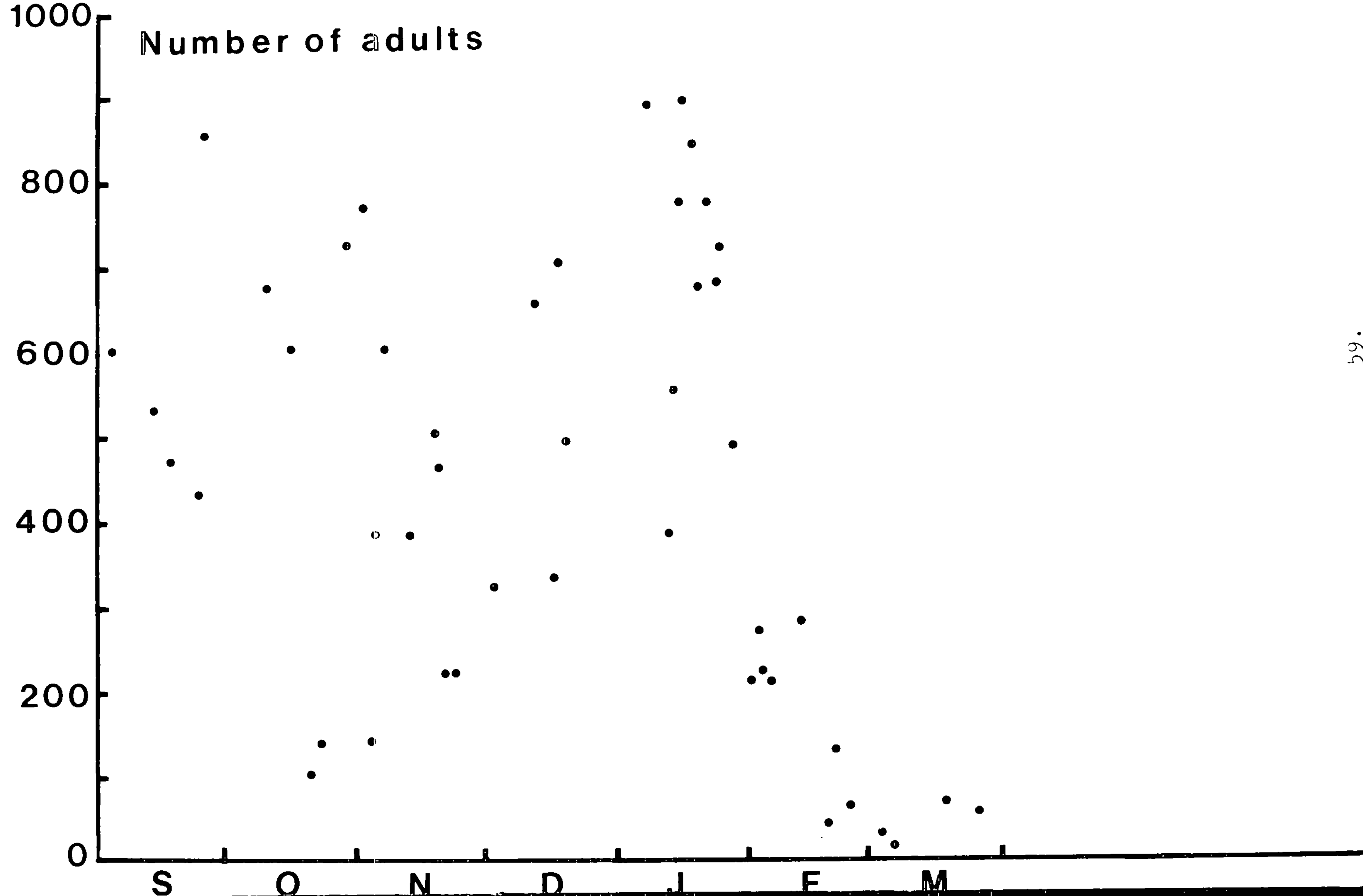
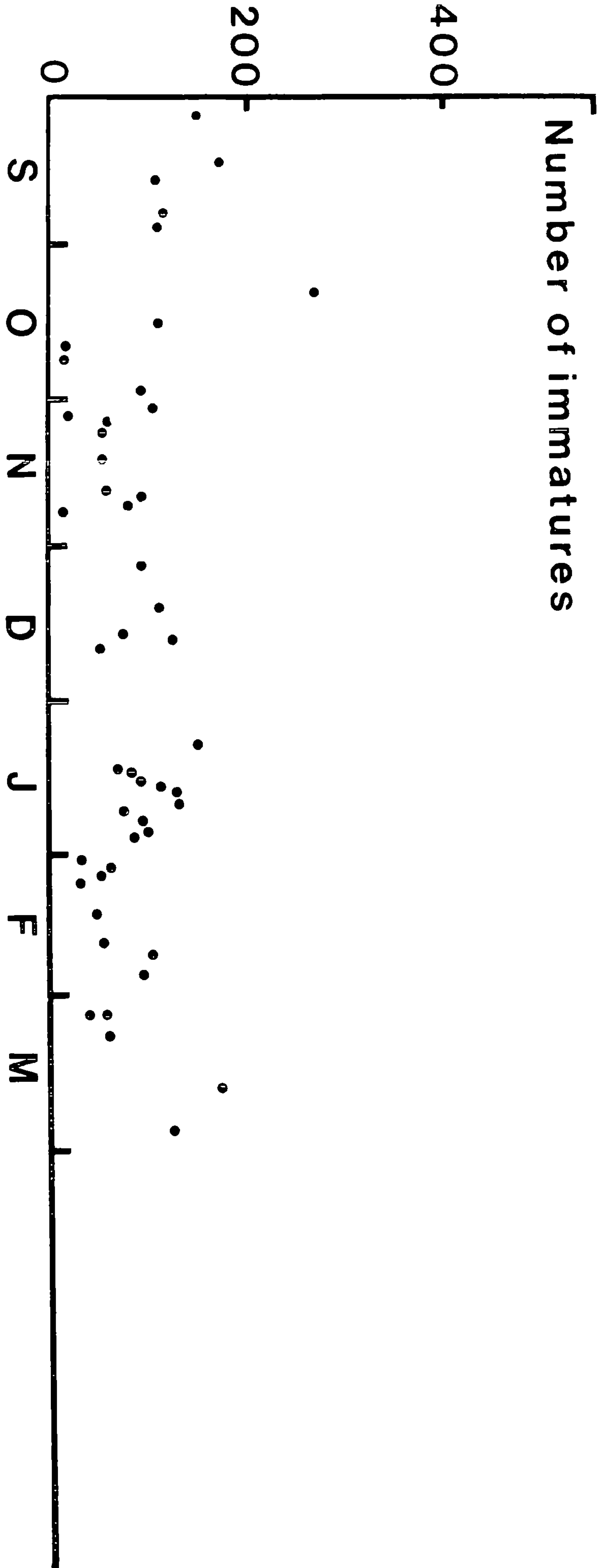

Number of adults
1000
800
600
400
200
0
S
O
N
D
J
F
M

Figure 3: The number of immature Herring Gulls present at Whitton tip on 46 weekdays on which accurate counts were made, between September, 1974 and March, 1975. (Month on the horizontal axis.)



Number of immatures
0
200
400
S
O
N
D
J
F
M

Figure 4: The number of adult Great Black-backed Gulls present at Whitton tip on 46 weekdays on which accurate counts were made, between September, 1974 and March, 1975. (Month on the horizontal axis.)

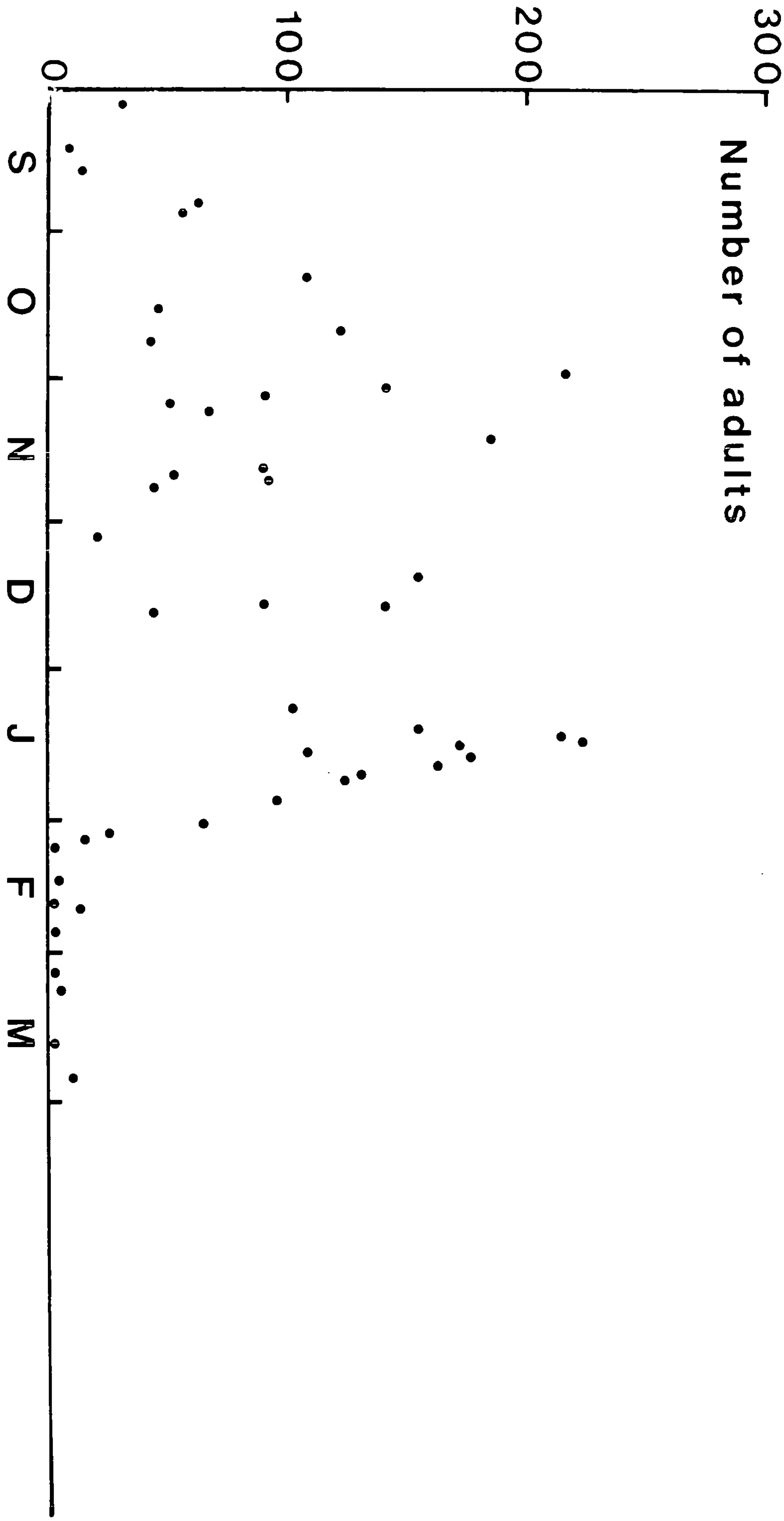

Number of adults
300
200
100
0
S
O
N
D
J
F
M

Figure 5: The number of adult Great Black-backed Gulls expressed as a percentage of the total number of this species present at Whitton tip, for each of 46 days between September, 1974 and March, 1975. (Month on the horizontal axis.)

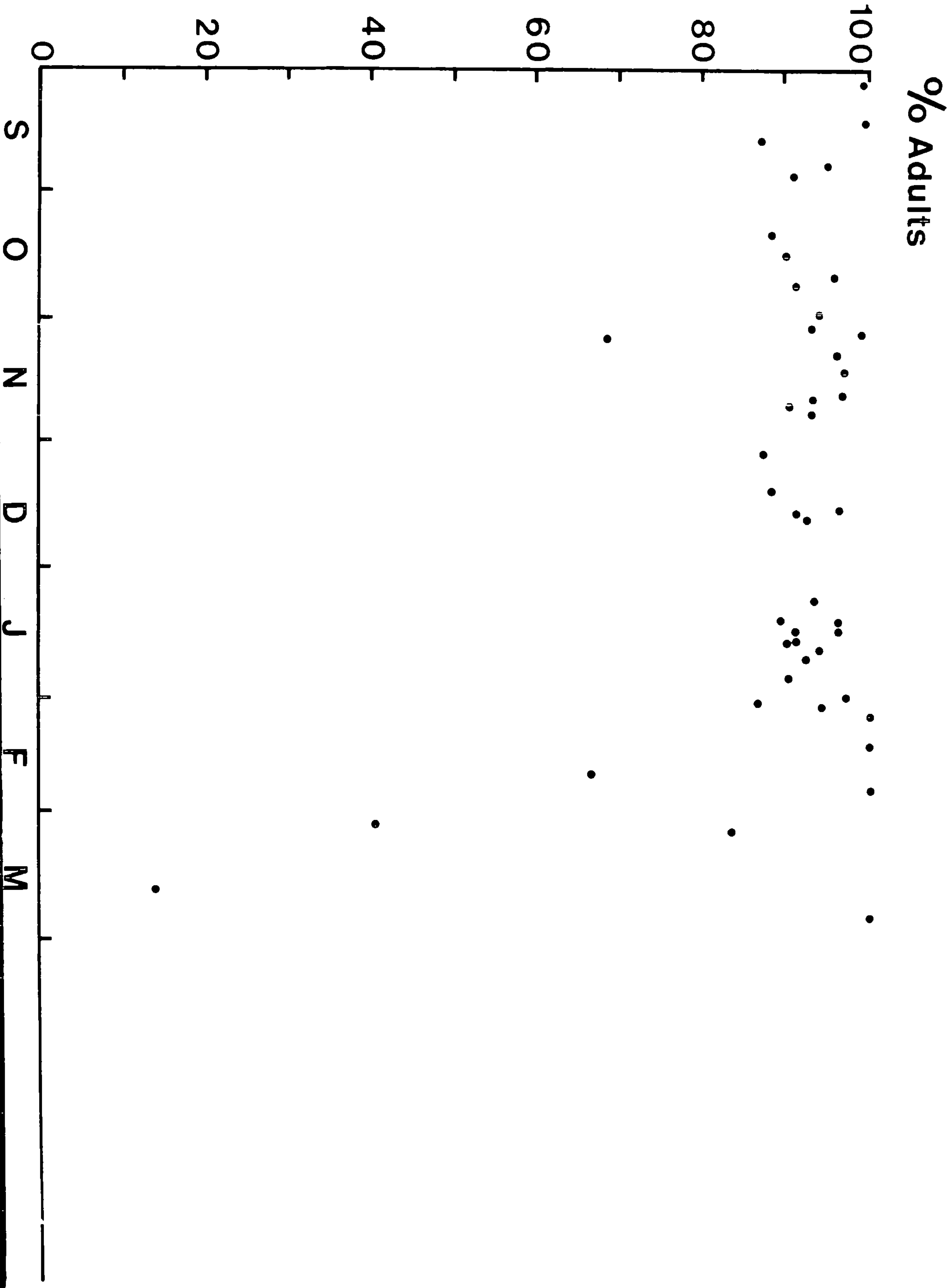

% Adults
0
20
40
60
80
100
S
O
N
D
J
F
M

Figure 4 shows the same data with respect to the number of adult Great Black-backed Gulls at Whitton tip. The numbers remained low in September, reaching their winter level towards the end of October. A rapid decline was recorded from mid-January onwards, which represented the departure of these birds to their breeding areas (p.24). The adult Great Black-backed Gulls arrived in the area later and departed earlier than did the adult Herring Gulls. The number of immature Great Black-backs feeding at Whitton tip was consistantly low throughout the study, generally representing around 10% of the total number of Great Black-backed Gulls present (Figure 5 , p.62).

3. RATIO OF ADULT TO IMMATURE HERRING GULLS

(1) Expected winter ratio of adult to immature Herring Gulls

In order to ascertain whether the observed ratio of adult to immature Herring Gulls recorded at Whitton deviated from the expected age ratio in the population, a life table was constructed for the Herring Gull, based on population parameters as calculated by Chabrzyk and Coulson (1976). These authors gave the mortality rate of Herring Gulls in their first year of life as 20% per annum; mortality in older age classes was found to be constant at 6% per annum. The rate of increase in the Herring Gull population in Britain was calculated at 13% per annum. Taking a sample of 1000 birds aged 5 years, the relative number in each older age class was calculated using the formula,

$$X_n \cdot S \cdot I = X_{n+1}$$

Where X_n = The number of birds aged n years

S = The adult survival rate (0.94)

I = The rate of increase of the population. This must be applied in a deductive manner to calculate the number of birds in older age classes.

(Increase of 13%/annum = $\frac{100}{113}$ = .885)

Thus for 1000 birds aged 5 years, the corresponding number in their 6th year of life is,

$$X_6 = 1000 \times 0.94 \times 0.885 = 832$$

Based on this 6% annual mortality rate, the average lifespan of a Herring Gull, on reaching maturity, is 16 years; this procedure was therefore terminated at age 30 years, when only 10 birds remained. This gave a total of 5,899 adults. The numbers of birds in age classes 4, 3 and 2 were calculated using the formula

$$X_{n-1} = \frac{X_n}{SI}$$

Assuming a 20% non-breeding adult population (Kadlec and Drury 1968) and an average breeding success of 1 chick per pair, the 5,899 adults would give rise to 2359 young. Thus the age composition of this population at the end of the breeding season would be 5,899 adults and 6,676 immatures (i.e. age classes 1 - 4 years). To obtain the expected winter age ratios, the annual mortality was taken as occuring in September, in order to avoid a bias in favour of the immatures. Thus a 20% mortality was deducted from the number/

number of first year birds, and 6% from the other age classes. This gave a total of 5,545 adults and 5,945 immatures. Thus the expected age composition of a winter population of Herring Gulls, using the above population parameters, is 48% adults and 52% immatures.

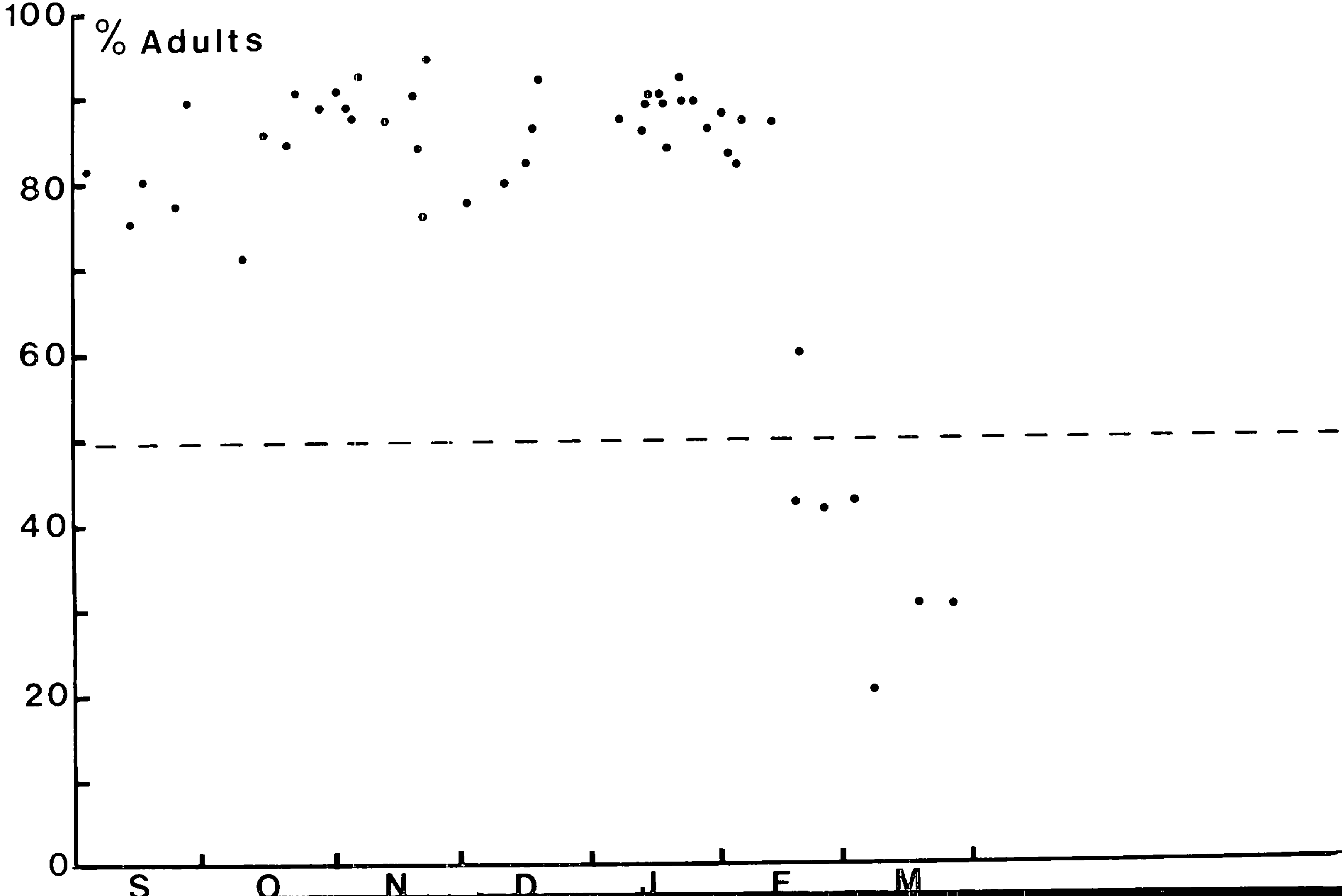
Similar calculations were carried out by Kadlec and Drury (1968) relating to the March age composition of Herring Gulls in New England, using a variety of hypothetical mortality rates. A stable population was calculated as being composed of 61% adults and 39% immatures. However, these authors have since questioned their assumptions with respect to the growth rate of the New England population, and the mortality and reproductive rates (see Drury and Kadlec 1975, Kadlec, 1976). It is not possible to make valid comparisons with their data at this stage.

(2) <u>Observed winter ratio of adult to immature Herring Gulls at tips</u>

Figure 6 shows the number of adult Herring Gulls expressed as a percentage of the total number of Herring Gulls present at Whitton tip during the 1974/75 season, on each week day on which accurate counts were made. Throughout the winter months, generally more than 80% of the Herring Gulls at this tip were adults, and less than 20% immatures. (The rise in the percentage of immatures in late January and early February is attributable to the decline in the number of adults at this time, and not to an increase in the number of immatures.) This observed age ratio at tips differed greatly from that expected as based on life table data (i.e. 48% adult, 52% immatures).

The/

Figure 6 : The number of adult Herring Gulls expressed as a percentage of the total number of this species present at Whitton tip for each of 46 days between September, 1974 and March, 1975. (Month on the horizontal axis.)


100
80
60
40
20
0
% Adults
S
O
N
D
J
F
M

The observed preponderance of adult over immature Herring Gulls in the winter months was not peculiar to Whitton tip. Similar ratios were recorded at the Seaton Carew and Darlington tips, from September to January. A large quantity of data relating to counts of adult and immature Herring Gulls at several tips in the Greater Boston and Gloucester areas of Massachusetts was supplied by Dr. William Drury, which covered both summer and winter months between 1962 and 1964. These data are summarised for months outside the breeding season in Appendix 3. The proportion of adult gulls at these tips rises from 50 - 60% of the total in September and October, to 80 - 90% during the winter months. (Gulls aged 4 years are included as adults in these counts.) A large scale aerial census of Herring Gulls, designed to account for possible differential migration of age classes, was conducted on the east coast of N. America, from Tampico, Mexico to Cape Sable, Nova Scotia, between January and March 1965 (Kadlec and Drury, 1968). Due to ageing difficulties, this count was biased in favour of adults. The observed ratio was 68% adult (+ 4th years) and 32% immature. This suggests that during the winter months, refuse tips in the Greater Boston and Gloucester area also showed a preponderance of adults. Dr. George Hunt also supplied details of the relative proportions of adult to immature Herring Gulls at a refuse tip in Maine. In winter and early spring, 74% of the birds were adult, while in summer and autumn months the proportion of adults was 54 and 40% respectively. This clearly showed a similar trend, the majority of the birds in winter being adults. Kadlec and Drury (1968) did however suggest that/

that first year Herring Gulls do gather in towns and dumps in certain metropolitan areas. There are two possible reasons for the observed preponderance of adult over immature Herring Gulls at refuse tips.

(1) There could, due to differential movements, be less immatures in these areas than expected.

(2) Refuse tips are being used more by adult Herring Gulls than by immatures.

A tendancy for young gulls to move further south than adults has been reported in N. America (Gross, 1940, Hofslund, 1959). Differential movement may account for the preponderance of adult Herring Gulls at refuse tips in New England since first year birds overwinter in more southerly areas (reported by Nisbet, 1977). There is little evidence for a differential movement of adults and young Herring Gulls in Britain (Harris, 1964). The North-east of England, where this study took place, is known to be a wintering area for young Herring Gulls fledged from the dense colonies in the Firth of Forth, and also from farther north, (Parsons, 1971). Also if there were more immatures in this area than as indicated by the counts at refuse tips, then immatures would be expected to predominate over adults at some other kind of feeding site in the same area. Information relating to the age composition of Herring Gull flocks feeding around inshore fishing boats in the Tyne-Tees area was supplied by J. Barker, a local ornithologist and inshore fisherman; on average 80% of these birds were immatures.

In/

In addition, relatively more immature Herring Gulls, colour-ringed at tips in the Teesmouth area, were seen following fishing boats than were adults (p.117). Counts of the numbers of adult and immature Herring Gulls following inshore trawlers in the west Irish Sea were made by Philip S. Watson, between January 1972 and March 1974 (Table 1). Since in these counts "immature" refers only to birds in their first and second years, there is clearly a similar preponderance of immature over adult Herring Gulls feeding around inshore fishing boats in this area in winter.

Table 1

Percentage of Immature Herring Gulls in Spot Counts Made by P.S. Watson from Inshore Fishing Vessels in the West Irish Sea, between January, 1972 and March, 1974

Date of Voyage	Total No. of Herring Gulls	% Immature
25th Jan. 1972	1000	60
11th April, 1972	300	50
22nd Jun. 1972	70	43
27th Jul. 1972	800	50
7th Sept. 1972	450	67
17th Oct. 1972	70	71
9th Jan. 1973	550	60
20th Feb. 1973	500	50
13th Mar. 1973	50	50
25th Oct. 1973	200	60
22nd Nov. 1973	300	67
13th Dec. 1973	800	60
23rd Jan. 1974	450	47
21st Feb. 1974	1050	57
27th Mar. 1974	750	39

It therefore appears that refuse tips in the Teesmouth area are used more by adult than by immature Herring Gulls and that this is not simply a reflection of the age ratio of the birds wintering in the area. Rather, there is a differential distribution of age classes over different feeding sites. While adult Herring Gulls predominate at refuse tips, immature birds predominate in the flocks feeding around inshore fishing vessels. Such differential use of resources by adult and immature Herring Gulls was also found by Lloyd (1968) in a study of gulls feeding inland in the Ythan valley in Aberdeenshire. (In this case immatures referred only to first and second year birds.) Lloyd found that the proportion of adults inland increased in November and December to 83% and 74% respectively, compared with around 50% in the other months between November and April. He found also that, in inland areas, immature Herring Gulls made more use of grass areas in certain months than did adults.

4. VARIATION IN NUMBER BETWEEN DAYS

Table 2 shows the mean numbers of Herring and Great Black-backed Gulls counted at Whitton tip between 09.00 and 10.30 GMT on different days of the week in the 1974/75 winter season. Excluding Fridays (for which there are insufficient counts) there were no significant differences in the numbers present on Mondays to Saturdays, for either Herring or Great Black-backed Gulls. The lowest weekday mean number, for both species, was on Mondays, but this did not differ significantly from the other weekdays: for all days the variation in the number of gulls present was high. The number/

number of Herring Gulls present on Sundays was consistently low, and differed significantly from the other days: this was also true of Great Black-backed Gulls. (In all cases $p < 0.05$.) No refuse was tipped on Sundays, and no food was available to gulls at tips in the study area on this day. Sunday did not constitute a feeding day at tips, and counts made on this day are excluded from further analyses.

Table 2

Mean Numbers of Herring and Great Black-backed Gulls Present at Whitton Tip on Different Days of the Week in the 1974/75 Winter Season

	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.
Herring Gull:							
No. of counts	5	9	10	9	2	4	7
Mean no. present	379.0	510.6	670.4	646.2	857.5	645.5	88.1
Standard Deviation	293.2	141.2	248.9	310.4	-	309.6	77.8
Great Black-backed Gull:							
No. of counts	5	6	10	7	1	4	7
Mean no. present	113.8	94.5	111.3	97.4	118	113.5	15.14
Standard Deviation	56.0	66.6	67.0	57.8	-	70.2	31.4

A wide fluctuation in the number of Herring Gulls present at Whitton tip on different feeding days was recorded throughout the study period. This was true for both adults and immatures, (Figure 2 and 3) in the 1974/74 season. Fluctuations were also recorded at Seaton Carew tip, and there was a significant positive correlation between the number of adult (Figure 7) and immature (Figure 8) Herring Gulls present/

Figure 7: The number of adult Herring Gulls present at Whitton and Seaton Carew tips on the same day. There was a significant correlation between the two ($r = + 0.72$, 8 D.F., $p < 0.02$).

The regression equation is:

$$Y = 0.91x + 49.1$$

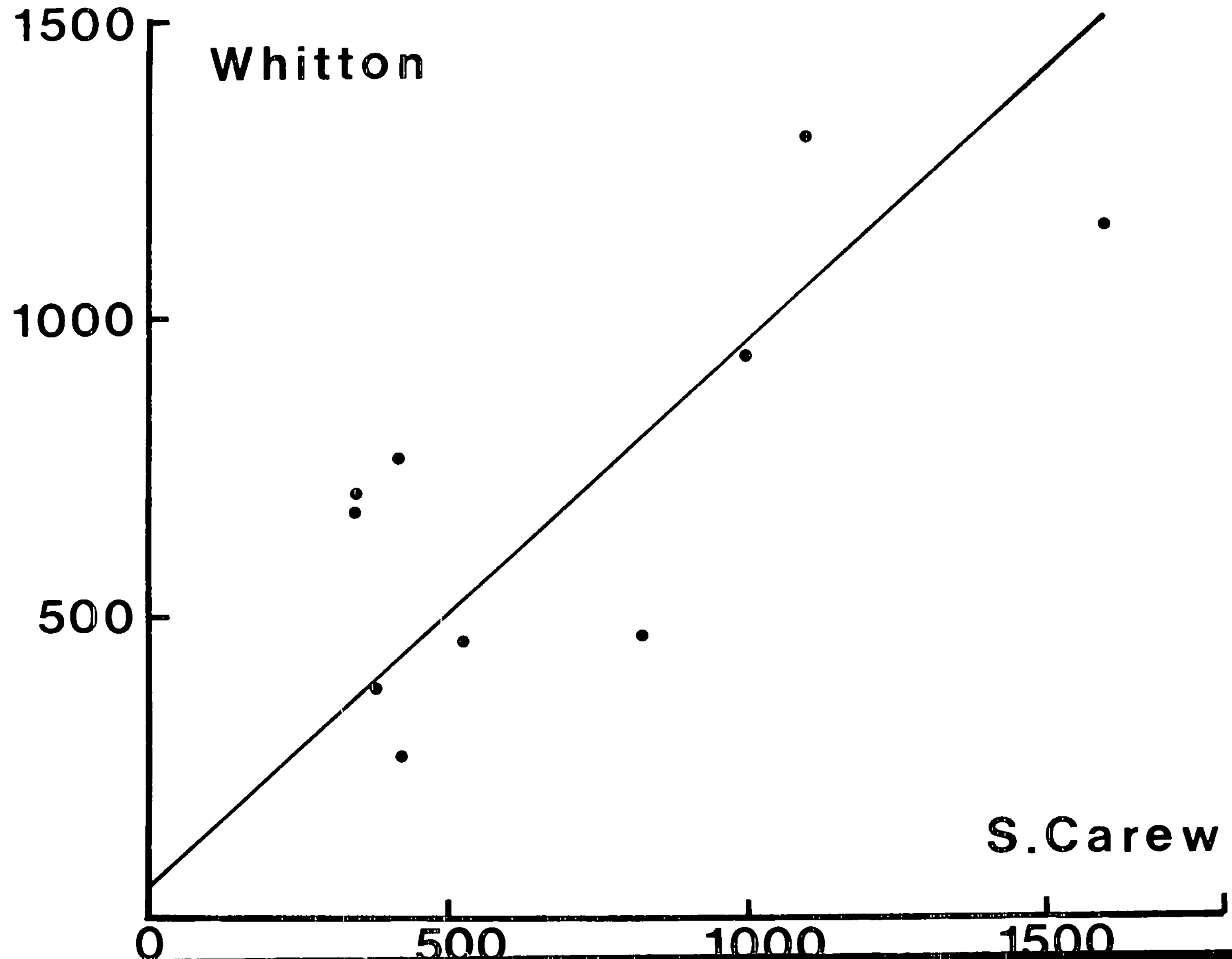
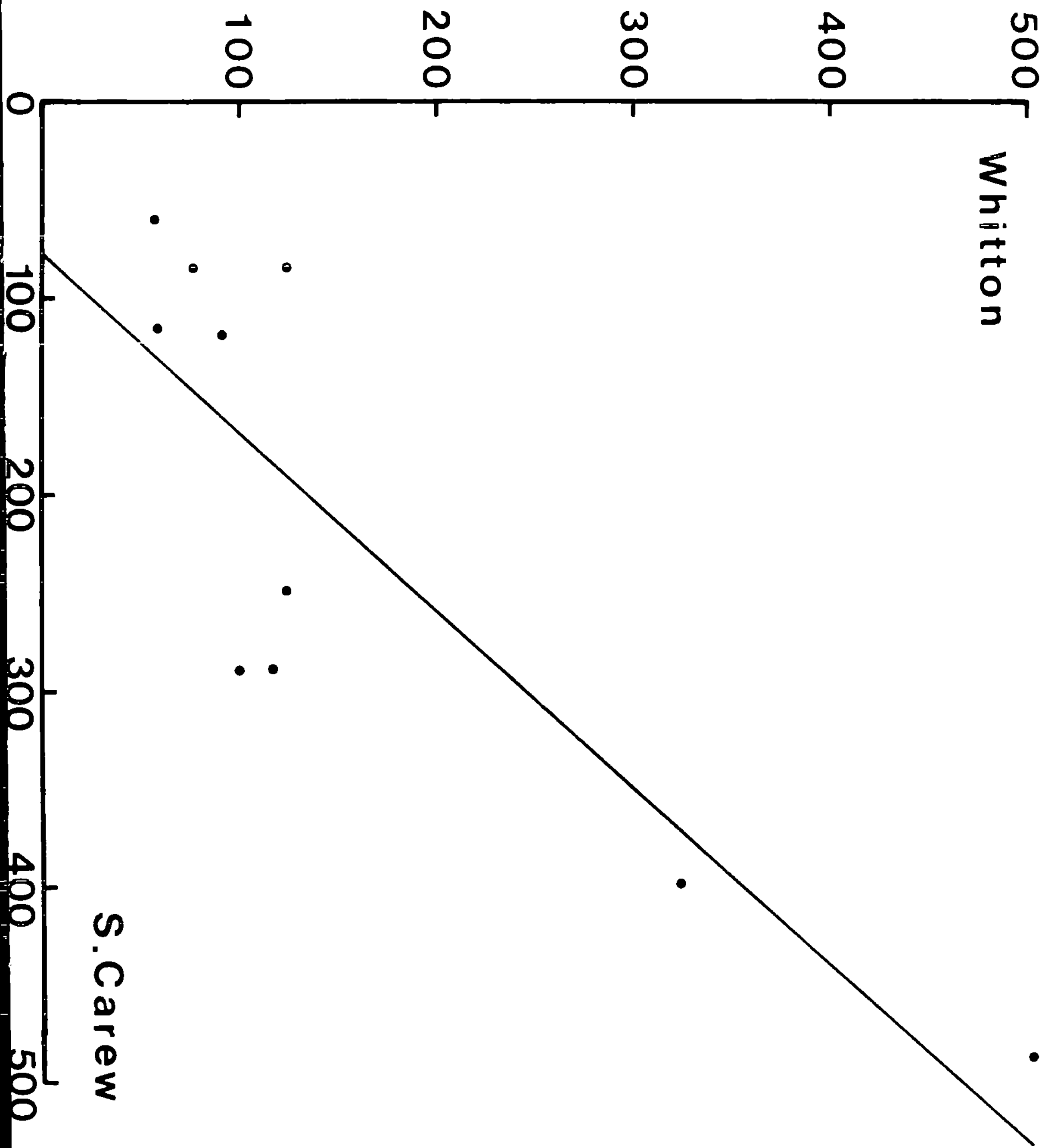

Whitton
1500
1000
500
0
500
1000
1500
S.Carew

Figure 8: The number of immature Herring Gulls present at Whitton and Seaton Carew tips on the same day. There was a significant correlation between the two ($r = +0.85$, 8 d.f., $p < 0.01$).

The regression equation is:

$$Y = 1.12x - 85.2$$


Whitton
S.Carew
0
100
200
300
400
500

present at Whitton and Seaton Carew tips on the same day. This suggests that the fluctuation in the number of gulls at Whitton tip was not due to a shifting of gulls from one dump to another. Similar wide fluctuations in the number of Herring Gulls present at refuse tips have been recorded elsewhere (Spaans, 1971 , Kilhman and Larsson, 1974). The means, standard deviations and coefficients of variance are given in Table 3 with respect to the number of adult and immature Herring Gulls counted at Whitton tip on 46 weekdays between September, 1974 and March, 1975. The relative variance did not differ significantly between the adults and immatures, and was high in each case. The immature Herring Gulls are known to make more use of other feeding sites in the area (p.68) and to vary their feeding site more than adults (p.93). It therefore seemed possible that different factors might influence their numbers at the tip, or that the same factors might act in different ways.

Table 3

Mean Number of Adult and Immature Herring Gulls Counted at Whitton Tip on 46 Week Days Between September, 1974 and March, 1975

	Mean No. Recorded	S. Deviation	Coefficient of Variation
Adults	431.5	269.3	62
Immatures	87.3	49.3	52

The relationship between the number of adult and immature Herring Gulls at Whitton tip and certain environmental variables was/

was tested using a BMD stepwise regression programme (see Appendix 10 for details). Several variables relating to weather, state of the tide and fishing factors were used. These applied both to the day on which the counts were made and also to the day prior to counting at the tip; it was felt that feeding success on one day might influence the choice of feeding site on the next.

Meteorological information was obtained from Newcastle Weather Centre. This related to coastal conditions measured at Teesport and Hartlepool throughout the day, and also to inland weather. Data relating to the amount of fish caught by inshore fishing vessels in the study area on particular days were made available by MAFF at North Shields. These records related to the total amount of fish caught measured in cwts (1 cwt = 50.8 kg); different species of fish were not separated for the purposes of analysis. The highest values related to the sprat fishing season, lasting from November until late January and early February. There was considerable variation between days with respect to the total amount of fish being caught.

Certain of the variables used were statistically insignificant: only the significant variables are considered here. Details of all variables used are given in Appendix 10.

The only significant variables were:

(a) Fishing success of inshore boats, converted to a logarithmic scale.

(b) Wind direction, measured as 0 = Onshore, 1 = Offshore.

Wind/

Wind speeds and other weather variables were not found to have any significant effects. However Kilhman and Larsson (1974) found that high wind speeds increased the number of gulls at tips in the Gothenburg area, while Grant (1969) stated that "frosty" weather increased the number of gulls at a tip in the Edinburgh area. On the other hand, Spaans (1971) found that under conditions of frost and high wind, the number of gulls at tips in the Friesland area was lowest.

Immatures

The number of immature Herring Gulls at Whitton tip was related significantly to the amount of fish being caught by inshore fishing vessels (log. scale) on the day prior to that on which the counts were made at the tip ($F = 9.20$, $d.f. = 1,44$, $p < 0.01$). There was no significant relationship between the number of immatures and the amount of fish caught on the day on which the counts were made. The regression equation for the significant factor was

$$\text{Number of immatures} = -16.44 \times \text{log. fish catch previous day} + 129$$

This accounted for 17% of the immature variance. The only other factor to have any appreciable effect was wind direction early in the morning of the day on which counts were made at the tip; this accounted for a further 5% of the variance in the number of immatures. The relationship was such that more immatures were recorded at the tip with an offshore wind than with an onshore wind. This factor was not however statistically significant.

Adults

The number of adult Herring Gulls present at Whitton tip was significantly related to wind direction early in the morning of the day on which the counts were made ($F = 11.6$, $df=1,44$, $p < 0.01$). The regression equation for this factor was

Number of adults = 320.99 x wind direction + 166

Thus as with the immatures, more adults were present at the tip when the wind was offshore rather than onshore. This accounted for 29% of the adult variance. This differed from the relationship reported by Schrieber (1968) who stated that Herring Gulls in Central Maine moved towards the coast with offshore winds and moved towards the dumps inland when there was little wind. Kilhman and Larsson (1974) however found that the effect of wind direction on the number of birds at tips in the Netherlands was negligible.

Table 4 gives the regression coefficients, and their standard errors for the relationships between log fish catch on the previous day and early morning wind direction (each taken singly), and the number of adult and immature Herring Gulls present at the tip. The regression coefficients for wind direction differed significantly between adults and immatures ($p < 0.01$). The difference between the regression coefficients for log fish catch on the previous day was not significant between the two age classes.

Table 4

Regression Coefficients for the Relationship Between the Number of Herring Gulls at Whitton Tip in the 1974/75 Winter Season and -log Fish Catch on the Day Prior to Counting & Early Morning Wind Direction (Both Independant Variables Taken Singly)

Dependant Variable	Independant Variable	Regression Coefficient (b)	S. Error of b	D.f.
No. of adults	log fish catch previous day	-21.00	32.39	44
No. of immatures	"	-16.44	5.41	44
No. of adults	early morning wind direction	320.99	94.22	44
No. of immatures	"	27.80	18.93	44

The relative effect of wind direction was much greater for adults than for immatures. The regression equation relating to the effect of wind direction alone on the number of immatures at Whitton tip was

Number of immatures = 27.8 x wind direction + 64

Thus, a change in wind direction from onshore to offshore resulted in a gain of 321 adults and 28 immatures at the tip or 74% and 31% of their respective means. A change in wind direction therefore had a much greater proportional effect on the number of adults than on the number of immatures at the tip.

The regression equation for the effect of log fish catch on the previous day on the number of adults at Whitton tip was

Number of adults = -21.00 x log fish catch previous day + 483

A unit change in this variable resulted in a loss of 5% of the mean number/

number of adults as compared with a loss of 19% of the mean number of immatures. A change in log fish catch on the day prior to counting at the tip had a proportionally greater effect on the immature Herring Gull numbers than on the adult numbers.

Discussion

Immature Herring Gulls which fed at the tip were known also to follow fishing boats (p.117) and to predominate over adults at this feeding site (p.68). There was however a time lag in the relationship between the number of immatures at the tip and the fishing success of inshore fishing vessels. This could be interpreted in at least three ways.

1. It is possible that the drop in the number of immatures at the tip on the day following a good catch by inshore boats relates to the availability of waste fish at the quayside on that day. There is however the problem of how the birds obtain this information. The extent to which young birds varied their use of fish docks in the area is unknown. Davis (1975a) found that there was a preponderance of adults over juveniles at fish docks in Pembrokeshire. (Juveniles referred to birds up to 13 months old.) Harris (1964) also reported that immature Herring Gulls visit fish docks less frequently than adults.

2. It could be suggested that the night roost is functioning as an "information centre", in the sense proposed by Ward and Zahavi (1973). That is, as a place where individuals, whose feeding success has been poor, obtain information relating to the availability of food elsewhere. Unsuccessful birds follow successful birds on the/

the next foraging trip. (There is of course the problem of how an unsuccessful bird recognises a successful bird.) It is unlikely that, other than on Sundays, birds feeding at the refuse tip would have an unsuccessful feeding day (p.106) and the refuse tip may be taken as constituting a relatively stable food supply. For this theory to work, immature birds would have to either <u>prefer</u> the food available around fishing boats to that obtained at the tip, or obtain more food at the former site. It is possible that, due to less adult competition, immature birds forage more successfully around fishing vessels than at refuse tips. There is at present no evidence of their being competitively excluded from the tips. However, since it is predominantly immature birds which follow fishing boats in the area this does indicate an effective preference for this site. Thus a bird which had been to the tip on one day, might, on the next day, follow individuals who had previously been feeding successfully around fishing boats.

3. A more probable explanation relates to the fact that immatures vary their feeding sites more than adults (p.93). On the day following a bad catch, birds which had previously been feeding around fishing boats may resort to another feeding site on that day. Since it is predominantly immatures which feed from the boats, this would result in a considerable increase in the number of immatures at tips on days following a bad catch. However, since the tip is a relatively stable food source and immatures do vary their feeding sites, it is possible that a certain proportion of immatures do not return to the tip on consecutive days, but switch to other feeding/

feeding sites. On days following a bad catch, this reduction in numbers would be more than compensated for by the gain of birds moving from feeding at fishing boats, to feeding at tips: thus a net increase in the numbers of immatures would be recorded. On days following a good catch however, there would be no movement of birds from the boats to the tips, and thus a decrease in number at the tip would be recorded. This does assume that immature Herring Gulls are more consistent with respect to feeding at fishing boats (provided their feeding success is high) than they are to feeding at refuse tips. The preponderance of immatures following fishing boats does suggest that this could effectively be a preferred feeding site. Nevertheless, fishing factors only accounted for 17% of the immature variance, and this was improved little by the addition of early morning wind direction. Thus certain other variables, some of which may relate to other kinds of feeding areas, have not been identified.

The data with respect to the number of adults at the tip suggest that the adults are acting in an anticipatory manner with reference to early morning wind direction in a way that immatures do not. Considering the factors which influenced the use of refuse dumps and mud flats in the Waddenzee area, Spaans (1971) suggested that

> "gulls make up their mind in the later part of the night, making allowance for direction and force of the wind".

That seabirds are to some extent responsive to weather factors was shown by Manowski (1971) in a study of the effects of meteorological factors on/

on the behaviour of 8 species of seabird feeding at sea. Since adults are known not to follow fishing boats in the area to any great extent (p. 68), the relationship with wind direction may be a reflection of the fishing success of the adult birds themselves. Much of these data relate to a time when dense shoals of sprats are present in inshore waters in the area (Cole and Holden, 1973). The weather factors which affect the availability of these fish to fishermen presumably also have some effect on their availability to Herring Gulls. Spaans (1971), quoting unpublished work, has suggested that Herring Gulls may prey selectively on sprats due to a preference for this very fatty fish.

For both adult and immature Herring Gulls, the number of birds at the tips was related to feeding conditions elsewhere. This is also illustrated by the fact that the highest number of gulls recorded at Whitton tip related to a period during which the success of inshore fishing boats in the area had been particularly low over several days. More than 1500 gulls were recorded at this tip on 29th November, 1973, and the numbers remained unusually high until 1st December, 1973. This co-incided with a period of prolonged offshore winds between 24th and 30th December, 1973, during which time there were only 5 landings by inshore vessels at North Shields, involving a total catch of 12 cwts of fish. In the preceeding week there were 99 landings and 790 cwts fish caught, and 86 landings involving 732 cwts of fish in the following week.

PART 2. THE BEHAVIOUR OF GULLS FEEDING AT TIPS

For the majority of the study, the tips at Whitton, Seaton Carew and Darlington were operative (p.7). Most of the observations were conducted at Seaton Carew and Whitton tips, the tip at Darlington being regularly visited only during the later part of the study. A total of 251 Herring Gulls and 61 Great Black-backed Gulls were ringed at the tips during the course of this study. Of the Great Black-backed Gulls ringed at Whitton tip, 43 were adults and 13 immatures. The number of Herring Gulls caught at Whitton tip over the 3 autumn and winter seasons during which observations were conducted are given in Table 1, according to age and sex classes of birds.

Table 1

Number of Herring Gulls Ringed at Whitton Tip During 3 Autumn and Winter Seasons

	Adult Male	Adult Female	Adult (? sex)	3/4th year	2 year	1 year
Ringed 1973/74	15	10	0	2	1	1
" 1974/75	30	20	2	7	8	32
" 1975/76	28	29	2	6	18	10
TOTAL	73	59	4	15	27	43

1. FREQUENCY OF SIGHTINGS

Table 2 shows, for the Herring Gulls ringed at Whitton tip, the number which were seen again in the study area subsequent to ringing. Relatively more adult males were seen again after ringing than females, but the difference is not significant; significantly fewer immature Herring Gulls were seen again in the study area after ringing than adults ($p < 0.05$). Twenty-eight of the Great Black-backed Gulls were seen again after ringing and 28 were not; there was no significant difference between adults and immatures. The observed ratio for Great Black-backed Gulls did not differ from that of immature Herring Gulls ($X_1^2 = 0.01$), but did differ significantly from that of adult Herring Gulls ($X_1^2 = 4.36$, $p < 0.05$).

Table 2

Number and Percentage of Herring Gulls Ringed at Whitton Tip which were seen again in the Study area after Release. The Difference Between male and female is not significant ($X_1^2 = 0.75$). The Difference Between Adults and Immatures (3/4 year + 2 year + 1 year) is Significant ($X_1^2 = 5.46$).

	Adult Male	Adult Female	Adult (? sex)	3/4 year	2 year	1 year
Number ringed	73	59	4	15	27	43
Number seen again	52	37	2	8	13	22
% seen again	71	63	50	53	48	51

The number of times a bird was seen at the tips is dependant not only upon the behaviour of the bird itself, but also on the number/

number of times the tips were visited after the bird's release, and on the date of ringing relative to the onset of the breeding season when the adult gulls leave the area. These difficulties can be overcome to some extent if, in comparing the frequency of sightings, birds ringed within the same period are considered. Birds ringed prior to this period are also included; the first sighting during the specified ringing period is taken as being equivalent to capture, and all sightings prior to this date are ignored. Table 3 shows the average number of sightings per bird at refuse tips in the study area, during the 1974/75 season, for Herring Gulls ringed between 19th November and 18th December, 1973. All birds which were not seen subsequent to ringing are excluded.

Table 3

Mean and Median Number of Sightings at Tips in the Study Area, During the 1974/75 Season, of Herring Gulls Ringed Between 19th November and 18th December, 1974. Difference between male and female not Significant. (U = 151, z = 0.07). Difference between Adults and Immatures Significant. (U = 128, z = 4.08, p = 0.00003.)

	No. of Birds	Mean No. of Sightings	Median No. of Sightings
Adult male	27	2.9	3
Adult female	13	3.9	5
Immatures	19	1.6	1

An individual bird which regularly visited the tips considerably alters the mean value and the data are not normally distributed. Figure 1 shows the number of sightings of each of these 59 birds during/

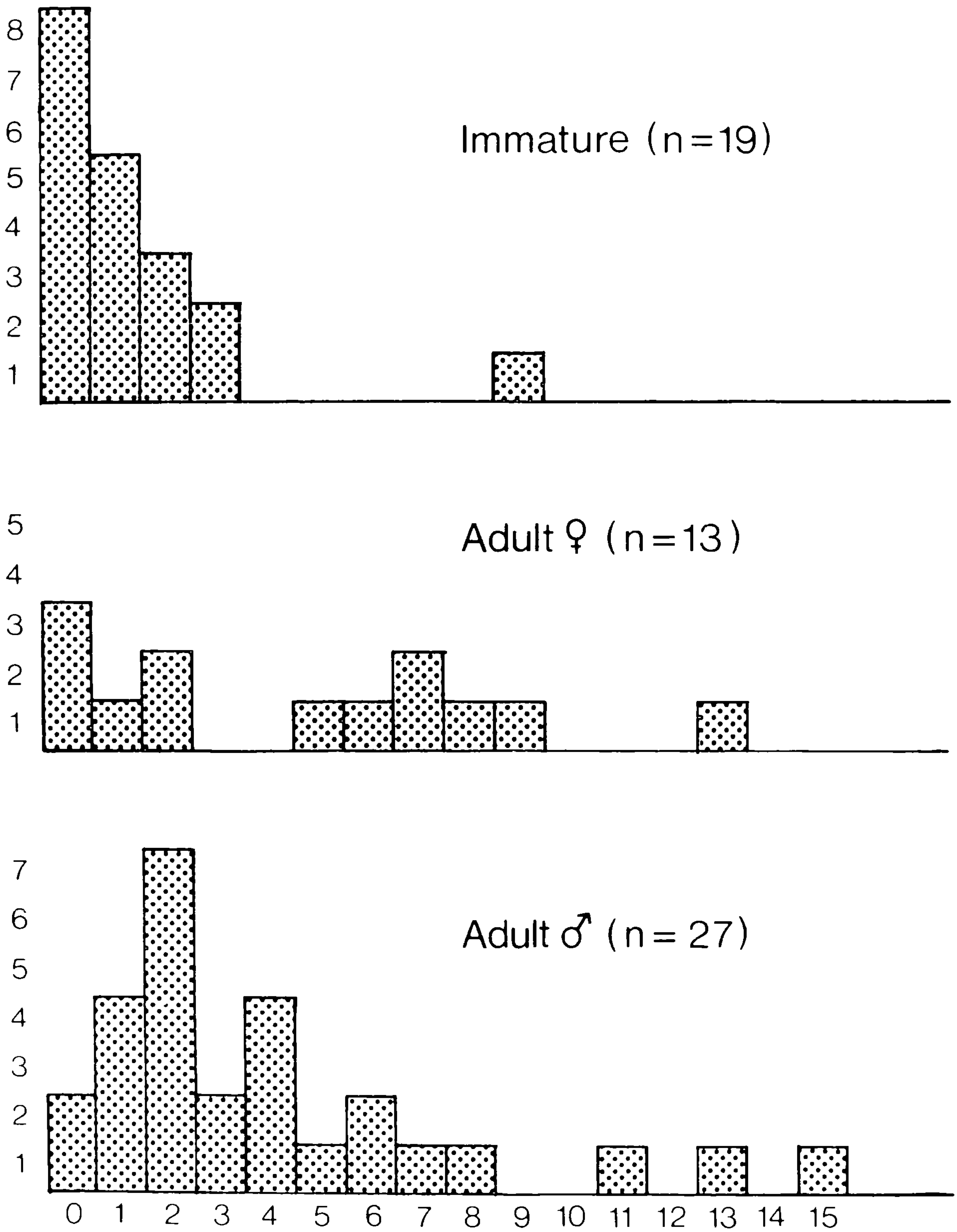
during the 1974/75 season, emphasising the individual differences. When compared using the Mann Whitney U test, the difference between the adult male and female Herring Gulls was not significant; there was however a significant difference between adult and immature Herring Gulls, the immatures being seen less often (Table 3).

Significantly fewer colour-ringed immature Herring Gulls were seen again at tips in the study area after ringing than adults. Considering birds ringed at the same time and subsequently seen again, immature Herring Gulls were seen significantly less often than adults. This is in agreement with the pattern of attendance at the tip by adults and immatures as a whole (p. 65), there being less immatures at the tip than expected. Similarly, Davis (1975b), observing individually marked Herring Gulls feeding at fish docks and refuse tips in the Milford Haven area, found that immatures were seen less often than adults.

2. RETURN BETWEEN YEARS

The Northeast of England is a wintering area for Herring Gulls which breed in more northern regions. Much of this information comes from recoveries during the breeding season of adults ringed in Northeast England during the winter months. Some adult birds ringed at tips during this study were seen elsewhere during the breeding season and returned again to the study area the following autumn/winter. Details of sightings of colour-ringed birds during the breeding season with the dates seen in the study area before and after this sighting are given in Table 4./

Figure 1: The number of sightings at tips in the study area of 59 Herring Gulls caught at Whitton tip between 19 November and 13 December, 1974. This emphasises the individual differences. The difference between adults and immatures is significant (Table 3).



Immature (n=19)
Adult ♀ (n=13)
Adult ♂ (n= 27)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

No Herring Gulls ringed in winter during this study were found breeding in local colonies (p.14).

Table 4

Details of Sightings of Colour-ringed Birds During the Breeding Season, and Dates Seen in the Study Area Before and After the Sighting

Age Sex	Date Ringed	Place Ringed	Last seen in Study Area	Sighting During Breeding Season	Next seen in Study Area
Adult male	21.11.73	Thorpe Thewles	10.12.74	14.2.74 Caithness	8.1.75
Adult male	23.11.73	"	19.12.73	8.7.74 Sutherland	9.8.74
Adult female	17.12.74	Whitton	17.12.74	4.6.74 Isle of May	14.10.75

Table 5 shows, for birds ringed in the 73/74 season, details of the return between years for different age and sex classes. A larger number of birds was ringed in the 74/75 season, and Table 6 gives details of their return in the following year (i.e. 75/76).

Table 5

Details of the Return to the Study Area Between Years of Herring Gulls Ringed at Whitton Tip During the 1973/74 Winter Season

	Total No. Ringed 1973/74	Total No. seen Subsequent to Ringing	No. seen in 1973/74	No. seen in 1974/75	No. seen in 1975/76
Adult male	15	13	5	8	5
Adult female	10	7	2	5	2
3/4th year	2	1	0	1	1
2 year	1	0	-	-	-
1 year	1	0	-	-	-

Table 6

Details of the Return of Herring Gulls, Ringed at Whitton Tip During the 1974/75 Winter Season, to the Study Area in the 1975/76 Season

	Total No. Ringed 1974/75	Total No. seen Subsequent to Ringing	No. seen in 1974/75	No. seen in 1975/76
Adult male	30	21	18	12
Adult female	20	16	8	11
3/4th year	7	6	4	2
2 year	8	5	3	4
1 year	32	19	13	7

A number of Herring Gulls were not seen in the study area during the season in which they were ringed, but were seen in the area in subsequent seasons. This suggests that these birds made only/

only very transient use of the tips in the study area. Table 7 shows the number of Herring Gulls seen during the season in which they were ringed, and the number seen only in seasons subsequent to ringing.

Table 7

Number of Herring Gulls Ringed in 1974/75 which were Seen During that Season, and only in Subsequent Seasons. Difference Between Males and Females Significant ($X^2_1 = 3.96$). Difference between Adults and Immatures not Significant ($X^2_1 = 0.002$)

	No. seen During Ringing Season	No. seen only in Seasons Subsequent to Ringing
Adult male	18	3
Adult female	8	8
Immature	20	10

There was no significant difference between adults and immatures and in each case, approximately 50% of the birds ringed in 1974/75 were seen again that season. There was a significant difference between adult males and females; relatively more adult females were not seen again in the study area until the season following that during which they were ringed ($p = 0.05$). This suggests that females were less consistent to the feeding areas under study than males. Adult female Herring Gulls were however found to vary their feeding sites within the study area more than males (p.93). Therefore to what extent the more transitory use of tips by these females represents less consistency to the area as a whole, or to refuse tips as a feeding site, is unknown. When the/

the data for birds ringed in 1973/74 are combined with that for 1974/75 ringed birds, the difference between males and females is no longer significant, though the trend remains the same (Table 8).

Table 8

Number of Herring Gulls seen During the Season in which they were Ringed and the Number seen only in Subsequent Seasons. Pooled Data for 1973/74 and 74/75 Seasons. Difference between male and female not Significant ($X^2_1 = 2.37$)

	No. Seen During Ringing Season	No. Seen only in Seasons Subsequent to Ringing
Adult male	23	11
Adult female	10	13

Table 9, based on birds ringed in both seasons, shows the total number of adult male and female Herring Gulls which returned to the study area in the season following that in which they were ringed. (Only birds known to have died (1 adult male and 1 adult female) are excluded from this analysis: birds for which there was no information are included since the adult mortality rate in Herring Gulls is low.) The difference between the sexes is not significant and the majority of birds returned to the study area in the following season.

Table 9

Number of Male and Female Herring Gulls which Returned to the Study Area in the Season Following that During Which they were Ringed. (Pooled Data for 1973/74 and 1974/75 Ringed Birds; Those known Dead are Excluded.) Differences not significant (adult male and female $X^2_1 = 0.405$; adults and immatures, $X^2_1 = 2.75$)

	No. seen in the Season Following Ringing	No. not seen in the Season following Ringing
Adult male	20 (61%)	13 (31%)
Adult female	16 (73%)	6 (27%)
Immatures	14 (45%)	17 (55%)

From these data, it appears that the majority of adult Herring Gulls of both sexes showed consistency to the study area, returning to this wintering area in consecutive years, though breeding in other areas.

The majority of immature Herring Gulls were not seen again in the study area during the season following ringing, but the difference between immatures and adults is not significant (Table 9). Of the 3 adult Great Black-backed Gulls ringed in 1973/74 and seen again that season, 2 were seen at tips in the study area in the following season; none of these birds were seen in the 1975/76 season. One immature Great Black-backed Gull was ringed and seen again in 1973/74, and this bird was also seen in 1974/75 and 1975/76. Eight adult Great Black-backed Gulls were ringed and seen again in 1974/75 and 5 were seen again in 1975/76; both immatures ringed in 1974/75 were seen again the following season. There are insufficient data for the Great Black-backed Gull to enable a meaningful comparison with the Herring Gull. The trend however appears similar, in that the majority of ringed Great Black-backs returned to the study area during the season following that in which they were ringed, though breeding elsewhere (p.24).

3. UTILISATION OF DIFFERENT TIPS

From October 1973 until January 1976 the tips at Whitton, Seaton Carew and Darlington were operative (p.7). Sightings of individually colour-ringed birds gave some information on the extent to which a bird visited more than one of the tips within the study area. Although a bird was not seen at a tip other than that/

that at which it was ringed, it cannot be said that it never visited the others. Nevertheless, frequent searches were made at Seaton Carew and Darlington, both by myself and others. If a bird regularly used another of these tips it would have been seen there. The frequency of sightings at tips other than the ringing site is low for both adults and immatures (Table 11). This is the case for birds ringed at Whitton tip and for those ringed at the other tips. Table 11 shows, for birds ringed at Whitton, the total number of sightings of these birds at Whitton tip, and at other tips. Immatures were seen more often feeding at other tips than adults ($p < 0.01$) and females were seen more often at other tips than males ($p < 0.01$).

Table 11

Total number of sightings of Herring Gulls, Ringed at Whitton, at this and Other Tips. Difference between male and female significant ($X^2_1 = 8.85$). Difference between Adults and Immatures Significant ($X^2_1 = 8.07$).

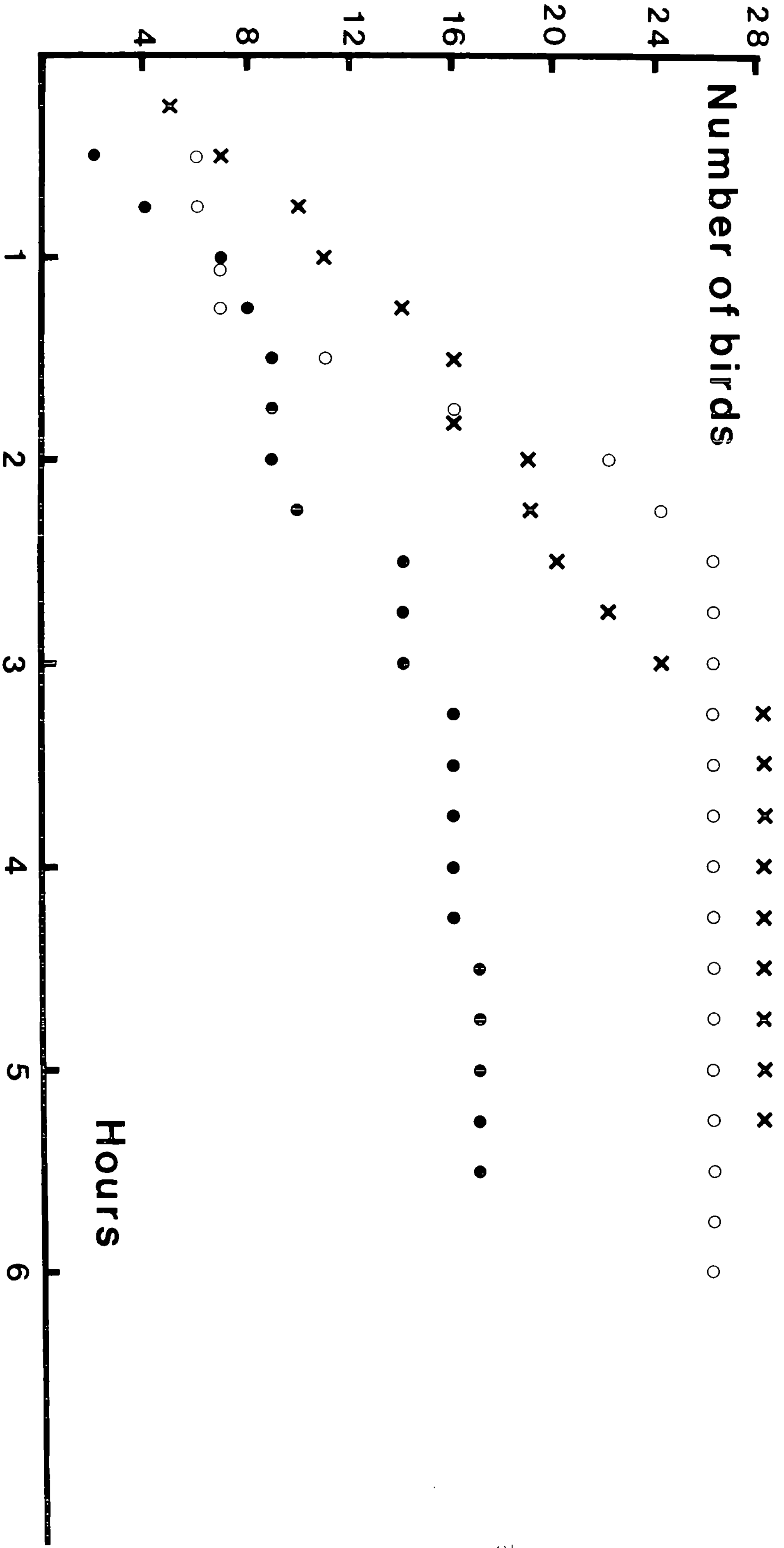
	Adult Male	Adult Female	Immature
Number of sightings at Whitton tip	206 (92%)	114 (81%)	74 (76%)
Number of sightings at other tips	17 (8%)	26 (19%)	24 (24%)
(Number of birds)	(45)	(33)	(37)

Davis (1975b) also found that immature Herring Gulls used more feeding sites than adults. However, for a bird which is infrequently seen, it is not always possible to ascertain whether this means the/

the bird has left the area, moved to another type of feeding site within the same area, (or alternatively died). When the tips were visited, not all of the colour-ringed birds were seen, though some birds were seen more often than others. While the maximum number of sightings of an individual bird was 31, some birds were seen only once subsequent to ringing. Finding colour-ringed birds on a tip is a difficult and time-consuming task, necessitating continued and concentrated scanning over a considerable time period. Various activities in which birds might be engaged prevent the colour-rings from being seen, (e.g. bathing, sitting, roosting, etc.). If only a short search is made, several of the birds present will probably be missed. Thus while it is often possible to state that a particular bird was present at a tip on a certain day, it is not always possible to state that it was not present on another. Figure 2 shows the cumulative number of colour-ringed Herring Gulls identified during periods of continued search on 3 separate observation days. It can be seen from this graph that a minimum of $3\frac{1}{2}$ hours searching is required in order to state that more than 95% of colour-ringed birds have been located. Individual birds have been observed sitting stationary in roosting or loafing areas for as much as 2 hours. The time spent searching for colour-ringed birds at a tip must be longer than the maximum period during which a bird could be engaged in activities which obscure the colour-rings. The chances of an individual bird being seen at a tip vary not only with its presence or absence, but also with the intensity and duration of the search made by the observer. Searching was not always such that all colour-ringed birds present would have been located on each visit to the tips.

In/

Figure 2: The cumulative number of colour-ringed Herring Gulls identified during periods of continuous searching on 3 separate observation days. (20 November, 1975, 15 December, 1975, 20 January, 1975).



Number of birds
Hours
4
8
12
16
20
24
28
1
2
3
4
5
6

In order to ascertain to what extent individual birds, known to be in the area, attended a particular tip within a certain period, Whitton refuse tip was visited every day from 13 - 20 January, 1975. An intensive search was made for colour-ringed gulls on each of these days for a minimum of 4 hours. A total of 31 Herring Gulls were observed during this period (16 adult males, 9 adult females and 6 immatures). The number of gulls visiting the tip was consistently low on Sundays (p.71), and this day is excluded from the analysis, leaving 7 possible days on which gulls might be expected to frequent the tip. Of the 7 possible days on which the birds could have attended the tip, only one bird (1st year) was present on all seven. The mean and the median number of days attended is given in Table 12 for each age and sex class.

Table 12

Mean ($\bar{x}$) and median (M) number of days Herring Gulls Attended Whitton Tip Out of 7 Possible Days. No Significant Differences. (U adult male and female = 42; U adult and immature = 39, z = 1.5)

	No. of birds	$\bar{x}$ days present	M days present
Adult male	16	2.4	2
Adult female	9	3.1	2
Immature	6	2.8	2

There was no significant difference in the number of days attended by adult males and females, or by adults and immatures. Eight adult Great Black-backed gulls were also present during this 7 day period, and the median number of days attended by these birds/

birds was 3.5. This did not differ significantly from that of adult Herring Gulls, (U = 18, z = 0.63).

Thus, though these birds were known to be alive and in the area, they did not feed at Whitton tip every day. It is possible that some may have fed at other tips in the area when not at Whitton; for certain individuals this is however unlikely (p.113). Other than information relating to those individuals seen feeding at fishing boats or foraging on the shore (p.117), the extent to which individuals used other sorts of feeding sites is unknown.

There was no tendency for individual gulls caught at the tip on the same day to occur together subsequently, nor was the presence of any one individual at the tip found to be associated with the presence of another.

4. TOTAL NUMBER OF HERRING GULLS USING WHITTON TIP

Individual Herring Gulls did not feed at Whitton tip every day (p.96). During the period 13 - 20 January 1975 (Table 12), 25 adult Herring Gulls were present at Whitton tip on average 2.7 days, or 38% of the 7 possible days. Immatures were present 2.8 days (40%). The number of Herring Gulls present at Whitton tip on any one day thus represents only a proportion of the total number which use the tip. This proportion changes in relation to feeding conditions elsewhere (p.82). In order to calculate the number of Herring Gulls using the tip, the number of colour-ringed individuals present on any one day were used in a "Lincoln Index" capture-recapture type estimate. It was assumed that the behaviour/

behaviour of the colour-ringed individuals was representative of the behaviour of the overall population of Herring Gulls using the tip. In estimating the population in this manner, it was necessary to account for the fact that certain colour-ringed birds may have left the area, in effect "emigrated" from the population. To account for this the number of marked gulls "available to be seen" on any one day was taken as the total number of individually colour-ringed gulls which had been seen in the study area 2 weeks before and after that particular day. The Lincoln Index estimate of a population is calculated by the formula

$$\text{Total population} = \frac{\text{total No. of individuals originally marked} \times \text{No. of individuals in sample}}{\text{number of recaptures}}$$

On any one day at Whitton tip, the number of colour-ringed Herring Gulls "available to be seen" wasequivalent to the original number marked, the total number of birds present at the tip to a "sample" of the population, and the number of colour-ringed birds present to the number of recpatures. Estimates of the number of Herring Gulls using Whitton tip were made for 15 days between 20 November, 1974 and 25 January, 1975: on each of these days a minimum of 4 hours was spent searching for colour-ringed birds: at least 95% of the colour-ringed gulls present would therefore have been seen (p.94). The overall population estimates obtained for adults and immatures are given in Table 13. Between 19 and 55% of the colour-ringed birds "available to be seen" were present at Whitton tip on these days. The estimates of the total population obtained by this method were in good agreement, particularly for the adults (Table 13).

Table 13

Estimates of the Total Population of Herring Gulls Using Whitton Tip in the 1974/75 Season, Using the Number of Colour-ringed Individuals Present in a Lincoln Index Type Estimate

	No. of Estimates	Mean Estimate of Population	S. Deviation	95% Confidence Limits
Adults	15	2120	475	1864 - 2376
Immatures	15	356	149	265 - 447

Whitton tip was thus used by just over 2000 adult Herring Gulls and 350 immatures in the 1974/75 season. This was not a closed population, but subject to some emigration and immigration. Using the mean number of gulls present at the tip in that season (431 adult Herring Gulls and 87 immatures), on average 22% of the adults which used the tip were present, and 24% of the immatures. This suggests that alternative food sources were used extensively by the Herring Gulls in the Teesmouth area.

5. FEEDING STRATEGIES

The domestic refuse tip generally offers a range of habitats to the birds which frequent it, and the relative size of these different areas varies both with the size of the tip and the condition of the refuse being dumped. The habitats found on the domestic tip were reviewed in detail by Darlington (1969). The following general description applies to the tips in this study, in which most, if not all, of the refuse dumped was untreated: it had not been incinerated or/

or processed in any way, other than by compression. Theee tips thus differed slightly from those described by Gibbs (1962) in which incinerated or processed refuse prevailed.

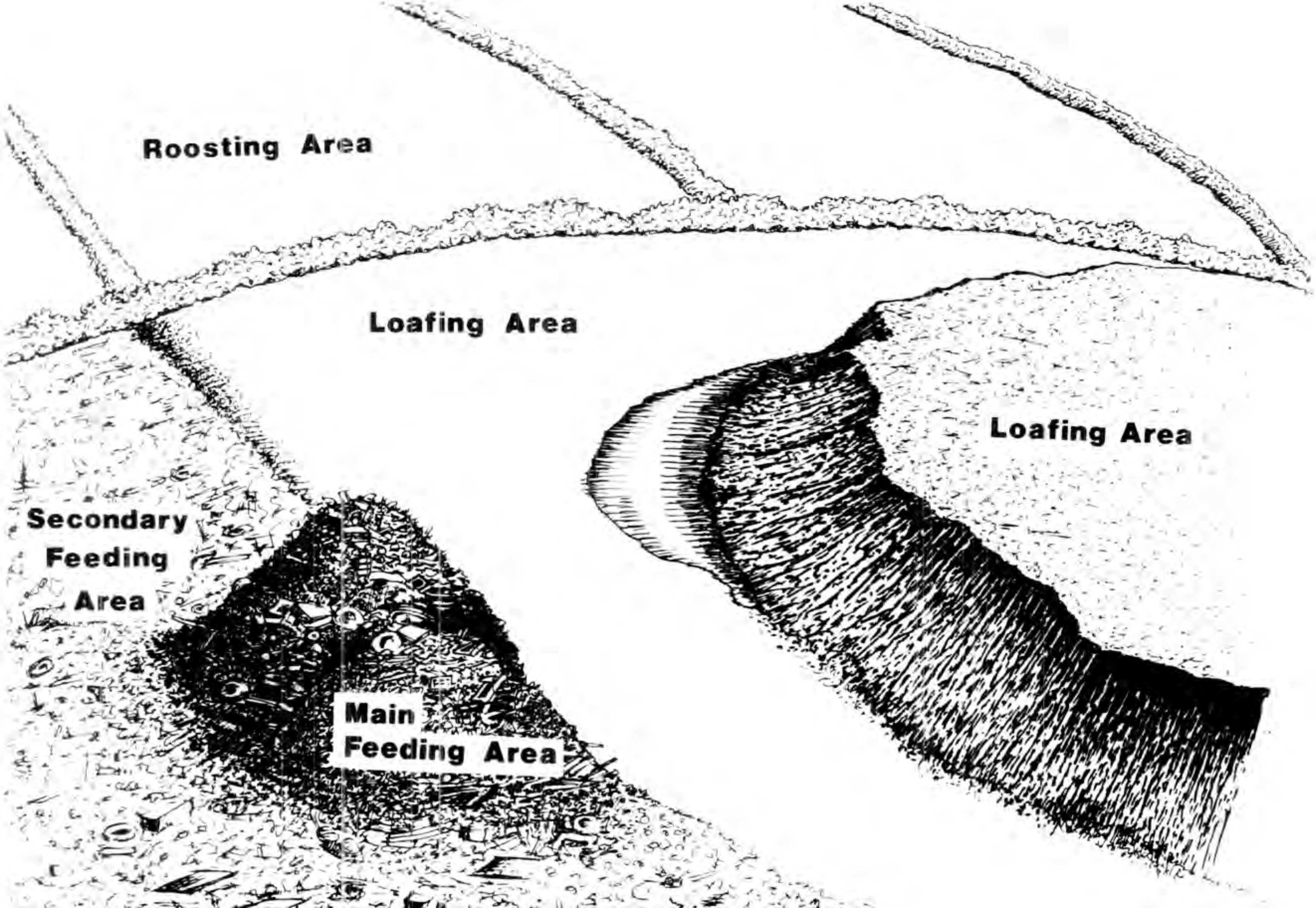
(1) Feeding areas (Figure 3)

Two distinct feeding areas occur on the refuse tips. A main feeding area, being the area upon which dumping is taking place at any one time, and a secondary feeding area, upon which dumping has only very recently ceased. The spatial location of these areas is constantly changing with the pattern of dumping. The relative availability and abundance of food on both areas differs.

(a) The main area is small, and characteristically has a high disturbance factor associated with it (due to the presence of lorries, workmen, etc.), which prevents the gulls from feeding. The food becomes available whenever there is a lull in tipping activity and particularly when heaps of refuse are levelled out by bulldozing. Food in the main area is thus concentrated in time and space. It is however abundant, and is not depleted as a consequence of the feeding activities of the birds, since it is constantly replenished by incoming refuse.

(b) The secondary feeding area is a larger, though still localised, area over which refuse has previously been spread by bulldozing, and may also be partly covered with loose earth. The food is more dispersed and is presumably less abundant than on the main area, since the material has already been fed upon to some extent by gulls at the time of dumping. There is little activity by workmen on the secondary area, and the food, though dispersed, is available to the birds other than when a major disturbance flushes gulls from the tip/

Figure 3: General layout of the different areas used by gulls at tips in the study area.



Roosting Area
Loafing Area
Loafing Area
Secondary Feeding Area
Main Feeding Area

tip as a whole. Though the secondary feeding area changes with the dumping pattern it is not replenished by incoming refuse and the abundance of food on one particular area decreases with time spent feeding.

(2.) <u>Other areas</u> (Figure 3)

(a) Loafing areas: a loafing area is a region of the tip where gulls collect together, and sit, stand, sleep or preen. No feeding normally takes place on these areas, and more than one loafing area is often in use simultaneously. Loafing areas may either be flat open areas on which tipping has not yet taken place, or terraces of consolidated refuse material which have previously been levelled out and covered with earth.

(b) Bathing pools: pools of water tend to collect in excavated or natural hollows on the tip. Such pools are extensively used by the gulls for drinking, and also for bathing between feeding bouts.

(c) Temporary roosting flocks of gulls collect in fields or open areas at varying distances from the tip itself during the course of the day, generally in sites such that the tip remains visible to the roosting birds.

(3) <u>Different feeding techniques</u>

As stated above (p.101) there are two distinct feeding areas on the refuse tip which differ in size, in abundance of food, and in the time available for feeding. Two different feeding techniques are used by gulls on these areas.

<u>Active Feeding</u>, refers to feeding on the main area. Food in this area/

area is highly localised in time and space, abundant, and constantly being replenished. Feeding in this area characteristically involves periodic rushes of gulls on to the exposed refuse: the birds feed in very dense flocks and cover a very small area when searching. Food is swallowed rapidly, and any pieces which cannot immediately be swallowed are taken elsewhere. This is similar to the "all in" behaviour described by Crook (1953) with reference to gulls feeding in estuarine areas.

Patrolling refers to feeding on the secondary area on which there is relatively little disturbance caused by dumping activities. The birds do not form dense flocks, and are spread out over the available area. The technique involves much walking, the bird scanning the surface for food scraps. A particular patrolling area is depleted with time, but new areas are constantly being formed.

(4) Time available for feeding

The amount of time during which feeding takes place on the two areas varies considerably, depending largely on the disturbance factors prevailing on a particular day. The secondary area is always available for longer periods than is the main area. Gulls are present in the area of the tip between ca 08.30 and 15 - 16.30 GMT (depending on light conditions), and are present on the tip itself 70 - 80% of this time, being absent during periods of major disturbance when all the gulls move on to the roosting areas. Active feeding takes place 30 - 40% of the time during which gulls are on the tip, and patrolling 60 - 70%. It must be emphasised however, that these represent only general figures, since the pattern varies greatly from day to day.

(5) Proportion of gulls engaged in different activities

There are four main activities in which gulls at refuse tips can engage. These are loafing, roosting, patrolling or active feeding. The numbers of Herring Gulls engaged in these different activities were counted throughout eight observation days, both when feeding was taking place in the main area and also when it was not. When the main area was available (20 counts), on average 34% of the birds were feeding in this area; of the remainder, 8% were loafing, 24% patrolling and 68% roosting. When the main area was not available, 16% were loafing, 23% patrolling and 62% roosting. There was a significant difference ($p < 0.001$) in the proportion of birds engaged in the remaining three activities when active feeding was taking place and when it was not (Table 14).

Table 14

The Number of Herring Gulls Engaged in Loafing, Patrolling and Roosting when Active Feeding was taking place, and when it was not. This is Based on the Summation of 33 counts throughout 8 Observation Days. There is a significant difference between the two $\chi^2_2 = 285$)

	Loafing	Patrolling	Roosting
Active feeding ongoing	944	2703	7666
No active feeding	1616	2242	6371

This difference was largely due to an increase in the proportion of birds loafing, which doubled during periods when the main area was not available. The proportion of birds patrolling did not change significantly. This suggests that, when the main area was not available, birds which would otherwise have fed in this area/

area did not move on to the secondary area to forage, but usually joined loafing flocks. The loafing area thus, in addition to being a resting place between feeding bouts, also serves as a place in which gulls "sit and wait" for the main area to become available. It must again be emphasised that this pattern did vary to some extent and, during periods of very prolonged disturbance on the main area, the percentage of birds foraging on the secondary area increased.

(6) Time spent feeding by individuals

It is extremely difficult to keep a marked gull under constant surveilance for long periods when feeding. The bird moves over the feeding area and may be lost from view for varying time intervals. However, when a bird is loafing or roosting, it is possible to observe the duration of periods during which the bird is known not to be feeding. Individual Herring Gulls were observed to remain on loafing areas for as much as 3 hour periods, during which time other gulls were often feeding. Table 15 shows the mean loafing time for 4 birds observed on different days. There was no evidence of any abnormal disturbances which prevented the birds from feeding during the time in which they were loafing. These figures represent only the minimum loafing time.

Table 15

Maximum Time Herring Gulls Could Have Spent Feeding, Based on Time Observed Loafing

Mean time observed loafing	% Time not Feeding	Maximum % Time Left for Feeding
2.4 hrs	34	39

Using a potential total time at the tip of 7 hours, these birds definitely did not feed for 34% of this time. Feeding would have been possible for a maximum of 60% of the remaining 4.6 hours; this means that the birds could have fed for 3.8 hrs, i.e. a maximum of 39% of the 7 hours spent at the tip. It is most unlikely that the birds were feeding the whole of the available time during which they were not loafing: it is not known for example how much of this time was spent roosting in fields adjacent to the tip. Since active feeding took place 30 - 40% of the time during which Herring Gulls were present on the tip, and involved on average 34% of the birds, individual gulls will spend in the region of 10 - 14% of their time feeding in the main area. Similarly, patrolling took place 60 - 70% of the time, involving 24% of the birds: individual gulls using this secondary area will spend 14 - 17% of their time feeding.

These observations suggest that an individual Herring Gull spends only a relatively small percentage of its time feeding at a refuse tip, probably around 10 - 17% depending upon the area utilised. This is not governed solely by disturbance factors which prevent the birds from feeding. Lloyd (1968) stated that Herring Gulls feeding/

feeding inland in the Ythan Valley, Aberdeenshire spent under half their time feeding, while Pearson (1968) stated that Lesser Black-backed Gulls feeding on the Farne Islands, Northumberland spent, depending on brood size, between 11 and 32% of the available time foraging. Other bird species have also been shown to spend only a small percentage of their time foraging, for example the Oystercatcher 8% (Drinnan, 1957) and the Sea Eagle 17% (Brown, quoted by Curio, 1976).

(7) Differences between active feeding and patrolling

Food in the main feeding area is relatively more abundant and the birds more densely packed in this area than in the secondary area. The extent to which this affects feeding success was studied by observing individual birds for "focal" periods of 1 min duration (Altman, 1974). This was the maximum time during which an individual could be kept under constant surveilance when feeding in the main area. It was rarely possible to identify food items taken by the birds, though it was possible to record when an item was swallowed. Feeding success was compared in the two areas with respect to the number of items swallowed per minute of observation. It is probable however that the quality of the food varied between the two areas, and that larger items were taken in the main area. The birds may also have swallowed non-food items on some occasions. However, with respect to "finding something worth swallowing", the mean number of swallows/min was 4 times greater in the main area than in the secondary area and the difference between the two areas was significant ($p = 0.00006$) (Table 16). Also recorded were the number/

number of aggressive encounters in which the sample bird, either as aggressor or recipient, was involved/minute of observation. These encounters generally involved displacement from food or food stealing and were characterized by high intensity threats, jabbing and attacks (Tinbergen, 1959). The mean and median number of encounters/minute was greater for active feeding than patrolling birds (Table 16). The difference was significant ($p = 0.00006$).

Table 16

Mean Number of Swallows and Encounters/minute ($\bar{x}$) for Patrolling Birds and Active Feeding Birds. Significant difference between the number of swallows ($U = 24$, $Z = 4.70$) and number of encounters ($U = 22$, $Z = 4.75$)

	No. of Samples	$\bar{x}$ Swallows/ Minute	Median	$\bar{X}$ Encounters/ Minute	Median
Active feeding	16	1.33	1	1.81	1
Patrolling	25	0.32	0	0.56	0

Birds feeding in the main areas thus swallow more items per unit time than do patrolling birds; they are also involved in more aggressive encounters per unit time than are patrolling birds. Using Carrion Crows feeding on hidden pastry larvae, Croze (1970) showed that the amount of effort expended by a bird to find each food item increases with scattering of the food. Though on the refuse tip there is more diversity of food items than in Croze's experimental situation, it is probable that patrolling birds expend more effort in finding food since they cover a larger area and find fewer items per unit time than do birds feeding in the main area. The secondary feeding area is however available for longer periods and/

and the lower feeding rate in this area may be compensated for by the longer foraging time. Nevertheless, it is likely that the higher feeding success in the main area is due to the superior quality of the food items.

In Royama's (1970) concept of the "profitability of hunting", the predator allots searching time to the most rewarding patches so as to maximise its yield. It is possible that patrolling birds are those individuals which cannot sustain the high level of aggressive encounters characteristic of the active feeding technique, and would loose the majority of food items found in this area to other birds. Feeding by patrolling could maximize food intake for these birds, since, although they must feed for longer periods, they are able to swallow most of the food items which they find. Those birds which can sustain a high level of aggressive encounters could maximise their food intake by feeding for short bouts on the main area; they will also profit by robbing other gulls feeding in close proximity to them. These two feeding techniques, active feeding and patrolling could represent optimal methods for the birds involved, thus being true strategies in the sense defined by Curio (1976) as -
"a hunting 'method', 'technique', or 'tactic', that has been shown to be functionally superior to any alternate behaviour of the predator concerned".

Curio states however that if this were the case -
"there would be reason to believe that the 'method' concerned has been evolved specifically to cope with a certain prey or prey situation".

There/

There is no suggestion here that these behaviours have evolved to cope with refuse tips, but rather that this intraspecific difference is both acquired and adaptive. The two different strategies may reflect differential abilities of the birds to gain access to clumped food sources irregularly available on the shore, such as carrion. The periodicity with which the main area becomes available may have led to the adoption of a "sit and wait" strategy by those birds able to exploit this area (p.105). When the main area is not available for exceptionally long periods some of these birds move on to the secondary area. It is also possible that, in the absence of competition from the active feeding birds, birds may move from the secondary area to the main area.

(8) Individual Specialisation

It has previously been suggested that Herring Gulls may specialise on particular food items, both during the breeding season (Conder, 1953, Goethe, 1958, Harris, 1965) and outwith it (Davis, 1975b). It has been shown above (p.109) that it might also be advantageous for gulls to specialise in a particular feeding strategy, in certain feeding situations. It would be predicted from this that birds feeding in the secondary area would not feed in the main area. A relatively constant proportion of birds was found to feed in the secondary area whether or no the main area was available: birds feeding in the main area tended to join loafing flocks when this area was not available (p.105). Using colour-ringed individuals regularly observed at tips in this study, it was possible to/

to ascertain whether individuals do in fact specialise in one of the two strategies outlined above.

Twenty-three individually colour-ringed adult Herring Gulls were regularly observed feeding at tips in the study area on 6 or more separate days, and on as many as 31 days. For all but one of these individuals, the feeding strategy used was consistent, even when the birds used more than one tip. The strategy used was also consistent between years.

On the few occasions in which the main area was disturbed for long periods, (e.g. due to fire), some birds which consistently fed on the main area moved on to the secondary area; they were not observed to do so otherwise. Consistent patrollers were never observed to use the main area. (The bird which used both areas was a male, which was not fully mature when ringed in 1973. This bird originally used the secondary areas. In the winter of 1975, now fully adult, it regularly fed on the main area.) Thus individual adults did specialise in a particular strategy, supporting the idea that this represented the optimal feeding strategy for this bird. A further 23 Herring Gulls were observed feeding on 3 - 5 separate days and each of these individuals used the same strategy on each occasion: this was therefore taken as representative of the feeding strategy consistently used by these individuals. Of the 45 adults who used a consistent strategy, 29 were male and 16 female. Table 17 shows the number of Herring Gulls of each sex class which were found to use consistently either feeding strategy. There was a significant difference between the sexes ($p < 0.05$) and the patrolling strategy predominated amongst the females.

Table 17

The Number of Individual Male and Female Herring Gulls Which Consistently Used Either Feeding Strategy ($X^2_1 = 4.21$)

Strategy Used	Active Feeding	Patrolling
Number of males	16	13
Number of females	3	13

Females were observed significantly more often at tips other than the ringing site than males (p.93). The frequency of sightings at different tips was therefore examined for birds of known feeding strategies, to establish whether or no this influenced movement between tips. Table 18 gives the frequency of sightings of birds of known feeding strategy at the ringing and other tips.

Table 18

Total Number of Sightings of Birds of Known Feeding Strategy at the Ringing and Other Tips

	Ringing Tip	Other tips
Male active feeders	119	8
Male patrollers	59	4
Female active feeders	31	1
Female patrollers	51	14

There was no significant difference in movement between tips for males using either strategy, ($X^2_1 = 0.46$). Active feeding females/

females were however more often seen at the ringing site than patrolling females, ($X_1^2 = 4.37$, $p < 0.05$), but did not differ significantly from active feeding males, ($X_1^2 = 0.07$). Patrolling females differed significantly from patrolling males, being more often seen at other tips, ($X_1^2 = 4.9$, $p < 0.05$).

Thus feeding strategy does not influence the movement between tips in male Herring Gulls; females on the other hand are less consistent to one tip than males, with the exception of those few females which feed in the main area. These latter are as consistent to one tip as are the male birds. This difference in behaviour between males and females is unlikely to be related to any dietary difference. Spaans (1971), found no difference in the diet of male and female Herring Gulls using stomach analysis. Harris and Hope Jones (1969) and Ingolfsson (1969) also found no intersexual difference in diet. Belopol'skii (1961) did however report a difference in diet between male and female Herring Gulls in the Barents Sea, the males eating more fish and showing more predatory behaviour than females; no statistical significance was attatched to these results.

The intersexual difference in behaviour with respect to movement between tips may be related in some way to feeding success. However when birds were feeding on both the main and secondary areas, a sizeable proportion were also roosting and loafing (p.104). Individual gulls were found to spend a small percentage of their time at the tip engaged in foraging activities (p.106), which suggests that they obtained sufficient food. Since the main area is not depleted with time spent feeding, failure to feed on this area is unlikely/

unlikely to represent a "giving up" by individual birds, in the sense outlined by Krebs et al (1974); that is the individual "gives up" a particular foraging area when its capture rate drops below a critical level such that it has stopped feeding. The secondary area is depleted with time, though new areas are constantly being formed. Failure to feed in this area could be taken as indicative of low foraging success rather than satiety. However, patrolling male birds were as consistent to one tip as were those which used the main area; if their feeding success was consistently low, they would be expected to change site more often. Patrolling females used other tips more often than did active feeding females, or males which used either strategy. There was no evidence that females feeding in the secondary area had a lower success than males which fed there, yet they were less consistent to one tip than the males. Chabryzk and Coulson (1976) found that a higher proportion of females select nesting sites away from their colony of birth than do females. Thus females have a tendency to move more than males, and this is also reflected in their feeding behaviour. The differential movement between tips for males and females feeding in the secondary area may therefore be due to a tendency for females to change feeding site more often than males, other than when their feeding success is very high, as with active feeding females.

(9) Use of other kinds of feeding sites

Though active feeding birds were rarely seen at other tips in the study area, they were not always present at the ringing site. During the period of intensive searching in January 1975 (p.96),

9 /16/

9/16 of the active feeding males were involved, and all 3 active feeding females. The remaining 7 active feeding males did not attend the tip during this period. Though the birds could have attended the tip on 7 days, the mean attendance for male active feeding birds was 3 days (Median = 3), and for females 4.3 (Median = 4). To what extent this reflects the use of other feeding sites within the study area, (or possibly even tips outwith the study area), is unknown. Spaans showed that well fed Herring Gulls could withstand more than 1 week of fasting, and restore their weight within only a few days. The Herring Gull is thus well adapted to an irregular food supply (Spaans, 1971). The possibility that the active feeding birds did not feed on the days when they did not attend the tip thus cannot be discounted. It does however seem unlikely. The birds may have fed on the coast or elsewhere on these days. Three of the colour-ringed adults have been observed foraging in the Teesmouth estuary and 2 have been observed feeding around inshore fishing boats. Davis (1975b) found that within a small geographical area, Herring Gulls restrict themselves to only a few of the possible feeding sites. This appears to be the case for active feeding birds in this study, with respect to refuse tips. However refuse tips were not the only feeding sites used by these birds.

(10) Size in Relation to Feeding Strategy

Active feeding involves more agressive encounters than patrolling and the relative size of birds employing the different strategies could be important.

Male/

Male Herring Gulls are, on average, significantly larger overall than females (p.29). If size is related to dominance, as found by Fretwell (1968) for Juncos, this could account for the fact that the majority of females used the patrolling strategy. Since the majority of the colour-ringed birds were weighed and measured at the time of capture, it was possible to examine size in relation to feeding strategy. Table 19 gives the mean weights and wing lengths of male birds which used each of the two strategies; there was no significant difference between the two on either measurement, and thus there is no evidence to suggest that males which feed on the main area are larger than those which do not.

Table 19

Mean Weight and Wing Lengths of Males Using Either Feeding Strategy. No significant difference in Weight (t = 0.58, 23df) or Wing Length (t = 0.97, 18df).

	No. of birds	Mean	S. Deviation
Patrolling males:			
Wing Length (mm)	11	425	9.5
Weight (gms)	12	1040	94.7
Active feeding males:			
Wing Length (mm)	9	421	8.4
Weight (gms)	13	1010	92.5

Table 20 gives the weights and wing lengths of the active feeding females (bill depths are also given).

Table 20

Weights, Wing Lengths and Bill Depths of Female Herring Gulls Which Consistently Fed on the Main Area

Weight (gms)	Wing Length (mm)	Bill Depth (mm)
805	402	17.4
854	414	17.2
906	418	17.6

Two of these females were particularly large birds, and one is classified as a Scandinavian female on the basis of the criteria outlined in Chapter 4. It is thus possible that, in 2 of the three cases, the larger size of these females was a contributory factor to their feeding in the main area.

(ii) Immature Behaviour

Immature Herring Gulls were found to predominate at other feeding sites in the area (p.68) and to be less consistent to one tip in the study area than were the adults (p.93). Eight Herring Gulls ringed at Whitton tip were observed feeding from fishing boats in the area; 6 of these were immatures. Another 2 immatures were observed feeding in the littoral zone in the Teesmouth area. Feeding strategies of immatures observed feeding on 6 or more days were identified; 4 consistently fed in the secondary area, and 3 in the main area.

It was also found that, after disturbance, immature Herring Gulls returned to the feeding area before adults, though generally preceded by Black-headed Gulls. This was also true during baiting procedures/

procedures (p.10). Similarly, Kadlec (1964) found that immature Herring Gulls were more difficult to deter from feeding areas than adults and Drury and Smith (1968) also found that young gulls were first to resume feeding after disturbance.

Begging calls were heard on the tips in August and September. On one occasion, an adult was observed to regurgitate food for a first year bird on 24 September, 1974, on a loafing area of Whitton tip. Drury and Smith (1968) reported that adults were observed feeding juveniles many times in August on mudflats and dumps in Maine. Adults feeding young in winter is probably rare, though Fisher and Lockley (1954) reported that juvenile Herring Gulls do frequently follow adults in autumn calling for food, and that an adult may respond to the begging of a juvenile not necessarily its own. Nevertheless adults have been observed feeding young in January (Brown 1945), March (Lloyd, 1945) and throughout the winter (Holley, 1970).

CHAPTER 6

THE UTILISATION OF TOWNS AS NESTING AREAS BY HERRING GULLS IN NORTHEAST ENGLAND

INTRODUCTION

The incidence of rooftop nesting by gulls in the British Isles, a relatively rare occurrence prior to 1940, has increased greatly in recent years. Herring, Lesser Black-backed, Great Black-backed, Common and Kittiwake Gulls have all been recorded nesting on buildings in Britain: the main species so doing at present are Herring and Lesser Black-backed Gulls. The first British gull colonies on inhabited buildings involved Herring Gulls, and were reported from Cornwall early this century; these were followed by colonies in Dover and elsewhere in southern England in the early 1930's, in Northeast England, Ireland and Wales in the late 1930's and early 1940's, and more recently in Scotland. Rooftop nesting gulls are not confined to the British Isles, and Cramp (1971) has provided a review of the incidence of such nesting in other countries. In Northeast England, gulls nest on buildings in Berwick-on-Tweed, Blyth, Newcastle-upon-Tyne, North Shields, South Shields, Sunderland and Hartlepool. (Full details are given in appendices 4 - 7). Herring Gulls predominate in all of these towns; only 6 pairs of Lesser Black-backed Gulls nested on buildings in Northeast England during 1976; 3 in Sunderland, 1 in Newcastle and 2 in South/

South Shields. Though in overall numbers the Lesser Black-back outnumbers the Herring Gull at more "natural" breeding sites in Northeast England, it is largely concentrated on the Farne Islands in this area. The two largest rooftop colonies in Northeast England, Sunderland and South Shields, were studied throughout the 1974-1976 breeding seasons.

1. <u>DISTRIBUTION OF NESTS IN TOWNS</u>

Gulls nesting on rooftops do not occur randomly distributed over the area of a particular town, but are formed into one or more nesting groups. They often tend, at least initially, to be concentrated in the town centre regions, on the relatively high and undisturbed buildings characteristic of these areas. In South Shields, 58% of the Herring Gulls nesting in the town were concentrated in the town centre, and in Sunderland 55%. In both towns, the nests outwith the town centre area were not dispersed over the town, but occurred in groups of variable size. Nesting in isolation was rare, as has been reported elsewhere (e.g. Chabrzyk and Coulson, 1976). In 1974, prior to any culling of gulls in either town, a few pairs were found to be nesting in comparative isolation from other nesting gulls. Two pairs nested more than 100 metres from the nearest neighbouring gull; a further 6 were between 50 - 100 metres and 8 between 30 - 50 metres from other gull nests. Nevertheless, though a pair appeared to be nesting in an isolated position, this may not have been the case when the nesting territory was first established; the use/

use of nesting deterents on adjacent sites may have effectively removed neighbouring pairs.

The density of the nesting birds, even within the town centre areas, does however tend to be much lower than in more "natural" colonies. The distribution of nests within a particular area is governed, to some extent, by the availability of nesting sites. Only a small proportion of the area of a town is available to nesting gulls, and they are confined to those rooftops suitable for nesting. Buildings essentially function as a series of "stacks", only some of which support a limited number of nesting sites. Parsons (1976) found the most common nesting density of the Herring Gull on the Isle of May to be 4 - 7 nests within a 15 ft (4.6 metres) radius around a particular nest. In towns observed during the present study, rarely were more than 1 - 2 nests found within a 15 ft radius around any nest. Densities higher than this were recorded only on flat roofs which supported multiple nesting sites; the maximum number of other recorded nests within a 15 ft radius around a particular nest was 6. Though gulls in towns exhibit a strong tendancy to nest in groups, the nature of the nesting sites enforces a relatively low nesting density on the birds since, due to the irregularities of the rooftops and the spaces between buildings, the number of nesting sites in close proximity to other gulls is limited.

2. NUMBERS OF BREEDING PAIRS

The numbers of nesting pairs of Herring Gulls were counted in South Shields and Sunderland in the 1974 - 1976 breeding seasons. Censusing commenced early in May each year, and was done whenever possible by counting the number of nests, either from vantage points or by visiting roofs; in the few areas where nests could not be seen and access to the roofs was not possible, the numbers of gulls frequenting the area were taken as indicative of the number of nests. The majority of the counts were based on actual nests.

(1) South Shields

The first records of Herring Gulls nesting in South Shields date from 1963 (F. Grey, pers. comm.); this involved only a small number of birds, less than 5 nesting pairs. Since then the numbers have increased steadily, but documentation of the actual colony size is poor. In 1971, it was reported that more than 100 pairs of Herring Gulls nested in South Shields (Durham County Bird Report, 1971). Table 1 gives the number of pairs of Herring Gulls which nested in South Shields in 1962 and 1971, and in each of the 3 years during which counts were made during the present study.

The average annual rate of increase in the number of nesting pairs of Herring Gulls in South Shields between 1963 and 1971 was 47%, and 29% between 1971 and 1974. This suggests that there was an initial period of very rapid growth in the early stages of colonisation of the town, and that as the colony size increased/

increased, the rate of growth decreased to some extent, though the colony was still expanding rapidly. In 1975, culling of gulls at nest sites was undertaken by the local authority in South Shields early in the breeding season, between March and May, in an attempt to reduce the numbers of nesting birds (p 142); this was confined to residential areas on the periphery of the colony. In 1976 culling was repeated, and affected also the central areas of the town where the number of nesting birds was greatest. This caused considerably more disruption. Thus, while there was a slight decrease in the number of nesting pairs in the years during which culling took place (Table 1), it is necessary to take into consideration the number of birds removed from the population due to culling measures. This enables an estimate to be made of the extent to which the colony size increased between these years. The equivalent of 75 pairs of Herring Gulls were removed in 1975, and 94 pairs in 1976 (Table 1). Thus at the onset of the breeding season and prior to culling operations, a minimum of 291 pairs of Herring Gulls were present in South Shields in 1975; this represents an increase of 23% over the 236 pairs which nested in 1974 (Table1). In 1976, 303 pairs were present at the onset of the breeding season, representing an increase of 40% over the 216 pairs which remained in 1975 (Table 1). Culling in the central area of the town was therefore followed by a 40% increase in the number of gulls holding territories in the town the following year. This increase was/

Table 1.

Number of pairs of Herring Gulls which nested in South Shields in all years for which counts were available, and the number of pairs present each year prior to culling operations in 1975 and 1976.

	1963	1971	1974	1975	1976
No. of birds shot early in the breeding season	0	0	0	151	188
No. of pairs which nested (after any culling completed)	ca.5	100 +	236	216	209
No. of pairs present prior to any culling	ca.5	100 +	236	291	303
Increase in numbers since the previous year	-	average 47% p.a.	average 29% p.a.	23%	40%

was greater than that recorded since 1971, but similar to that recorded during the period of very rapid growth between 1963 and 1971 (Table 1). Chabrzyk and Coulson (1976) suggested that, while the denser areas of a gull colony are more attractive to potential recruits, this is counteracted by the difficulty of establishing a territory in this area; only 16% of recruits attracted to a high density area retained a territory, as compared with 71% in a low density area. Though held at a comparatively low density due to the nature of the nesting sites, the majority of the gulls in South Shields nest in the central area of the town. It is therefore probable that this area will attract most of the potential recruits. A limited thinning out of the central area in 1975 may have enabled a much greater proportion of recruits to become established in the following year than would otherwise have been the case.

(2) Sunderland

The first definite records of Herring Gulls nesting in Sunderland in the town centre area date from 1964, involving approximately 5 pairs. In 1971 50 pairs were reported nesting in this area (Durham County Bird. Report, 1971). In Sunderland, the nesting Herring Gulls fall into two main groups: those concentrated in the town centre (Monkwearmouth area) near the mouth of the River Wear, and those $1\frac{1}{2}$ km further upriver (Alexandria area) on large shipbuilding sheds. The information available for the Alexandria area is limited to counts made during the present study/,

study, and it is not known when this area was first colonised. The numbers of pairs of Herring Gulls which nested in Sunderland in each of the years during which counts were made are given in Table 2. In the Monkwearmouth area the pattern is similar to that recorded in South Shields, an initial period of very rapid growth being followed by a slowing of the growth rate as the colony size increased. No culling of Herring Gulls took place in Sunderland in 1974 or in 1975; in 1976 large numbers of gulls (ca 600) were shot on the premises of Austin and Pickersgill Ltd, in the Alexandria area of the town. Not all of these birds were of breeding age, and a proportion of the adults did not belong to the population nesting in Sunderland. It is not known therefore how many gulls were removed from the breeding population by this measure. Between 1974 and 1975, there was a 20% increase in the numbers of gulls nesting in the Alexandria area; shooting in 1976 reduced the numbers from 94 to 58 pairs. The numbers nesting in the Monkwearmouth area increased by 30% in 1976, as compared with only 10% in 1975. It is therefore possible that some birds, deterred from nesting in the Alexandria area due to the disturbance early in the breeding season, moved into the Monkwearmouth area. The increase in the number of Herring Gulls nesting in the town as a whole between 1974 and 1975, prior to culling operations, was 17%.

Table 2

The number of pairs of Herring Gulls which nested in the two areas of Sunderland in all years for which counts were available.

	Monkwearmouth Area	Increase in Numbers since the previous year	Alexandria Area	Increase in numbers since the previous year
1964	c.a. 5		?	?
1971	c.a.50	average 39% p.a.	?	?
1974	91	average 22% p.a.	75	?
1975	100	10%	94	20%
1976	131	30%	58	?

3. SOURCE OF THE BREEDING BIRDS

It has frequently been stated or implied that young Herring Gulls return to their colony of birth to breed on reaching maturity (Gross, 1940; Paynter, 1949; Tinbergen, 1953; Harris, 1970 and Davis, 1973). The evidence for this generalisation is largely inductive, often based on observations of a number of marked individuals breeding in their natal areas. Extensive searches in colonies other than the natal colony are rarely undertaken; where Herring Gulls have been found breeding in colonies other than those in which they were born, this is usually held as an exception to an otherwise general rule (e.g. Spaans, 1971). On the other hand, Drury and Nisbet (1972) concluded that as many as one third of adult Herring Gulls may breed in areas other than their natal colony. Ludwig (1963) and Chabrzyk and Coulson (1976) have suggested that this inter-colony dispersion could involve as many as 60 - 65% of the surviving young. It is difficult to establish movement between colonies in the absence of extensive ringing programmes, coupled with searching over a wide area. On the Isle of May in the Firth of Forth, 15,000 young Herring Gulls were ringed by Parsons (1971) and the late M. Emmerson between 1966 and 1969; in addition to B.T.O. numbered metal rings, these birds were also given coloured darvic rings which identified their year and place of birth. Chabrzyk and Coulson (1976), on the basis of the number of these marked birds found breeding on the Isle of May in later years,/

years, concluded that about 65% of the surviving young did not return to their natal colony to breed. In Sunderland and South Shields 21 of these ringed birds have been found breeding in 1974 and 23 in 1975. Since only 41% of the total number of young fledged from the Isle of May were actually ringed, this must be taken into account in estimating the percentage of the total breeding population in these towns which fledged from the Isle of May in these years. This was done for 1975, for both South Shields and Sunderland (Table 3).

Table 3

Proportion of Herring Gulls fledged from the Isle of May breeding in South Shields and Sunderland. This is based on the number of marked gulls found breeding in these towns and the percentage of young marked at fledging

	No. of breeding birds ringed	% of breeding population ringed	% from Isle of May
South Shields	11	5.3	13
Sunderland	13	6.7	16

These figures take into consideration only those Herring Gulls fledged from the Isle of May and can probably be doubled to account for the other gull colonies in the Forth area. Moreover, they are based only on recruitment into Sunderland and South Shields from 4 year classes of gulls, fledged between 1966 and 1969. Since very little ringing took place prior to this date, recruits fledged/

fledged before 1966 cannot be identified. The Forth area is clearly a major source of recruits into rooftop colonies in Sunderland and South Shields. Northeast England is a wintering area for gulls fledged from the Isle of May (Parsons, 1971, also p.23). A number of birds have thus taken up nesting in the wintering areas.

From the disparate sex-ratio of birds known to have returned to the Isle of May to breed, Chabrzyk and Coulson (1976) suggested that proportionately more male than female Herring Gulls do not return to their natal colony to breed, (55% and 70% of males and females respectively). Consequently it is to be expected that more females would be found breeding elsewhere than males. By observing the behaviour of the birds at their nest sites, it was possible to determine the sex of 18 of the Isle of May ringed gulls in South Shields and Sunderland; 12 of these birds were female, and 6 were male. Thus twice as many emigrant females were identified as males. This does not differ significantly from the expected values calculated by Chabrzyk and Coulson (1976) and supports their suggestion that females are more likely to nest away from the natal area than males.

4. TYPES OF NESTING SITES USED IN TOWNS

Herring Gull rooftop nests are most commonly found on residential and commercial properties. Towns may resemble, to a Herring Gull at least, the irregular rocky outcrops characteristic of "natural" sites. Sunderland was the only large British rooftop/

rooftop gull colony outside of the Bristol Channel area known to have appreciable numbers of gulls nesting on industrial properties in 1976; 50% of the nests in this town were on industrial sheds. In the Bristol Channel area, gulls were nesting on industrial properties in Port Talbot, Bristol and Gloucester. At the present time, no clear cut differences have been detected in the types of sites used by Herring and Lesser Black-backed Gulls on buildings; the main difference between them seems to be in their geographical distribution (p.157).

The nature of the nesting sites used by gulls in towns is extremely variable. The most common site is where the nest is wedged between the pots on top of chimney stacks; nests situated in the crevices between the chimney stack and the roof are also very common, as are those on top of dormer windows. The flat roofs of modern buildings are also used, and a single roof often supports a large number of nests. On industrial premises, the nests tend to occur on the sloping roofs of warehouses and large sheds. The types of nesting sites used by gulls on buildings were broadly classified into 5 main categories; those on flat roofs (Figure 1), on chimney stacks (Figure 2), sloping roofs (Figure 3), ledges (Figure 4) and a fifth rather heterogenous category defined simply as "others". The distributions of site types recorded in Sunderland and South Shields in 1974 and 1975 (prior to major disruptions in either town) are given in Table 4: also given, for comparison, is the information available for two other rooftop colonies in Hastings and Staithes.

There/

Figure 1: Herring Gull nest on a flat roof.

Figure 2: Herring Gull nest between the pots on top of a chimney stack.

Figure 1.

Figure 2.

Figure 3: Herring Gull nest supported by ventilation shafts on a sloping roof.

Figure 4: Herring Gull nest on a ledge.

Figure 3.

Figure 4.

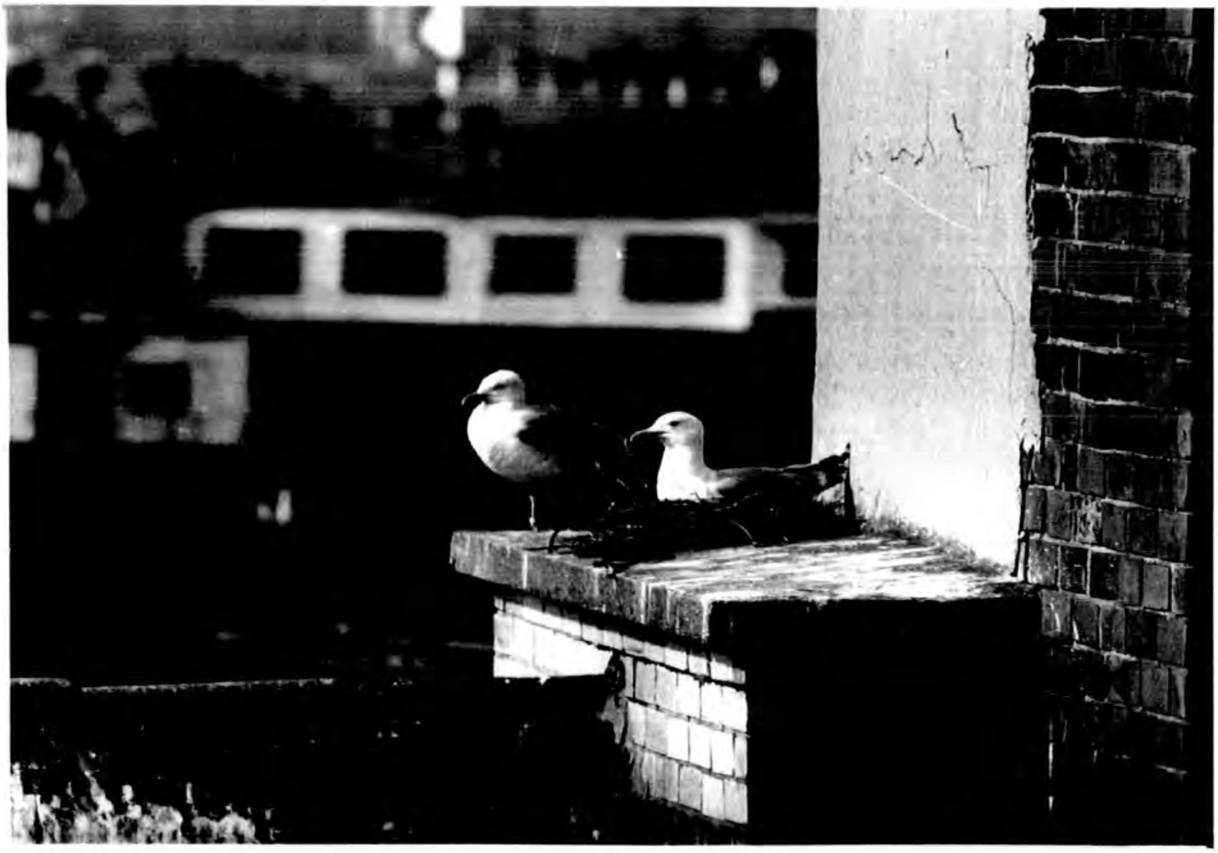


Table 4

The distribution of site types used by Herring Gulls nesting on buildings in 4 towns in Britain. Significant difference between Sunderland and South Shields in 1974, $X^2_3 = 45.5$ and in 1975 $X^2_3 = 36.0$ (Ledges and others combined for analysis)

Town	Year	Chimney Stacks	Sloping Roofs	Flat Roofs	Ledges	Others	No.Sites Counted	Total No. nesting Pairs
South Shields	1974	33%	16%	35%	8%	8%	210	236
South Shields	1975	36%	10%	40%	11%	3%	166	209
Sunderland	1974	15%	46%	32%	4%	3%	148	166
Sunderland	1975	18%	41%	32%	9%	0	142	194
Hastings*	1976	64%	30%	5%	1%	-	198	198
Staithes*	1976	71%	23%	6%	-	-	78	78

* Counts for Hastings and Staithes supplied by H.A.R. Cambell and R. Morgan respectively during the 1976 Census of Gulls Nesting on Buildings in Britain and Ireland.

There was no significant difference between years 1974 and 1975 for the distribution within South Shields or for the distribution in Sunderland. Between the two towns however the distribution was significantly different in both years ($p < 0.001$). A proportionally greater number of nests occurred on chimney stacks in South Shields, and on sloping roofs in Sunderland. This difference is largely due to the use of industrial premises in Sunderland.

Nests on chimney stacks were generally confined to those which supported 4 or more pots set in a square or rectangular fashion, and above ca 25 cms in height; this was necessary for sufficient anchorage of the nest. On sloping roofs, there was a tendancy for nests to be buttressed by an upright structure such as ventilation shafts etc. (Figure 3). This was true for both towns; there was no significant difference between the two and the incidence of unsupported nests on sloping roofs was low (Table 5). Where such nests did occur, they were invariably built up on one side so as to render the nest cup horizontal.

Table 5

Number of buttressed and unbuttressed Herring Gull nests in Sunderland and South Shields in 1974. (No significant difference, $x_1^2 = 0.35$).

	No. of Buttressed Nests	No. of unbuttressed nests
Sunderland	63 (90%)	7 (10%)
South Shields	29 (83%)	6 (17%)

On flat roofs, the majority of nests were constructed against walls or parapets surrounding the edges of the roofs. Figure 5 shows the distribution of 16 nests found in one flat roof in Sunderland; the unprotected edge was avoided, and 13 (81%) of the nests were constructed against a wall. There was no significant difference between the two towns with respect to this tendency (Table 6).

Table 6

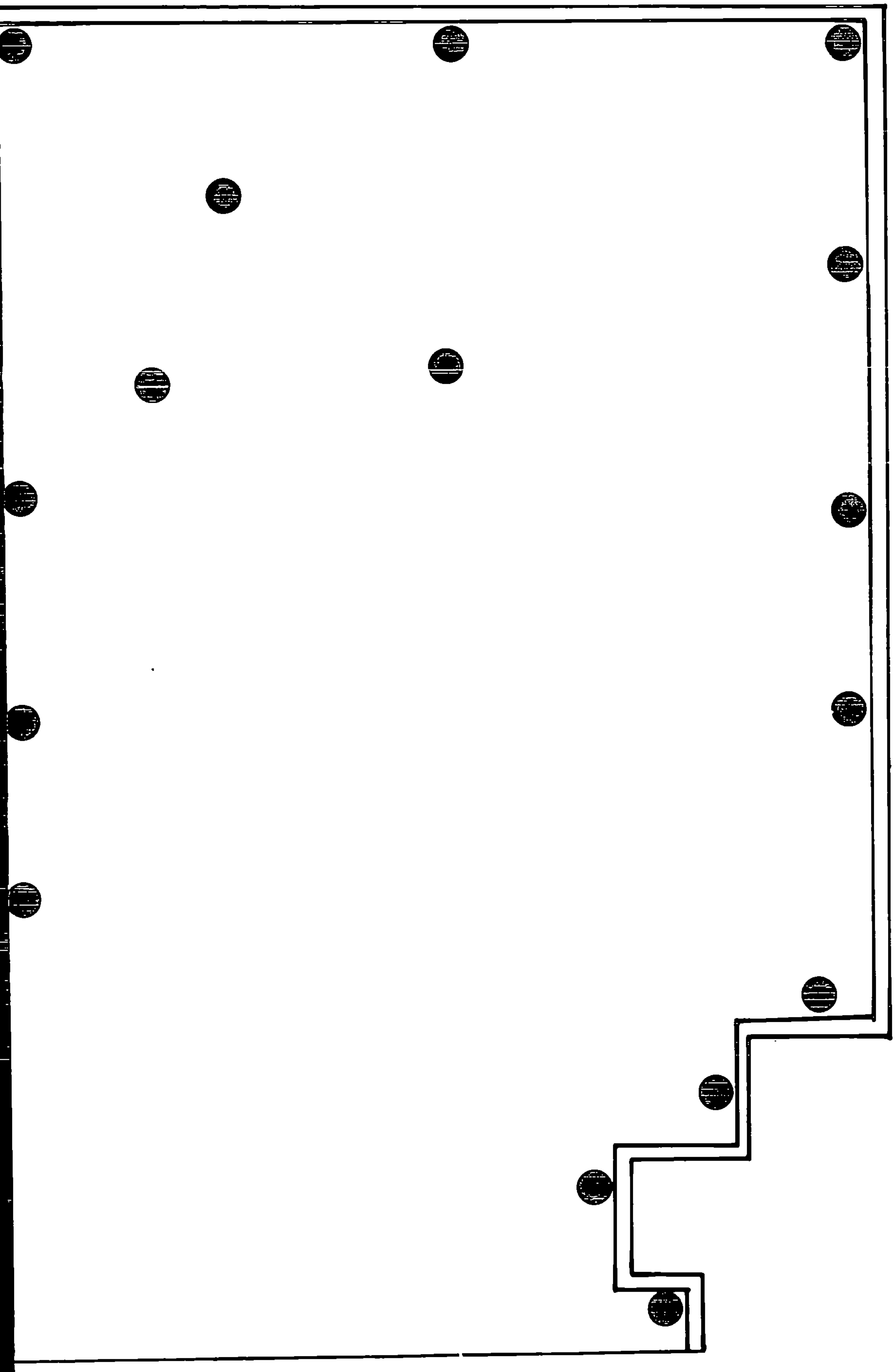
Number of Herring Gull nests on flat roofs in South Shields and Sunderland which were and were not constructed against a wall. (No significant difference, $X_1^2 = 2.27$.)

	No. of nests against walls	No. of nests not against walls
South Shields	58 (79%)	15 (21%)
Sunderland	43 (88%)	6 (12%)

5. BREEDING SUCCESS OF GULLS IN TOWNS

The breeding success of gulls nesting in Sunderland and South Shields was measured between 1974 and 1976. Since the colonies are relatively small, it was possible to record the number of chicks reaching fledging age per nest, provided the nest could be viewed. This was possible for more than 60% of the nests in both towns. Table 7 gives the breeding success of gulls nesting in both towns expressed as the average number of chicks successfully fledged per pair. In 1976, the breeding success/

Figure 5: The distribution of 16 nests on a flat roof in Sunderland. Nests are indicated as dots. The double outline indicates a walled edge, and the single outline an unprotected edge. Note that the free edge is avoided, and all but 3 nests are in proximity to a wall. (Scale ca 1 mm - 2 metres).



success in culled areas of both towns was low, due to extensive disturbance of those birds which survived; figures are given in Table 7 for both disturbed and undisturbed areas in 1976. Prior to the disturbance in 1976, these figures are high in comparison with those from more traditional colonies. Parsons (1971) recorded an average breeding success of between 0.8 and 0.9 young/pair for Herring Gulls nesting on the Isle of May. Darling (1938) recorded an average of between 0.78 and 1.13 young fledged per pair on Priest Island, Scotland, Paynter (1949) 0.9 young/pair on Kent Island, New Brunswick, Paludan (1951) 0.5 young/pair on the Baltic Island of Graesholm, Drost et al (1961) 0.4 - 0.9 young/pair in Wilhelmshaven and Vermeer (1963) recorded 1.0 young/pair on Mandarte Island, British Colombia. Kadlec and Drury (1968) recorded a range of breeding success in colonies on the eastern U.S.A. from 0.8 - 1.4 young/pair and Spaans (1975) recorded a success of 1.2 young/pair on the Dutch Frisian Island of Terschelling. Thus, on natural colonies the breeding success of Herring Gulls is generally much lower than that recorded in towns in this study.

The hatching and fledging success of gulls nesting on 3 rooftops which supported multiple nesting sites was studied in 1974. Two of these rooftops were in Sunderland, with 17 and 18 nests, and the third in South Shields with 17 nests. Table 8 gives the percentage of hatched chicks which gave rise to fledged young. The hatching success varied from 48 - 75%, and is similar to the 65% hatching success reported by Parsons (1971) for the Isle of May. The percentage of chicks giving rise to/

Table 7

The average number of young successfully fledged per pair by Herring Gulls nesting on buildings in South Shields and Sunderland

	1974	1975	1976 Disturbed	1976 Undisturbed
South Shields	1.5	1.6	0.5	1.6
(Sample Size)	(144)	(130)	(69)	(58)
Sunderland	1.2	1.3	0.1	1.4
(Sample Size)	(100)	(120)	(45)	(59)

Table 8

Hatching and fledging success recorded on 3 rooftops in Sunderland and South Shields in 1974.

	Sunderland (1)	Sunderland (2)	South Shields
No. of nests	18	17	17
No. of eggs laid	44	33	33
No. of eggs hatched	32	16	21
% Hatching Success	73	48	64
No. of chicks fledged	30	15	16
% Fledging Success	94	94	76

to fledged young on the rooftops, 73 - 94% is considerably greater than the 30 - 50% found on the Isle of May and elsewhere (Parsons, 1971 and Pauldan, 1951). In the towns, the majority of chicks which hatched survived until fledging.

Thus, rather than being unattractive alternatives to the more traditional kinds of nesting areas, the breeding sites used by Herring Gulls in towns often represent relatively safe and secure nesting places, with a correspondingly high breeding success. Proximity to food sources, such as nearby fish quays, may be a contributory factor. However, in natural colonies, starvation is rarely the major cause of chick mortality (Paludan, 1951; Harris, 1964b and Spaans, 1971). Adult Herring Gulls attack young that wander from the nest into other territories, and also prey upon chicks as food (Paynter, 1949; Tinbergen, 1953; Parsons, 1970). Paludan (1951) found that 65% of chicks hatched disappeared during the first 6 days of their life, nearly all of which were taken by adult gulls. This has been found to account for a large proportion of pre-fledging mortality in other Herring Gull colonies (Deusing, 1939; Brown, 1967), and was also found to be the case for the Glaucous-winged Gull (Vermeer, 1963). In towns on the other hand, while the hatching success is similar to "natural" colonies, unlike the latter, the majority of chicks hatched survived until fledging. This can be to some extent attributed to a lack of disturbance of gulls nesting on rooftops, and also to the relatively low densities of the colonies, enforced by the nature of the nesting sites (p.121). Parsons (1976) found that/

that Herring Gulls nesting at high densities sufferred a lowered breeding success due to the increased egg and chick losses to neighbouring gulls. He also found a decrease in breeding success at very low nesting densities, and suggested that this could be due to the selective predation on chicks in these areas by cannabalistic Herring Gulls. There was no evidence of any cannabalistic behaviour amongst the Herring Gulls in either Sunderland or South Shields. The effective isolation of many of the nests from neighbouring gulls, due to the positioning on chimney stacks, ledges, etc., prohibits chicks wandering into other territories. Attacks on chicks by adult gulls in towns is rare, and "infanticide" as a major cause of chick mortality has been removed.

6. THE EFFECTIVENESS OF THE CONTROL PROGRAMMES

Shooting of Herring Gulls was requested at 229 sites in South Shields in 1975; 20 of these had nests in 1974, 16 of which were occupied in 1975. A total of 151 Herring Gulls were removed from the breeding population in South Shields in 1975, at 56 sites. Though each of these sites supported only one nesting place, 29% had more than 2 gulls removed, and some as many as 7 or 8. This indicated that replacement of removed pairs was taking place in the same year. In one locality where 8 pairs nested in 1974, 44 gulls were shot in 1975, suggesting a high recruitment rate.

In/

In no case did gulls nest in the same year on sites where shooting had occurred. As a result of the 1975 cull, 16 pairs which nested in 1974 were prevented from doing so in 1975. Rather than effectively reducing the population, the culling measures undertaken in 1975 served only to maintain the status quo; despite 151 gulls being culled, the number of nesting pairs was reduced by only 8%, from 236 pairs to 216. Shooting was continued on the same basis in South Shields in 1976 and 188 gulls were shot at 56 sites. However efforts were directed at the central area in 1976, and shooting took place at only 2 sites in both years. Only on 1 site out of the 56 where shooting took place in 1975 did a pair successfully nest in 1976. Areas of the town where the 1975 cull had taken place were largely clear of nesting gulls in 1976. Forty nine of the sites affected by culling in 1976 supported only one nesting place; as in 1975, several of these sites had more than 2 gulls removed (24%), again indicating rapid replacement of culled birds. Those birds which remained in the central area in 1976 had a lowered breeding success. In many cases birds built nests, but no eggs were laid. In areas where no disturbance took place, breeding success was as high as in previous years (p.139). It is likely that this will facilitate more change of site in 1977. As in 1975, the population nesting in the town was not greatly reduced (from 216 to 209 pairs). The increase in the number of pairs present in the town prior to culling in 1976 represented a 40% increase over the number of pairs remaining in/

in 1975, a considerably greater increase than in recent years (p.129) The cull in the town centre area of South Shields may in part have resulted in the density of nesting birds being reduced to a level at which the maximum number of recruits could establish territories in the following year. At the present time, culling operations in the town are serving only to prevent any further increase in the number of nesting pairs, rather than effect any real decrease. In Sunderland, the culling operations undertaken in the Alexandria area of the town in 1976, may have resulted in more birds moving into the Monkwearmouth area. This illustrates the necessity for a co-ordinated control programme if the problem of rooftop nesting gulls is not merely to be shifted from one area to another, or alternatively from one local authority to another.

CHAPTER 7

THE STATUS OF LARGE GULLS NESTING ON BUILDINGS IN BRITAIN AND IRELAND IN 1976

INTRODUCTION

The first census of gulls nesting on buildings in Britain and Ireland was organised in 1969 by the Seabird Group as part of "Operation Seafarer", a national census of sea-birds (Cramp *et al*, 1974). In his report on gulls nesting on inhabited buildings Cramp (1971) showed that the Herring Gull (*Larus argentatus*) was the main species involved, although rooftop nesting by the Lesser Black-backed Gull (*Larus fuscus*)is increasing. The first instance of rooftop nesting in the Great Black-backed Gull (*L. marinus*) was reported in 1970, and has since increased. One pair of Common Gulls (*L. canus*) nested at Dalcross Airport, Inverness in 1971, but this appears to have been an isolated occurrence.

There has been much evidence that the number of gulls nesting on buildings has increased markedly since 1969 and a second census was organised in 1976 as a B.T.O. enquiry, to quantify the recent changes.

CENSUS METHODS

The 1976 survey, like that of 1969, was confined to gulls nesting on buildings or other man-made structures frequented by human beings. Requests were made for the number of known *nesting pairs*/

pairs, and where available, details of the colony history, nest site types, breeding success and control measures employed. Early in 1976, all coastal local government authorities were consulted for previous information of gulls nesting on buildings in their areas and whether complaints had been received concerning these birds. Similar information relating to the 1976 breeding season was supplied by MAFF Pest Officers. The main enquiry details were circulated directly and via the B.T.O. Regional Representatives to county bird recorders, local bird clubs and interested ornithologists. Requests for information were published in appropriate journals and magazines and this brought a good response from the general public.

Counting breeding gulls in towns is more difficult than is often realised. Rarely are all nests visible from ground level and an accurate count necessitates the use of vantage points, if these exist, which overlook other buildings. Accurate counts of large groups are very difficult and there is a tendency to underestimate the size of the population since all the nests are often not located. Accordingly, the counts represented in Appendices 4 - 8 will, in many cases, refer to minimum numbers and the actual rate of increase will thus tend to be underestimated. Counting has been further hampered by control measures which involved the removal of nests in certain areas. Again the figures presented will be minimum estimates.

In general individual towns have been regarded as single units, but in some instances, gulls nest across the boundary between two towns which have continuous urbanization. In other instances, some towns have gulls nesting in more than one group, presumably/

presumably representing two or more colonies. This information has been recorded in the records but it has been found impractical to make these interpretations in all towns.

As a result of this enquiry, data which had not been reported to the 1969 census were obtained. Accordingly, the 1969 records (Cramp, 1971) were amended where necessary to include this information before comparison was made with the 1976 results. Negative records, stating that no gulls nested on buildings in particular towns and counties in 1976 were also requested; such information is valuable for future monitoring of the growth and spread of rooftop nesting.

A summary of the results is listed in Appendices 4 - 8. Appendix 4 gives the 1969 and 1976 counts available for those Herring Gull colonies which existed in 1969. Counts for Herring Gull colonies established since 1969 are listed in Appendix 5. Appendices 6 and 7 give similar details for Lesser Black-backed Gulls and all negative records for both species are listed in Appendix 8.

1. HERRING GULL

(1) Abundance and distribution

The Herring Gull is the most abundant roof nesting gull in Britain and is the only species recorded nesting on buildings in Ireland (O'Meara, 1975).

Fig. 1 shows the distribution and abundance of nesting pairs of rooftop nesting Herring Gulls known to exist in 1969 (based on Cramp, 1971 and additional information). Fig. 2 shows the/

Fig. 1. The distribution and size of the 61 colonies of Herring Gulls nesting on buildings reported in 1969. Symbols as in Fig. 2.

Fig. 2. The distribution and size of the 92 colonies of Herring Gulls nesting on buildings reported in 1976. The symbols denote the number of nesting pairs. The question marks relate to colonies reported in 1969, but for which no information was available in 1976. Jersey and Lerwick not shown.


1969
1976
100+
26–100
6-25
1–5
nesting
prospecting

the situation in 1976 and there is clear evidence of an extensive increase in the numbers of areas occupied, and an increase in the size of colonies in existence in 1969. Taking those colonies which were known in 1969 and were counted again in 1976, the number of breeding pairs has increased by 143%, which is equal to an increase of 13% per annum. In addition, there were 416 gulls nesting in areas colonized since 1969, which raises the overall rate of increase to 17% per annum. This is equivalent to the numbers of gulls nesting in towns doubling every 5 years.

In 1976 a minimum of 2,968 pairs of Herring Gulls were nesting on buildings. This total is still small, particularly in relation to a total population in the British Isles of about half a million pairs. However, the number of localities is increasing rapidly. Of 92 localities in the British Isles reported in 1976, 50 of these had been colonized since 1969.

(2) Rate of occupation of towns

From the information in Cramp (1971), a search of the literature, and information supplied in response to the present enquiry, the number of locations where gulls were nesting on buildings in the British Isles has been determined for each year between 1920 - 1976. These data are plotted in Fig.3, which shows a progressively larger number of new colonies in recent years. A plot of the same data on a logarithmic scale is more informative (Fig. 4). In this plot, the trend line is linear, indicating a geometric increase of 9.3% per annum since at least 1940.

The/

Fig.3. The number of towns with nesting Herring Gulls during the present century. Note the rapid increase in the number of towns affected in recent years.

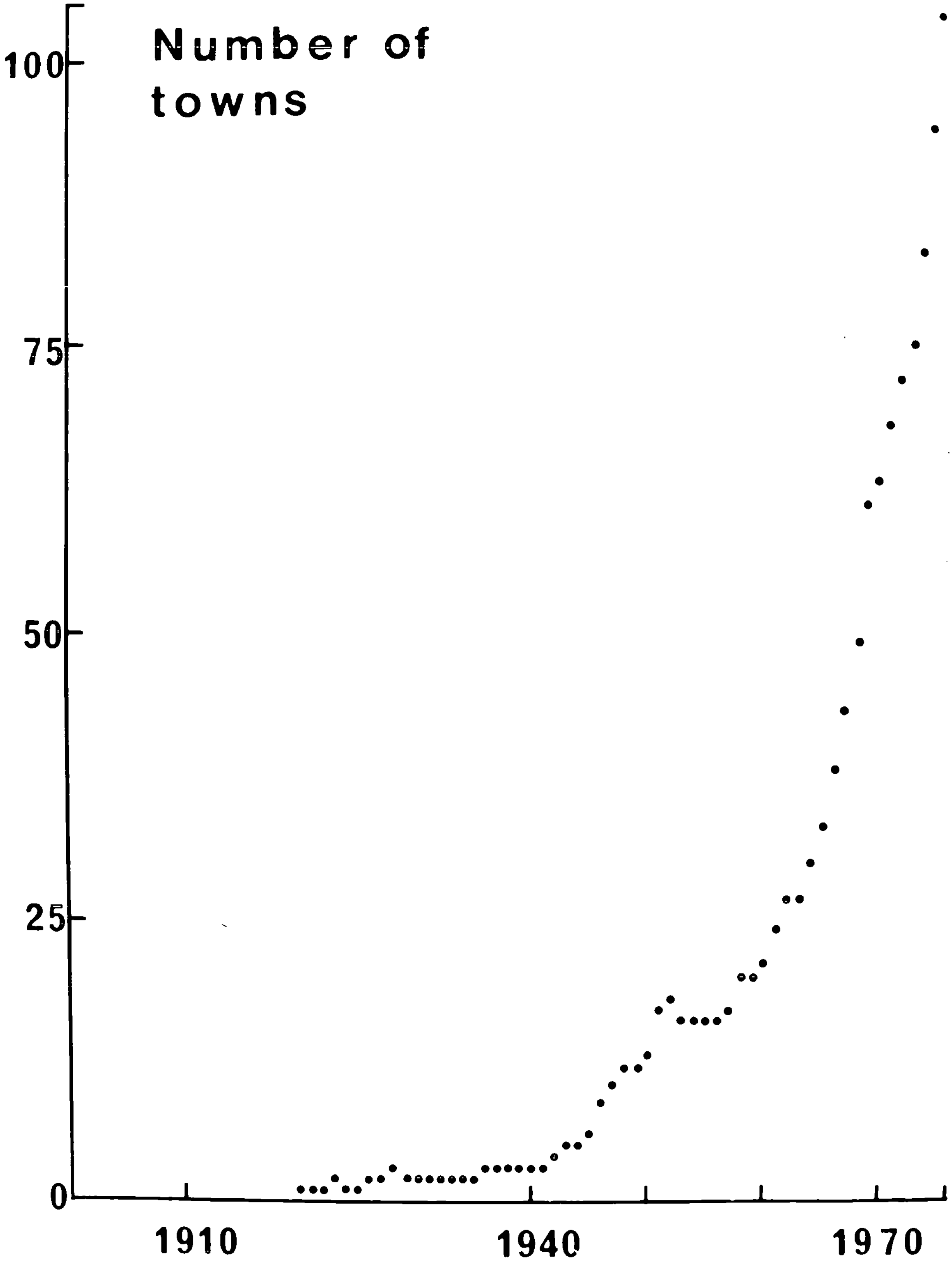
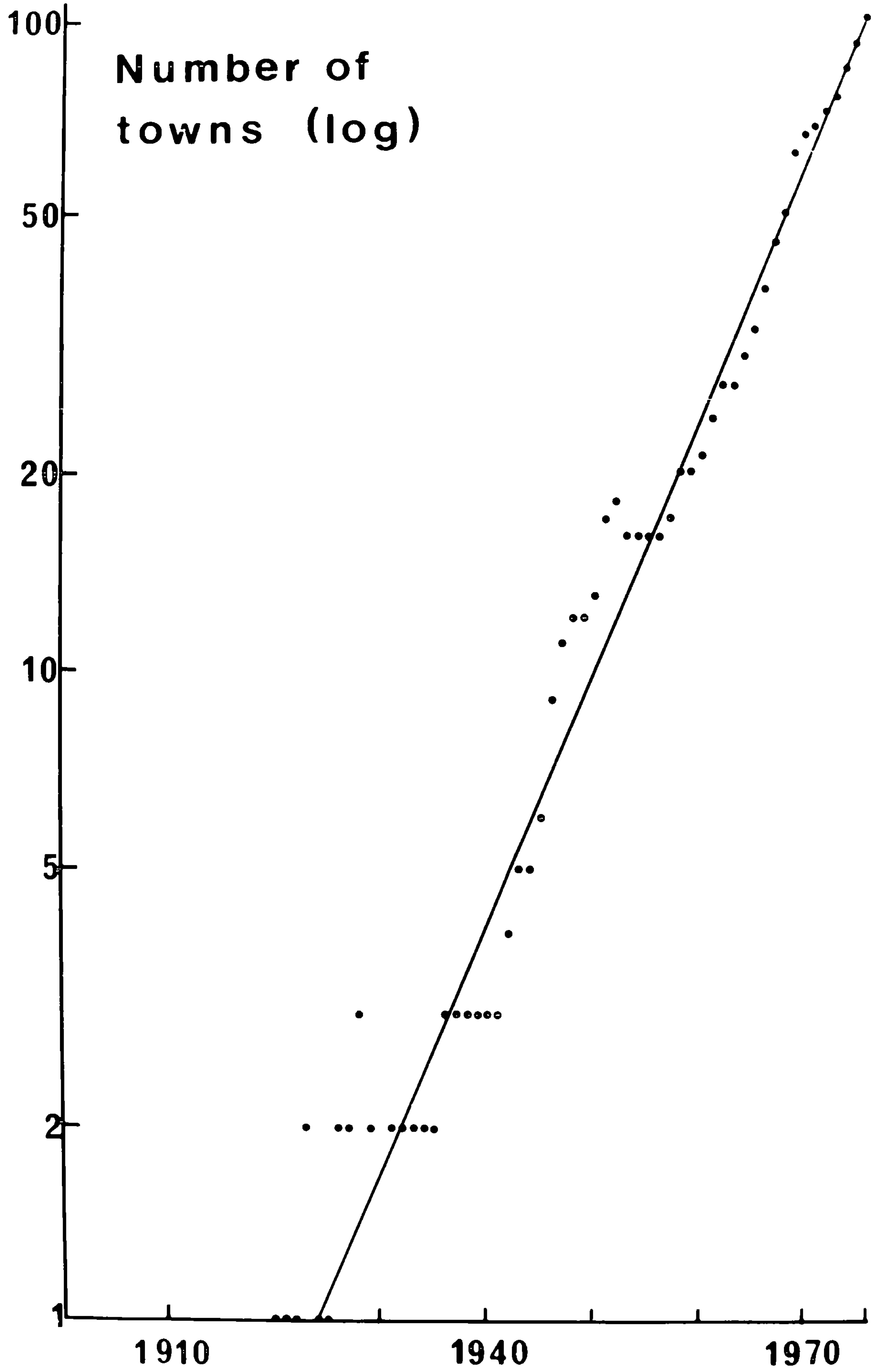

Number of towns
100
75
50
25
0
1910
1940
1970

Fig.4. The data in Fig.3 plotted on a logarithmic scale to show that the rate of increase in the number of towns occupied by nesting Herring Gulls has remained consistent since at least 1940.


Number of towns (log)
100
50
20
10
5
2
1
1910
1940
1970

The sharp rise between 1968 and 1969 can be attributed to the 1969 enquiry concentrating observers on gull nesting sites, thus reporting new sites earlier than would normally have been the case.

It is evident from the records obtained that, in several cases, towns which have been colonized have been deserted subsequently. On some occasions, this desertion appears to have resulted from human intervention, but in others it has apparently been spontaneous. Out of 24 towns in which breeding has, at least temporarily, ceased, 18 had only one breeding pair of gulls previously; a further three contained only two pairs. Clearly, it is much easier to oust breeding birds when there are only a few pairs, and so far almost all attempts to move colonies of over 10 pairs have failed.

As the total number of town-nesting Herring Gulls has increased, so also has the average colony size. Although this is difficult to express precisely, it is evident that this has occurred since the rate of occupation of towns (9.3% per annum) is less than the rate of increase in the numbers of gulls nesting in towns (17% per annum). Consequently, it might be expected that fewer colonies are being deserted in recent years than previously. This is the case. The number of areas deserted, expressed as the number of colonies deserted per 100 towns per year to aid comparison, has been calculated for 5 time periods (Table 1). The "desertion rate" has increased markedly in recent years.

Table 1

The rate at which towns, once colonized by Herring Gulls, are deserted. The risk of towns being deserted has been much smaller since 1961.

Period	No. of desertions/100 towns/annum
1921 - 40	7.70
1941 - 50	5.00
1951 - 60	4.52
1961 - 70	1.02
1971 - 76	1.07

(3) Regional rate of increase

The localities where Herring Gulls nest on rootfops can be conveniently divided into 5 geographical regions:

(i) SE England: stretching from the River Thames around the south coast to Swanage.

(ii) SW England: From Weymouth Dorset, westward on the south coast to Land's End then to Newquay on the north coast of Cornwall; including inland sites to Yeovil, Somerset.

(iii) Bristol Channel: includes colonies on the south coast of the Channel as far inland as Bridgewater, and along the north coast of the Bristol Channel to Tenby, Dyfed.

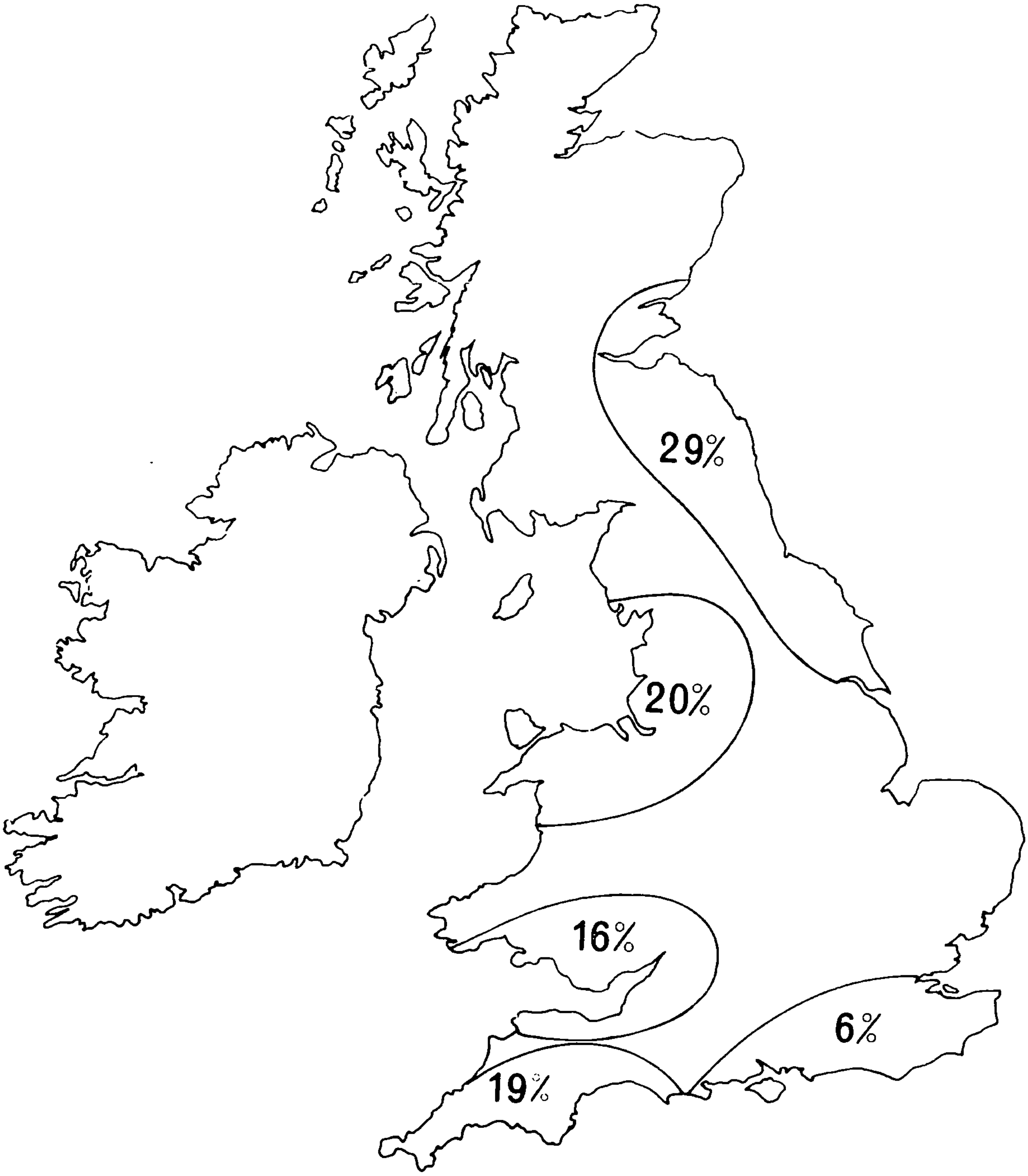
(iv) West Britain: the Welsh coast from Barmouth, Gwynedd, north to Barrow-in-Furness, Lancashire and including the Isle of Man.

(v) East Britain: covering the east coast of England north of the River Humber and the southeast coast of Scotland as far north as Dundee.

Only a few colonies in Scotland and Ireland do not fall within these categories. The average annual increase in rooftop nesting Herring Gulls between 1969 and 1976 has been calculated for each of these regions (Fig. 5 and Table 2). Similar rates of increase (16 - 20%) were obtained for the three western groups (Groups 1, 2 and 3). The two eastern groups showed wide disparity with the highest rate of increase, 29 % per annum in East Britain and the lowest rate, 6 % in SE England.

While/

Fig. 5. The annual rate of increase in the number of breeding pairs of Herring Gulls nesting in towns in 5 regions of Britain.


29%
20%
16%
19%
6%

While there is clearly a national increase in the numbers of town nesting gulls, the highest rate of increase is in East Britain, between the rivers Humber and Tay.

Table 2

The average annual rates of increase in the numbers of rooftop nesting Herring Gulls in 5 regions in Britain. Colonies which were in existence in 1969 but for which no information was available in 1976 are excluded.

	Estimated No. of Pairs 1969/70	Estimated No. of Pairs 1976	% Annual Increase
S.E. England	366	556	6%
S.W. England	101	344	19%
Bristol Channel	286	794	16%
West Britain	77	276	20%
East Britain	162	985	29%

The high rate of increase in East Britain and the low rate in SE England require an explanation. The number of town nesting Herring Gulls, some 3,000 pairs, is small in comparison with the national population. It is known that in East Britain many of the recruits into the towns are young reared on natural sites in the Firth of Forth and neighbouring areas (p.129). There is an overflow from the cliff and island nesting gulls. The gull colonies in the Firth of Forth area are large and are nearing saturation of suitable nesting areas. In contrast, the SE of England does not have large colonies of Herring Gulls nesting in the vicinity, and there are relatively few recruits available to/

to move into the towns from natural breeding areas. Although there may be other explanations of the differing rates of increase in East Britain and SE England, the difference in the number of potential recruits in the two areas seems, at the present time, the most likely.

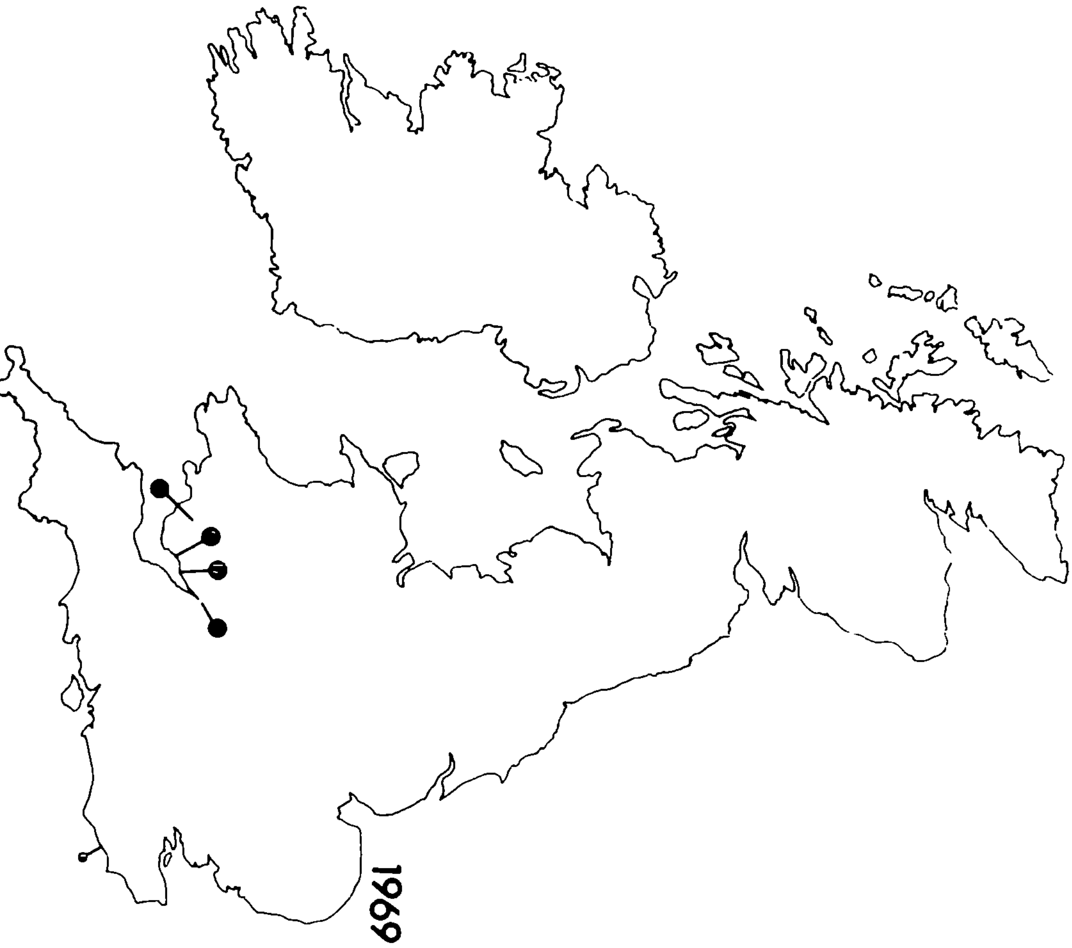
2. LESSER BLACK-BACKED GULL

The distribution and abundance of Lesser Black-backed Gulls nesting on buildings in the British Isles is shown in Fig. 6 for 1969 and Fig. 7 for 1976. A total of 323 nesting pairs were reported from 12 towns, whilst this species was prospecting at a further two localities. In 1969, only 5 towns had breeding colonies of Lesser Black-backed Gulls and the increase in rooftop colonies up to 1976 represents an annual increase of 13%. The rate of increase in nesting birds in the 5 colonies in existence in 1969 is 24% per year and if birds colonizing new town sites are included, the rate of increase becomes 28% per annum. While these rates of increase are based on relatively small samples, in all cases the rates of increase of the Lesser Black-backed Gull are higher than the comparable values for the Herring Gull.

The distribution of Lesser Black-backed Gulls nesting on buildings is markedly different from that of the Herring Gull (Figs 2 and 7). The ratio of Lesser Black-backed Gulls nesting in each region per 1,000 Herring Gulls is shown in Table 3, highlighting the absence or virtual absence of Lesser Black-backed Gulls in all regions except in the Bristol Channel. There is, however, some evidence of the numbers of Lesser Black-backed Gulls nesting on buildings increasing in East Britain.

Fig. 6. The distribution and size of the 5 colonies of Lesser Black-backed Gulls nesting on buildings reported in 1969.

Fig. 7. The distribution and size of the 12 colonies of Lesser Black-backed Gulls reported nesting on buildings in 1976.


1969

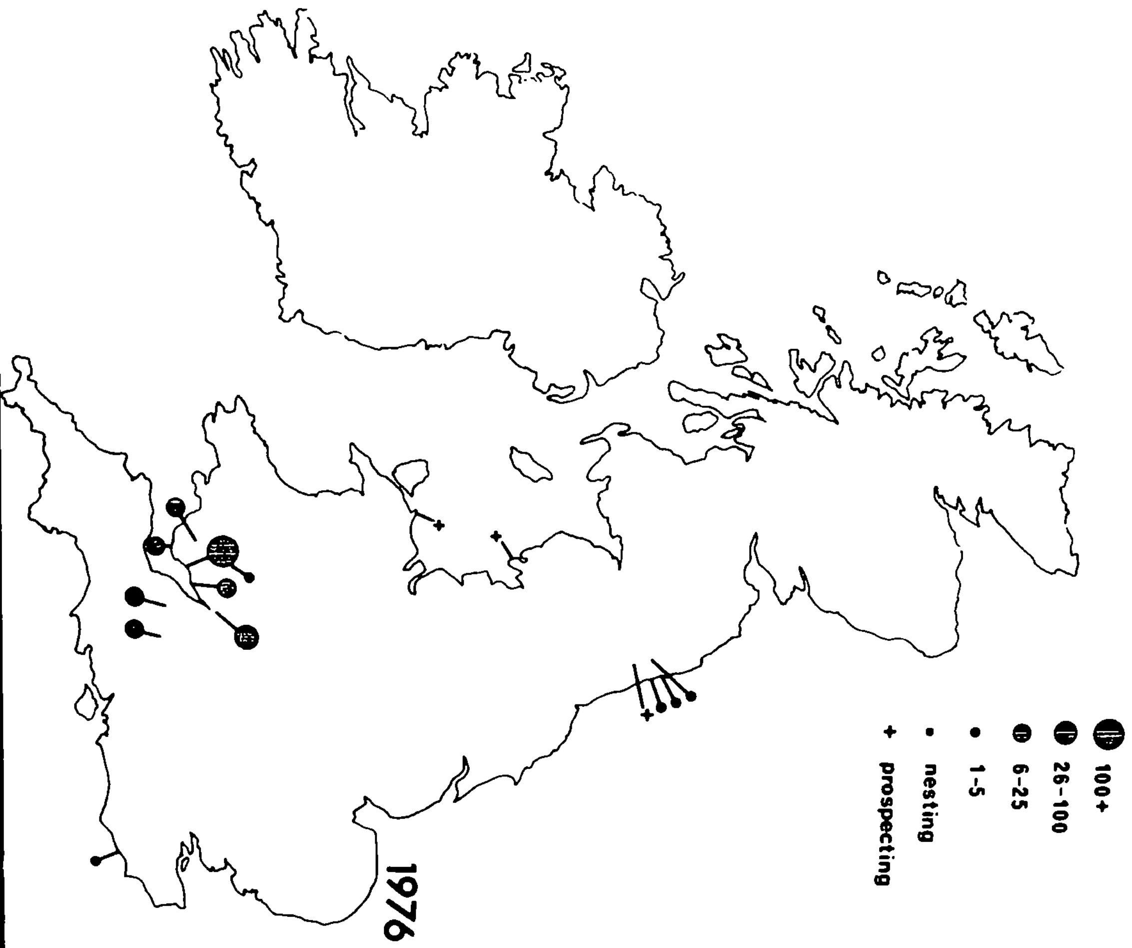

1976
100+
26-100
6-25
1-5
nesting
prospecting

Table 3

Ratio of Lesser Black-backed Gulls to Herring Gulls nesting on buildings in 5 regions in Britain

	No. of Herring Gull Pairs	No. of Lesser Black-backed Gull Pairs	No. of Lesser Black-backs/1000 Herring Gulls
S.E. England	556	1	2
S.W. England	344	0	0
Bristol Channel	794	316	398
West Britain	276	0	0
East Britain	985	6	6

3. GREAT BLACK-BACKED GULL

Cramp (1971) refers to the only record of the Great Black-backed Gull nesting on a building, involving a single pair which laid one egg at Newlyn, Cornwall in 1970. In 1974 all of the breeding records of this species were still restricted to Cornwall, with 2 pairs nesting in Newlyn, a further 2 pairs at Penlee Quarry, Newlyn and 3 pairs in Mousehole.

4. INLAND NESTING OF GULLS

Though Herring and Lesser Black-backed Gull colonies most frequently occur in coastal areas, inland nesting does occur both on buildings and in moorland sites. In 1969, 5 of the 61 localities in use were more than 8km from the sea. Of the 92 localities at which rooftop nests were reported in 1976, 16 were more than 8km from the coast; of these, 6 were more than 25km from the coast and nesting on buildings occurred as much as 56km inland. Nesting on rooftops inland may increase in future years and since large inland gulleries already exist on moorland, future changes may not be confined to coastal regions.

CHAPTER 8

GULLS AS A HAZARD TO THE PUBLIC HEATLH

INTRODUCTION

The increasing numbers of rooftop nesting gulls result in increased contact between gulls and man: the consequential large amount of faecal and regurgitated material present on streets and rooftops, if infected with pathogens, is a potential public health hazard. By virtue of their scavenging habits, particularly at refuse tips and sewage outfalls in and around the urban environment, it is possible for gulls to pick up and distribute human pathogens in their faeces. Refuse dumps are a deposition site for poultry carcasses, contaminated food and other material. Under certain conditions, the interior of bones for example, pathogens such as the *Salmonella* can survive for long periods. There is evidence to suggest that household refuse from dumps distributed by gulls provides one source of salmonellae from which water storage reservoirs are contaminated (Fennel *et al*, 1974). Utilisation of reservoirs by gulls can also give rise to pollution via the faecal material. An investigation by the London Metropoliton Water Board showed that salmonella serotypes recovered from gull faeces in the region of water storage reservoirs overlapped with those found in primary and secondary filtration instalations: of 9 species, including 7 phage types (see below) of *S. typhimurium* isolated from gull droppings, 5 were common to both the filter washings and the gull faeces, as were 4 of the *S. typhimurium* phage types. Fennel *et al* (1974) concluded that the improvements known to occur in/

in the bacteriological quality of water stored in reservoirs (Houston, 1909) are nullified if the reservoir is frequented by gulls. Fourteen serotypes of Salmonella were isolated from 52 of 111 water samples from a Pennine reservoir, but never from the incoming waters. Sewage outfalls provide an abundant supply of human pathogens. In his study of sewage polluted natural waters, McCoy (1963) found that irrespective of whether the sewage pollution came in the form of effluent from a sewage treatment works, or as crude sewage, salmonellae were isolated in every month of the year, and could be correlated with the current isolations from human and industrial sources in the area of discharge. Survival of salmonellae in the environment varies with different serotypes. They survive in water for 3 - 6 weeks without multiplying, though Gauger and Greaves (1946) found that salmonellae could multiply in water provided there was sufficient organic matter present and the temperature high enough. These organisms can survive on crops and in soil. In the U.K. S. typhimurium was recovered from garden soil for at least 251 days (Mair and Ross, 1960); contamination of pasture land by gulls could thus be an important source of infection for domestic animals (Williams 1975). The literature on the genus Salmonella, its occurence and pathogenicity is spread throughout a variety of disciplines (veterinary, medical and microbiological), much of which is not readily available to the zoologist. A review of this field is presented here, the main aim being to provide a survey of those aspects of the epidemiology of salmonellae pertinant to zoologists, and in particular the ornithologist. For similar reasons, a review is/

is also provided of the literature relating to ornithosis, a potential health hazard faced by all those who come into contact with bird species.

THE SALMONELLAE

Part 1.

1. The Nature of Salmonellae Infection

In humans, the individual contributes daily to crude sewage on average 100g wet weight of faeces containing up to 1000 millions per gramme of normal intestinal organisms (Thomson, 1954). In acute intestinal disease and also in the carrier state, the normal gut inhabitants are replaced by pathogens. The majority of intestinal organisms belong to the family Enterobacteriacea, mainly *E. coli*, some types of which are pathogenic. Shigellae and Salmonellae occur in the faeces of infected individuals.
There is a wide variety of *Salmonella* serotypes pathogenic to man and other animals and usually both. McCoy (1963) states "Of pathogenic organisms present in human and animal populations, the most common are the Salmonellae". Salmonellae have been isolated from practically all animal groups, including insects, crustaceans, molluscs, reptiles, birds and mammals. Certain cold blooded animals such as snakes, lizards and tortoises appear to harbour salmonellae in the bowel as part of the natural gut flora (Taylor, 1968). The antigenic complexities of the salmonellae are most thoroughly documented, largely through the systematic studies of Kauffman in Denmark and White in England. Examination of gull material for the presence of specific salmonellae was therefore possible, through readily available serological techniques.

The/

The organisms of the genus *Salmonella* are non-spore forming, and can grow under both aerobic and anerobic conditions. Around 1700 serotypes (McCoy, 1976) have been distinguished under the Kauffman White Scheme, the majority being pathogenic to man in varying degrees. Two clinically distinguishable forms of salmonellosis occur in human hosts.

(1.) *Enteric fevers*, (*S. typhi*, *S. paratyphi* *A, B, C*) which result from the ingestion of contaminated food or water. Enteric fever caused by S. paratyphi B is usually milder than that caused by the other serotypes. Septicemia, characterised by a high remittant fever, usually without any apparent involvement of the gastro-intestinal tract, occurs in the enteric fevers but only rarely in other *Salmonella* infections. Suppurative lesions may develop anywhere in the body.

(2.) *Acute gastroenteritis*, confined primarily to the gastro-intestinal tract, follows consumption of contaminated food or water. The symptoms begin after 8 - 48 hours, and the onset is sudden. Headache, chills and abdominal pain are followed by nausea, vomiting, diarrhoea and fever lasting 1 - 4 days. Blood cultures are rarely positive, the causative agent being confined to the gut and its associated lymph nodes.

Diagnosis of *Salmonella* infection is either by isolation from the blood, faeces or urine, or by demonstration of a significant rise in antibody titre during illness; the method involved varies with the nature of the illness. Salmonellae are the commonest causative agents in food poisoning and, in the U.K. between 1969 - 73, account/

account for 80% of the total reported for all agents (Table 1). Symptomless excretors are usually found in association with acute infections, indicating that these individuals have consumed fewer salmonellae than required to produce clinical infections (Table 2).

During the period 1969 - 73, 120 deaths in which salmonellae were thought to have contributed to, or caused, occurred. The number of human incidents of salmonellosis, having declined between 1965 - 66, more than doubled between 1966 - 71 (Lee, 1974). This was mainly due to a threefold increase in the incidence of serotypes other than S. typhimurium: this latter however remains the most common Salmonella species isolated from humans (Tables 1 and 3). During 1969 - 73, 250 Salmonella spp. were isolated from man; the most common 20 of these are listed in Table 3, those isolated from gulls in this study being marked with a cross (x)

Animal hosts vary greatly in their resistance to different strains of salmonellae. S. typhi, while highly pathological to man, is not for mice; the reverse is true of S. typhimurium. A few species of salmonellae are classified on epidemiological grounds as host specific. For example, S. typhi and S. paratyphi (A,B,C) cause serious disease only in man, S. dublin only in cattle, S. cholerasuis in pigs, S. gallinarum and S. pullorum only in fowl (McCoy, 1976). Little is known of the comparative resistance of birds to salmonellae, and indeed the reasons for the differing susceptibilities in animals are largely unknown. Following enteric fevers, the bacteria, often by virtue of their ability to persist in bile, occasionally become established in the host and give rise to a carrier state. These organisms find their way into natural waters via the sewage system. Little is known

of/

Table 1

Numbers of Reported Cases of Food Poisoning in Man in England and Wales and their Causal Agents During the Four Years from 1969 - 73 (After Vernon and Tillet, 1974)

Causal Agent	1969	1970	1971	1972	1973*
S. typhinurium	1892 (23.1%)	2396 (27.8%)	2691 (33.3%)	2043 (33.9%)	2367 (27.6%)
Other salmonellae	4384 (53.4%)	4452 (51.6%)	4093 (50.7%)	2806 (46.6%)	4506 (52.6%)
Staphylococci	397 (4.8%)	523 (6.0%)	302 (3.7%)	116 (1.9%)	168 (2.0%)
Clostridium welchii	1534 (18.7%)	1263 (14.6%)	978 (12.1%)	1026 (17.0%)	1311 (15.3%)
Bacillus cereus	-	-	15 (0.2%)	16 (0.3%)	61 (0.7%)
E. coli	-	-	-	-	141 (1.6%)
Vibrio parahaemolyticus	-	-	-	13 (0.2%)	17 (0.2%)

* provisional returns

Table 2

Number of Human Symptomless Excretors of Salmonellae Reported in England and Wales, 1969 - 1973

Excreted agent	1969	1970	1971	1972	1973*
S. typhimurium	261	361	437	279	365
Other salmonellae	785	880	864	568	1261

* (1973 provisional)

Table 3

Salmonellae Isolations (1968-72): Common Serotypes in Man and Isolations of These Serotypes from Other Sources (Vernon and Tillet, 1974).

Twenty most Common Serotypes Isolated from Man	No. of Isolations from man (%)	Home Produced and imported egg and egg products	Poultry*	Imported meat and offal for human consumption	Meat and offal for human consumption (not specified as imported)	Sausages and made up meat	Knacker meat and pet meat	Meat, bone fish and feathermeals and feeding stuffs	Milk and Cream†	Sea food**
1.S.typhimurium	10,360 (35)	80	493	31	15	44	103	157	26	11
2.S.enteritidis	3,528 (12)	22	81	-	1	4	32	101	-	1
3.S.panama	2,302 (8)	-	29	2	6	47	8	21	2	5
x 4.S.agona	1,778 (6)	24	119	-	23	100	13	38	11	2
5.S.heidelberg	1,088 (4)	11	114	-	8	8	8	37	-	-
6.S.virchow	932 (3)	3	86	-	-	3	6	23	-	5
7.S.saint-paul	800 (3)	18	156	-	1	4	3	14	2	-
x 8.S.indiana	797 (3)	-	228	-	5	16	9	18	-	-
x 9.S.bredeney	739 (3)	-	118	-	13	16	15	56	-	-
x10.S.stanley	585 (2)	-	5	-	-	12	3	6	1	1
11.S.infantis	514 (2)	5	44	1	5	90	12	28	-	-
x12.S.anatum	422 (1)	-	79	21	4	54	28	159	7	1
13.S.4.12: d:	379 (1)	1	209	-	1	42	12	112	-	4
14.S.dublin	317 (1)	1	-	12	5	12	50	13	24	-
15.S.derby	307 (1)	-	-	12	8	34	4	28	-	-
16.S.montevideo	289 (1)	25	57	2	-	1	1	39	-	-
x17.S.brandenburg	285 (1)	1	6	-	-	10	-	2	-	1
18.S.newport	270 (1)	3	2	4	-	9	2	15	-	3
19.S.muenchen	265 (1)	1	2	4	1	7	1	3	-	-
20.S.thompson	244 (1)	36	102	-	-	3	1	16	-	-
Total of 20 serotypes	26,201(90)	231	1930	89	96	516	311	886	73	34
Other serotypes	2,991(10)	118	487	62	6	49	272	1699	4	31
Total	29,192(100)	349	2417	151	102	565	583	2585	77	65

* Chicken 2203, Turkey 27, Duck 187. † Raw milk 73, Cream 4: ** Prawns/Shrimps 33, Mussels 21, Scallops/Oysters 3, Lobster Tails 6, Other fish 2. 230 different serotypes

x isolated from gulls in this study.

of the pathogenesis or carrier potentials of wild birds. However gulls and other species which feed at sewage outfalls and on refuse tips provide a means whereby salmonellae excreted by the human population may be transferred to reservoirs, pasture or even rooftops, and elsewhere in towns.

2. The Incidence of Salmonellae in wild populations

Salmonella infections have been documented in several animal species, and the relevance to man and his domestic animals noted. Natural outbreaks, particularly of S. typhimurium and S. enteritidis, have been reported in rodents, with symptoms varying from fatal septicemia to carrier state (Savage and White, 1923). Chitty and Southern (1954) drew attention to the part played by rats and mice in contamination of food by their faeces containing Salmonella spp. and also by culture sold as 'poison' for their control, in which S. typhimurium and S. enteritidis have been employed. Australian magpies in particular, certain other birds and also foxes have been identified in South Australia as being responsible for spreading S. typhimurium in sheep stocks through contamination of their drinking water (Watts, 1951). Harbourne (1955) isolated S. gallinarum from rooks which were believed to act as an important reservoir and to which widespread outbreaks of the disease amongst domestic fowl in the area may have been due. Wilson and Macdonald (1967) describe 4 outbreaks of S. typhimurium in greenfinches and house sparrows, the first occurring in 1964. In 1968, 22 such outbreaks were described and Macdonald and Brown (1974) report that similar outbreaks have continued as a regular feature/

feature of wild bird mortality each spring. The phage types (see below) had not previously been isolated prior to 1967 other than in wild birds. From the sequence of later isolations of these phage types however (in pigs and sheep, 1969, in turkeys 1970), these authors suggest that wild birds could act as a source of infection for farm animals. Between 1972 - 74 they report 4 human cases of salmonellosis due to these phage types, though there is no direct evidence that these were due to associations with wild birds. Isolations of salmonellae from various other birds, without any stated implications for human populations are numerous; for example in starlings (Pohl and Thomas, 1968), in blackbirds (MacDonald et al, 1968) pigeons (Miller, 1965) and in wild ducks (Mitchell and Ridgewell, 1971). A review of the occurrence of the Salmonella in various animal groups is provided by Taylor (1968) and Buxton (1957).

The first recorded case of Salmonella isolation from a seabird was reported in 1935 (Van Dorssen, 1935) and there now appears to be an association of salmonellae with seabirds, particularly seagulls, which has generally been attributed to the nature of their feeding sites. Spain (unpublished) examined the excreta of gull populations in the Hull area (Common, Herring and Black-headed Gulls at a reservoir a refuse tip and a sports field) for the presence of salmonellae and for marine halophilic vibrios; these latter are indicative of the birds' recent presence in marine or estuarine conditions. Salmonellae were found in 70% of the freshest excreta obtained from the refuse tip, falling to 3% where dessication and exposure to sunlight reduced the bacterial flora. Ten serotypes were isolated/

isolated and these were associated with recent human and animal infections in the area. Sixty percent isolation of marine vibrios was obtained from the freshest samples, indicating that the birds also frequented a marine or estuarine environment. The serotypes isolated at the tip had also been isolated in routine river water sampling in the area. Numerous other authors (Steiniger, 1956, Neilsen, 1960, Faddoul et al, 1966, Snoeyenbus et al, 1967, Taylor, 1968) give details of Salmonella isolations from Herring Gulls, from Black-headed and other gull species (Steiniger, 1965, Muller, 1965, Wuthe, 1973) and various other seabirds (Steiniger, 1956, 1965). Williams et al (1976) in a survey of the extent to which gulls introduce infection on to pasture, examined Herring Gull faeces from 3 colonies in the Carmarthen and Skomer area, from one of which the gulls were known to scavenge on a refuse tip; 22% of the samples were positive, the frequency of isolations being highest in the refuse utilising group. The phage (see below) types of S. typhimurium were similar to those isolated from cattle in the area. Salmonella serotypes, such as S. typhi and S. paratyphi B, which are particularly hazardous to man, have been isolated from gulls in various areas (Steiniger, 1970, Muller, 1965). Steiniger (1956) has shown an approximate parallelism between salmonellae causing disease in man and those infecting seabirds or present in seawater around the mouth of the River Elbe. He also reported an epizoosis of salmonellae among Common and Sandwich Terns and Herring Gulls on Scharhorn, near the mouth of the Elbe. Young birds were found heavily infected with S. typhi, S. paratyphi B, S. bareilly and S. infantis. This high incidence/

incidence of Salmonella infection was believed to have contributed to the high mortality of eggs and young during that period; however it was thought that bad weather had lowered their resistance (Steiniger, 1967). S. typhimurium was isolated from fully grown chicks from the Isle of May, Firth of Forth, in 1968 (Parsons, 1971). Several fledglings died in the late summer of that year and 4 of 6 analysed contained S. typhimurium, which was thought to have contributed to or accelerated death in already weakened chicks. Macdonald and Brown (1974) examined 83 gulls submitted by the general public between 1967 - 73, 6% of which yielded S. typhimurium. All the infected birds were less than 1 year old, and all were affected with some other pathological process which could have caused death. However, no details were given of the relative numbers of adults and young present in this sample. These authors also examined 70 healthy adults from the Isle of May and found no trace of Salmonella infection, serological or cultural. Though no comparable sample of healthy young birds was examined, these authors suggest that salmonellosis is more common in young gulls. The weakened state of the young birds as mentioned by Macdonald and Brown may have lowered their resistance to salmonellae and a higher incidence of infection is perhaps a reflection of the overall higher mortality of young compared with adult gulls. In addition, the incidence of a carrier state in healthy adults is likely to be low, and examination of only 70 birds would not necessarily give a positive result. Serological examination of blood samples must be treated with some caution since it is not known for how long serum antibodies to Salmonella remain detectable in/

in birds; a negative result, while indicative of a recent non-infected state, does not prove that the bird had not sustained a past infection. Moreover, since in 1968 unfledged chicks on the Isle of May were infected with salmonellae, this must have been contracted via food or other material provided by adults which may or may not have sustained an active infection themselves. A transient, but passive colonisation of a bird's gut, without any active infection and thus no antibody reaction, would not give a positive result on serological examination of the blood. Nevertheless, such transportation of *Salmonella* spp. by otherwise healthy gulls makes them potential disseminators of organisms pathological to man and his domestic animals.

From these investigations it is clear that gulls and other seabirds can passively transport and disseminate salmonellae. While this may in the past have been of only minor importance with respect to transmission of disease to man, by virtue of the increasing numbers of gulls, their increasing proximity to human populations and water supplies, these birds could become a serious health hazard, particularly in an epizootic situation.

During this study, a sample of town nesting gulls and of gulls frequenting a refuse tip were examined in order to ascertain whether or no any salmonellae were associated with these birds.

3. Examination of town and refuse tip gulls for *Salmonella* spp.

The Kauffman White Scheme (1966) distinguishes more than 1,700 varieties of *Salmonella*. Identification is thus complex, and/

and requires a large number of serological preparations. Three centres were involved in the examination and identification of salmonellae from samples in this study. During 1975, examination was carried out by the Pathology Laboratory, Dryburn Hospital, Durham, under Dr. Graham. In 1976 samples from South Shields were dealt with by the North West Water Authority Microbiological Laboratories, Liverpool Polytechnic, under Mr. David Watson. Samples from Scarborough and Whitby were analysed by Dr. McCoy and Mr. Spain in the Public Health Laboratory, Hull Royal Infirmary, Hull.

Tentative identification of *Salmonella* organisms is by fermentation (they are generally non-lactose and non-sucrose fermenters and thus any culture which ferments these sugars can be discarded) and other metabolic reactions. Selective media, containing chemical inhibitors such as brilliant green, desoxycholate, selenite, tetrathionate and citrate, which supress the growth of coliform bacteria, are used to isolate the salmonellae. Identification of individual species is based on highly specific differences in antigenic structure, using specific anti-sera. Phage typing, which permits recognition of, for example, 72 types of capsular antigen in *Salmonella typhi*, is based on the susceptibility of the bacterium to lysis by certain bacteriophages. This detailed typing is most useful in tracing sources and progress of epidemics, and is done at central Enteric Reference Laboratories. This was not done for the samples dealt with in this study. In addition to examination for *Salmonella* spp., those samples submitted to the laboratory at Hull were examined also for the presence of marine halophilic vibrios (including *Vibrio parahaemolyticus*), indicative of recent feeding in marine or estuarine conditions.

Method

The procedure followed for the isolation of the salmonellae was broadly as set out below. That detailed here, refers to the procedure used by Dr. McCoy and Mr. Spain in Hull; at the other two centres the procedure was essentially the same, with only minor variations in what are otherwise standard techniques.

The samples were inoculated into tetrathionate enrichment broth for a salmonellae and submitted to aerobic incubation at 37°C overnight. This enrichment medium facilitates the growth and multiplication of any salmonellae present (while as previously mentioned the tetrathionate inhibits the growth of coliform bacilii). Enrichment medium is essential when only a small number of bacteria are expected, as would be the case if the salmonellae were merely a transient colonisation passing through the bird's gut with the material taken in during feeding, the bird not being actively infected. After this incubation, the mixture was then transferred to Bismuth sulphite agar (McCoy, 1962) and incubated aerobically at 37°C for 18 hrs. Characteristic Salmonella colonies were identified serologically (McCoy and Spain, 1969).

The technique used for isolation of marine halophilic vibrios was as follows: The sample was inoculated into Teepol enrichment broth, followed by aerobic incubation overnight at 37°C, and then seeding into Thiosulphate citrate bile salt agar (TCBS) and examination after overnight incubation at 37°C for halophilic vibrios (Vibrio algi nolyticus and Vibrio parahaemolyticus).

Table 4

Results of examinations of the rectal contents of Herring Gulls for Salmonella serotypes and marine halophilic vibrios

Date	Analysing Laboratory	Source of Birds	Total No. Examined	No. of Adults	No. of Immatures	Isolations of Salmonellae	% Infected	Isolations of vibrios
23.3.75 - 20.5.75	Durham	South Shields (rooftops)	66	66	0	S.agona*	2	-
5.3.76 - 20.5.76	Liverpool	South Shields (rooftops)	33	33	0	S.anatum* S.stanley*	6	-
30.4.76	Hull	Whitby (rooftops)	36	30	6	0	0	0
30.4.76	Hull	Scarborough (harbour)	63	35	28	S.poona	2	0
30.4.76	Hull	Scarborough (tip)	48	44	4	S.brandenberg* S. indiana*	4	0
24.5.76	Hull	Scarborough (tip)	76	52	24	S.give S.livingstone	4	0
24.5.76	Hull	Scarborough (rooftops)	7	7	0	S.seftenberg	0	0
24.5.76	Hull	Whitby (rooftops)	35	35	0	0	0	0

* listed in the most common 20 serotypes isolated from man (Table 3)

Table 5

Results of Examinations of Carcasses of Herring Gulls for *Salmonella* serotypes and mannic halophilic vibrios

Date	Analysing Laboratory	Source of Birds	Total No. Examined	No. of Adults	No. of Immatures	Isolations of Salmonellae	% Infected	Isolations of vibrios
24.5.76	Hull	Scarborough (tip)	17	16	1	0	0	2
24.5.76	Hull	Whitby (rooftops)	3	3	0	0	0	0
21.6.76	Hull	Scarborough (tip)	20	16	4	*S. bredeny**	5	0

* listed in the 20 most common serotypes isolated from man.

Results

The results obtained from the samples submitted for examination are set out in Table 4, which gives the source and age of the birds whose rectal contents were sampled. (For the purposes of this table, brown birds, i.e. in their 1st/2nd year are designated as "immatures": the others as adults.) In addition, on two occasions 20 whole birds were sent for analysis to Hull. The results obtained for these are given in Table 5. Water samples from the pool frequented for bathing and drinking purposes by gulls on the tip at Scarborough were examined in Hull (Table 6).

Table 6

Water Samples Taken from Burniston Refuse Tip, Scarborough and Examined in Hull.

Date	Isolations	Most Probable Number/100ml
2.6.76	S. agona	1
23.6.76	S. bredeney	2

The first water sample was not taken concurrently with the gull samples, and the salmonellae isolated were not found in gulls which had been taken 8 days previously. The second water sample was taken within 2 days of the gull sampling; the same Salmonella species was on this occasion isolated from both the pool and the gull population. Eleven Salmonella species in all were isolated and 6 of these are listed in the most common 20 serotypes recently isolated from human sources in England and Wales (Table 3.).

Discussion

Of the 307 gull samples examined for marine halophilic vibrios, two showed positive for V. alginolyticus, indicating recent feeding in marine or estuarine conditions. (It is not known how long these organisms survive in the gut of a gull, and consequently the word "recent" cannot be further qualified,) Absence of marine vibrios in the gut does not mean that the birds feed exclusively at refuse tips.

From the Salmonella analyses of the gull rectal contents, 2 - 6% of the birds (mean 2.4) were voiding salmonellae in their faeces. Enrichment media were used in all isolations, and it is not known how many cases involved carried states or transient colonisation of the bird's gut. All birds were however in a healthy condition and there was no evidence that any of those examined were suffering heavy or debilitating infections. In addition, there was no evidence that the incidence of salmonellae was greater in young birds, though it may be that young gulls are less likely to sustain heavy infection, particularly if already weakened due to other causes, as were those examined by McDonald and Brown (1974). Since salmonellae generally survive in water (without multiplying) for 3 - 6 weeks, it is possible that drinking pools frequented by gulls on refuse tips provide a vehicle through which salmonellae can be picked up by a large number of birds and transported, albeit in small numbers, elsewhere. Active infection of gulls, while varying with the species of Salmonella involved, is probably commoner in those in poor condition for other reasons. The percentage of gulls found positive for salmonellae was fairly low; nevertheless, the turnover of species involved in transient colonisation of the gut may be great. A potential health hazard to human beings, which must not however be/

be overstated, does exist. Moreover, this is increased in situations where gulls and their excreta come in close contact with human populations, their food or their drinking water; this is the case with gulls nesting on rooftops or frequenting reservoirs, particularly in winter. The incidence of reported Salmonella infections in humans is high, and this despite only a fraction of acute intestinal infections being investigated bacteriologically (McCoy, 1963). Infections in man are closely related to temperature, with major rises in summer and early autumn (McCoy, 1963, Vernon and Tillet, 1974). Hence it is during their breeding season that gulls are most likely to come into contact with salmonellae at sewage outfalls and refuse tips; this is also the period during which rooftop nesting gulls will be in closest contact with human populations. The hazard to reservoirs is also serious, particularly in the case of open reservoirs containing treated water which is distributed without further chlorination. Prevention of transmission of typhoid and other salmonellae in man has been achieved by four main precautionary measures; milk pasteurisation, exclusion of carriers as food handlers, sanitary sewage disposal and the provision of unpolluted water supplies (Davis et al, 1967). It is with the latter two procedures that gulls interfere. Powers to designate diseases of animals or organisms carried by them considered to constitute a risk to human health were granted under the Agricultural Act 1972, Section 1. The Zoonoses Order, 1975, which thus designates the Salmonella and Brucella organisms, was the first order passed under this act. While compulsory reporting procedures apply/

apply to only a few species of food animals, investigatory and emergency measures may be used for a much wider range of species (Bennet, 1976). Though direct transmission of salmonellae to human beings via the gull population is not proven, an epizootic amongst town nesting gulls could have serious consequences, and as the gull population continues to increase, so also does the potential hazard to the public health.

Part 2.

PSITTACOSIS/ORNITHOSIS

The psittacosis agent is the type species of a large group of organisms infecting man, other mammals and birds. Being of traditionally uncertain taxonomic status and originally thought to be viral, these organisms are now generally held to have a bacterial ancestry, but to be dependent upon the host cytoplasm to compensate for certain metabolic deficiencies. Often called "bedsonias" after Sir Thomas Bedson who was responsible for many fundamental observations on the psittacosis agent, they are now, on the recommendation of an international committee, referred to by the generic term *Chlamydia* (Davis *et al*, 1967). A review of the properties, occurence and pathogenicity of *Chlamydia* is provided by Schachter *et al* (1974). As a disease, psittacosis has been known for some time. The earliest accounts of its occurence in humans refer to it as "pneumo-typhus" (Ritter, 1880, Wagner, 1884). The term psittacosis was first used by Morange (1895) in a description of the Paris epidemic of 1892, and reflects the original belief that the disease was associated with South American parrots, extensively exported. Between 1879 and 1928 localised epidemics of the disease occured in Germany, France, Switzerland, U.K. and the U.S.A. (Christensen, 1957). During 1929-30 however, a pandemic occurred in 12 countries of 400 cases, with a 35 - 40% mortality (Roubakine, 1930). Psittacosis was found to be endemic amongst psittacine birds in all 5 continents, but it was not until the late 1930s that it was shown to occur in other avian species (Rasmussen, 1938, Haagen and Mauer, 1939). An epidemic in the Faeroes in 1938 was attributed to an epizootic amongst Fulmar Petrels. Those women who split and salted the young/

young Fulmars were the most heavily infected, and of 165 cases, only 24 of which were male, there was a 19.4% fatality (Fisher, 1952). An outbreak in Iceland was also attributed to the Fulmar population (Lairusson and Guttermausson, 1939). However, Miles and Shrivastiv (1951) described an initial outbreak in Fulmars in 1933 and showed that Herring, Lesser black-backed and Black-headed Gulls could also be affected; in addition they provided evidence to suggest that these infections were long established in gulls before Fulmars became infected.

In 1940, a similar agent was demonstrated in pigeons and within the next few years numerous cases of human infection from pigeons were reported, (Meyer et al, 1942, Eddie and Francis, 1942, Pinkerton and Swank, 1940, Smadel, 1945, Andrews and Mills, 1943, Bacon, 1953). Psittacosis was demonstrated also in Ricebirds (Eaton et al, 1941), chicks and fowls (Meyer and Eddie, 1942), game birds (Treuting and Olson, 1944), domestic turkeys (Meyer and Eddie, 1953), herons (Rubin, 1954) and numerous seabirds (Pollard, 1955). One hundred and thirty species of birds have since been shown to be affected and as Christensen (1957) has stated, "in all probability all avian species must be considered susceptible to the disease and may, if occasion should arise, pass the disease to man".

Meyer (1942) suggested replacing the term "psittacosis" by the more general "ornithosis". This latter was regarded as an equivalent term for psittacosis in the 6th Revision of the International/

International List of Diseases and Causes of Death (WHO, 1948) and as a synonym in the 8th Edition of the Control of Communicable Diseases in Man (American Public Health Association, 1955). "Ornithosis" is however usually reserved for the same infection in other than psittacine birds and has been held to be less virulent (McDiarmid, 1962, Miles and Shrivastav, 1951). Ornithosis is a very common, natural disease of birds, usually symptom-free and chronic; if however the balance established with the host is disturbed, an epizootic my result. Inadequate feeding, overcrowding of birds in cages or other conditions of stress may trigger such outbreaks (Meyer, 1959 and Christensen, 1957). It is impossible to diagnose psittacosis in birds by clinical or gross anatomical inspection (Meyer, 1942 and Christensen, 1957). In man the symptoms can be severe; while responsive to modern chemotherapy, the disease has a recent case fatality of 2.6% (Meyer, 1959). A latent period of 25 days is usually followed by a steep rise in temperature and shivering; a fever develops lasting 2 - 3 weeks but of diminishing intensity after the first few days. The general condition of the sufferer is poor and a distended abdomen plus severe diahorrea is frequent. In fatal cases collapse occurs at this stage. Pulmonary involvement occurs in most severe cases with however only slight coughing. Convalescence is marked by a period of considerable fatigue and recovery usually takes 2 - 3 months. These symptoms resemble a variety of other respiratory or atypical pneumonic diseases in man and diagnosis is difficult. Routine complement fixation tests have revealed that both apparent and subclinical infections are much commoner/

commoner than originally supposed. Of 5,000 serum samples randomly collected from humans in Denmark, 7.4% gave a positive reaction with the ornithosis antigen; the number of cases annually reported in Denmark at that time was 12 - 29, (Matthiesen and Volkert, 1956). In a similar study in Hamburg, 17.4% of 2,844 sera were positive, with the number of reported cases in the Federal Republic of Germany then varying annually between 14 and 121, (Weyer and Lippet, 1956). Ten out of 14 schoolchildren examined in Adelaide gave positive reactions though contact with birds had not been unusually high and all 10 had suffered mild respiratory complaints (Meyer, 1959). These records emphasise that it is mainly severe and clinically typical cases which are reported to health authorities. Others are either undetected or wrongly diagnosed and the symptoms treated with broad spectrum antimicrobial drugs.

Transmission from person to person has been documented (Horder and Gow, 1930, Meyer, 1942, Bedson et al, 1930, Treuting and Olsen, 1944, Zichis and Shaughnessy, 1945, Sørensen, 1955), but transmission via an avian host is the most frequent, and usually comes through the handling of an infected bird. Hence, certain occupational groups such as poultry workers and pigeon fanciers have a very high incidence of infection. Ornithosis agent was recovered from 34.5% of 116 ducks examined on commerical duck farms in New York: ornithosis was detected in 42% of 62 persons who had contact with them and in only 4.9% of 61 comparable individuals who had not (Korns, 1955). Those most at risk are "all occupational groups that come into direct contact with overtly diseased birds or into indirect contact with infective droppings or/

or soiled feathers" (Meyer, 1959). Of 70 cases reported in the Somerset area between 1964 and 1971, significant bird contacts had occurred in the majority of patients (Anderson, 1974). Even if contact isnot direct, the ornithosis agent can, independant of avian hosts, survive in the dessicated droppings, and airborne dried faecal material is the major source of infection in man (Davis et al, 1967). The agent is discharged in the droppings of sick birds and those attaining a healthy carrier state and "such dried dust-like droppings represent highly contagious vehicles" (Christensen, 1957).

For man however the disease is generally no more than a mild respiratory infection and the case fatality, which though prior to the use of broad spectrum antimicrobial drugs such as tertracycline was high, is now fairly low. As Meyer (1959) states: "Psittacosis (ornithosis) is of importance to the person who contracts it, to the physician who must diagnose it and to the public health agency obliged to cope with family outbreaks of a disease known to have had a high case fatality, and to identify and limit the source of infection".

Nevertheless, as he also points out, it is an interesting, but normally minor health problem. This is the case where human and avian contact is low. Ornithosis is a highly contagious disease. With the increasing numbers of rooftop nesting gulls, human populations in these areas are at risk from contact with infected birds or their droppings. Serious consideration has also been given to the role of seagulls in the infection of domesticated poultry and hence poultry workers (Meyer, 1959, Jernelius et al, 1975). Should an epizootic occur amongst these birds the consequences could indeed be serious.

CHAPTER 9

GENERAL DISCUSSION

(1) The population increase in the Herring Gull

Population "explosions" in animal species may result from the invasion of a new environment by a foreign species whose numbers multiply unchecked, as occurred with the introduction of the rabbit into Australia (Elton, 1927). Spectacular population changes may however also occur in a long established species when the effects of certain factors which previously limited population growth are lessened or removed. Elton (1927) gives numerous examples of sudden population increases in established species, such as mice, ungulates, Collembola, red locusts and butterflies. Such a population increase is at present taking place in the Herring Gull in most parts of its range. The Herring Gull is an opportunist, adapted to a changing environment. Its ability to take advantage of readily available food supplies, and exploit new nesting areas as traditional sites reach near saturation, aptly illustrates this adaptability.

The expansion of the Herring Gull in the British Isles this century has involved both the formation of new colonies and the expansion of those already in existence. This can for example, clearly be seen in the growth and spread of rooftop nesting.

This/

This study has shown that the national increase in large gulls nesting in towns has been in progress since before 1940, and that the rate of colonisation of towns has remained consistent throughout the past 36 years. Although resulting in a marked increase, this change was not noticed until the national survey of breeding sea-birds, "Operation Seafarer", took place in 1969 and gave rise to a report on town nesting (Cramp, 1971). It is of interest that this increase, and others such as the increase of the Kittiwake Rissa tridactyla during this century (Coulson, 1963), should go undetected for so long. Since 1969, Herring Gulls have been increasing in towns at an average annual rate of 17% and the Lesser Black-backed Gull, although more confined and involving fewer birds, is increasing at an appreciably higher rate of about 28% per annum.

From a knowledge of the survival rates of adult Herring Gulls, their breeding success and age of maturity (Chabrzyk and Coulson, 1976), it is unlikely that a Herring Gull population could increase at a rate above 14% per annum without the immigration of additional birds. The annual rates of increase in the numbers of gulls nesting in towns is in excess of this value for 4 of the 5 regions examined. Almost certainly, "natural" gull colonies are a source of recruits into rooftop colonies. This has been confirmed in Northeast England where appreciable numbers of gulls ringed as young in the Isle of May have been found breeding on buildings in South Shields and Sunderland.

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These rates of increase in gull colonies are remarkably high; in effect, the numbers of Herring Gulls nesting in towns are doubling within five years whilst the Lesser Black-backed Gulls are doubling every three years. This increase is made up of two components; the expansion of existing town colonies and additional birds colonising new towns. In the case of the Herring Gull, those colonies in existence in 1969 have been expanding at a rate of 13% per annum, a rate very similar to the 12.8% annual increase of Herring Gulls on natural sites such as islands and coastal dunes (Chabrzyk and Coulson, 1976). However the formation of new rooftop colonies is taking place at a rate of 9.3% per annum. This value may be a slight underestimate, (and will be more so in the future), as the methods used cannot recognise new colonies arising close to those already in existence, for example in different parts of a single town or city. If the present rates of increase are sustained, by 1986 the numbers will reach 14,000 pairs nesting in 246 towns in the British Isles. While more towns are being colonised, those colonies already in existence are growing larger and there is less likelihood of existing rooftop colonies disappearing spontaneously.

It is suggested that the increase in town breeding is mainly a consequence of the rapid expansion of the Herring Gull in Britain, and particularly resulting from the saturation or near saturation of many colonies on "natural" sites encouraging the young to seek new nesting areas.

For/

For a population to increase, the reproductive rate plus any immigration must outweigh the death rate plus any emigration. The Herring Gull has been increasing in the British Isles for most of this century and, for the past 30 years at least, at a rate of 13% per annum (Chabrzyk and Coulson, 1976). The British Herring Gull population, unlike those of Scandinavia and North America, is largely sedentary. While Scandinavian gulls overwinter in Britain, there is no evidence of extensive immigration from elsewhere into the British breeding population. The increase of the Herring Gull in Britain can therefore be taken as evidence of a mismatch between the reproductive rate and the mortality rate.

It has often been stated that animal populations are "balanced" or "regulated", fluctuating in time only within certain upper and lower limits (e.g. Nicholson, 1933; Lack, 1954). The equilibrium population level is taken to represent the "carrying capacity of the environment", which must, for population stability, remain relatively constant. Lack has postulated that such regulation is brought about by extrinsic factors which act in a density dependent manner (Lack, 1954, 1966). Others have suggested that there is a "self-regulation" of animal populations effected through their social behaviour (Wynne-Edwards, 1962), or through a deterioration in the quality of individuals when the population is increasing and selection is relaxed (Chitty, 1960). Lack (1954) has stated that bird populations are relatively stable, and seabirds in particular are/

are often cited as examples of species whose population levels, remaining at or near the carrying capacity of the environment, are characterised by stability; a low reproductive rate "balances" low mortality rate. There is little evidence to support this notion of stability in seabird populations. The information provided by "Operation Seafarer", a national census of breeding seabirds in Britain and Ireland in 1969, has shown that British seabird populations, during the 20th century at least, are characterised not by stability, but by change. In addition to the Herring Gull, there have beennotable increases in Fulmars, Gannets, Shags, Kittiwakes and Great Skuas; Little Terns, Puffins, Razorbills and Guillemots have decreased (Cramp et al, 1974). The data for other seabird species were insufficient to delineate definite trends, but did not suggest stability. Since historical records are poor, to what extent these changes are a 20th century phenomenon, attributable to the effects of man on the environment, or reflect previously undocumented population changes, is unknown. Such population changes do not however support the contention that seabird populations are "regulated". The relatively long generation time characteristic of most seabird species means that population changes will take place rather slowly. Monitoring only over short time periods will thus tend to give an impression of stability which is apparent rather than real. The concept of stability in animal populations has largely been conjectured rather than corroborated. A stable population requires a stable/

stable environment, but as pointed out by Andrewartha and Birch (1954), the environmental conditions for many species are unstable, and oscillate between being favourable and unfavourable to population growth. When conditions are favourable, rapid population expansions can give rise to "plagues" of a particular species, as occurs for example in red locusts. When, on the other hand, conditions are unfavourable, the population will go into a decline. The Herring Gull population is at present expanding rapidly, and there is no compensatory relationship between reproductive and mortality rates. This increase may have come about through an increase in the reproductive rate, a decrease in the mortality rate, or both. Certain environmental constraints have altered, and conditions at present favour population growth.

If increased food availability has effected the population increase in the Herring Gull, food shortage must hitherto have limited population growth. An increase in the number of Herring Gulls would thus have paralleled an increasing food supply. Alternatively food may at all times have been abundant for Herring Gulls, and the population been limited, by other factors, at a level below that which the available food supply could maintain. It is difficult to assess to what extent food is super-abundant for an animal population, or how near the population size is to a level at which food shortage would limit further population growth. Time spent foraging may give some indication of the abundance of food. Pearson (1968) for example, suggested/

suggested that there was a superabundance of food for 8 species of seabird breeding on the Farne Islands, Northumberland. There was no evidence of any starvation of young and the larger species were found to utilise only a small percentage of the available time foraging; there was a considerable reserve of time which could be utilised should food become less abundant.

Since it has been suggested that an increased amount of refuse and other waste material has been responsible for the increase in the number of Herring Gulls, it is important to consider to what extent there has in fact been an increased food supply to gulls from these sources. Details of refuse production and treatment were obtained from the Report of the Joint Standing Committee on Refuse Treatment and Disposal (1971) and the Fourth Report of the Royal Commission on Environmental Pollution, (Flowers, 1974).

Though the amount of vegetable and putrescible material produced per household has not increased since 1935, there has been an increase in the number of households and thus in the amount of refuse produced. Some 15 million tonnes are collected annually in Britain, 18% of which is vegetable and putrescible matter. There has however been a large increase in the amount of paper and packaging in refuse and it is doubtful if the nutritive quality of refuse has increased as suggested by Davis (1974); on the contrary, the same weight of refuse will contain less food material. The practice of burning refuse in large incinerators (or destructors as they were previously known) has been adopted to varying extents by local authorities in Britain/

Britain and elsewhere for nearly a century. While in some areas there has apparently been a decrease in the amount of refuse incinerated (Hickling, 1967), the recent trend is towards increasing the quantities burned. In County Cleveland, where much of this study took place, 105 thousand tonnes of domestic refuse are incinerated annually, as compared with 45 thousand tonnes which are disposed of by landfill tipping. In the country as a whole however, most refuse is still disposed of by tipping; 90% in 1966/67, with a slight decrease to 86% in 1972/73. Nevertheless, improved tipping methods have greatly decreased the extent to which tipped refuse is available to birds. Controlled tipping was introduced in this country 40 - 50 years ago. This follows certain recognized principles, involving the depositing and compacting of refuse on land in shallow layers, and the covering of exposed surfaces with soil or other material to form a seal. Tipping is now largely carried out under recommendations of the Department of the Environment and themore stringently these recommendations are followed, the less food material available to birds. While these recommendations are not mandatory, only 25% of tipped refuse is still disposed of by a direct uncontrolled tipping method. Thus while there has been some increase in the amount of refuse available to gulls, it seems unlikely that it has in fact been as great as the increasing quantities of refuse produced would suggest. On considering the extent to which the increased quantities have actually constituted an increased food supply to gulls, the Joint Standing Committee on Refuse Treatment and Disposal (1971) stated:/

stated:

> "We are aware of a suggestion that a reported increase in the gull population in Britain could be linked partly, at any rate, with an increase in the quantity of refuse tipped thus making more food available; though undoubtedly there has been an increase in the quantity of refuse tipped over the last 30 years, we do not think this is likely to have had more than a marginal effect".

Harris (1970) also pointed out that there was little evidence of any great increase in the availability of refuse or waste fish to gulls, and suggested that the reverse was possibly true due to increased gutting of fish at sea for freezing and improved waste disposal.

If an increase in the amount of refuse tipped has effected the Herring Gull population increase, it is to be expected that a proportion of the population are in some way dependent upon this food supply.

Though the Herring Gull is generally taken to be largely a scavenging bird, the importance of refuse material in its diet varies greatly in different areas, depending on the availability of other food supplies and the proximity of the birds to urban areas. Much of the data on Herring Gull food supplies relate to the diet during the breeding season; it is difficult to avoid bias in favour of particular feeding sites when sampling the winter food. A review of the food of the Herring Gull is provided by Harris (1965) and Spaans (1971) which reflect the omnivorous character/

character of the diet and the adaptability of these birds. Refuse features in the winter diet of Herring Gulls in many areas (e.g. Spaans, 1971; Kadlec and Drury, 1968; Drury and Nisbet, 1969; Hickling, 1967; Kilhman and Larsson, 1974). However there is much evidence to suggest that refuse does not constitute the only food source of these birds, but serves as a reserve supply largely utilised when conditions elsewhere have deteriorated. Andersson (1970), studying an inland breeding population of Herring Gulls, found that refuse served as a reserve food supply in times of shortage. The amount of feeding on refuse decreased in May, due to the availability of an abundant supply of grain; when the birds were largely unable to obtain fish, refuse and offal were most important. Shaffer (1971) found that Herring Gulls on Walney Island, Cumbria, made extensive use of refuse only when the mussel beds were unavailable. Kilhman and Larsson (1974) found that refuse tips in the Gothenburg area were utilised in winter to a high degree when food elsewhere was not available. When conditions were not restrictive, the archipelago was preferred. Spaans (1971) found that fluctuations in the number of gulls at dumps in Friesland in winter were related to feeding conditions in the Waddenzee area. He did not however feel that this indicated any preference for more "natural" foods, but suggested rather that garbage could not continuously support the larger population of gulls over a prolonged period. Nevertheless, since the number of gulls feeding at tips dropped when feeding conditions elsewhere improved, this indicates a preference, on the part of some birds at/

at least, for the littoral zone. There was no evidence to suggest that these birds were being excluded from the tips or that, when the largest number of gulls were feeding on refuse, there was increased competition for food as would be expected if this constituted an overloading of tips. Pimlott (1952) found that Herring Gulls only fed on fields where fish offal was used as fertilizer in the absence of Herring shoals; the greatest "field offal activity" was correlated with poor weather.

In this study, refuse tips in the Teesmouth area were used during winter predominately by adult birds, the immature Herring Gulls feeding largely at other kinds of feeding sites in the same area. Fluctuations in the number of gulls present at the tips were related to feeding conditions elsewhere and individuals which fed at tips were known also to feed at sea; even those individuals which were most consistent to one tip in the area did not feed at this site every day. On average, only 22% of the adult and 23% of the immature Herring Gulls known to use the tips were present each day. On Sundays, no refuse was dumped at tips in the area, nor was there any appreciable amount of commercial fishing in inshore waters. Thus two food sources used by gulls in the Teesmouth area, fish offal and refuse, were not available on Sundays. The birds using those food sources must either not have fed at all on Sundays, or, as seems more probable, made use of alternative feeding areas. Refuse does not constitute the only, or necessarily the major, food source for gulls in the Teesmouth area.

Lack/

Lack (1966) has suggested that many bird species are regulated in numbers by their food supply outside the breeding season. The contrary opinion has however been expressed by Pearson (1968) and Ashmole (1963), for both British and tropical seabird species respectively.

If by acting as a reserve food supply, refuse tips are increasing the overwinter survival of Herring Gulls, in accordance with Lack's hypothesis, then it is to be expected that, if refuse were not available, certain birds would succumb when feeding conditions elsewhere deteriorated. Alternatively it could be postulated that they would suffer a lowered breeding success in the following season. However, as shown by Spaans (1971), the Herring Gull is well adapted to an irregular food supply and can quickly regain weight lost in times of shortage. Nisbet (1977) reported that, while the amount of refuse being tipped in the U.S.A. has increased, the Herring Gull is undergoing a regional decline. This may be related to the inshore fishing industry which has decreased in those areas where the Herring Gull population is decreasing; in areas where the inshore fisheries have increased or been maintained, the Herring Gull is increasing. There has thus been a re-distribution of the population. It is unlikely that the availability of food outside the breeding season could in any case "regulate" the British Herring Gull population independent of the Scandinavian population since there is considerable mixing of the two during the winter months. If food were limiting at this time, competition between the British Herring Gull and the larger Scandinavian form/

form could result in a decrease in the British population independent of its density. Population growth could therefore be limited by winter food supply, but not regulated. To overcome this difficulty, it is necessary to postulate regulation on a very large geographical scale, for which there is no evidence.

Refuse tips represent a concentrated, easily available and relatively stable food source for gulls. Gulls feeding at tips spend only a small percentage of the available time foraging. If this food source were not available, it does not necessarily follow that the birds would suffer a chronic food shortage; it is probable that longer periods of time would be spent in search of food elsewhere. While there has undoubtedly been some increase in the amount of refuse available to gulls this century, the increasing number of gulls feeding on this food source is a reflection of the population increase in these birds, rather than evidence for a causal relationship. The catholic diet of the Herring Gull suggests that it is adapted to a variable food supply and it is unlikely that the availability of food has in the past been a limiting factor in the population growth of this species. Moreover, in a long lived species such as the Herring Gull in which the annual mortality is very low, starvation as a cause of mortality, if it occurs, must occur infrequently. Lack of predators has been responsible for increases in the numbers of many introduced species, and the introduction of predators has served as a means of biological control. This has been the case both with plant species such as/

as prickly pear in Australia and animal species such as the cottony cushion scale in California (Krebs, 1972). There has been a relaxation of predation on all bird species this century. Prior to 1869, the adults and young of many seabird species were killed in large numbers by man, for sport, for the plumage trade and also for food; large numbers of eggs were also collected. The first act to protect seabirds in Britain was passed in 1869, and was followed by more general bird protection acts between 1880 and 1896. Since then, there has been little predation on the adults, young or eggs of British seabirds by man. Of the seabird species which have increased this century, only the Herring Gull, the Great Black-backed Gull and the Fulmar make extensive use of refuse as a food supply: all have been protected. The dramatic decline in species such as the Little Tern is thought to have been due to the encroachment of man on to its nesting area (Cramp et al, 1974). Similarly, the Herring Gull increases in the Netherlands and in North America date from the introduction of protection (Spaans, 1971; Kadlec and Drury, 1968).

The intrinsic rate of increase in an animal population can be altered by a change in the reproductive rate, the mortality rate or both. (Or of course by immigration or emigration.) Relaxation of predation on the eggs and young of the Herring Gull has increased its reproductive rate; protection of adults and immatures has decreased the mortality. This latter is particularly important/

important in a long lived, iteroparous species; as pointed out by Coulson (1963) a small change in adult mortality can considerably extend the breeding life. A change in annual mortality rate after the first year of life from 10% to 6% extends the average breeding life from 9 to 15 years. If mortality during the first year of life is taken as 17%, age of first breeding 5 years, and each pair presumed to fledge an average of one chick per year, then when the mortality in older age classes is 10% per annum each pair will rear on average 5 young to maturity; when the mortality in age classes older than one year is 6%, 10 young will be reared per pair to maturity. With an annual mortality of 10%, each pair would have to rear 2 young per year on average in order to rear 10 young to maturity. Thus in terms of the number of offspring surviving to breeding age, a 40% change in adult mortality has the same effect as doubling the number of young fledged per pair per year.

At the present time, the Herring Gull population is producing 3 times as many young per year as is necessary for the population to remain stable. There is no evidence to suggest as yet that the population increase has ceased. Such is the success of the non-specialist, whose opportunism enables it to increase when certain limits to population growth are removed.

(2) Control of the Herring Gull

The increase in the number of Herring Gulls in Britain and elsewhere this century has caused a variety of problems, and the/

the Herring Gull has come to be regarded as a pest species. In addition to the health hazards to man and livestock already reviewed, Herring Gulls have been implicated in air strikes (Stables and New, 1968; Brough, 1969; Grant, 1974) and have been reported to oust other nesting birds, particularly terns (Drury, 1965; Thomas, 1972). A review of the different management techniques attempted at "natural" gull colonies in Britain and elsewhere has been provided by Thomas (1972).

While it is true that gulls nesting on rootfops in small numbers often give pleasure to an interested few, it is also true that a large rooftop colony causes considerable disturbance to a very irate human populace. Noise is a major cause for complaint, as is damage to the fabric of buildings. Roofs and pavements become fouled with droppings and downpipes choked with nest debris give rise to unpleasant smells and floodings. The defensive "dive bombing" behaviour also causes considerable disruptions in a town. A variety of methods have been employed in attempts to reduce the number of gulls nesting in towns. These have ranged from the futile, such as hard-boiling their eggs, to the ridiculous, such as tying fireworks at the end of broom handles. Nesting deterents such as wire mesh, spikes, glass, etc. can be effective for the individual householder, but do not serve to remove nesting gulls from the town as a whole. Measures aimed at wintering gulls in the area of a rooftop colony are unlikely to be effective, since this population may not contain sufficient numbers of local breeding birds to make the effort required worth while/

while. Broadcasting alarm calls, as was done in South Shields in 1971, is not only of no avail, but can serve to facilitate colony increase by scattering the nesting birds over the town, and thereby providing more sub-groups for the attraction of recruits. When the colony is small, continued disturbance may cause the birds to abandon the area. However, as the colony increases in size, it becomes more stable, and the birds increasingly more difficult to dislodge. In 1975 and 1976,31 district authorities in Great Britain reported continued complaints from local residents with respect to problems created by gulls nesting on buildings, particularly on hotels and private residences. Nevertheless, there is no recognised policy for removal of these birds, and most control attempts so far employed have met with very little success. Areas where control action has been undertaken are denoted as such in appendices 4 - 7; the fact that the localities at which control attempts have been most intense still support the largest rooftop colonies demonstrates the ineffectiveness of the control measures generally in use. Since gulls will rebuild a nest and lay a replacement clutch, if not in the same year then in the next, and if not in the same site then in another cloee by, control attempts aimed at egg or nest destruction are futile. Moreover, since more than 50% of the recruits into a colony are born in other areas, a local reduction in breeding success will not prevent colony growth. If it is deemed necessary to reduce or remove gulls nesting in towns the solution to the problem lies with the removal of adult birds. It is not/

not necessarily the case that nesting sites on buildings are an unattractive alternative to the traditional sites. Rather, the former often represent relatively safe and secure nesting sites with a correspondingly high breeding success. The presence of successfully breeding adults attracts young birds prospecting for a nesting site. Merely thinning out a town population will thus not serve as a long term control measure. It may in some cases even accelerate colony growth since low density colonies are possibly more accessible to young birds (Chabrzyk and Coulson, 1976). Large scale culling may however have a disruptive effect on recruitment into an area, and effects produced by the continuous extensive culling of gulls on the Forth Islands may be contributing to the high rate of increase in rooftop colonies in Northeast England.

It must be borne in mind that the rooftop nesting Herring Gull population represents only a very small proportion of the breeding population of these birds on British and Irish coasts. These colonies are not discrete populations of breeding birds, and there is considerable inter-colony dispersal. Management policies for Herring Gulls must therefore take into consideration the possible immigration of birds from other colonies into culled areas, and the movement of gulls out of a highly disturbed habitat. As pointed out by Drury and Nisbet (1969), the Herring Gull is adapted to a changing environment, and is thus well equipped to resist or evade control measures.

SUMMARY

1. This study has been concerned with the utilisation of urban resources for feeding and breeding purposes by the Herring Gull. The study has centred on Northeast England, between 1973 and 1976. Individual birds were identified using unique colour-ring combinations.

2. Ringing recoveries show that the population of Herring Gulls overwintering in Northeast England is composed mainly of breeding birds from East Scotland and Norway. The local breeding population is small (ca 1,000 pairs).

3. Immature Herring Gulls from East Scotland and Norway also overwinter in Northeast England, some of which remain throughout the winter months. A proportion of young fledged from the local colonies dispersed south in winter while others remained in the natal area throughout the year.

4. Adult Herring Gulls from breeding localities in Britain were found to be smaller in size than their Norwegian counterparts. British male Herring Gulls overlapped with Norwegian females in wing and bill length but not in bill depth, or summer weight.

5. Bill depth provides the most reliable indicator of sex in gulls where British and Scandinavian birds are known to be present. Birds with bill depths less than 18.4 mm were females.

6. Wing length gives a good indication of geographical origin when the sex of a Herring Gull is known. Of birds captured in Britain wing lengths greater than 415 mm in females and 435 mm in males indicate birds of Scandinavian origin.

7. Gulls fed at refuse tips in the study areathroughout the winter months. Adults departed from the area with the onset of the breeding season in late January and early February returning to the area in late August and September.

8. Gulls coming to feed at Whitton tip (17 km inland) arrived early in the morning and remained there throughout the day. The birds roosted at night in the Teesmouth estuary.

9. The expected ratio of adult to immature Herring Gulls as calculated from life table data was 48% adults and 52% immatures. The observed ratio at refuse tips was 80% adults and 20% immatures.

10. Eighty per cent of the Herring Gulls feeding around inshore fishing boats in the study area were immatures.

11. The number of gulls present at the tips was consistently low on Sundays, when no refuse was dumped.

12. There was considerable fluctuation in the numbers of gulls present at the tips on different weekdays, which was not due to a shifting of gulls from one tip to another.
The relative fluctuation in numbers did not differ between adults and immatures.

13. The number of adults present at Whitton tip was found to be significantly related to early morning wind direction at the night roost; the numbers were greater when the wind was offshore rather than onshore. The number of immature gulls present was significantly related to the success of inshore fishing boats on the day prior to counting at the tip.
The number of immatures present at the tip dropped as fish catch on the previous day increased.

14. Fewer colour-ringed immatures were seen again at tips in the study area after release than adults. Considering those birds which were seen again, immatures were seen less often than adults.

15. The majority of adult Herring Gulls showed constancy to the study area and returned to this wintering area in consecutive years, though breeding elsewhere.

16. Immature Herring Gulls moved between tips more than adults, and adult females more than adult males.

17. Individual Herring Gulls did not feed at refuse tips every day. On average 22% of the adults and 23% of the immatures which used the tip were present on any one day.

18. There were two different feeding areas on the refuse tips; a main feeding area on which food was concentrated and abundant, and a secondary feeding area on which food material was more spread out. The secondary feeding area was available to birds for longer periods than was the main area.

19. Individual birds spent between 10 - 17% of their time at the tip engaged in feeding activities.

20. Individual birds consistently fed on one of the two feeding areas. Proportionally more adult females were found to use the secondary area than males.

21. Refuse did not consitute the only or necessarily the major food source for gulls in the study area.

22. The utilisation of rooftops as nesting areas by Herring Gulls in Sunderland and South Shields was studied from 1974-1976. Each of these towns supports in the region of 200 nesting pairs.

23. The number of pairs of Herring Gulls present in South Shields increased by 23% between 1974 and 1975, and 40% between 1975 and 1976. In Sunderland the number of nesting pairs in the town overall increased by 17%

between 1974 and 1975. Culling measures undertaken in both towns prevented further increases in the number of pairs which nested, but did not effect any real decrease.

24. From the numbers of ringed Herring Gulls breeding in South Shields and Sunderland, it appears that the Forth Islands are a major source of recruits into rooftop gull colonies in North east England Twice as many breeding females as males were identified as having been fledged from the Isle of May, Firth of Forth.

25. Herring Gull rooftop nests are most commonly found on commercial and residential properties; industrial sheds are extensively used by nesting gulls in Sunderland and in the Bristol Channel area.

26. The breeding success of gulls in towns during this study was on average between 1.2 - 1.6 young fledged/pair. This is higher than that recorded in "natural" colonies, and may be due to the nature of the nesting sites.

27. A national census of gulls nesting on buildings in Britain and Ireland was organised in 1976 as a B.T.O. enquiry. A minimum of 2968 pairs of Herring Gulls were reported nesting on buildings in 92 localities in 1976: the number of nesting pairs has been increasing at 17% per annum since 1969.

28. The rate of formation of new Herring Gull rooftop colonies was 9.3% per annum and has remained at this level since about 1940. The rate of desertion of rooftop colonies is decreasing while the average colony size increases, and desertion is more likely when only 1 or 2 nesting pairs are involved.

29. When examined on a regional basis, rooftop nesting Herring Gulls were found to be increasing most rapidly in East Britain (29% per annum) while those in Southeast England are increasing least rapidly (6% per annum). A difference in the number of potential recruits into those two areas is suggested as a possible reason for this disparity.

30. Between 2 - 6% of Herring Gulls subjected to pathological analysis were found to be voiding Salmonella organisms in their faeces. These birds can also carry Ornithosis agent. These organisms cause disease in man, and gulls nesting on rooftops may constitute a potential public health hazard.

REFERENCES

Altman, J. (1974). Observational study of behaviour: sampling methods. Behaviour 49: 227-267.

Amadon, D, (1943). Bird weights as an aid in taxonomy. Wilson Bull. 55: 164-177.

-- (1958). The encroachment of Herring Gulls on more desirable seafowl in eastern United States. VII Bull of ICBP: 113.

Anderson, J.P. (1974). Ornithosis in Somerset. Postgrad. med. J. 49: 533-534.

Andersson, A. (1970). Food habits and predation of an inland-breeding population of the Herring Gull Larus argentatus in Southern Sweden. Ornis Scand. 1: 75 - 81.

Andrewartha, H.G. and Birth, L.C. (1954). The distribution and abundance of animals. University of Chicago Press, Chicago.

Andrews, C.H. and Mills, K.C. (1943). Psittacosis (Ornithosis) virus in English pigeons. Lancet 1: 292-94.

Ashmole, N.D. (1963). The regulation of numbers of tropical oceanic birds. Ibis 103B: 458-73.

Bacon, A.P.C. (1953). Psittacosis. Two further human cases. Lancet 2: 376-378.

Bailey, N.T.J. (1959). Statistical methods in Biology. English Universities Press Ltd., London.

Baldwin, S.P. and Kendeigh, S.C. (1938). Variations in the weight of birds. Auk 55: 416-467.

Barth, E.K. (1966). Mantle colour as a taxonomic feature in Larus argentatus and Larus fuscus. Nytt Mag. Zool. 13: 56-82.

-- (1967). Standard body measurements in Larus argentatus, L. fuscus, L. canus and L. marinus. Nytt Mag. Zool. 14: 7 - 83.

-- (1975). Moult and Taxonomy of the Herring Gull Larus argentatus and the Lesser Black-backed Gull L. fuscus in Northwestern Europe. Ibis 117: 386-387.

Baxter, E.V. and Rintoul, L.J. (1953). The birds of Scotland, Vol.2. Oliver and Boyd, Edinburgh.

Bedson, S.P. (1930). Observations on the aetiology of Psittacosis. Lancet 1: 235-236.

Belopol'skii (1961). The ecology of sea colony birds of the Barents Sea (IPST 125). Jerusalem.

Bennet, G.H. (1976). The Zoonoses Order. R. Soc. Hlth J. 96: 19 - 20.

Bergman, G. and Koskimies J. (1958). Statement on the Herring Gull in Finland. VII Bull ICBP: 111.

Bourne, W.R.P. (1971). Feather wear in Guillemots. British Birds 64: 236.

Brough T. (1968). Recent developments in bird scaring on airfields. In "The problems of birds as pests". Ed. R.K. Murton and E.N. Wright. Academic Press, London.

-- (1969). Damage by gulls. Ibis 111: 445-446.

Brown, R.H. (1945). Herring Gull feeding independant young. British Birds 38: 217-218.

Brown, R.G.B. (1967). Breeding success and population growth in a colony of Herring and Lesser Black-backed Gulls Larus argentatus and L. fuscus. Ibis 109: 310-317.

Buxton, A. (1957). Salmonellosis in animals. Review Series No. 5, Commonwealth Agricultural Bureaux, England.

Bruyns, M.F.M. (1958). The Herring Gull probelm in the Netherlands. VII Bull of ICBP: 103-7.

Chabrzyk G. and Coulson, J.C. (1976). Survival and recruitment in the Herring Gull Larus argentatus. J. Anim. Ecol. 45: 187-203.

Chitty, D. (1960). Population processes in the vole and their relevance to general theory. Can. J. Zool. 38: 99-113.

Chitty D. and Southern, H.N. (1954). Control of rats and mice. Oxford University Press, London.

Christensen, P.M. (1957). Ornithosis. Acta path. et microb. Scand. Suppl. 118.

Cole, H.A. and Holden, M.J. (1973). History of the North Sea Fisheries. In "North Sea Science", Ed. E.D. Goldberg Colonial Press Inc. U.S.A.

Conder, P.J. (1953). Some individual feeding habits of gulls breeding on Skokholm. Skokholm Bird Observatory Report for 1952: 30-34.

Cornwell, P.B.(1966). Control of house sparrows with a-chloralose. Int. Pest Control 8: 10-13.

Coulson, J.C. (1963). The status of the Kittiwake in the British Isles. Bird Study 10: 147-179.

Cramp, S. (1971). Gulls nesting on buildings in Britain and Ireland. British Birds 64: 476-87.

Cramp S., Bourne, W.R.P. and Saunders, D. (1974). The seabirds of Britain and Ireland. Collins, London.

Crook, J.H. (1953). An observational study of the gulls of Southampton Water. British Birds XLVI: 385-397.

Croze, H. (1970). Searching image in carrion crows. Z. Tierpsychol. Beih. 5: 1-85.

Curio, E. (1976). The ethology of predation. Springer-Verlag N.Y.

Curry-Lindhahl, K. (1961). Våra Fåglar i Norden. Stockholm.

Darling, F.F. (1938). Bird flocks and the breeding cycle. Camb. Univ. Press, Cambridge.

Darlington, A. (1969). Ecology of refuse tips. Heinemann, London.

Davis, B.D. (and others) (1967). Microbiology. Hoeber, London.

Davis, J.W.F. (1973). Aspects of the breeding ecology and feeding of certain gulls. Unpubl. D. Phil Thesis. University of Oxford.

-- (1974). Herring Gull population and man. Nature in Wales 14: 85-90.

-- (1975a). Variations in the number of Herring Gulls at a feeding site. Nature in Wales 14: 234-240.

-- (1975b). Specialisation in feeding location by Herring Gulls. J. Anim. Ecol. 44: 795-804.

Deusing, M. (1939). The Herring Gulls of Hat Island, Wisconsin. Wilson Bull. 51: 170-175.

Drinnan, R.E. (1957). The winter feeding of the oyster catcher (Haematopus ostralegus) on edible cockle. J. Anim. Ecol. 26: 439-469.

Drost, R. (1938). Geschlechtsunterschiede am Schnabel der Silbermowe, Larus argentatus Pont. Orn.Monatsh. 46: 129-131.

-- (1958). The Herring Gull problem in Germany. VII Bull of ICBP: 108-11.

Drost, R., Focke, E. and Freytag, G. (1961). Entwicklung und Aufbau einer Population der Silbermowe Larus argentatus argentatus. J. Orn. 102:404-429.

Drury, W.H. (1964). Results of a study of Herring Gull populations and movements in southeastern New England. Colloque: Le problème des oiseaux sur les aérodromes (Nice, 1963) Paris: Inst. Nat. Rech. Agron.

-- (1965). Gulls vs Terns. Clash of coastal nesters. Mass. Audubon 49: 207-211.

Drury, W.H. and Smith, W.J. (1968). Defense of feeding areas by adult Herring Gulls and intrusion by young. Evolution 22: 193-201.

Drury, W.H. and Nisbet, I.C.T. (1969). Strategy of management of a natural population: the Herring Gull in New England World Conf. on bird hazards to aircraft. Nat. Res. Council, Kingston, Ontario: 441-454.

Drury, W.H. and Nisbet, I.C.T. (1972). The importance of movements in the biology of Herring Gulls in New England. In "Population Ecology of Migratory Birds: A symposium" U.S. Dept. Interior Wildl. Res. Rept. 2: 173-212.

Drury, W.H. and Kadlec, J.A. (1974). The current status of the Herring Gull population in the northeastern United States. Bird-Banding 45: 297-306.

Dunnet, G.M. and Anderson, A. (1961). A method for sexing living Fulmars in the hand. Bird Study 8: 119-126.

Durham County Bird Rept. (1971). No. 35. New Series, No.2.

Eaton, M.D., Beck, D. and Pearson, H.E. (1941). A virus from cases of atypical pneumonia. J. exp. Med. 73: 641-654.

Eddie, B. and Francis T. (1942). Occurrence of Psittacosis-like infection in domestic and game birds of Michigan. Proc. Soc. exp. Biol. and Med. 50: 291-5.

Elton, C. (1927). Animal ecology. Methuen, London.

Faddoul, G.P., Fellows, G.W. and Baird, J. (1966). A survey on the incidence of salmonellae in wild birds. Avian Dis.10: 89-94.

Fennel, H., James, D.B. and Morris, J. (1974). Pollution of a storage reservoir by roosting gulls. Water Treatment and Examination. 23: 5.

Fisher, R.A. (1921) Metron 1:3.

Fisher, J. (1952). The Fulmar. Collins, London.

Fisher, J.M.M. and Lockley, R.M. (1954). Sea-birds. Collins, London.

Flowers, B. (1974). 4th Rept. Royal Comm. on Envir. Poll. H.M.S.O. (Cmnd 5780). London.

Fretwell, S. (1968). Dominance behaviour and winter habitat distribution in Juncos (Junco hyemalis). Bird-Banding 40: 1-83.

Gauger, H.G. and Greaves, R.E. (1946). Poult. Sci. 25: 476.

Gibbs, A. (1962). The bird populations of rubbish dumps. London Bird Rept. 1962: 104-110

Goethe, F. (1958). Anhäufungen unversehrter Muscheln durch Silbermöwen. Natur und Volk 88: 181-187.

-- (1961). Zur taxonomie der Silbermöwe (Larus argentatus) in südlichen deutschen Nordseegebiet. Vogelwarte 21:1-24.

-- (1964). Lenkung der Mowenbestande an der deutschen Nordsee. Int. Rat. Vogelschutz Deutche Sektion, 4: 53-7.

Grant, D.R. (1969). The dispersion of gulls in the Lothians. Unpubl. M.Sc. Thesis, University of Edinburgh.

-- (1974). Gull movements as a hazard to aircraft. Bird Study 21: 169-179.

Grant, P.J. (1971). The wing tip patterns of gulls. British Birds 64: 285-287.

Gross, A.O. (1940). The migration of Kent Island Herring Gulls. Bird-Banding 11: 129-155.

Haagen, E. and Mauer, G. (1939). Die Psittakose in Deutschland. Deutsche med Wschr. 20: 808-809.

Harbourne,J.F.(1955). The isolation of *Salmonella gallinarium* in wild birds. J. comp. Path. 65: 250-254.

Horder, T. and Gow, A.E. (1930). Psittacosis: a record of nine cases with special reference to the morbid anatomy of two of them. Lancet 1: 442-445.

Harris, M.P. (1964). Recoveries of ringed Herring Gulls. Bird Study 11: 183-191.

-- (1964b). Aspects of the breeding biology of the gulls *Larus argentatus*, *L. fuscus* and *L. marinus*. Ibis. 106: 432-456.

-- (1965). The food of some *Larus* gulls. Ibis 107: 43-53.

-- (1970). Rates and causes of increases of some British Gull populations. Bird study 17: 325-335.

-- (1971). Ecological adaptations of moult in some British gulls. Bird Study 18: 113-118.

Harris, M.P. and Hope Jones, P. (1969). Sexual differences in the measurements of Herring and Lesser Black-backed Gulls. British Brids 62: 129-33.

Hickling, R.A.O. (1967). The inland wintering of gulls in England, 1963. Bird Study 14: 104-113.

Hofslund, P.B. (1959). Fall migration of Herring Gulls from Knife Island, Minnesota. Bird-Banding 30: 104-114.

Holley, A.J.F. (1970). Some aspects of rearing the young in *Larus* gulls at Steart Island - an interim report. Bristol Ornithology 3: 100-117.

Houston, A.C. (1909). 3rd Rept. Res. Wtr. Bd., London.

Ingolfsson, A. (1969). Sexual dimorphism of large gulls (Larus spp). Auk 86: 732-737.

Johansen, O. (1977). Reproduction and reproduction problems of some Laridae species in western Norway, including chemical pollution. Paper presented to conf. "The Changing Sea-bird Populations of the North Atlantic", Aberdeen University.

Kadlec, J.H. (1964). The effect of amplified sounds on movements of Herring Gulls. Prog. Rept. (Unpubl.) U.S. Fish and Wildlife Service.

-- (1976). A re-evaluation of mortality rates in adult Herring Gulls. Bird-Banding 47: 8-12.

Kadlec, J.A. and Drury, W.H. (1968). Structure of the New England Herring Gull population. Ecology 49: 644-676.

Kauffman, F. (1966). The bacteriology of Enterobacteriaceae, Munksgaard, Copenhagen.

Kennedy, P.G., Ruttledge, R.F. and Scroope, C.F. (1954). The birds of Ireland. Oliver and Boyd, Edinburgh and London.

Kilhman, J. and Larsson, L. (1974). On the importance of refuse dumps as a food source for wintering Herring Gulls Larus argentatus Pont. Ornis Scand. 5: 63-70.

Korns, R.F. (1955). Psittacosis in ducks and persons exposed to ducks. In "Psittacosis. Diagnosis, Epidemiology and Control", Ed. F.R. Baudette, Rutgers Univ. Press.

Krebs, C.J. (1972). Ecology. Harper and Row, London.

Krebs, J.R., Ryan, J.C. and Charnov, E.L. (1974). Hunting by expectation or optimal foraging. Anim. Behav. 22: 953-964.

Lack, D. (1954). The natural regulation of animal numbers. Clarendon Press, London.

-- (1966). Population studies of birds. Clarendon Press, Oxford.

Lairusson, O.O. and Guttermaussan, E. (1939). In "The Fulmar", Fisher, J. 1952, Collins, London.

Lee, J.A. (1974). Recent trends in human salmonellosis in England and Wales: the epidemiology of prevelant serotypes other than Salmonella typhimurium. J. Hyg., Camb. 72: 185-195.

Lindroth, S. (1946). Eh bidrag till frågan om gråtrutens (Larus argentatus Pontopp.) ställning som marin relikt i våra insjöar. Vår Fågelrärld 5: 97-114.

Lloyd, B. (1945). Herring Gulls feeding independant young British Birds 38: 39-40.

Lloyd,D.E.B. (1968). The use of inland habitats by gulls (Larus spp) in the Ythan Valley, Aberdeenshire. Unpubl. M.Sc. Thesis, University of Aberdeen.

Ludwig, J.P. (1963). Return of Herring Gulls to natal colony. Bird-Banding 34: 68-72.

McCoy, J.H. (1962). The isolation of Salmonellae. J. appl. Bact. 25: 213.

-- (1963). Salmonellae in crude sewage, sewage effluent and sewage-polluted natural waters. Int. J. Air Wat. Pollut. 7: 597-611.

-- (1976). Salmonella infections of man derived from animals. R. Soc. Hlth J. 96: 25-30

McCoy, J.H. and Spain, G.E. (1969). Bismuth Sulphite media in the isolation of Salmonellae. In "Isolation Methods for Microbiologists" Ed. Shapton D.A. and Gould, G.W. Academic Press, London.

McDiarmid, A. (1962). Diseases of Free-living wild animals. F.A.O., Rome.

MacDonald, J.W. and Brown, D.D. (1974). Salmonella infection in wild birds in Britain. Vet. Rec. 94: 321-2.

MacDonald, J.W., Everett, M.J. and Maule, M. (1968). Blackbirds with Salmonellosis. British Birds 61: 85-87

MacRoberts, M.H. and MacRoberts, B.R. (1970). The Gulls of Walney Island. Nat. Hist. (J. Amer. Mus.) 79: 64-69.

Mair, N.S. and Ross, A.I. (1960). Survival of Salmonella typhi-murium in the soil. Monthly Bull. Minist. Hlth (Lond.) 19: 39-41.

Manowski S. (1971). The influence of meteredlogical factors on the behaviour of sea birds. Acta Zool. Cracoviensia XVI: 582-667.

Matthiesen, M. and Volkert, M. (1956). Serological diagnosis of ornithosis: a serological follow-up of 163 patients. Dan. med. Bull. 3: 245-247.

Meyer, K.F. (1942). The ecology of psittacosis and ornithosis. Medicine, 21: 175-206.

-- (1959). Some general remarks and new observations on Psittacosis and Ornithosis. Bull. Wld. Hlth Org. 20: 101-119.

Meyer, K.F., Eddie, B., Yanamura H.Y. (1942) Ornithosis (Psittacosis) in pigeons and its relation to human Pneumonitis. Proc. Soc. Exp. Biol. and Med. 49: 609-615.

Meyer, K.F. and Eddie, B. (1953). Characteristics of a Psittacosis viral agent isolated from a turkey. Proc. Soc. Exp. Biol. and Med. 83: 99-101.

Miles, J.A.R. and Schristaviv, J.B. (1951). Ornithosis in certain seabirds. J. Anim. Ecol. 20: 195-200.

Mitchell, J.R. and Ridgewell, T. (1971). The frequency of Salmonellae in wild ducks. J. Med. Microbiol. 4: 359-361.

Morange, A. (1895). De la Psittacose, ou infektion speciále determinée par des perruchés. These de Paris.

Muller, G. (1965). Salmonella in bird faeces. Nature, 207: 1315.

Murton, R.K., Isacson, A.J. Westwood, N.J. (1963). Capturing wood pigeons with α-chloralose. Ann. Appl. Biol. 52: 271-293.

Neilsen, B.B. (1960). Salmonella typhi murium carriers in Seagulls and Mallards as a possible source of infection to domestic animals. Nord. Vet.-Med. 12: 417-424.

Nicholson, A.J. (1933). The balance of animal populations. J. Anim. Ecol. 2: 132-178.

Nisbet, I.C.T. (1967). Migration and moult in Pallas's Grasshopper Warbler. Bird Study 14: 96-103.

-- (1977). Gulls in the western Atlantic. Paper presented to conf. "The Changing Sea-bird Populations of the North Atlantic". Aberdeen Univ.

Olsson, V. (1958). Dispersal, migration, longevity and death causes of Strix aluco, Buteo buteo, Ardea cinerea and Larus argentatus. Acta Vertebrata. 1: 91-189.

O'Meara, M. (1975). Building nesting Herring Gulls (Larus argentatus Pontoppidan) in Co. Waterford. Irish Nat. J. 18: 152-153.

Paludan, K. (1951). Contributions to the breeding biology of Larus argentatus and Larus fuscus. Vidensk. Medd. Dansk naturh. Foren. 114: 1-128.

Parslow, J.L.F.(1967). Changes in status among breeding birds in Britain and Ireland. British Birds 60: 177-202.

Parsons, J. (1971). Cannabalism in Herring Gulls. British Birds. 64: 528-537.

-- (1971). The breeding biology of the Herring Gull (Larus argentatus). Unpubl. Ph.D. Thesis. University of Durham.

-- (1976). Nesting density and breeding success in the Herring Gull Larus argentatus Ibis 118: 537-546.

Paynter, R.A. (1949). Clutch-size and the egg and chick mortality of Kent Island Herring Gulls. Ecology 30: 146-166.

Pearson, T.H. (1968). The feeding biology of sea-bird species breeding on the Farne Islands, Northumberland. J. Anim. Ecol. 37: 521-552.

Pienkowski, M.W. and Minton, C.D.J. (1973). Wing length changes of the Knot with age and time since moult. Bird Study 20: 63-68.

Pimlott, D.H. (1952). The economic status of the Herring Gulls of the Gran Manan Archipelago, New Brunswick, 1949. Wild Life Man. Bull. Series 2, (5).

Pinkerton, H. and Swank, R.L. (1940). Recovery of virus morphologically identical with Psittacosis from Thiamin-deficient pigeons. Proc. Soc. Exp. Biol. N.Y. 45: 704-706.

Pohl, P. and Thomas, J. (1968). Salmonella in starlings. Ann. Med. Vet. 112: 704-11.

Pollard, M. (1955). Psittacosis in seashore birds. In "Psittacosis: DiagnosisEpidemiology and Control". Ed. F.R. Baudette, Rutgers Univ. Press.

Prater, A.J. (1970). The variation of the weights and wing lengths of Blackbirds at Rye Meads. 5th Rept. of the Rye Meads Ringing Group: 16-24.

Rasmussen, R.K. (1938). Ueber eine durch Sturmvögel übertragbare Lungenerkrankung auf den Färöern. Zentra Cbl. Bakt. (Abt. 1) 143: 89-93.

Rept. of the Joint Standing Comm. on Refuse Treatment and Disposal 1971. H.M.S.O. London.

Rept. on Bird Ringing (1972). Supplement to Bird Study, Vol. 21: 1974. Ed. R. Spencer and R. Hudson.

Ritter, R. (1880). Deutsch. Arch. Klin. Med. 25: 53.

Roubakine, A. (1930). Month. Epidemiol. Rep. Health Section League of Nations No. 9.

Royama, T. (1970). Factors governing the hunting behaviour and selection of food by the Great Tit (Parus major L) J. Anim. Ecol. 39: 619-668.

Rubin, H. (1954). A disease in captive egrets caused by a virus of the Psittacosis-Lymphogranuloma venereum group. J. Infect. Dis. 94: 1-8.

Salomonsen F. (1963). Oversigt over Danmarks fugle. Munksgaard. København.

Savage, W.G. and White P.B. (1923). Rats and Salmonella group bacilli. J. Hyg. 21: 258-261.

Schater, J., Storz, J., Tarizzo, M.L. and Bogel, K. (1974). Chlamydia as agents of human and animal diseases. Bull. Wld Hlth Org. 49: 443-449.

Schrieber, R.W. (1968). Seasonal population fluctuations of Herring Gulls in central Maine. Bird-Banding 39: 81-106.

Sharrock, J.T.R. (1976). The atlas of breeding birds in Britain and Ireland. B.T.O. Herts.

Shaffer, L.C. (1972). Aspects of specialisation in the feeding behaviour of gulls and crows. Unpubl. D. Phil. Thesis, University of Oxford.

Siegel S. (1956). Non parametric statistics for the behavioural sciences. McGraw Hill and Kogakusha, Tokyo.

Smadel, J.E. (1945). A new virus disease of pigeons. J. exp. Med. 81: 385-397.

Snedecor, G.W. and Cochrane, W.G. (1971). Statistical Methods. Iowa State University Press, Iowa.

Snoeyenbus, G.H., Morin, E.W. and Wetherbee, D.F. (1967). Naturally occurring Salmonella in Blackbirds and Gulls. Avian Dis. 11: 642-646.

Sørensen, P.M. (1955). Ugeskr. Laeg 117: 1152.

Spaans, A.L. (1971). On the feeding ecology of the Herring Gull Larus argentatus Pont. in the northern part of the Netherlands. Ardea 59: 75-188.

Spaans, M.J. and Spaans, A.L. (1975). Some data on the breeding biology of the Herring Gull Larus argentatus on the Dutch Frisian Island of Terschelling. Limosa 48: 1-39.

Spärk, R. (1951). The Food of North European Gulls. Proc.10th Orn. Congr. 1950: 588-591.

Spain, G.E. (1974). Comparison of the feeding habits of different gull populations from a bacteriological viewpoint. Unpubl. Rept. to Open University.

Stables E.R. and New, N.D. (1968). Birds and Aircraft. In "The Problems of Birds as Pests". Ed. R.K. Murton and E.N. Wright. Academic Press, London.

Steiniger, F. (1956). The biology of free-living Salmonellae in the Western Mediterranean. Zent. f. Bakt 166: 245-65. Abst. Bull. Hyg.32: 276.

-- (1965). Salmonellas in birds in the area of the "Vogel-fluglinie" Zent. f. Bakt 197: 210-23. Abst. Bull Hyg. 42: 331.

-- (1967). Salmonellae in an epizootic among seabirds on Scharhorn. Arch. Hyg. Bakt 151: 265-78. Abst. Bull. Hyg. 43: 1643.

-- (1970). Transport of micro-organisms by migratory birds between Europe and South Africa, in relation to bird ringing and disinfection. III Pan African Ornithol. Cong. Pretoria 1969.

Stewart, I.F. (1963). Variation of wing length with age. Bird Study 10: 1-9.

Taylor, J. (1968). Salmonella in wild animals. Symp. Zool. Soc. Lond. 24: 51-73.

Thomas, C.J. (1972). A review of gull damage and management methods at nature reserves. Biol. Conserv. 4: 117-127.

Thomson, S. (1954). The number of bacilli harboured by enteric carriers. J. Hyg., Camb. 52: 67-70.

Tinbergen, N. (1953). The Herring Gull's World. Collins, London.

-- (1959). Comparative studies of the behaviour of gulls (Laridae): a progress report. Behaviour 15: 1-70.

Treuting, W.L. and Olson, B.J. (1944). An epidemic of a severe pneumonitis in the Bayou region of Louisiana. Publ. Hlth Rep. 59: 1299-1320.

Van Dorssen, C.A. (1935). Salmonella typhi-munium-infectie bijeen kleine zeemeeun (Larus canus) Tijdschr. Diergeneesk. 62: 1263-1264.

Vermeer, K. (1963). The breeding ecology of the Glaucous-winged Gull (Larus glaucescens)on Mandarte Island, B.C. Occ. Papers of B.C. Prov. Mus. 13: 1-104.

Vernon, E. and Tillet, H.E. (1974). Food Poisoning and Salmonella Infections in England and Wales, 1969-1972. Publ. Hlth London. 88: 225-235.

Voous, K.H. (1960). Atlas of European Birds, Elsevier, Amsterdam and Brussels.

Wagner, E. (1884). Deutsche Arch Klin Med. 30: 190.

Ward, P. and Zahavi, A. (1973). The importance of certain assemblages of birds as "information-centres" for food finding. Ibis 115: 517-534.

Watts, P.S. (1951). 13th Rept. Inst. Med. and Vet. S. Australia. Vet. Path Section.

Weyer, F. and Lippet, H. (1956). Study of pigeon ornithosis in Germany. Z.Hyg.Infectkrankh.143: 223-246.

Williams, B.M., Richards, D.W., Lewis, J. (1976). Salmonella infection in the Herring Gull (Larus argentatus) Vet. Rec. 98: 51.

Wilson, J.E. and MacDonald, J.W. (1967). Salmonella infection in wild birds. Br. vet. J. 123: 212-219.

Witherby, H.F., Jourdain, F.G.R., Ticehurst, N.F. and Tucker, B.W. (1940). The Handbook of British Birds. Witherby, London.

Wuthe, H.H. (1973). Salmonella in a breeding colony of Black-headed Gulls. Berl. Münch. tierärztl Wschr. 86: 225-256.

Wynne-Edwards, V.C. (1962). Animal dispersion in relation to social behaviour. Oliver and Boyd, Edinburgh.

Zichis, J. and Shaughnessy, H.J. (1954). Isolation of an apparently new virus from two fatal pneumonia cases. Science 102: 301.

APPENDIX 1

Measurements of Great Black-backed Gulls

Parameter	Age	Date Measured	No. Measured	Place	Mean	S.Deviation	S.Error
Weight	Adult	Sept. 1976	39	Scarborough	1787.1	293.4	47.5
Weight	Adult	Nov. 1974	18	Whitton	1658.6	188.3	44.3
Weight	Adult	Dec. 1974	16	Whitton	1797.0	165.8	41.4
Weight	Immature	Sept. 1976	11	Scarborough	1468.3	196.2	59.1
Weight	Immature	Nov. 1974	6	Whitton	1703.0	217.9	88.9
Weight	Immature	Dec. 1974	4	Whitton	1739.3	-	-
Bill Depth	Adult	Sept. 1976	39	Scarborough	24.4	1.7	0.3
Bill Depth	Immature	Sept. 1976	11	Scarborough	21.3	1.3	0.4
Bill Length	Adult	Sept. 1976	39	Scarborough	61.9	4.1	0.7
Bill Length	Immature	Sept. 1976	11	Scarborough	59.5	4.0	1.2
Wing Length	Adult	Dec. 1974	16	Whitton	493.3	16.8	4.1
Wing Length	Immature	Dec. 1974	4	Whitton	501.0	-	-
Moult Score	Adult	Sept. 1976	39	Scarborough	31.1	6.8	1.1

APPENDIX 2

Criteria used to age Herring and Great Black-backed Gulls

1. HERRING GULL

Herring Gulls were classified into age categories using the following winter plumage characteristics.

(1) 1st year

Bill: black

Body: head, neck, mantle, back and underparts mottled brown/buff; no grey body feathers.

Tail: tail feathers tipped white with broad black/brown subterminal band.

Wings: primaries black/brown, some mottling on inner primaries; secondaries and wing coverts mottled brown.

In the field identified as basically an overall mottled brown bird with a black bill and distinguished from immature Great Black-backed Gulls by virtue of the smaller size of the former and its darker neck and underparts.

(2) 2nd year

Bill: black

Body: head, neck and underparts whiter with less mottling than 1st year bird; mantle and back with varying amounts of blue-grey and mottled brown feathers.

Tail: broad black/brown subterminal band still evident.

Wing: outer primaries black/brown, varying amounts of brown/buff and grey mottling on inner primaries; secondaries and wing coverts with varying amounts of/

of mottling, but paler than 1st year.

In the field, distinguished from first year bird by much paler colouration and presence of some blue-grey body feathers. Distinguished from immature Great Black-backed Gull by virtue of smaller size of the former and presence of blue-grey colouration.

(3) <u>3/4th year</u>

Bill: Brownish - flesh coloured, varying amounts of yellow colouration.

Body: basically white head and neck with brown streaks similar to adult winter plumage; underparts white; back and mantle basically blue-grey.

Tail: generally white, with varying amounts of brownish mottling.

Wing: primaries blackish, but absence of prominent wing mirrors as found in adult; secondary wing coverts mottled brown.

In field, distinguished from adult by bill colouration, a prominent mottling on secondary wing coverts and absence of obvious wing mirrors. No attempt was made to distinguish between 3rd and 4th year birds on the basis of plumage characteristics.

(4) <u>Adult</u>

Bill: prominent yellow colour.

Body: head and neck streaked brown, underparts white, back and mantle blue-grey.

Tail: white

Wing: blackish primaries, obvious wing mirrors (amount of wear variable); secondaries and wing coverts blue-grey. Absence of any obvious brown mottling.

2. GREAT BLACK-BACKED GULL

(1) Immatures

Basically mottled blackish brown/buff birds were classified as immatures; this included 1st and 2nd years.

(2) Adults

All birds with obvious dark mantle were classified as adults; included 3rd and 4th year birds.

APPENDIX 3

Counts of adult and immature Herring Gulls at refuse tips in the Greater Boston and Gloucester areas of New England. Immature refers to birds 1 - 3 years. (Supplied by Dr. W.H. Drury, Mass. Audubon Soc.)

Year	Month	Location	% Adults	% Immatures	No.Counts
1962	Nov.	Boston: Coleman's Dump	89	11	7
	Dec.	"	91	9	3
1963	Jan.	"	97	3	2
	Feb.	"	81	19	1
1962	Nov.	Cambridge Dump	90	10	6
	Dec.	"	96	4	4
1963	Jan.	"	98	2	1
	Feb.	"	95	5	2
	Mar.	"	88	12	3
1962	Sept.	Everett, Mystic Dump	65	35	10
	Oct.	"	64	36	5
	Nov.	"	88	22	5
	Dec.	"	87	13	3
1963	Jan	"	98	2	4
	Mar	"	92	8	3
1962	Nov.	S. Roxbury Dump	81	19	6
	Dec.	"	93	7	5
1963	Jan	"	95	5	3
	Feb.	"	80	20	3
	Mar.	"	93	7	1
1962	Sept.	W.Roxbury Dump	54	46	5
	Oct.	"	54	46	4
1963	Mar.	"	88	12	1
1964	Sept.	"	75	25	5
	Oct.	"	75	25	2
	Nov.	"	84	16	1
1962	Sept.	Sagus, clam dump	58	42	10
	Oct.	"	73	27	5
	Nov.	"	86	14	7
	Dec.	"	86	14	6
1963	Jan.	"	92	8	4
	Feb.	"	87	13	3
	Mar.	"	90	10	3
1962	Sept.	Sagus, commercial dump	55	45	10
	Oct.		82	18	5
	Nov.	"	91	9	6
	Dec.	"	89	11	6
1963	Jan.	"	90	10	4
	Feb.	"	92	8	2
	Mar.	"	91	9	3

APPENDIX 3 (Contd)

Year	Month	Location	% Adults	% Immatures	No.counts
1964	Feb.	Sagus: commerical dump (+ Daggits)	94	6	3
	Sept.	"	76	24	4
	Oct.	"	84	16	2
	Nov.	"	97	3	3
	Dec.	"	93	7	1
1962	Sept.	Daggit's dump	56	44	10
	Oct.	"	80	20	5
	Nov.	"	76	24	5
	Dec.	"	89	11	6
1963	Jan.	"	92	8	3
	Feb.	"	88	12	1
	Mar.	"	91	9	3
1962	Sept.	Gloucester, Fishpier	95	5	11
	Oct.	"	96	4	6
	Nov.	"	95	5	7
1963	Jan.	"	96	4	3
	Feb.	"	97	3	2
	Mar.	"	94	6	2
1964	Sept.	"	82	18	2
	Oct.	"	93	7	2
	Nov.	"	92	8	1
	Dec.	"	90	10	1
1962	Sept.	Boston Fish pier	75	25	10
	Oct.	and others	63	37	5
	Nov.	"	85	15	7
1963	Jan.	Boston Fish pier	91	9	3
	Feb.	" and others	90	10	2
	Mar.	"	91	9	3
1964	Jan.	"	21	79	1
	Feb.	" "	85	15	4
	Mar.	"	91	9	1
	Sept.	"	80	20	6
	Oct.	"	71	29	2
	Nov.	Boston Fish pier	84	16	3
	Dec.	"	81	19	4

APPENDICES 4 - 8

Notation:

+	following total	=	more than
+	alone	=	prospecting birds only reported

Control of gulls:

* no organised clearance attempted but wide usage of nesting deterrents and some removal of nests and eggs.

** organised clearance, involving local authority. Extensive use of nest deterrents, egg and nest control measures, some culling of adults and/or chicks.

APPENDIX 4

1969 and 1976 counts available for rooftop Herring Gull colonies in existence in 1969

LOCATION	1969	1970	1975	1976	CONTROL
Northumberland					
Berwick on Tweed & Tweedmouth,	2			33	
Tyne & Wear					
North Shields & Tynemouth	2+			42	**
South Shields	25			209	**
Sunderland	10			189	**
Cleveland					
Hartlepool	8-11			27	
North Yorkshire					
Staithes		3		78	*
Runswick	2			0	
Whitby	97			200+	**
Robin Hoods Bay	3+			30	
Scarborough	4			120	**
Greater London					
London	1			5+	
Kent					
Kingsgate, Ramsgate & Broadstairs	27			110+	
Canterbury	1 – 3			1	
Dover	c. 225			150+	**
Folkestone & Cheriton	1			20	
Hythe	nesting			nesting	
East Sussex					
Hastings & St Leonards	126			198	*
Bexhill	nesting			10+	
Dorset					
Swanage	1			?	
Wyke Regis & Weymouth	1			'several'	

LOCATION	1969	1970	1975	1976	CONTROL
Devon					
Beer	5			?	
Budleigh Salterton	10-15			10+	
Torquay		1		40	**
Paignton		1+		30	
Brixham	22+			31	
Thurlestone	2			?	
Bigbury-on-Sea	2			?	
Teignbridge	nesting			nesting	
Cornwall					
Looe	2			?	
Polruan		11		?	
Mullion		3		?	
Helston (Culdrose RN Stn)		100		?	
Marazion	nesting			4	
Newlyn		48		102	*
Mousehole	1			45	*
St Ives	c. 40			?	
Newquay	189			?	
Gwent					
Chepstow	6		8		
Newport	100		61		
South Glamorgan					
Cardiff	45		425		
Mid Glamorgan					
Hirwain	67		66		
Dyfed					
Pembry	50-60			0	
Carmarthen	9-15			0	
Gwynedd					
Holyhead	2			0	
Conway	40-50			92-101	
Deganwy	nesting			11	
Llandudno		20+		c.150	**
Rhos-on-Sea		5		1	

LOCATION	1969	1970	1975	1976	CONTROL
Isle of Man					
Douglas	1			?	
Port St Mary		1		?	
Port Erin		1		?	
Dumfries & Galloway					
Stranraer	1			0	
Strathclyde					
Kilmarnock	2+			3+	
Shetland					
Lerwick	4-5			6+	
Highland					
Inverness	2+			3+	
Nairn	1			9	*
Grampian					
Lossiemouth	c. 8			1	
Aberdeen	1			1	
Tayside					
Arbroath	3-4			0	
Dundee	3-6			9+	
IRELAND					
Waterford					
Dunmore East	5			12	*

APPENDIX 5

Counts for rooftop Herring Gull colonies established since 1969

LOCATION	1976	CONTROL
Northumberland		
Blyth	nesting	
Tyne & Wear		
Newcastle upon Tyne	19	
North Yorkshire		
Filey	5	
Filingthorpe	1	
Kent		
Margate	20	
Ashford	+	
East Sussex		
Eastbourne	23	
Brighton	13	**
Hove	nesting	
West Sussex		
Worthing	+	
Dorset		
Burton Bradstock	23	*
Bridport	3	
West Bay	nesting	*
Bothenhampton	nesting	*
Charmouth	3	
Lyme Regis	nesting	*
Devon		
Honiton	+	
Sidmouth	+	
Exeter	nesting	
Dawlish	5	
Shaldon	nesting	
Teignmouth	20+	
Babbacombe	4	
Exmouth	nesting	
Ilfracombe	1	

x.

LOCATION	1976	CONTROL
Cornwall		
Torpoint	+	
Penzance	nesting	
Perranuthnoe	+	
Lelant	1	
Hayle	nesting	
Carbis Bay	nesting	
Somerset		
Yeovil	nesting	
Bridgewater	nesting	*
Burnham-on-Sea	2	
Avon		
Bath	+	
Bristol	54	**
Portishead	10-20	
Gloucestershire		
Gloucester	60	*
South Glamorgan		
Penarth	+	
Barry	6+	
Rhoose	4	
Mid Glamorgan		
Pontypridd	+	
Merthyr Tydfil	8	
West Glamorgan		
Port Talbot	82	
Dyfed		
Tenby	nesting	
New Quay	+	
Gwynedd		
Barmouth	nesting	
Caernarvon	3	
Bangor	+	

LOCATION	1976	CONTROL
Clwyd		
Old Colwyn	5	
Colwyn Bay	1	
Merseyside		
Heswall	nesting	
West Kirby	1	
Cumbria		
Barrow-in-Furness	3	*
Isle of Man		
Peel	1	
Highlands		
Fortrose	1	
Fife		
Dunfermline	nesting	
Borders		
St Abbs	8	*
Eyemouth	14	
IRELAND		
Dublin		
Dublin City	2+	
CHANNEL ISLANDS		
Jersey	1	

APPENDIX 6

1969 and 1976 counts available for rooftop Lesser Black-back colonies in existence in 1969

LOCATION	1969	1970	1975	1976	CONTROL
East Sussex					
Hastings & St Leonards	1			1	
Gloucestershire					
Gloucester	7			80	*
Gwent					
Newport	10		9		
South Glamorgan					
Cardiff		23-24	156		
Mid Glamorgan					
Hirwain	c. 17		14		

APPENDIX 7

Counts for rooftop Lesser Black-back colonies established since 1969

LOCATION	1975	1976	CONTROL
Tyne & Wear			
South Shields		2	**
Sunderland		3	**
Newcastle		1	
Durham			
Durham City		+	
South Glamorgan			
Barry	14		
Mid Glamorgan			
Merthyr Tydfil	5		
Avon			
Bath		15-20	
Bristol		18+	
Gwynedd			
Llandudno		+	
Cumbria			
Barrow-in-Furness		+	

APPENDIX 8

Negative records for Herring and Lesser Black-backed Gulls

ENGLAND

Bedfordshire

Whole County

Berkshire

Whole County

Buckinghamshire

Whole County

Cambridgeshire

Whole County

Cheshire

Whole County

Cleveland

Hart Station, Hartlepool Headland, Seaton Carew, Graythorp, Greatham, Southern housing estates and western suburbs of Hartlepool, Middlesborough.

Cornwall

Portwinkle, Cawsand, Millbrook

Derbyshire

Whole County

Durham

No nesting records (but Lesser Black-backs prospecting in Durham City)

Essex

Whole County

Greater London

Heathrow Airport, Hatton Cross (central area)

Hampshire

Whole County

Hereford and Worcester

Whole County

Isles of Scilly

Whole County

Kent

Maidstone, Clatham, Rochester, Gillingham

Lancashire North

North of River Ribble - including Lancaster, Wyre, Blackpool, Fylde and Preston Districts

Leicestershire

Whole County

Lincolnshire

Whole County

Norfolk

Whole County

Northamptonshire

Whole County

Northumberland

Coastal area from Seahouses to Alnmouth

Nottinghamshire

Whole County

Oxfordshire

Whole County

Salop

Whole County

Staffordshire

Whole County

Surrey

Whole County

Sussex East

North of Hastings Borough boundary to Rye, Cooden Beach to Pevensey

Sussex West

Bognor Regis, Littlehampton, Selsey

Tyne & Wear

Gateshead, Jarrow

West Midlands

Whole County

Wiltshire

Whole County

Yorkshire North

Inland areas, Whernside to York

Yorkshire South

Whole County

WALES

Clwyd

Rhyl

Dyfed

Pembroke Dock, Pembroke, Borth, Aberystwyth, Aberdaeron

Gwynedd

Porthmadog, Abersoch, Pwllheli, Criccieth, Nefyn, Penmaenmawr, Llanfairfechan

Powys

Brecknock District

SCOTLAND

Central

Whole County

Dumfries & Galloway

Whole County

Grampian

Burghead, Hopeman

Highland

Isle of Skye

Coastal area from Kylestrome to Shiegra

Orkney

Whole County

Tayside

Perth and Kinroos District

IRELAND

Northern Ireland

APPENDIX 9

Index of Specific Names of Animals Mentioned in the Text

Vertebrates

Australian Magpie	Gymnorphina tibicen
Black Headed Gull	Larus ridibundus
Blackbird	Turdus merula
Carrion Crow	Corvus corone corone
Common Gull	Larus canus
Common Tern	Sterna hirundo
Fox	Vulpes vulpes
Fulmar	Fulmar glacialis
Gannet	Sula bassana
Glaucous Gull	Larus hyperboreus
Glaucous-winged Gull	Larus glaucescens
Great Black-backed Gull	Larus marinus
Great Skua	Stercorarius skua
Greenfinch	Carduelis chloris
Guillemot	Uria aalge
Heron	Ardea cinerea
Herring Gull	Larus argentatus
Jackdaw	Corvus monedula
Junco	Junco hyemalis
Kittiwake	Rissa tridactyla
Lesser Black-backed Gull	Larus fuscus
Little Tern	Sterna albifrons

Appendix 9 (Contd.)

Oyster-catcher	Haematopus ostralegus
Pied wagtail	Motacilla alba
Rabbit	Oryctolagus cuniculus cuniculus
Razor bill	Alca torda
Rook	Corvus frugilegus
Sea eagle	Haliaetus vocifer
Shag	Phalacrocorax aristotelis
Sparrow (House)	Passer domesticus
Starling	Sturnus vulgaris

<u>Insects</u>

Cottony Cushion Scale	Icerya purchasi
Red Locust	Nomadacris septemfasiata

Appendix 10

(1) Statistics used in this study were based on methods outlined by Snedecor and Cochrane (1971), Bailey (1959) and Siegel (1956).

(2) Computer Programmes used were as follows:

(a) Discriminant analysis: Statistical Packages for the Social Sciences, Version 6.

(b) Stepwise Regression: Biomedical Computer Programs (BMDO2R)

Additional variables used in (b) above which were statistically insignificant were:

Wind speed on day prior to counting (log. value)

Wind speed early in the morning of the day on which counts were made (log. value)

Wind direction on day prior to counting (0 = onshore, 1 - offshore)

State of the tide in the early morning at the roost site (coded with respect to the amount of shore covered at 07.00 GMT)

Air temperature on the day prior to counting

Rainfall on the day prior to counting

Month in which counts were made

Early morning visibility.